PLANNING AND MANAGEMENT FOR STORMWATER AND SULLAGE IN ENVIRONMENTALLY VULNERABLE INFORMAL LOW INCOME URBAN COMMUNITIES: A CASE STUDY OF DARAJA MBILI, KISII MUNICIPALITY, KENYA

BY

JOHN-SUIT NTABO MOGENI, B.A.(Hons) Nairobi.

A thesis submitted in partial fulfilment of the requirement for the Degree of Master of Arts (Planning) in the Department of Urban and Regional Planning, University of Nairobi.

October, 1996

DECLARATION

I declare that this thesis is my original work and has not been presented for a degree in any other University.

John Suit Mogeni Ntabo
(candidate)

This thesis has been submitted for examination with my approval as University supervisor.

Dr. I.Karanja Mwangi
(Supervisor)

ABSTRACT

This study was carried out in Daraja Mbili within Kisii municipality and concerns environmental consequences of uncontrolled stormwater and sullage in environmentally vulnerable quasi-legal urban low income settlements. These settlements are more often than not found in environmentally vulnerable area like flood plains or steep slopes. In putting up a new dwelling the urban squatter is constrained by income, inaccessibility to sustainable land and urban planning laws. Thus, most policies of development agencies on urban development operate outside the scope of squatter settlement needs.

Severe environmental degradation has accompanied the increasing pressure on such environmentally vulnerable areas. This situation magnify the vulnerability of the urban poor to a broad array of environmental problems and natural disasters. In this context, there was conclusive evidence derived from the study showing that environmental problems faced by the residents of Daraja Mbili are attributable to three factors; the low socio-economic status of the residents, whose way of life encourage disposal of sullage and stormwater in a way that is harmful to their own health. This has come about in terms of unsanitary disposal methods and lack of environmental health infrastructure like stormwater drains. The second factor was the nature of the topography in the area. The steep slopes have encouraged soil erosion by the stormwater. This comes about due to increased water runoff velocities caused by steep slopes of Nyanchwa hill

that have had their vegetation cover reduced over the years. Poor farming methods on Nyanchwa hill resulted to replacing natural vegetation with pasture crops. The pasture crops do not encourage stormwater infiltration.

ACKNOWLEDGEMENT

It is the custom for an author to acknowledge those who contributed to the development of his work. While I am extremely conscious of this indebtedness, unhappily, I am unable to make this awareness specific by naming the many persons who have given assistance.

Particular gratitude, however, go to the Ministry of Lands and Settlement for sponsoring me for this programme, the Department of Urban and Regional Planning, for the moral support they gave me. I would also like to thank the Government of Kenya for guaranteeing permission to carry out the research.

I am deeply indebted to the Department of Survey, Kisii District and the District Statistics Office for making available to me maps and data on Kisii urban centre.

Special thanks go to my supervisor, Dr. I.K. Mwangi for the guidance and assistance he offered me during the various stages of the study.

I would also like to express my sincere gratitude to all my field research assistants, especially Eric Bisonga and John Misoka for agreeing to walk me the length and breadth of Daraja Mbili to administer the questionnaire.

However, all the academic sins of omission and commission that may be detected in this work should, however, be attributed to the author and not to the persons mentioned above.

DEDICATION

Dedicated to my parents Samuel Ntabo and Teresa Nyaberi. Thank you for your inspiration and support with deepest regards and affection.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF PLATES

ABBREVIATIONS

EUDTP: Environmental and Urban Development Training Programme

KWAP: Kenya woodfuel and afforestation programme

CHAPTER ONE

THE INTRODUCTION

1.1 Introduction

The management of storm water and sullage is for healthy urban settlements[1]. The potential for socio-economic benefits to be derived from urban storm water and sullage management are huge. They include improved health and quality of life in low income urban settlements.

Urban areas devoid of any effective management practices suffer from lack of the improvement, especially during period of intensive rainfall when flooding of low lying areas occur and landslides on steep slopes resulting from denudation of these hilly land which has no protective vegetation cover. The flood water combine forces with sullage to damage the houses and other infrastructure like roads and lower areas.. The health of those living in flooded areas is affected more adversely. Vector borne diseases such as malaria, filariasis and yellow fever become more common as flood waters provide ground for disease vector to live in and reproduce more rapidly. Diarrhoeal diseases also increase and malaria, a major killer disease and geohelminth infections become endemic (UNCHS/Habitat, 1991).

Urban communities living in low income settlements have a very poor health profile, and their productivity is correspondingly low. Storm water and sullage management, then,

---

[1] Sullage is all domestic waste water originating from sources other than the wet core and include waste domestic water.

is essential in urban planning and development. Storm water management also increases the value of land by making developed land habitable by more people who can pay for its development. These benefits alone are economic justification for storm water and sullage management.

Drainage systems in Africa, South America and Southeast Asia have generally evolved from natural systems passing through significant changes as land uses change from low density village settlements gradually to higher densities of urban population. The systems in most instances combine functions of drainage of storm water runoff with the disposal of sullage generated from residential, commercial and industrial buildings. The result is a combined system which is designed to cope with the effluent. More importantly the sewerage systems have no capacity to accommodate the dry weather flows which have low velocities of flow. This leads velocities of flow in flat graded channels or pipes with attendant problems to the settlement of solids, resulting to odour and corrosion in the flat graded channels.

Urban development in these areas is usually not guided and controlled. As the settlement grow and the net incomes of populations increase existing drainage become obsolete leading to diversifying of sullage from conventional systems to a separate foul water sewerage system, popularly called "green water channels".

1.2 Conceptual Background

The concept of human settlements is very broad, encompassing every area of human activity and habitat. Some define human settlements from a physical point of view. Others define settlements from a systematic perspective. From the physical point of view human settlements are the places where human activities occur, whether a tented camp, a village,or scattered places of abode in the rural areas. Specifically, human settlements are the organized spaces regardless of their density and level of infrastructure provision (Ramachandran, 1983).

Nyamu (1983) defines human settlements from a systematic point of view as "part and parcel of the total environment, both natural and man-made". He has suggested that human settlements are there to satisfy social, political and economic needs of man. Conventional settlements or nodes of human activity attract more people to look for shelter there and this give rise to communities and a system of human settlements.

While squatter clearance was being undertaken in Kenya and other countries in Africa, Asia and South America, a new orthodoxy was gaining ground among academicians. Squatter mode of settlement was being eulogized by Turner (1963, 1969) and Mengin (1967). Turner and Mengin showed that a squatter is not a temporary migrant, socially deviant or a revolutionary individual. Instead, a migrant is a long-term urban resident with middle-class aspirations trying to build a house for his family using his own labour.

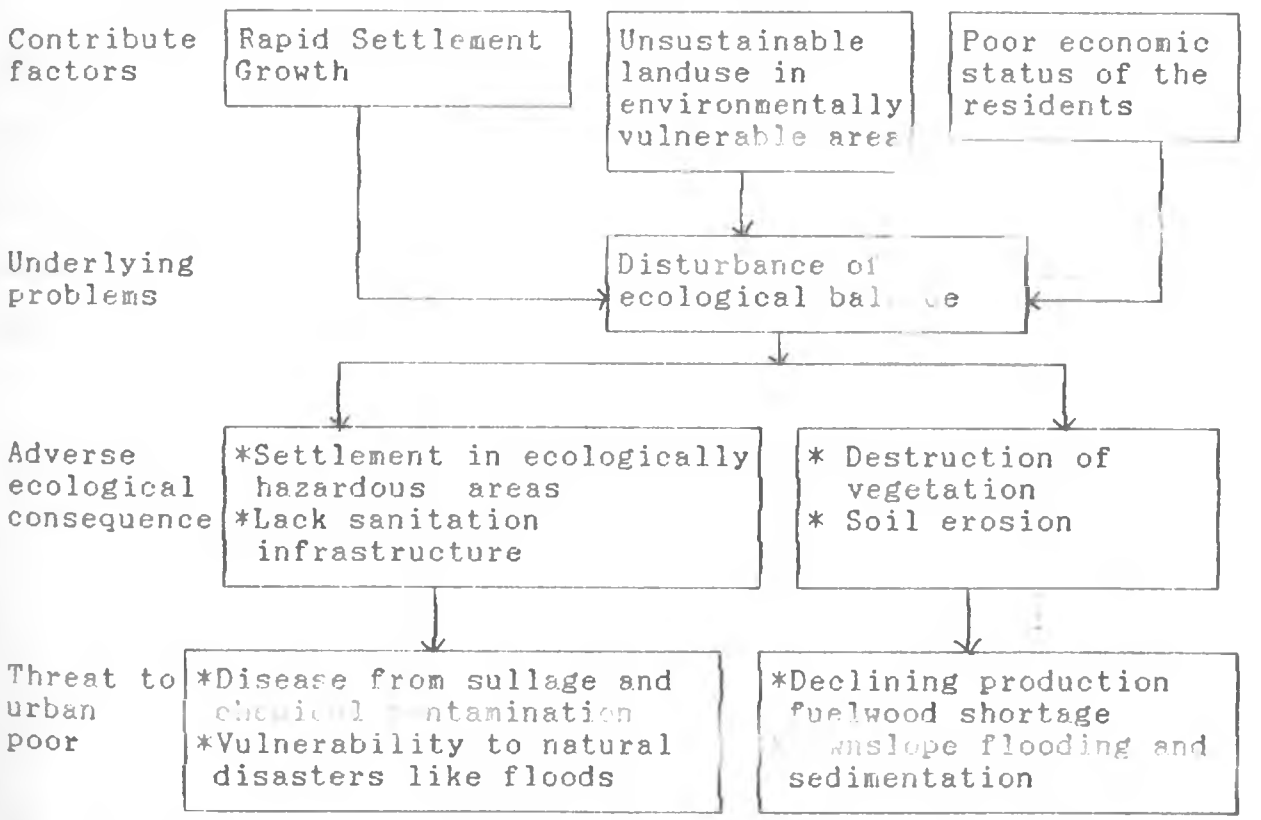
The squatter is free to build a shelter that suit one's own taste according to what one can afford with local building materials but without relying on large construction firms. This line of argument sees the squatter as a hero of self determination and squatter settlements are seen, less as a problem, but more as a solution for a basic need provision. In creating a new dwelling the urban squatter is constrained by, income, inaccessibility to land and urban planning laws. Most policies of Governments and development agencies on urban development operate outside the scope of low income people who make bulk of squatters in urban areas. Interventions that these policies implement become impediments and not solutions for the urban environmental problems and shelter needs in urban areas.

Here in Kenya in 1980, the World Bank persuaded the Government to allow squatter settlements remain in place, also persuaded the government to improve them. During the second urban project the Government of Kenya in 1977 proposed that Mathare Valley, Ruaraka, and Riruta in Nairobi; Chaani in Mombasa; and Manyatta, Nyalenda, and Pandperi in Kisumu should be improved by providing conventional piped water, a sewerage network, storm water drainage system, refuse collection service and access roads. Since that time, the government was committed to the improvement of urban squatter settlements and the settlements have undergone substantial evolution. Today (1990s) squatter settlements are recognized as areas of human abode in the urban areas. These settlements however, need constant

evaluation and Daraja Mbili in Kisii municipality is such settlement requiring a study to evaluate the environmental problems affecting the living standards of the residents.

Figure 1.1 is a presentation scheme and it depicts the relationship between the economic status of the urban poor and their environment. Factors that contribute to the situation they find themselves in, the underlying problems to the ecology of the area they inhabit, the possible consequences that arise from settling in ecologically vulnerable areas and possibilities to affect the health of the inhabitants shown in the figure.

Figure 1.1: The connection between Poverty and Environmental problems in low income areas in cities.



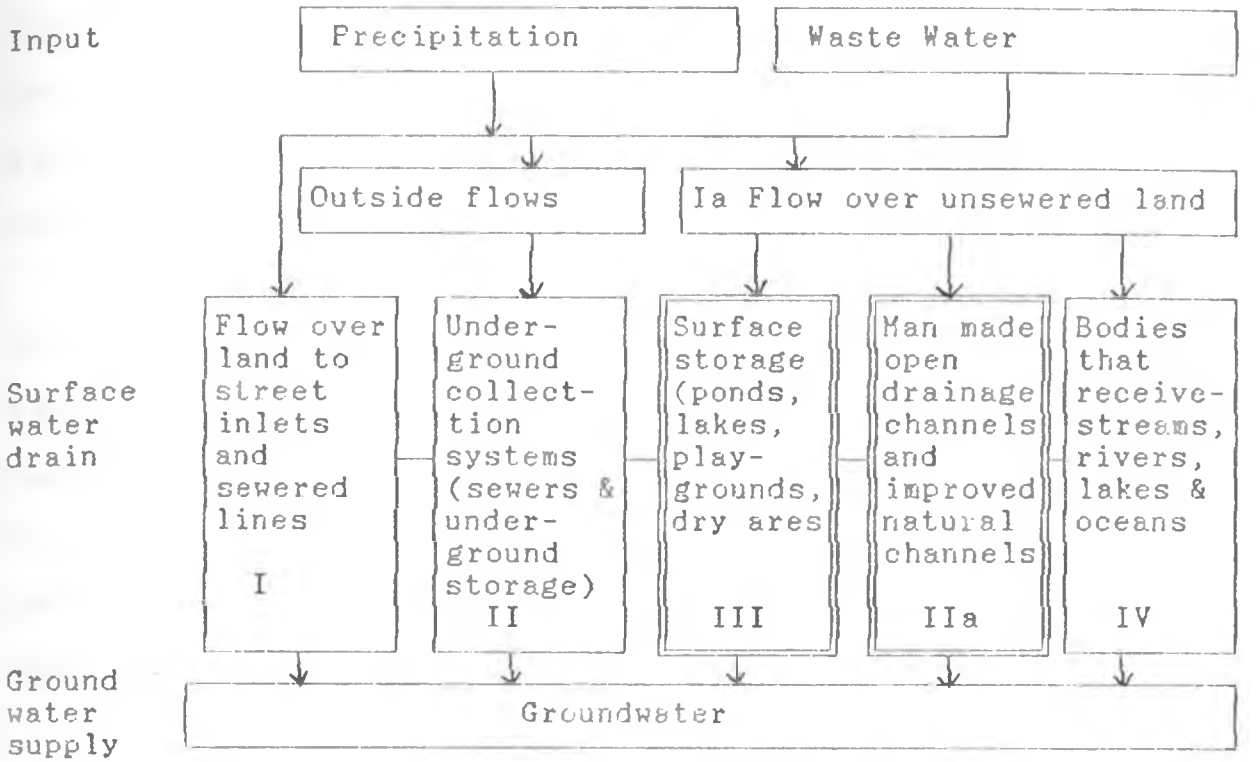
Source: *Modified from Environment and the Poor: Development Strategies for a Common Agenda (Leonard, J.H. 1989, Transaction Books).*

A large number of the poorest households in urban areas cluster in makeshift, ramshackle dwelling units. The shortage of affordable land and the high economic rents make land inaccessible. Life at peripheral urban areas is often characterized by hazardous natural and man-made ecological conditions. Often these adverse ecological conditions make the vulnerability of the urban poor to be more vulnerable to a abroad array of sanitation problems, notably waterborne diseases and natural disasters such as floods and soil erosion.

1.2.1 Conceptual Background of Urban Storm Runoff

Urban drainage system is an array or assemblage of subsystems characterised by three basic subsystems; surface runoff, transport through sewer and major drainage facilities, and storage processing reactors. The three subsystems are represented in figure 1.2 below in sectors marked I and Ia, II and IIa and IV respectively.

Figure 1.2: Subsystems Of Urban Water Disposal



(Evapotranspiration negligible during precipitation)
Source: Oyebande, I. (1990) pp. 63.

The surface subsystem may consist of discharge from catchment areas, tributary sewer inlets as well as flow over unsewered land in Ia in figure 1.2 above. Each catchment is characterised by the extent of the area, its imperviousness, hydraulic roughness, slope and coefficients related to water quality.

In urban areas in Africa, most areas that are impervious are not sewered. The ratio of impervious areas may reach 30 percent, but often not more than 10 percent of this is connected to existing sewer system and thus contribute to surface runoff regime. The flow eventually reach surface storage, natural and manmade channels or receiving bodies of water, often after resulting in local flooding.

The transport system is made up of drainage works for conveying storm water from all inlets in the system through a network of storm channels to a point of disposal, wrong sizing of pipes conveying water from inlets or from detention storage ponds result in flooding of the area surrounding the ponds.

The channels or drains get clogged up with garbage during the dry season. During the rainy season, running water gradually removes these impediments from the channels increasing the flow conditions drastically to higher densities. The receiving water subsystems are of diverse forms. They include streams, rivers, lakes, estuary lagoon or ocean. The discharge of storm water is expected to have impact on the quality of the receiving water.

1.3 Research problem

1.3.1 General Trend

Cities in Africa, Southeast Asia and Latin America are experiencing increases in population growth. Estimated growth rates averaged 4 percent. This growth adds 45-50 million to urban areas each year (Grimes, 1976). This trend will add an estimated total population of 600 million by the year 2000 in urban area of these regions. According to Grimes, this has resulted from large-scale rural to urban migration and natural growth of population. The consequence of this urbanization trend in Africa, Asia and South America is increase in the number of urban poor. This number is estimated at 300 million and is expected to rise to a half a billion by 1999 (Pouliquen, 1991).

The rapid urbanization in these regions has caused shortage of shelter and ultimately slums and squatter settlements. Further environmental degradation has brought pressure to bear on these environmentally vulnerable areas. Problems such as waterborne diseases, urban floods and soil erosion are some of the environmentally related planning issues that need to be addressed as they cause poverty. Anti-poverty solutions are therefore intertwined with environmental improvement strategies.

Sullage which is domestic waste water from sources except wet core, is freely discharged on to the ground surface. This waste find its way into existing natural channels which are a common feature in slum and squatter urban communities. The result of this flow of sullage on unprotected channels is unpleasant odours during the dry periods. During rain season the channels drain storm water. Often, there are instances of flooding which lead to soil erosion, erosion of roads and footpaths and sanitation facilities. The flood water is also a hazard as it often find its way into residential units, at times leading to collapse of the structures.

1.3.2 Situation in Kenyan Cities

In Kenya, there are considerable economic gains that have been made since 1963 (Kenya, 1994). However laws relating to environmental sanitation have not been enforced effectively. In the urban centres, there are many unregulated slum and squatter settlements. The settlements are a response to inadequate

provision of low income housing schemes and distorted patterns of regional economic development which favour the more affluent residential areas.. Areas that were once thought unhabitable are now habited by urban poor. These areas are located on inadequately drained areas that are either on flat, steep slopes abandoned quarry sites. Nairobi's mathare Valley and Daraja Mbili within Kisii municipality are examples of urban communities in kenya affected by these factors (Kenya, 1986 and Duchhart, 1988).

Demand for low income shelter in urban areas is large. Households living in these areas cannot afford to pay market rates for the improvement of physical and social infrastructure. These two factors are constraints for solutions to poverty and environmental problems in Kenyan cities like Mombasa and Nairobi.

Local governments are entrusted with the task of providing most physical infrastructure and services but their resource and institutional capacities are weak. Their resource base is weak and the major sources of funds are from service charge and cess. So governments have ignored the needs of slum and squatter settlement communities. Because of weak capacity, the ability of local authorities to plan and manage growth and development of Kenyan cities is limited. Examples include Nairobi whose garbage problem has grown out of control. Open spaces left for recreation and service lanes are the most common areas where waste has accumulated. This has led to the degradation of the urban environment.

Maintenance of existing sullage and storm water drainage is therefore difficult in the face of uncollected and rotting garbage which has also found its way into these channels leading to blockage and clogging. It is therefore common now to experience flooding even with the shortest rainfall, and burst sewer lines are common as discharge into the system is beyond their planned capacity. Once again, this is common feature in all Kenyan cities (Obudho, 1987).

It is recognised that governmental agencies are the lead agents in provision of sullage and storm water drainage system and other societal factors which will also play a role in improving the urban environment in Kenya (Kenya, 1986). These factors include inter alia the level of education, income levels in relation to food they can access and to recreation and more importantly awareness on public health and environmental sustainability. Linking environmental conservation and promotion of health with economic and social development in Kenya's low income urban settlements communities will help in their contribution to environmental improvement.

The location of squatter settlements on poorly drained sites on steep slopes and valley bottoms, and the densities associated with squatter settlement leave little space for sanitary disposal of sullage.

1.3.3 Daraja Mbili in Kisii municipality

We have examined the research problems in much broad way earlier. This is the background to the environmental problems for which data was collected and analyzed for the study in Daraja Mbili in Kisii municipality.

Kisii town, where the case study area is found, is one of the middle level towns in Kenya with a population of 44,000 and a population growth rate of about 3.98 per annum (Kenya, 1994). This high population growth rate has had the effect of exerting pressure on existing shelter. Consequently, slums and squatter areas have emerged in various parts of the town. Daraja Mbili is one such area. Daraja Mbili is located about two kilometres from the central business district of Kisii town. The site on which Daraja Mbili is located is the northern slope of Nyanchwa hill within Kisii municipality (Haeringen, 1988). The low economic status of the town has limited financial resources for provision and improvement of sanitation infrastructure. The extent of the neglected sanitation especially storm water and sullage management important.

One reason for the neglect of sullage and storm water drainage system by Kisii Municipal council in Daraja Mbili is the feasibility of projects for the town centre and other higher income residential areas like Milimani and the ability of the middle income urban residents to pre-empt both the local authority's attention and funds. The inhabitants of Daraja Mbili are not capable of paying for the installation of a

drainage system. This is because they have low incomes and the settlement is quasi-legal. Such that informal nature of the settlement has been used as the reason why Kisii municipal council does not provide services to the community. Consequently each household in the community has to meet its own basic drainage needs (Kenya, 1971 and Kenya, 1983).

Storm water and sullage management are key to sustainable life at Daraja Mbili where the monthly average rainfall received is 1957 mm. This high average rainfall results to high runoff rate because the steep slope which has no vegetation cover make infiltration difficult. The vegetation has been cleared to put up shelter. And in Nyanchwa hill use of poor farming systems has led to more storm runoff. This has made the area unsuitable for settlement development unless there is rehabilitation because of the high risks of soil erosion. At the present time the establishment of an efficient waste and storm water drainage is necessary (Duchhart, 1988).

Daraja Mbili site was allocated to Luo and Nubia community in 1939. At present time, the area has attracted more people. The implication for more people coming to live in Daraja Mbili's steep slope characteristics, is lack of conventional sewer systems, and storm water drainage channels and vegetation cover at Nyanchwa hill affect living conditions.

The increased settlement on steep sections has led to clearing of vegetation leaving the ground bare and vulnerable to runoff. During heavy rains, top soil is being washed away.

The environmental situation described above has led to deterioration of the environment and the liveability of the place. The people themselves are victims and contributors to the state of the environment. These problems were studied to come up with alternative strategies to manage the environment.

1.4 Study Objectives

The overall objective of the study is to suggest sustainable alternatives to minimize environmental degradation.

This general objective will be achieved through four specific objectives which are:

(i). To find out the relationship between socio-economic processes and organization on the one hand, and problems of sullage and storm water management.

(ii). To describe the relationship between landuse activities in various landscape units with environmental problems in Daraja Mbili.

(iii). To find linkage between environmental problems linked to lack of adequate sullage and storm water drainage provision with a view to suggesting management strategies to contain them.

[v]. To suggest planning and management strategies and/or methods for a sustainable environmental and economic processes in view of objectives i to iv.

1.5 Research questions

The above objectives and the research problem described earlier is addressed in the context of the following five research questions:

(i). How is the socio-economic processes and organization of the community in Daraja Mbili contributed to poor management of sullage and storm water drainage?

(ii). What linkage exists between landuse activities in various landscape units and environmental degradation factors?

(iii). What environmental problems experienced in the community are linked to lack of adequate sullage and storm water drainage within the settlement?

(iv). What is the Municipal Council of Kisii and the local community in Daraja Mbili doing to manage the economic and environmental problems experienced in the community?

(v). Is existing policy for managing environmental degradation in environmentally vulnerable areas such as informal settlements effective?

1.6 Justification

A thorough understanding of the roots of environmental problems is the base on which effective environmental planning and management policies can be built. The promotion of a good environment in such informal urban settlements is dependent upon operational waste and storm water drainage system. Livable environment will contribute to local economic and social

development, and can be easily achieved if considered integral part of the planning and upgrading of squatter settlements. In Kisii town limited supply of low income housing has led to areas with steep slopes and environmentally vulnerable like Daraja Mbili being settled (Haeringen, 1988). These people who have settled on the steep sloping landscape the usually high rainfall Kisii Highlands have exposed the area to environmental degradation which comes about due to excessive soil erosion caused by sullage and storm water. Also the high population density in the study area has outstripped the capacity of the available sullage and storm water drainage.

United Nations has recognized that provision of drainage for sullage and storm water is essential for safeguarding environmental health and promotion efficient operation of squatter settlements (UN, 1986)[2]. This study is on health in low income settlements. The study also sought to identify the role played by the socio-economic processes and organization of the community in environmental degradation in environmentally sensitive area such as Daraja Mbili.

It is an imperative to have drainage systems suited to the requirements of the low income community in Daraja Mbili in order to improve their environmental conditions. This is because provision of adequate drainage in squatter settlements has the objective of protecting life and property against flooding and

---

[2] In this regard the General Assembly proclaimed 1987 the International Year of Shelter for the Homeless.

erosion. At the same time the provision of safe and healthy living surroundings. The management of sullage and storm water drainage can be an effective tool in the overall management of squatter settlements in a sustainable manner.

This background will require that the study focuses on the level of provision of sullage and storm water drainage system in Daraja Mbili and the way the community can be involved in managing the stormwater and sullage sustainably.

Promotion of environmental conservation with economic and social development will help the people to adapt to their environment and also improve the environment so as to facilitate adaptation and conservation.

1.7 The Scope Of The Study

The scope of the study is limited to the study objectives listed earlier. It is essentially concerned with two basic infrastructure facility; sullage and storm water drainage. These facilities are usually used together with others in managing urban areas against environmental degradation. The study identified major factors constraining sustainable management of sullage and storm water.

In dealing with the above central problems socio-economic processes and organization of the residents and the role of Kisii municipal council as the local authority in environmental planning and management, specifically linkages to lack of sullage and storm water drainage were inevitably considered. Lastly,

linkages to environmental degradation are dealt with.

Spatially, the study covers Daraja Mbili residential area in Kisii Municipality. This is a low income informal settlement located along the Kisii-Kisumu road to the south east of the town, about two kilometres from the town centre (figure 2.3).

1.8 Methodology

1.8.1 Sources Of Data

primary and secondary data together with informal interviews and field observations were used in collecting data in the study.

(a). Secondary data sources

Secondary data was collected from published and unpublished literature including National and District Development Plans and Local Authority Development programme Report documents on Kisii town. Central Bureau Statistical records that were used included Urban Housing Survey reports and Ministry of Land and Settlements including the National Town Planning Handbook. UNCHS/Habitat publications on squatter upgrading programmes. Maps were obtained from Survey of Kenya to show the area's extent.

(b). Primary data sources

Primary data was collected through administration of questionnaires, interview schedules, photography and general field observations.

A total of 88 questionnaires were administered . The questionnaires were in three categories. One category of 36 questionnaires was administered to households. Another category of 31 questionnaires was administered to business entrepreneurs in Daraja Mbili to get information on their economic activities and how these activities contribute to the environmental problems in general, and to sullage and storm water drainage in particular. A third category of 31 questionnaires was administered to farmers on Nyanchwa hill to capture how their farming practices affect storm water management in Daraja Mbili.

(c) Informal Interviews

Oral discussions will be held with various resource persons in the town including the Town Clerk, Town Engineer, Public Health Officer and the Local Chief. In addition field observations will be used to observe causes and consequences of sullage and storm water drainage within the area, which will not be investigated through questionnaires. Some of these observable problems will be captured in photographs.

1.8.2 Primary Data Collection

(a). Commercial Sample

A preliminary survey of commercial outlets in Daraja Mbili was carried out. The commercial outlets were numbered and a table of random numbers used to select every fourth house. A total random sample of 31 businesses was selected.

A random sample was preferred because the particular number of outlets was not known and their exact positions.

(b). Household sample

Systematic sampling was used to select the 36 households where the household questionnaire was administered.

The first unit was selected using the help of random numbers. The first ten units were numbered and a table of random numbers used to select the one to be interviewed. Thereafter every fourth housing unit was selected automatically according to this pattern. The pattern involved regular spacing of units. Thus suppose a population consists of N units, serially numbered from 1 to N. N is expressed as a product of two integers say K and n, so that N=kn. A random number was drawn which was less than or equal to K, say i, and then selected the unit with the corresponding serial number (4) and every 4th unit in the population thereafter. Clearly, the sample contained the n units i, i+4, i+2(4),....i+(n-1)4; such a sample is known as a systematic sample, (Sukhatme and Sukhatme, 1970). This was the criteria behind the selection of household, business and landuse sample selection process for administration of questionnaires.

This method was selected because was it is cost effective and on account of its low cost and simplicity. This was necessary because the selection of the sample was carried out in the field. A systematic sample also offered advantage in organizing control over field survey.

The relative position in the population of different units included in the sample was fixed. There was consequently no risk that any large contiguous part of the population could fail to be represented. Indeed, the method gave an evenly spaced sample and therefore, gave a more precise estimate of the population mean than random sampling could, unless the K-th units constituting the sample happen to be alike or correlated. Since the first number less than or equal to k is to be chosen at random, every one of the k columns gets an equal chance of being chosen as the systematic sample.

Limitations of the Sampling method

There are two types of situations systematic sampling may cause biases. If the individuals are ordered so that a trend occurs, and if the population has some periodic or cyclical characteristics which correspond to the sampling fractions (Levin, 1981). Therefore there should be some elements of randomization on the population. In the study area systematic sampling was permissible because there was no indication of periodic repetition of conditions at the same interval as the sample interval. The population data, from which the systematic random sample was picked was distributed randomly.

1.8.3 Methods Of Data Analysis

Frequency Distribution

Frequency distribution was used to organize data, to highlight the lowest and highest values. The frequency also indicated the values which had the highest frequency. The frequency distribution summarised the information which made it possible to make deductive conclusions and in decision making. (Sukhamte and Sukhamte, 1970)

Frequency distribution allow for organizing data into groups of values which describe a given characteristic of phenomena. The distribution show the number of observations from the data set and helps to explain occurrence of phenomena in reality.

The frequency of each variable is expressed as a fraction or percentage of the total number of observations. The sum of all the relative frequencies equal to 1.00 or 100 percent. Each variable is paired with its appropriate percentage of the total.

Chi-Square analysis (X2)

Chi-Square analysis was used to analyze the third research problem which posed the question whether problems experienced in Daraja Mbili are linked to the way sullage and storm water is drained or disposed of.

Chi-Square (X^2) is used to know whether differences observed among the sample proportions are significant or due to chance. This is used to determine whether problems experienced due to exposure to different factors are dependent or independent.

The variables are listed and the frequency of affected respondents noted. A contingency table made up of row and columns is created. The null and alternative hypotheses are noted. The data from the variables is combined and the number of people affected by the problem is estimated.

The observed and expected frequencies are compared. If the sets of observed and expected frequencies are nearly alike, it is reasoned intuitively that the null hypothesis is true. A large difference between frequencies lead to rejection of null hypothesis and concluded that there are significant differences in the proportion of problems faced from different factors.

Beyond intuitive feelings about the observed and expected frequencies, Chi-quare statistic is used. The Chi-Square is calculated using the following formula.

Chi square is obtained from

$$x^2=\sum_{i=1} \frac{(O_i-E_i)^2}{E_i}$$

Where

X^2 is the Chi-Square

O is the observed frequency and

E is the expected or theoretical frequency.

Expected values are calculated for each corresponding observed frequency as the product of the total of the column and the total of the row, divided by the grand total of items

Precautions In Using X2 Test

An expected frequency of less than 5 in one cell of a contingency is too small to use. This problem can be overcome by combining ells to get an expected frequency of 5 or more.

If the X^2 value is zero, care should be taken to question whether absolutely no difference exists between observed and expected frequencies.

1.9 Limitations of the study

Some of the respondents were unnecessarily rude and other refused to answer questions which made the researcher to opt for the next household to interview. In some instances the respondents did not know any Kiswahili or English so some questions had to be administered in the local language. This was why statistical models were used in data analysis.

1.10 Operational Definitions

Sullage: All domestic waste water originating from sources other than the wet core.

Storm water: Run off water resulting from surface flow of rain water.

Erosion: Is a function of the erosivity of the rain and the erodibility of the soil.

Environmental planning and management: Deliberate actions to plan and manage natural and built habitat of man and other physical and biological factors and resources.

CHAPTER TWO

LITERATURE REVIEWED

2.1 Introduction

In this chapter literature on environmental planning and management is reviewed. This has been done to get background information on environmental management issues and how they are related to the problem under study. The literature is reviewed under different subtopics.

2.2 Environmental Problems In Urban Informal Settlements

United Nations agencies responsible for promoting effective planning and management of human settlement have put a lot of effort in the area of environment and development from the 1970s when their was growing recognition for conservation of the environment(UNEP, 1987). The United Nations Conference on Human Environment held at Stockholm Sweden in 1972 led to creation of the United Nations Environment Programme (UNEP). Four years later in 1976, United Nations Conference on Human settlements was held in Vancouver, Canada. Thereafter United Nations Centre for Human Settlements (UNCHS/Habitat) was created to underscore the growing importance of environmental awareness. The existence of Habitat in the 1990s is a clear indication that environmental issues in human settlement planning will remain in public policy for a long time to come, as was confirmed by the holding of the Earth in 1992 in Rio de Janeiro.

Since the Stockholm conference, other agencies of the United Nations organization have invested both money and human resources to increase their capacities to deal with the environment as part of assistance programme. United Nations Development Programme is also well known for its efforts (UNEP, 1979).

Initial emphasis to understand the interaction between human settlements and the natural environment. Research in the relationship between human settlements and the natural environment by UNEP and UNCHS (UNEP/UNCHS, 1987 and UNEP, 1979) has been inevitable so as to generate data and information. It is now inescapable that settlement planning methodologies and approaches that are adopted in various parts of the World have bearing on Environment (UNEP/UNCHS ibid, UNEP, 1989)

In 1992 a meeting in Paris to discussed how to coordinate efforts to deal with problems faced by the world increasing urban areas , 1992). The Paris meeting found out that environmental degradation in urban areas especially urban areas was caused by a lack of improper disposal of waste and storm water among other infrastructure. Urban squatter settlements phenomenon is linked to lack of shelter for low income households. These households have limited housing and they end up living in environmentally vulnerable areas in the city. Problems of waste water and storm water disposal are inextricably linked to poverty, inefficient productivity in urban economies and the performance of macro economy popularly called natural economies (Campell, 1989). The Paris meeting did not suggest the relationship between these

environmental problems with urban planning and management. Government representatives in that meeting only emphasized on the outcomes of these problems.

The incorporation of environmental management in the housing sector is basically required for health reasons (UNCHS/Habitat, UNEP, 1987). According to United Nations Environment programme and United Nations Centre for Human Settlement provision of basic sanitary and preventive health measures are requisite conditions to reducing the incidence of disease and minimizing the possibility of injury from natural hazards in urban housing.

In the tropics, the most common cause of flooding is intensive rainfall (UNEP, 1987). As a result, a combination of high sediment load in the storm-water run-off, rapid vegetation growth and uncontrolled garbage disposal which makes open drains in tropical cities especially prone to blockage and thus making the mosquito habitat. The United Nations Environment Programme, therefore suggest that in order to avoid the flooding and mosquito breeding, maintenance of clean drains is essential. They suggest community approach to drain maintenance.

In a study carried out in Ghana, Leitmann (1994), found that 13 of the 36 major diseases reported within in the Accra Metropolitan Area (AMA) were linked to poor housing, stagnant waters, poor drainage and lack of facilities for domestic waste disposal especially in low-income neighbourhoods. Large population of disease pests were found in the area and they included mosquitoes, houseflies, cockroaches and rodents.

In the city of Dar es Salaam, Tanzania officials of the city together with private and popular participatory environmental appraisal work to clarify and prioritise environmental issues enabled the stakeholders to design and implement a cross-sectoral response. From the appraisal work, several environmental development problems were identified. Solid waste management was ranked the most urgent problem that required solution. It is apparent from this approach that the involvement of all stakeholders in the environmental planning process is necessary in order to make it sustainable.

2.3 Storm Water Drainage

The provision of adequate drainage in human settlements has the objective of protecting life and property against flooding and provision of a safe and healthy environment (Ramachandran 1992). Ramachandran has noted that the management of rain water in forming runoff flows is one of many ways to promote healthy living in cities.

The planning of new human settlements especially the allocation of land for urban development has, in the past, been done with no regard to surface drainage requirement (UNCHS,1992). When drainage network is provided at a later stage, investment is usually expensive than it might have been were it done at the earlier stage of settlement in the area. It also creates more problems because the new reticulation system of chains encroach on existing property whose owners might ask for compensation.

Although the need for sanitary drainage varies from area to area in a city (UNCHS 1983), sanitary drainage is of highest priority in urban squatter settlements. Unfortunately, urban squatter settlements are usually located on land that is not suitable for conventional urban development. Flooding is one of the most frequent environmental hazard occurrence in the areas.

Drainage systems is a service whose demand increases with the growth population in any given area within a Town. According to the United Nations Centre for Human Settlement, safe and healthy human environment requires to put in place of community based measures that ensure that people are protected from substances or disease pathogens.In many cases this is not the case (UNCHS,1990).

In calcutta, India, existing sewerage network cover one third of the city (Sivaramakrishanan and Green, 1986). This network is not well maintained and periodic clogging of the drain pipes is common during rain weather. This lead to flooding every year. In metropolitan Manila, Jimenez and Velasquez (1989) found out that inadequate services to collect domestic wastes have led to accumulated garbage which block open drains. In Manila city also, the problem of flooding is also a serious one.

Research show that improved management of storm water will reduce flooding and thus minimize sanitation problems and other hazards (Boyce, 1990). Boyce has suggested that some of storm water management measures are roadside drains pounds to store and release excess rain water.

According to the UNCHS, mental ill health in peri-urban areas is a public health issue that was appreciated long time ago. Living in peri-urban area subject to flooding and mudslides contribute to, anxiety as well as the acute water-related psychoses such as malarial psychosis and chronic neuroses such as filarial neurosis (UNCHS,19984). Bancroftian filaris is also a serious disease in urban areas. People become infected when infected mosquitoes bite them . Mosquitoes in urban areas breed in among others stagnant water that is left in open drains and erosion depressions and uncollected containers. This comes about because in some city authorities improve the water supply but make no or insufficient provision for the removal of the resulting waste water. In order to prevent transmission of water borne diseases, cities require efficient storm water drainage. (UNCHS/Habitat, 1991). Thus urban malaria is to a great extent related to inadequacies of sanitation and storm water drainage.

One of policy areas by Government of Kenya is to protect land that is vulnerable to degradation. In Kisii town, the government has zoned landuse activities to steer development to the most suitable direction, and also has offered support the local people, especially farmers, to manage their land better (Duchhart, 1989). Duchhart suggest that people who inhabit environmentally fragile ecosystems like steep hillsides should receive incentives to manage their land in a sustainable way. She goes further suggests that when considering storm water management, it important to incorporate the whole catchment area

because the water management in one area depend on how the people upstream manage their environment.

In Nairobi, the storm water drainage system is also used to dispose domestic and industrial waste water. According to Krhoda (1991), separate systems for storm water and sullage are useful when we have a situation of frequent flooding problem, because the waste water treatment plants will not have adequate capacity to handle such large quantities of water [Krhoda, 1991]. He goes on to state that steep slopes encourage erosion especially along road sides which are not provided with kerbs. The erosion reduce the life of city roads by more than one half.. Gullies are now a common feature along many roads and footpaths in the city districts outside the city centre.

In a slope analysis done in Kisii town, Duchhart et al (1988) found that the slope gradient in Daraja Mbili was over between 4 and 8 percent. They argued that the area was susceptible to soil erosion in case any intensive uncontrolled activity continued to be carried. Nyamweno (1994), concurs with Duchhart that the steep slopes of Daraja Mbili have led to serious environmental degradation, especially soil erosion. The soil erosion is a result of the economic processes in the area and also the uncontrolled shelters put up in the place.

The runoff water in Kisii town accumulates down the slopes towards the rivers (Haeringen, 1988). Here it causes severe gully erosion. The size of the concerned water catchment area and the amount of paved surface in it have determined amount of

runoff in certain areas. Haeringen argue that to allow rainwater to infiltrate, notwithstanding the large amount of paved surface, zones of open space or afforested areas should be created. In this way the stream of runoff water will be decreased.

2.4. Sullage Disposal

Gitonga (1980), observes that as demand for water increases in a town the volume of waste water also increases. This water has to be disposed of in a sanitary manner.

According to UNEP (1987), the overall goal of sanitation development in urban settlements in developing countries involves among others the protection of the environment by adequate treatment and disposal of waste water.

It is not enough to provide urban areas with clean portable water. The system that handle waste water must also be put in place and maintained to prevent degradation (UNCHS, 1992). Levels of sewer provision in Africa and Asia, including many cities with a million or more inhabitants are very low (UNCHS/Habitat, 1992). Rivers, streams, canals, gullies and ditches are where wastewater end up untreated. According to UNCHS (1992), health problems resulting from this method of waste water disposal increase the risk of urban population living in such contaminated environment. According to the UNCHS (1982), where waste water disposal system is part of water supply strategy to urban communities it inevitably lead to the spread of contagious diseases and decline in the quality of settlements.

In a survey of 660 households in Dar es Salaam city, in 1986 and 1987, only 13 per cent of the domestic waste water and sewage is regularly disposed (Kulaba, 1989). Most households shared sanitary facilities. In Dar es Salaam, Kulaba found out that overflowing pit latrines were a serious problem, especially in the rainy season and the levels of empty septic tanks and pit latrine provision was very inadequate.

Phantumvanit and Liengecharernsit (1989) found out that only 2 percent population in Bangkok city were connected to a sewer and had waste-water disposal, laundries, baths and kitchens. All this waste is finally disposed together with storm water in either closed or open drains.

2.5 Urban Environmental Stakeholders

According to Leitmann (1994), urban environmental stakeholders belong to one of three sets of actors; representatives of individuals and groups in society who are adversely affected by urban environmental degradation as well as those who have an interest in urban environmental conditions (example Non governmental organization, Community leaders, Public advocacy groups); those with expertise about one or more environmental problems that affect the city (e.g., academics, research institutes, private consultants); and those who have the power to make decisions that influence urban environmental quality (e.g., government officials at the municipal, regional and national levels, private and informal sector enterprises).

The provision of services is the source of an important partnership between the government, communities and Non governmental organizations. A partnership where the government provides material and technical assistance, the community provides labour and the Non governmental organizations coordinates construction and improvement work. This partnership allow the people to fulfil a decision-making role in the development of their settlement while the government, through the people's contribution, is able to make meagre resources go a great deal further (UNCHS/Habitat, 1988). Such an approach promotes a general change in attitude to the provision of services.

2.6 Role Of Community

World Bank (1991), recognises the importance of involving citizens groups in the environmental matters as way of managing the deteriorating squatter environment encouraging communication between citizens and public officials. In the 1980s, improved communication through forums that encourage debate and exchange of ideas is favoured and encouraged by the Bank.

In her article "People power: Community participation in the planning of settlements", Hollnsteiner (1977) argues that people's participation may help rectify planning misconceptions of architects, planners and administrators and therefore rectify planning errors by making it possible for the population to point out to them what will work and what will not. This incorporation

of beneficiaries in the design and implementation of the project will make the programme more successful.

According to Yap (1983), the residents of a settlement are directly affected by its conditions, so no settlement improvement project can succeed without the initiative and participation of its residents. The people responsible should carry planning with people to define their means and needs for improvement. Successful people's participation is a boon to all concerned, as it will encourage collaboration instead of conflict.

The UNCHS (1991), in this publication presents an assessment of experiences gained with community participation training programme which UNCHS/Habitat has been carrying out since 1984. Within this programme there are stimulating examples of effective and practical cooperation between the public sector and poor urban communities. It is demonstrated that, with an organized effort, commitment and open exchange of ideas, at both policy and community levels, progress can be made towards the goal of sustainable development of human settlements. The lesson so far is that community participation is critical for effective human settlements programme designed to benefit low-income groups.

The experience in many countries of the failure of infrastructure projects indicates that there is a need to involve the target community at all stages of a project, from conception, through planning and design to implementation and operation. Planning from the community upwards is a practical means of improving a project's chances of success, and therefore of making

best use of resources. Public participation can also serve as an input to project financing, usually in the form of labour.

In a pilot project in Karachi, Pakistan (Hasan 1989), a local organization called Orangi Pilot Project (OPP) in an unauthorized settlement with some 700,000 inhabitants, organized for an improved sanitation, sewers were installed with maintenance organized by local groups. As the scope of the sewer construction programme grew more local groups approached OPP for help, eventually the local authorities began to provide some financial support. By December 1985, over half of the lanes within Orangi had sewerage systems. In a later study also focusing on the squatter settlement of Orangi, which now had a population of about 800,000 Peterson (1994) found that the OPP promotes the formation of community organization and mobilizes community self-help. Its principal activity has been community construction of sewer lines. The Orangi Pilot Project has carried out its activities independently of, and sometimes in conflict with, municipal government. However, municipal authorities originally tried to discourage construction of sewer lines within the area, arguing that the technology was inappropriate for the income group and environmental conditions.

Later, the municipality began to acknowledge the community's investment effort. It even suggested using the Orangi Pilot Project team to organize community self-help construction in other settlements. It is clear that initially any community action to improve conditions may be opposed from the formal

organizations. However persistence and education of the relevant authorities can persuade them to acknowledge the invertibility of community action. So it should be in Daraja Mbili.

2.7 Role Of Non Governmental Organizations

The UNCHS/Habitat (1989), urges for a more relevant debate about privatization and improving environmental health for lower income groups has to do not with private commercial enterprises but with non-profit organizations set up by residents of particular areas. Such organizations are able not only to match private enterprises record in cost recovery but also to provide cheaper services [since no profit is made] and to be more immediately accountable to their customers.

Urban authorities are increasingly looking to the private sector and to Non governmental organizations and Community based organization as a source of investment and improved efficiency for their infrastructure services, (Gidman 1995). Gidman urges for the provision of services by the most effective means, whether this is from the authority's own resources, or through partnerships with other groups. He identified four different groups of actors which are relevant in public/private partnerships.

The community-based organizations are essential in organizing poor people, taking collective action, fighting for their rights and representing the interests of their members in dialogue with Non governmental organizations and government. Non

governmental organization, on the other hand, are better at facilitating the supply of inputs into the management process, information-dissemination and policy reform (UNCHS,1993).

2.8 Role Of Government Agencies

There is tremendous potential in new partnerships between local governments and local organizations (UNCHS/Habitat, 1989), which could be regarded as privatization in another form but where control of some services rests largely with representatives of 'consumers' of that service. The possibility of tackling the most serious health problems with limited resources needs cooperation between local government and community-based citizen groups . Joint programmes can be set up to drain stagnant pools.

In a UNCHS sustainable cities programme (Peterson et al. 1994) it was found out that less than 5 percent of Dar es Salaam's solid waste was collected daily. This had precipitated sectoral problems like blockage of the city's drains and sewers and the transmission of disease. In response, a cross-sectoral working group set up investment priorities in order to develop community collection systems in unplanned informal settlements. Therefore in any approach in storm water and waste water management in an urban setting the issue of solid waste management becomes necessary. Therefore in Daraja Mbili, the same approach can be taken to install needed drainage facilities if the government does not treat it as a priority.

The literature reviewed has broadened the understanding of the critical importance for environmental planning and management of low income settlements. It is clear that environmental litigation is now more than ever receiving grater attention. Various efforts have been done towards achieving this objective.

CHAPTER THREE

THE STUDY AREA

3.1 Introduction

In order to understand and evaluate the problems posed by stormwater and wastewater in Daraja Mbili, knowledge on how development in Kisii town has contributed to the problems is essential. This chapter deals with topography and human factors in Kisii town influencing management of stormwater and sullage.

3.2 Location Of The Study Area

Kisii town, of which Daraja Mbili is one of its residential areas, is located in Kisii highlands of Nyanza province in Western Kenya. The municipality covers an area of 35km2. The town is the second largest urban centre in Nyanza province after Kisumu town. The town is the headquarters of Kisii District, which lies some 400km southwest of Nairobi, and 110km south of Kisumu, the provincial headquarters of Nyanza province (refer to figures 3.1, 3.3).

3.3 Physical Environment

3.3.1 Relief

Kisii town is situated at an altitude of 1,600m. above sea level. The town lies on a topography characterised by a series of valleys and ridges and can be described as gentle undulating with average slope gradient of about 4 per cent to rolling landscape with average slope gradient of between 4-8 per cent.

The general slope of the land is from east to west. The site of the main section of the town is a valley bottom that runs in a northeast-southwest direction. This valley bottom is bounded by steep hills with slope gradient of between 8-16 per cent. The central part of the town stands on a ridge between two rivers; Nyamisaro and Riana (Figure 3.4). The hills rise to about 1,800m. above sea level. Nyanchwa hill is located southeast of the town while North and Northeast are Nyambera hill and Manga ridge respectively. Bobaracho and Gesarara hills to the east mark the highest point of the town at 1950m. above sea level.

The topography described above and shown in figure 3.4 present some constraints to urban development in the town. Steep slopes and shallow soils discourage intensification of cultivation and intensive urban development. The soils are too susceptible to erosion. In the river valleys the risk of flooding is too high to allow building activities close to the river banks. Also, the steep slopes are a constraint for building activities. Duchhart et al.(1988) used slope analysis to determine the suitability of land for urban development within the municipality. They suggested that flat to gentle land slopes of approximately 0-4 percent and undulating slopes of 4-8 percent were suitable for urban development. In the central ward of the town, Nyanchwa hill, Daraja Mbili settlement and Upper parts of Jogoo fall in this category. Parts of the town with rolling slopes of approximately 8-16 percent are also suitable for urban development. But areas with slope gradient of 16 percent are not

suitable for urban development as the cost of construction and provision of infrastructure are high. This include land units around Bobaracho, Gesarara, Mwamosioma hills, Nyanchwa hill, and the land above Nyanza Research Institute. Figures 3.4 and 3.5 shows the environmental situation described above.

The hilly topography of the town has had a significant influence on the management of storm water. Storm water runoff from the hills has led to gully erosion, especially along the roads which are aligned towards the hill. Daraja Mbili-Nubia road in Daraja Mbili is a good example.

Figure 3.1: Location of Study area in Kenya

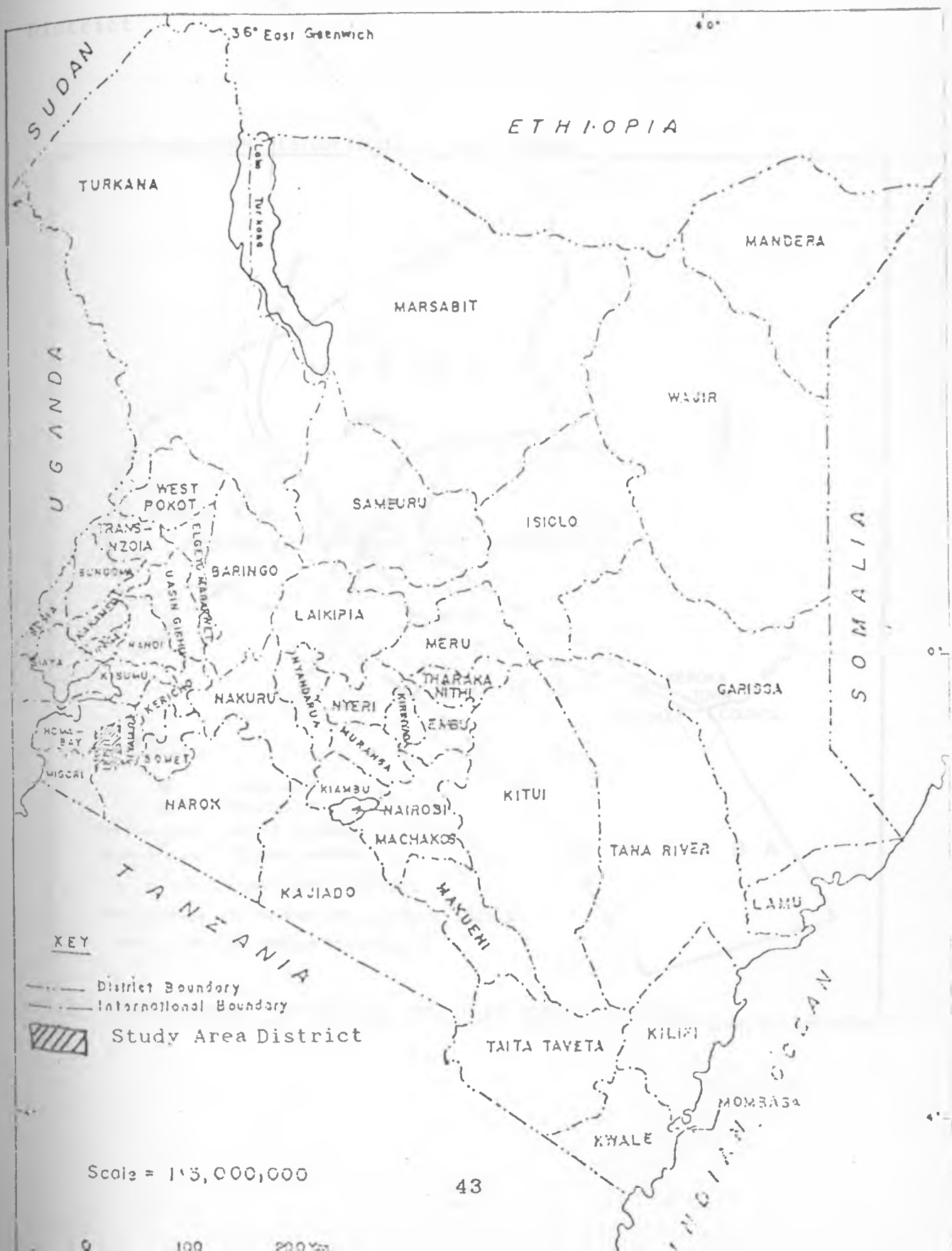


Figure 3.2 : Location of Kisii town (study area) in Kisii District

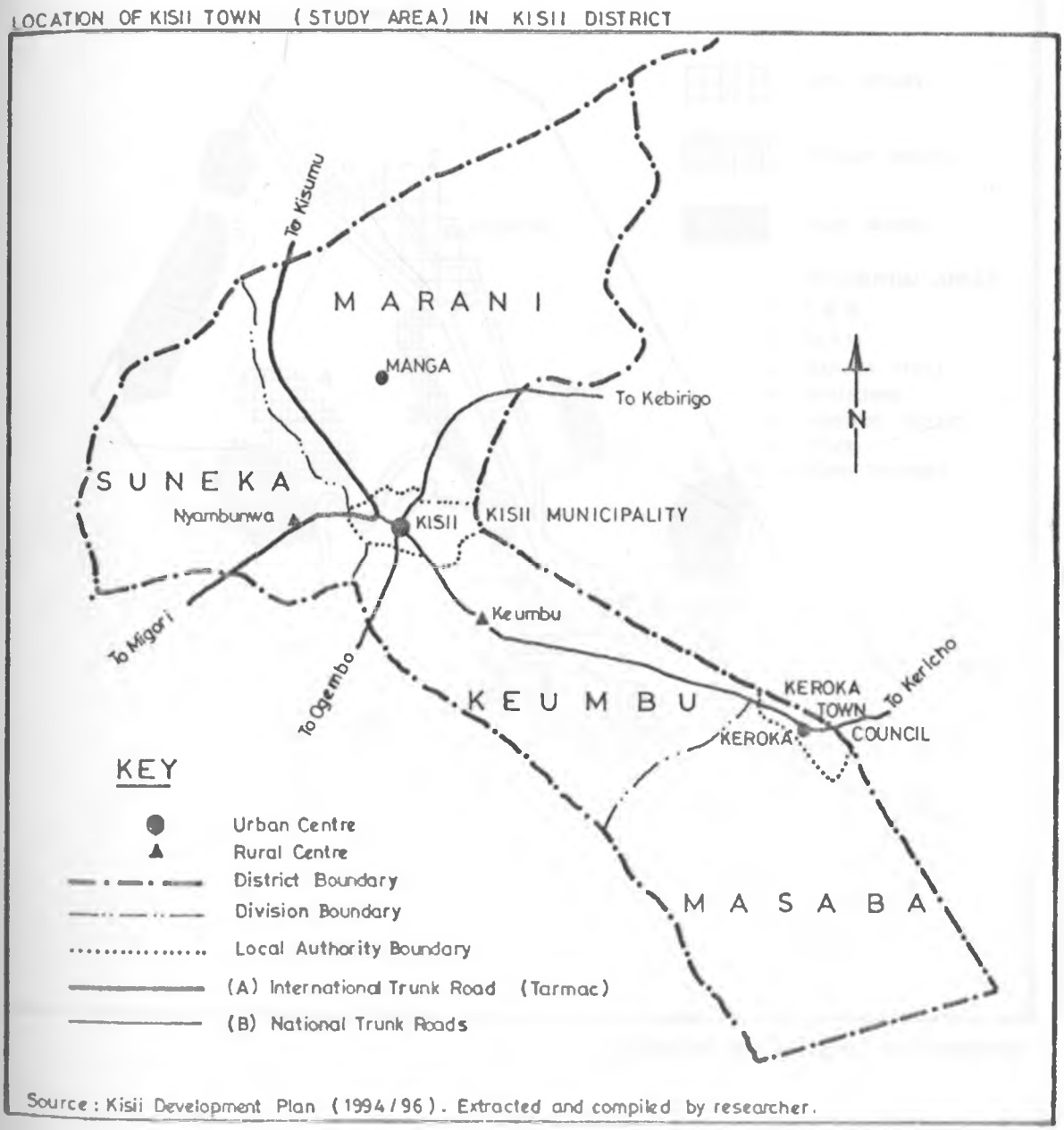
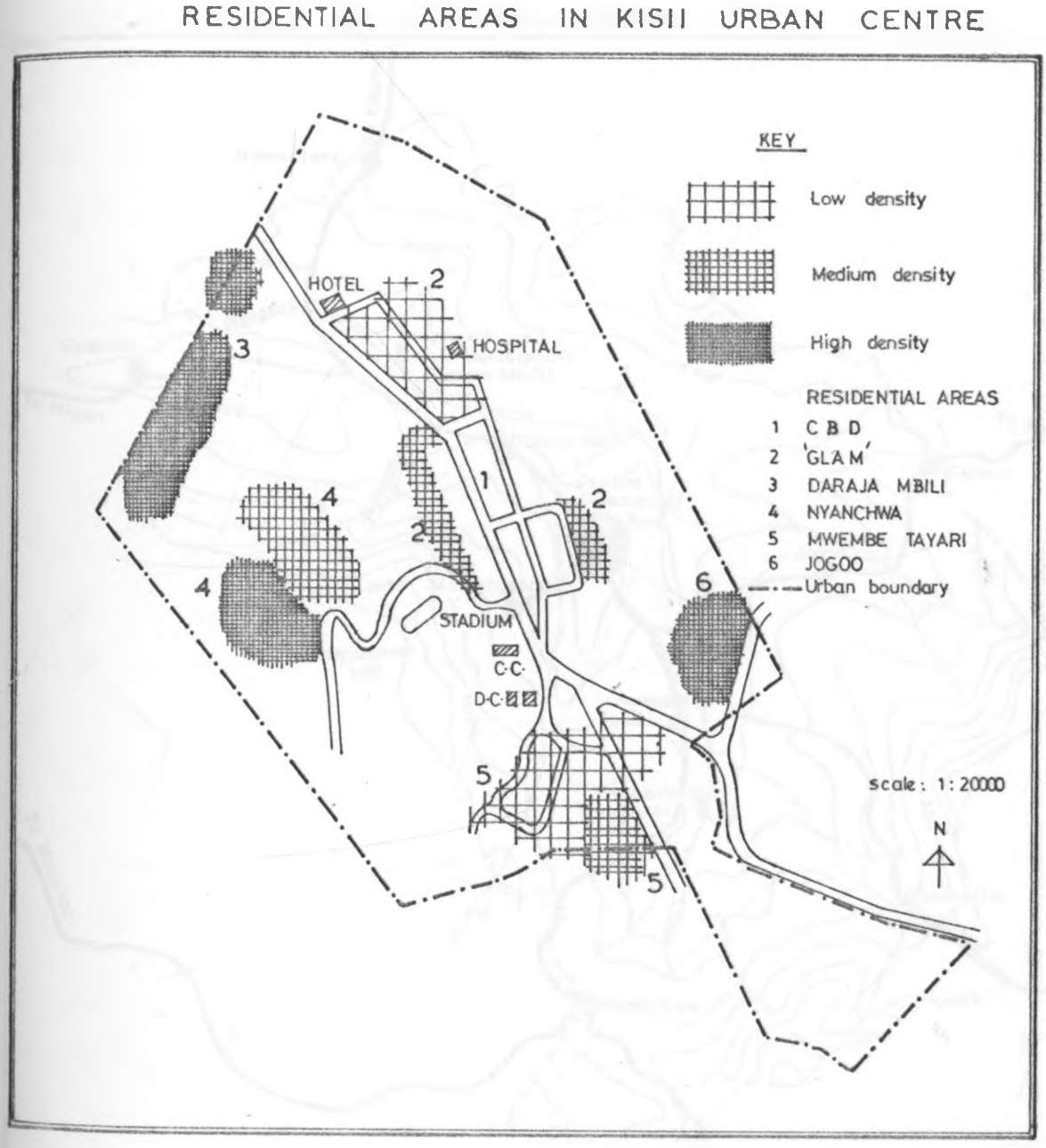
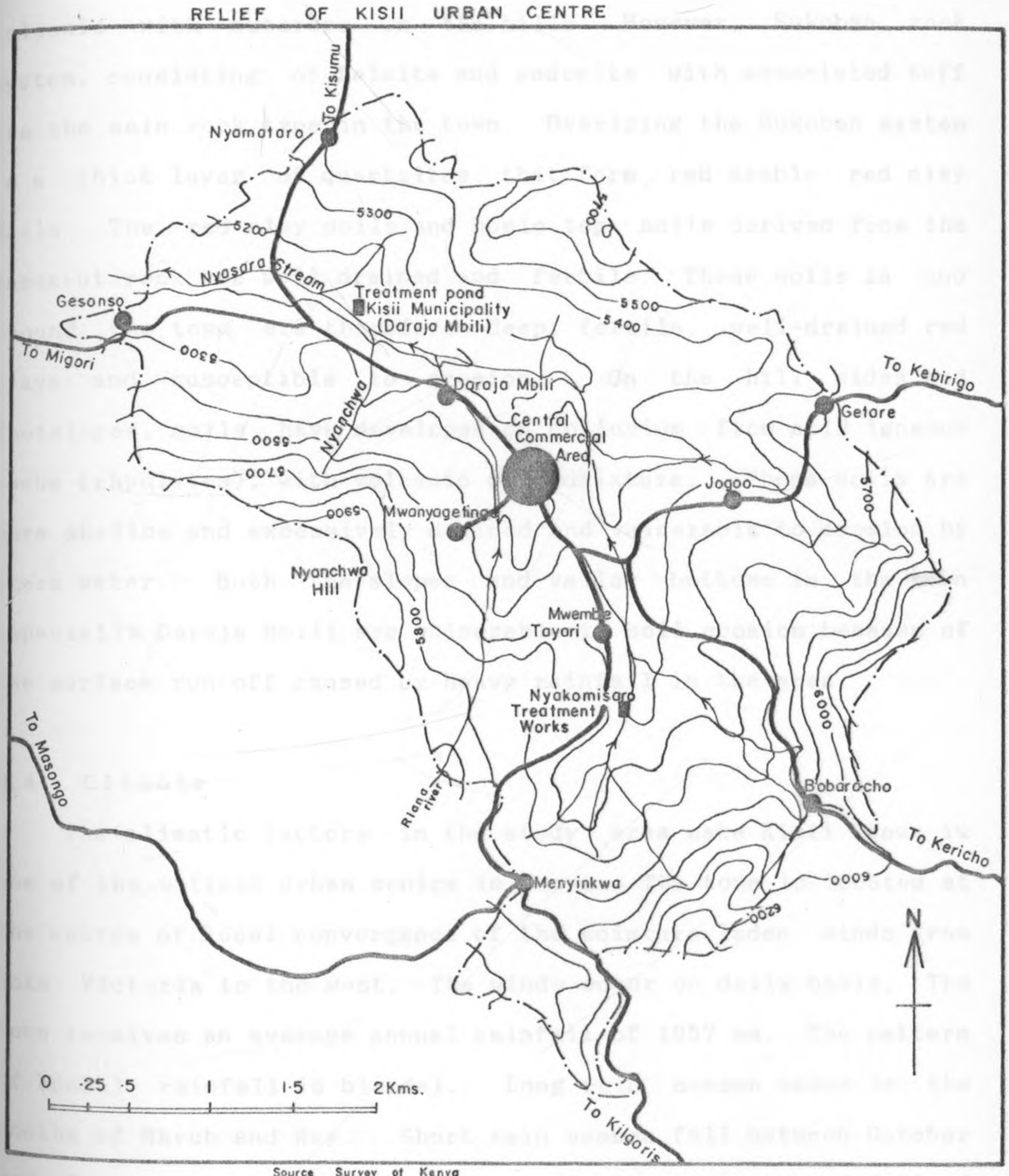


Figure 3.3: Location of Daraja Mbili within Kisii urban centre



Extracted and Compiled by Reseacher

Figure 3.4: Relief of Kisii urban centre



3.3.2 Geology and Soils

The parent rock of the areas covering Kisii town is mainly volcanic with outcrops on the hills. However, Bukoban rock system, consisting of felsite and andesite with associated tuff are the main rock type in the town. Overlying the Bukoban system is a thick layer of quartzites that form red arable red clay soils. The red clay soils and humic top soils derived from the basement rock are well drained and fertile. These soils in and around the town are therefore deep, fertile, well-drained red clays and susceptible to erosion. On the hill sides and footslopes, soils have developed on colluvium from acid igneous rocks (rhyolites), with volcanic ash admixture. These soils are more shallow and excessively drained and vulnerable to erosion by storm water. Both the slopes and valley bottoms in the town especially Daraja Mbili are vulnerable to soil erosion because of the surface run-off caused by heavy rainfall in the area.

3.4 Climate

The climatic factors in the study area make Kisii town is one of the wettest urban centre in Kenya. The town is located at the centre of local convergence of the moisture laden winds from lake Victoria to the west. The winds occur on daily basis. The town receives an average annual rainfall of 1957 mm. The pattern of annual rainfall is bimodal. Long rain season occur in the months of March and May. Short rain season fall between October and December. April and May records the highest rainfall of

about 300mm. January and August are the most dry periods (Kisii District Development Plan 1989-1993).

The rain seasons of the year are not easy to distinguish because there are no prolonged dry seasons. The annual rainfall is however high and also reliable. Rainfall reliability during long rains is 60 percent. At most 900-1000 mm. or more is expected during this period. This amount can be surpassed in 6 out of 10 years. During the short rains, reliability is also 60 percent. At most 500-600 mm. is expected and this is also surpassed in 6 out of 10 years (Kenya, 1982).

The valley where Kisii town is located is a water catchment area. There is a permanent stream of water seeping down the slopes through the soil and drain into rivers Riana any Nyamisaro. On places where the base of is exposed, ground water flow out as springs. Part of the large amount of surface rain water drains rivers Nyamisaro and Riana in form of surface streams and subsurface streams. During heavy rainfall in the rainy season surface run-off cause flooding and soil erosion.

Kisii town area is drained by a number of rivers which are tributaries of River Riana. Nyamisaro forms the boundary between Central ward and Kanga ward. The other tributary Nyasara forms the boundary between Nyanchwa and Central ward (figure 3.4).

The rate of average evaporation is 127 mm. per month but is highest in January and lowest in April and November. Evaporation is insignificant during the rainy season. Due to the high altitude there are no temperature variations. Evenings tend to

be cool while days are unduly hot. Daily mean minimum temperature range from 11.4°c to 13.3°c and is stable throughout the year. However the mean annual minimum temperatures range from 10°c to 18°c, and the mean annual maximum temperatures range from 22°c to 26°c (Kenya, 1982 and Kenya, 1994).

3.5 Historical Background Of Kisii Town And Daraja Mbili

The British colonial government established Kisii town as an administrative centre in 1905. At that early time the town was a small trading centre. Subsequent years saw increased population and commercial activities. Kisii town became a township in 1911. By 1948, the population had increased to 2,426 people with a total land area of about 8 km². By 1955 the town had developed so that distinct sections of the urban area had acquired urban functions. These sections included Jogoo, Nyanchwa, Mwembe Tayari, Daraja Mbili and Nubia village. In 1961, Kisii town had a population of 4,542 which increased to 6,080 in 1969. In 1973 the town was extended to include peri-urban areas so that the whole town covered 29 km² and today the town covers an extended area of 35 km². In 1981 the town became a municipal council. From then it was required to provide the broadest range of services including water supply, sewerage, housing, solid waste management, and drainage among others. The population of the town grew by 14,000 between 1979 and 1989 to reach 44,000. Projections showed that the population could grow to 52,000 by

the year 2,000 (Kenya 1994). The population of the town over the years is summarised in table 3.1 below.

Table 3.1: Actual Population and Projections in Kisii Town

YEAR	POPULATION
1948	2,426
1962	4,542
1969	6,080
1975*	8,000
1979	29,661
1983*	38,000
1989	44,000
2000*	52,000

* Projected/Estimate population
Source: Kenya 1971, 1979, 1994.

At present this Kisii municipality is divided into 14 wards namely; Central, Kanga\Jogoo, Mwembe Tayari, Nyanchwa, Daraja Mbili, Nyaura, Gesonso, Bobaracho, Kiamwasi, Nyangongo, Getare, Kiongonga, Nyabururu and Mosando. Daraja Mbili the study area is within Daraja Mbili ward. Each ward is a local authority civil political unit within the municipality. Central, Kanga\Jogoo, Mwembe Tayari, Nyanchwa and Daraja Mbili make up the old township area with a total land area of 5.7 km^2 which is trust land. The remaining wards are located outside the old town within the freehold land area (Kenya, 1971 and Kenya,1986).

In the high density, low income areas of Mwembe Tayari, Nubia and Daraja Mbili, are low income-high communities. Most people live in substandard overcrowded temporary structures. Sanitation facilities are overstretched and degraded. Housing is

made of temporary materials like wattle and mud and iron sheets.

Rapid urbanization in the town is leading to intensification of built up area, including the steep slope areas. More people are relying on the same facilities and infrastructure. The intensification and expansion of the urban area has also increased the total area of built-up land. Houses and roads are covering the soil and so little rain infiltrate into the soil. This has reduced the infiltration capacity by approximately 90 percent. Because the rainwater cannot infiltrate into the ground rain water accumulate and destroy some sections of roads and land. The damaged roads form an extra burden on the already stressed infrastructure (Duchhart, 1989).

Urban expansion is taking up more areas that are not suitable for urban development. Built up area on the steep slopes like Daraja Mbili are experiencing soil erosion. In the absence of improved drainage system. The impact of storm water makes it important to search for a balance between urban landuse and the environment in Kisii town (Haeringen 1988).

3.6 Daraja Mbili: The Study Area

Daraja Mbili is a satellite market community in Kisii town which is 2 km from the town centre to the west (figure 3.3 and 3.4). The area covers about 1 km2 and has both business and residential activities (figure 3.5). This settlement was initially at the urban fringe of Kisii town but has gradually become a part of the town itself as the town expanded.

Initially Daraja Mbili was started as a settlement for Luo community who worked for the European administration in 1939. It was upgraded to a market in 1947. The land was alienated from private owners and allocated to individuals on a temporary basis. Presently, Daraja Mbili has grown and now incorporate privately owned land and trust land, belonging to Kisii Municipal Council. The Luo workers who had been settled on the site were moved to an area overlooking the present sewerage pond.

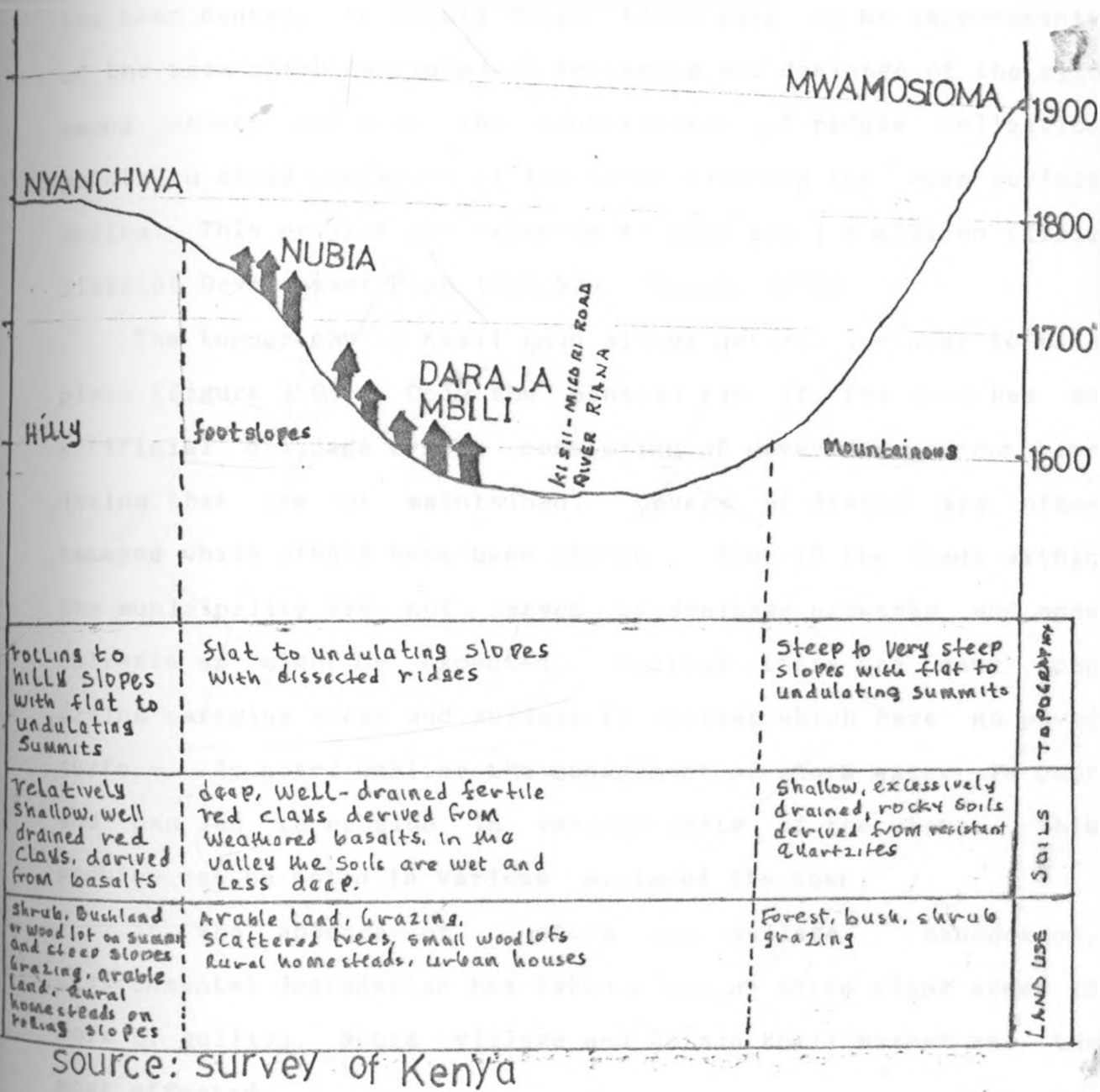
After independence in 1963, the low income people who could not find affordable shelter in the affluent sections of Kisii town set up temporary shelter in Daraja Mbili without any formal control. This led to overcrowding and because of the environmental vulnerability of the area, the cleared steep slopes exposed the soil to surface runoff from stormwater originating in Nyanchwa hill. Agricultural practices on the hill do not undertake environmental protection measures leading to accelerated storm water runoff. The result is damaged roads especially during heavy rains and has led to gullies in open fields and on the road sides and exposed water pipes and damage to open storm water drains.

Therefore Daraja Mbili is an established urban settlement within Kisii municipality. It has a residential and thriving commercial sector. It is situated on the lower section of Nyanchwa hill (Figure 3.6). The general direction of natural drainage is south-north.

Daraja Mbili lies within Nyanchwa hill catchment. This catchment area has four landscape units (figure 3.6). At the top of Nyanchwa hill is largely for farming and has no major urban development. The effect of farming on cover soil and impact of rain water affect other landuses downslope. This area generates most of the storm-water that cause soil erosion and sanitation problems downslope in Daraja Mbili market. The second landscape unit is where the low-income Nubia settlement is located. Below Nubia village is Daraja Mbili which form the third landscape unit this area has commercial and residential landuse. The fourth landscape unit is the River Riana and its valley bottom which is also part of River Riana. This landscape unit receives the storm water originating in the catchment. Human activities in this area include transport routes and market stalls.

Figure 3.5: Settlement Layout of Daraja Mbili.

Figure 3.6 Cross-Section through Kisii Town showing Landscape Trend.



Source: survey of Kenya

3.7 Storm Water Drainage

During the 1989-93 development period, Kisii town was targeted for construction of a 12 km storm-water drain system in the town centre. In Daraja Mbili, there were to be improvements of the area which consisted of terracing and drainage of the site among others and also the construction of refuse collection points to avoid instances of the waste blocking the open surface drains. This project was expected to cost Ksh.1.5 million (Kisii District Development Plan 1989-93), (Kenya, 1989).

The topography of Kisii town allows natural drainage to take place (figure 3.6). Only the central part of the town has an artificial drainage system consisting of covered open concrete drains that are not maintained. Covers of drains are often damaged while others have been stolen. Most of the roads within the municipality are not served by drainage networks and open culverts as might be expected. Instead there are many open drains carrying storm and sullage to streams which have no paved surface. As noted earlier the management of storm water is poor and has led to erosion in various parts of the town. This problem can be noted in various areas of the town.

In the absence of storm and sullage management, environmental degradation has taken place on steep slope areas in form of gullies. Nubia village and Daraja Mbili market are the most affected.

Uncontrolled disposal of solid-waste has also led to the waste being swept by storm water. This waste is disposed into the storm water open channels, blocking them. Furthermore the refuse accumulates in the channels and decaying process produces awful smell which pollutes the environment. Also lack of waste-water drainage system cause accumulation of sullage close to the dwelling units. This problem is common in the residential areas of Jogoo, Mwembe Tayari and Daraja Mbili.

CHAPTER FOUR

STATUS OF ENVIRONMENTAL PLANNING AND MANAGEMENT

4.1 Introduction

This chapter highlights the status of the environment with reference to storm water and sullage management. The various methods in use are reviewed.

The physical condition of Daraja Mbili has had a critical influence on the type of environmental management programmes in the area (Duchhart, 1989). Inadequate supply of housing in Kisii town has influenced the nature and magnitude of environmental problems and conflicts in Daraja Mbili. This in turn determined the kind of environmental planning and management approaches adopted for the area. Above all social and economic circumstance of the people, has had much to do with the environmental management strategies put in place[3]. Legal, institutional structures, and climatic conditions have also played a role in determining environmental planning and management approaches now used by lead agents that include Kisii Municipal council, district administration in the town, Non-governmental organizations and the local community.

---

[3] Some of the strategies include digging trenches, practising contour farming and agroforestry

4.2 Environmental Management Institutions

The tools which are popular in managing the environment include legal mechanisms in form of Public Health Act and Local Authority Act CAP 265. Organized community initiatives, public awareness creation and training assistance in local economic development. The Public Health Act has not been enforced effectively in Daraja Mbili because of lack of monitoring, enforcement, and coordination. As a result most of the garbage is not collected, storm water is not adequately drained and sullage is disposed in an insanitary manner. Economic instruments have yet to be used to address environmental problems.

Various actors are involved in managing environmental effects of inadequate storm water and sullage disposal systems. The central government through the district administration, Kisii municipal council, the community through community based groups[4], Non-governmental organizations, especially the Environment and Urban Development Training Project (EUDTP) popularly known as the Green Towns Projects (GTP) and Kenya woodfuel and afforestation programme (KWAP).

Environment and Urban Development Training Project (EUDTP) has been collaborating with the local community through Kisii Green Town Action Group in laying culverts and encouraging better farming systems to control storm water runoff.

Environment and Urban Development training Project (EUDTP)

---

[4] For example Kisii Green Town Action Group which has taken a lead in storm water management in Daraja Mbili.

was making efforts to control storm water drainage. This programme has had some success in controlling storm water. However there was poor maintenance of the infrastructure put in place to control storm water and sullage runoff. Some of the culverts have been submerged by soil sediments carried by runoff.

Better farming and afforestation programmes to control storm water runoff were undertaken by both the Environment and Urban Development programme (EUDTP) and Kenya woodfuel and afforestation programme (KWAP) has been mainly involved in afforestation programme to control storm runoff and soil erosion.

The local community was participating in environmental protection through Kisii Green Town Action Group.

4.2.1 Kisii Green Town Action Group Partnership

The community through Kisii Town Green Town Action Group is actively involved in managing environmental consequences of storm water runoff in the area. This group was registered in January 1993 with the objective of promoting community participation in environmental management programmes started by The Environment and Urban Training Project (EUDTP).

The main objective was to mobilize local community in rehabilitating the 2 km. of Daraja Mbili-Nubia road made impassable by erosion from uncontrolled storm water and sullage. The road runs down hill from Nyanchwa hill and has become channel for surface runoff and sullage. The second objective was to rehabilitate Daraja Mbili market affected by storm water.

The community identified main causes of environmental degradation in the area. Storm water ranked first, others were weak economic base of the inhabitants, lack of dumping sites for solid waste and insanitary disposal of sullage and the steep slope that is part of Nyanchwa hill which accelerated runoff leading to soil erosion. Agricultural activities in the upper sections of the hill which affected vegetation cover. Rain water up the slope was not controlled and resulted to surface runoff that erode soil carrying it down the slope.

A committee of 30 members forwarded the problems to the District Development Committee in April 1993. The District Development Committee identified the Environmental and Urban Development Training Project as project sponsors. In June 1993 the community met with the project sponsors and identified two areas which needed immediate attention. First, storm water management which led to soil and solid waste management which needed to be collected and deposited to open the needed drains. Secondly the 2 km. Daraja Mbili-Nubia road needed rehabilitation with a view to divert storm water from the road.

The community cooperated to rehabilitate the road. By June 1993, 140 community members were actively involved in the rehabilitation of the road constructing roadside drains. Six masons were provided by the community to construct storm water inlets for new culverts. Ten culverts were constructed with the help of the Town Engineer. The Environment and Urban Development Training Project provided ballast, cement and sand for culverts

construction and drains along the road side. The community also planted trees along the road from Daraja Mbili to Nubia.

People living on Nyanchwa hill were encouraged to use roof gutters for rainwater catchment to control storm water runoff. Farmers in the area were also encouraged to plant nappier grass and to cut contours across their shambas to control runoff. The community had considerable success in controlling storm water runoff compared to previous period[5].

4.2.2 Formal Institutions

Various Government agencies are involved in managing storm water and sullage in Daraja Mbili. Kisii Municipal Council is involved through the town Engineer's department. The central government is involve through the Ministry of Agriculture's extension services and the Ministry of local government who are coordinating the project. The Ministry of Works, through the Staff Training College in Kisii town constructed culverts for the project free of charge.

Kisii municipal council is involved by clearing the drains in the open market once a week. It is not unusual for garbage to block the storm water and sullage open drains due to the

---

[5] The programme later run into difficulties when some community members started to demand payment in form of money for any input contributed towards the project. As a result some of the culverts became submerged by solid waste deposits like soil sediments. Trees planted along the road were no longer protected from livestock. In Nyanchwa hill farmers stopped planting nappier grass and digging of contours. This led to increased storm water runoff worse than before the community intervened.

municipality's failure in doing the work. The local authority is supposed to collect garbage generated from household once a month. However this is rarely done. As a result garbage can be found blocking the main storm water and sullage open drains. The blockage has led to formation of pools of water which have become breeding grounds for mosquitoes and other vermins.

4.2.3 Informal Organizations

The two notable informal organizations which have contributed to the management of storm water and sullage disposal are the Environment and Urban Development Training Project (EUDTP) and Kenya woodfuel and afforestation programme (KWAP).

Environment and Urban Development Training Project (EUDTP)

The Environment and Urban Development Project group, the project sponsors started to be involved in the area in June 1993. They met with the community and together identified storm water management as the main objective for controlling soil erosion, solid waste deposition and road degradation.

The group provided construction materials for moulding culverts. They provided tree seedlings for planting along the 2 km. Daraja Mbili-Nubia road. Awareness campaigns for better farming methods like planting of nappier grass and contours farming were carried out with the assistance of this group. These farming methods increased infiltration decreasing runoff.

The group funded construction of a market in Daraja Mbili to house the periodic open market. The open market located next to Kisii-Migori road and River Riana on a steep slope has been experiencing serious soil erosion because of the concentrated human activity. This area has been cleared of vegetation decreasing infiltration therefore increasing surface runoff.

Kenya Woodfuel And Afforestation Programme (KWAP)

Kenya woodfuel and afforestation programme has contributed to the improvement of farming practices on Nyanchwa hill with a view to increasing rain water infiltration and reduce surface runoff. The group also organised seminars to create awareness and encourage terracing and agroforestry.

4.3 Sullage Disposal

The main concern for sullage disposal are its content of pathogenic organisms and toxic chemicals which harbour potential hazards. The concentration or strength of sullage is expressed in terms of its bio-oxygen demand (BOD)[8]. The oxygen demand is a gross and indirect measure of the total organic load contained in sullage.

The strength of waste water is governed by the water consumption by the household. High water consumption (300-400 l pcd) results in weak sullage while low water consumption (BOD:

---

[8] BOD is an important parameter for estimating the degree of harm that can be caused by pathogens in sullage discharged.

200-250 mg/l) lead to strong sullage. In Daraja Mbili the water consumption is low averaging (50-150 1 pcd) therefore result in strong sullage.

Disposal of sullage from bathing, laundry and cooking on to the ground is the common practice in almost the entire of Daraja Mbili area. The practice is insanitary and offensive.

Sullage is disposed on the ground next to the houses and into the open drains outside the house in the narrow pathways between houses. Commercial enterprises in the market area dispose their sullage on the main Nubia- Nyanchwa hill road, the main streets, and side streets between buildings. In some places the ground is more or less impervious with hard patched surface. High population concentration make sullage to remain on the surface in puddles and small streams. The stagnant sullage is attractive to children and constitute breeding areas for bacteria, insects and rodents. However, in areas with sufficient land for sullage to soak a way, the disposal method is acceptable. So that pouring a bucket of dirty water on the ground cause little trouble because a combination of soakage and evaporation soon eliminate the pool as long as it does not go beyond the infiltration capacity of the soils. This is done especially in dispersed house units.

Pathways and areas outside houses are littered with garbage, which petrify when soaked in sullage. Sullage generated from commercial uses contain a wide range of unpleasant and suspended matter decompose anaerobically and the grease anaerobically.

Kisii municipal council employs a number of sweepers in Daraja Mbili , part of whose job is to keep drains clean. However, clearing is done by householders past whose plots/houses the drains ran.. Drains crossing open land or behind houses were unattended and blocked with refuse.

4.4 Storm Water Drainage

On the flat and gentle undulating areas splash erosion occur without any superficial flow of rain water. On the hilly slopes and rolling land, the rate of rainfall exceeds the rate of infiltration of rain water into the ground such that superficial flows take place. Velocity of rill flows is higher on the steeper slopes of Nyanchwa hill than the footslopes of Daraja Mbili. The amount of erosion (E) experienced differ with the slope gradient and intensity of the rain.. However the amount is not proportional to the steepness of the slope but increases more rapidly. The soil loss per unit area in Daraja Mbili increase with the length of the slope but not proportionally.

The rainfall is high, averaging 157 mm. and reliable. The highest rainfall is recorded in April and May which is normally about 300 mm . There is more surface runoff during long rains between March and May than the short rains between October and November. (Kenya 1989). The average rainfall erosion index [R] for Kisii town is 500[4]. This is quite high and comes about

---

[4] Rainfall exceeding 120 mm/h cause soil erosion. Soil erosion is a function of the erosivity (of the rainfall) and the erodibility (of the soil).

because of the high rainfall, the intensive and the big raindrops which fall per unit of time (Kenya, 1981). The estimated magnitude of rainfall intensity in the study area based on Nyakobisara weather station is 140.6 which is quite high. This data is presented in figure 4.1 which show the rainfall intensity for 5, 10, 25, 50 and 100 years return period, for each duration. The Rainfall intensity-duration-frequency relationship for Daraja Mbili based on the same station is given in figure 4.2. Figure 4.3 is an example showing graphically how the rain duration-intensity behaves in different time-periods. This information is important when designing an urban storm sewer for Daraja Mbili for example short and intense storms result in steep flow hydrographs with high peaks. This rainfall-intensity-duration-frequency determine the deign of the storm sewer structure for the area. The design may not be efficient in handling storm water if the different landuses and physical characteristics of the area are not considered. Figure 4.4 show the various Rainfall intensity in millimetres per hour which will have to be taken into account. In Daraja Mbili, surface runoff has been accelerated by rapid urbanization trends. Urban land activities are claiming agricultural land. The new landuses generate more storm runoff. Vegetation has been cleared and replaced by property development reducing infiltration.

The steep slopes of Nyanchwa hill accelerate storm runoff leading to soil erosion. The natural vegetation cover in Nyanchwa hill of grass, shrub bush and woodlot are not very

effective in encouraging infiltration. Intensive agriculture practised in the area does not encourage infiltration. The red loamy clay soil dominant in the area cannot withstand the size and velocity of raindrops.

The presence of hard surface like roads, built up areas and other impervious surface have limited the rate of rainwater infiltration.

There are many gullies along the Daraja Mbili - Nubia road which go uphill, and on the open market place next to Kisii-Migori road and River Riana. The gullies are short, cutting back up the slope. At the head of the gullies are 'waterfall' type of erosion which cause a rapid cutting back into the slope.

The repairing of the Daraja Mbili-Nubia road periodically, especially during its rehabilitation by the community, became a temporal solution that worked against its intended purpose, because the loosened soils encouraged soil erosion and led to further degradation of the road.

A high sediment load in the storm water runoff and uncontrolled garbage disposal has made the open drains prone to blockage making maintenance of clean drains essential to control flood, soil erosion and mosquito breeding.

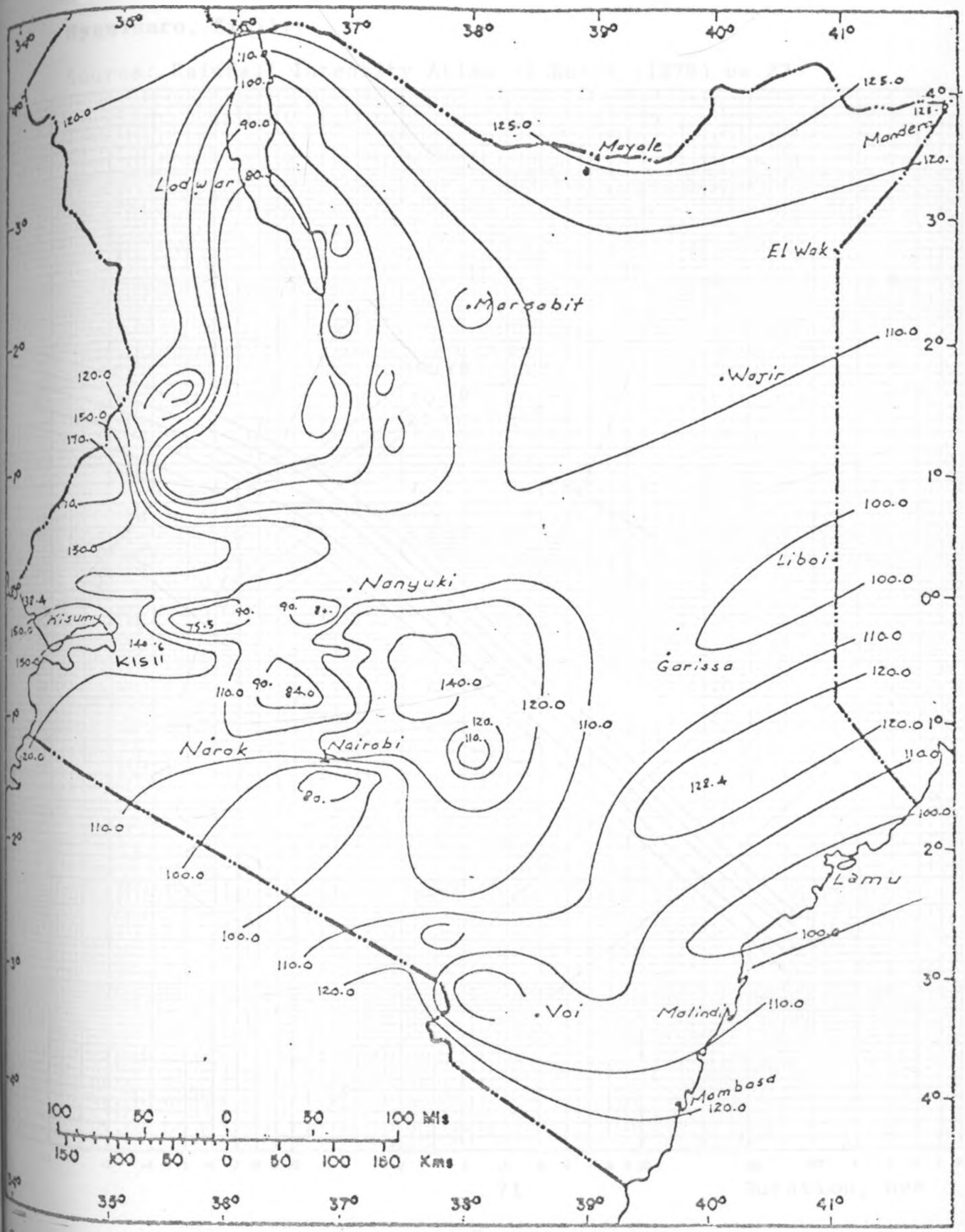
The only storm water drainage system is a crude system that drain water from the heavy rainfall experienced in Kisii town to prevent flooding.

The drains are roadside ditches extensively used for all sorts of solid waste disposal. Accumulated wastes in storm drains pose high potential health risks. They have become breeding sites for mosquitoes and flies which act as vectors for diseases such as malaria and filariasis and flood the streets and shelters.

Discharges from such polluted storm drains cause serious pollution to river Riana the receiving water body. Therefore it is important that the environmental management programme for Daraja Mbili, the storm water drainage system's role and impact should be considered. A well maintained and regularly cleaned storm water drain system may become a feasible means to dispose of sullage. Effective storm water management is needed to protect not only low-lying areas of Daraja Mbili f`rom inundation, but also the areas on Nyanchwa hill, where soil erosion resulting from storm water can be minimized or even obviated.

A sustainable solution is an implementation of an effective drainage system, that reduces the erosive power of the runoff water. Protection of areas vulnerable to land degradation and steering urbanization process into suitable areas, otherwise a combination of high sediment load in the storm water runoff and uncontrolled garbage disposal has made the open drains prone to blockage making maintenance of clean drains essential to control flood, soil erosion and mosquito breeding.

Figure 4.1 Five-Year 10 minute Rainfall Intensity in mm/hr.



Source: Rainfall Intensity Atlas of Kenya (1978) pp.27.

Figure 4.2 Rainfall Intensity-Duration-Frequency Relationship For Nyamisaro, Kisii.

Source: Rainfall Intensity Atlas of Kenya (1978) pp.27

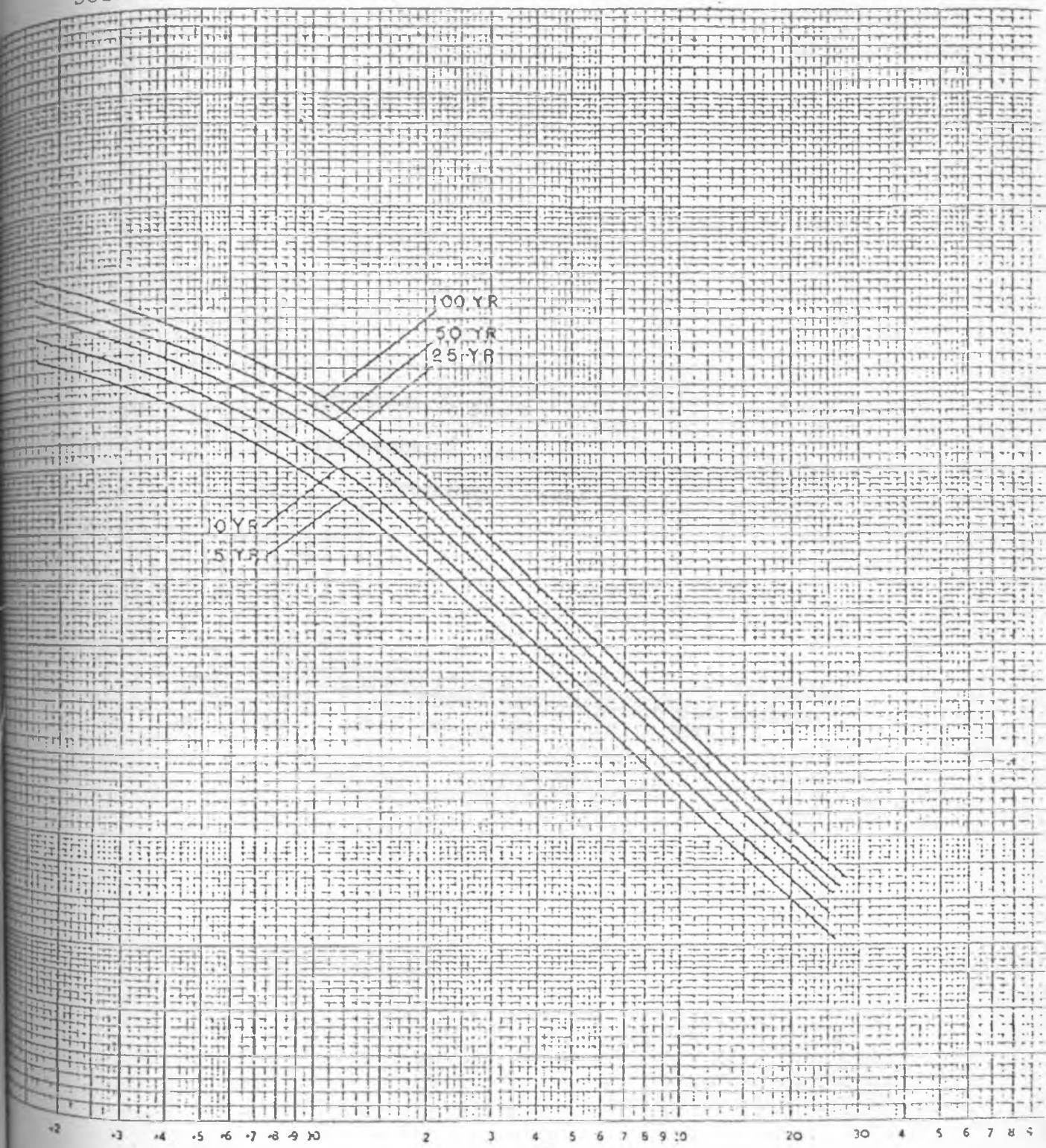


Figure 4.3 Example of Rain Duration-Intensity Curve.

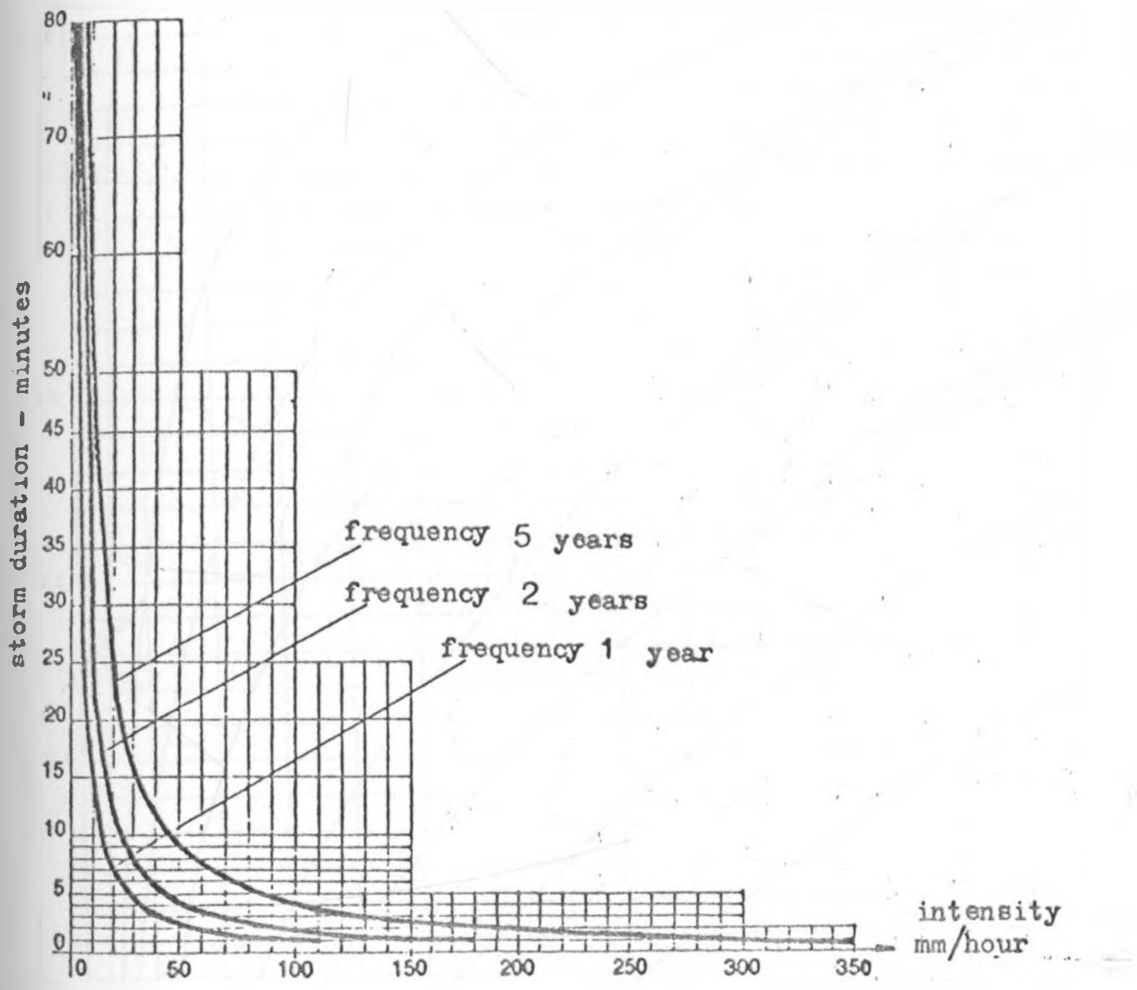
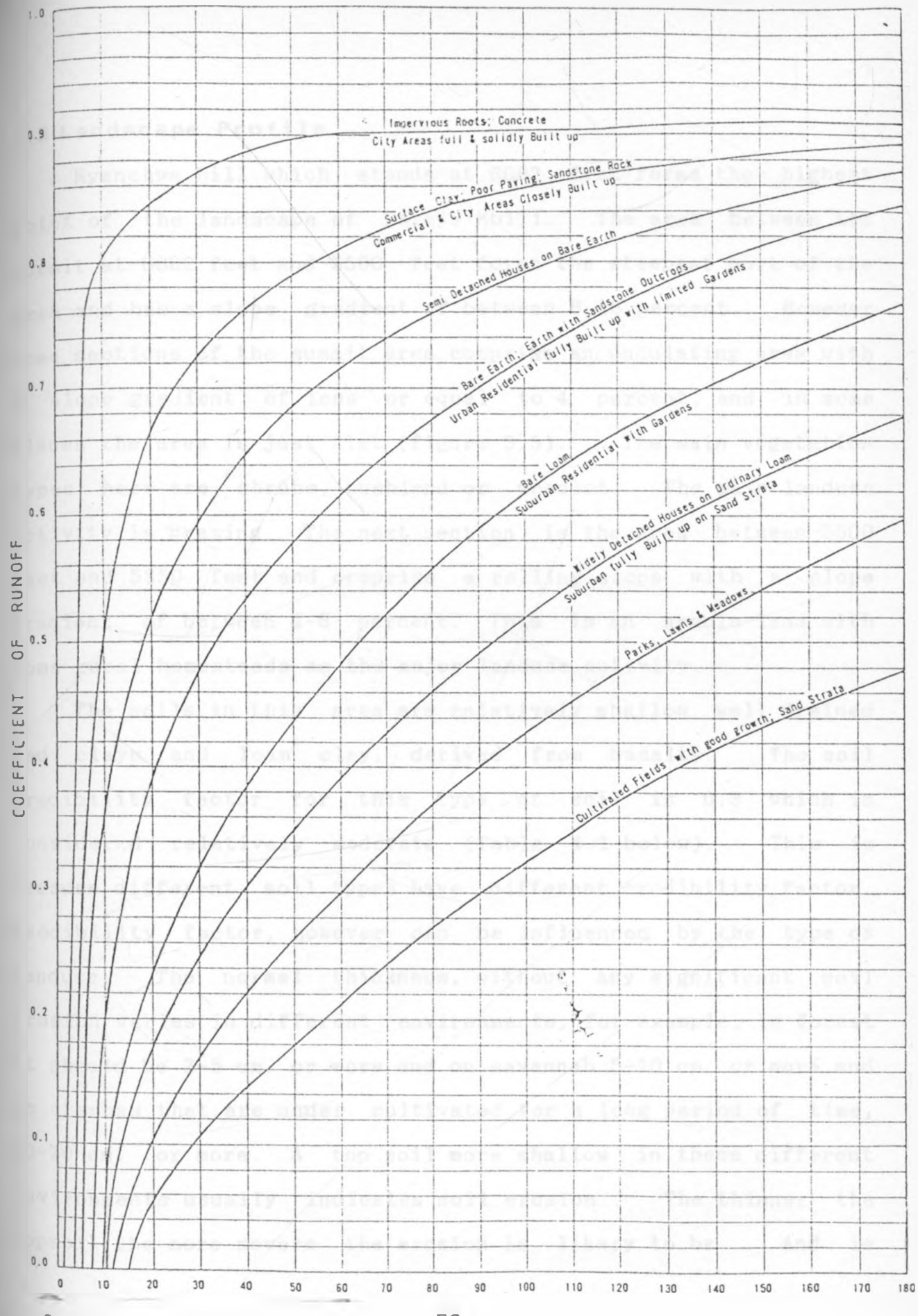


Figure 4.4 Run-off Coefficients for Urban Catchments



4.5 Landscape Profile

Nyanchwa hill which stands at 6082 feet forms the highest point of the landscape of Daraja Mbili. The area between the summit at 6082 feet and 5500 feet forms the steepest part of the area and has a slope gradient of between 8-16 percent. However some sections of the summit area comprise an undulating area with a slope gradient of less or equal to 4 percent, and in some places the area is just flat (figure 3.5). The main vegetation types here are shrubs, bushland or woodlot. The main landuse activity is grazing. The next section is the area between 5500 feet and 5350 feet and comprise a rolling slope with a slope gradient of between 4-8 percent. This is an arable land with some rural homesteads as the major landuse activity.

The soils in this area are relatively shallow well drained red clays and loam clay, derived from basalts. The soil erodibility factor for this type of soil is 0.3 which is considered relatively moderate (Table 4.1 below). This is because different soil types have different erodibility factor. Erodibility factor, however can be influenced by the type of landuse. The normal thickness, without any significant soil erosion varies in different environments, for example, in forest it should be 2-5 cm. or more and on savannah 5-10 cm. or more and on shambas that are under cultivated for a long period of time, 10-20 cm. or more. A top soil more shallow in these different environments usually indicates soil erosion . The thinner the topsoil the more severe the erosion is like;y to be . And is

also evident from poor growth and low yields of cultivated plants. This factors have to be compared with the situation in Daraja Mbili in order to appreciate the extent of the problem.

Table 4.1: Soil Types and Their Erodibility Factor

Soil type	Erodibility factor
Sand and loamy sand	0.1 [low because high infiltration]
Sandy loam and silt loam	0.2
Loam	0.4 [high because low infiltration and weak cohesion]
Red clay and loam clay	0.3
Clay	0.2 [low because strong cohesion]

Source: Soil Conservation in Kenya (Kenya 1981)

Implication for Daraja Mbili is vulnerability of the area to erosion because of the high erodibility of the soil . This is made worse as it lies on footslope of Nyanchwa hill on a flat to undulating land with a slope gradient of less or equal to 4 percent. Soils in this area comprise deep well-drained fertile red clay derived from weathered basalts. Towards the valley bottoms the soils are wet and less deep. The major vegetation type comprise scattered trees and woodlot with very low infiltration capacity (Duchhart 1989]. The main landuse activities are rural homesteads and urban landuse activities like residential and commercial buildings.

Landscape profile plays an important part in determining infiltration rates, which is also influenced by pedological and slope conditions. Infiltration is a very important hydrologic process, because it has runoff on the other side, as the water that does not infiltrate runs off in the absence of any detention

or depression storage, either as overland flow or as channel flow. Therefore lack of an effective drainage system in the sloppy landscape of Daraja Mbili has been a threat to the infrastructure facilities, which has hampered a sustainable development. Because of these impacts, it has become urgent to search for a new balance between the physical landscape and the environment , and urban development in Daraja Mbili.

The intensification and extension of the built up area in Daraja Mbili has increased the total surface of built-up land. As a result houses, roads, footpaths and open spaces like the open market have continued to seal the soil leading to no to little rain infiltration into the soil. This has reduced the infiltration capacity. For example, soil erosion per acre on land put into use for roads, houses or shopping centres, is about 10 times grater than on land cultivated in row crops, 200 times greater than land in pasture, and 2,000 times greater than land with timber [Duchhart 1989].

CHAPTER FIVE

DATA ANALYSIS AND FINDINGS

5.1 Introduction

In this chapter data from the field is analyzed and the findings are presented. The data is analyzed under three parts, the socio-economic situation, housing characteristics and the environment conditions.

5.2 Socio-Economic Characteristics

This section analyses the socio-economic characteristics of the households and the business enterprises in Daraja Mbili. This has been done in relation to the first research question which sort to inquire how the socio-economic processes and organization of the community has contributed to poor management of storm water and sullage. These characteristics include sex, age, marital status, educational level, the household size and the occupation of heads of household and their income levels. In business enterprises the attributes analyzed include sex, age, marital status, educational level of the entrepreneur and when the business was started. The objective of analyzing this data is to find out how the socio-economic processes and organization of residents of Daraja Mbili has contributed to poor management of sullage and storm water drainage.

5.2.1 Household Composition

Household composition give an insight into the housing conditions. The conditions determine the way storm water and sullage is managed. The household sizes in Daraja Mbili were distributed as follows, 45 percent of the respondent households had a two member family, 40 percent had between four to six member family and 5 percent had a seven member family. The average household size was 3.3 persons. Table 5.1 below show the distribution of household sizes of the respondent households. The findings show that over half of the respondent households had a small family size when considered that 55 percent of the households had a family size of two or three members. The reason for the peculiar small-household size is the low economic status of the residents such that most households cannot afford to stay with the whole family in the urban area. Most members of a household were either working and sharing the rent or relatives looking for work.

The small family sizes generate very little solid waste and sullage. So the system of environment infrastructure for sullage disposal is not big and therefore its cost is not high.

Table 5.1 Household Size of Respondents

Size of Household	Number of Households	Percentage Households
2	9	45
3	2	10
4	3	15
5	2	10
6	3	15
7	1	5
Total	20	100

Source: Field Survey.

5.2.2 Marital Status

Most of the household heads were married, and they accounted for 86 percent of the respondents. Only 14 percent of the respondents were not married and they all happened to be women. Table 5.2 below show the distribution of the marital status of the respondents. Early school drop has led to early marriage. This reason is supported by the fact that most of the respondents were young and had low incomes. The female headed households had lower income than those headed by males.

It can also be explained by the fact that most people are known not to want to admit that they are separated or divorced and could therefore have indicated they were married when actually they were not.

Table 5.2 Marital status

Marital Status	Number of Households	Percentage Households
Married	31	86
Single	5	14
Total	36	100

Source: Field Survey.

5.2.3 Education

The level of formal education in principle hold out the promise of equality of opportunity and increased access to better housing with better facilities such as sanitation infrastructure. In the study most of the household heads (both spouses) had primary education. They accounted for 86 percent of all respondent households. The household heads with secondary school education were 28 percent. Three percent of the respondents had no formal education at all. Table 5.3 below gives a breakdown of the educational background of the respondent households heads. The reason for this low level of education are many and varied. Most of them had dropped from school early. The low education disadvantaged them and most of them lack marketable skills. As a result they end up in low paying jobs and low income levels. Thus the community has to continue to rely on low rent houses many of which lack sanitary infrastructure. This state arises from processes dictated by the economic status of Daraja Mbili. Where it was found that the standard of living are low because most of the people live in low standard housing because they cannot afford batter housing somewhere with better services.

Table 5.3 Education Level of Household Head

Education Level	Number of Respondents	Percentage Respondents
Primary	40	69
Secondary	16	28
No formal education	2	3
Total	58	100

Source: Field Survey.

5.2.4 Age of Household Heads

The average age of household heads was 28 years which is quite young. Slightly more than half (52 percent) of the household heads were in the age bracket of 20-35 years. Out of this age category 33 percent are in the 20-30 years range, and 19 percent, the 31-35 years. Only 6 percent of the respondents were over 45 years old.[5] Table 5.4 below gives the breakdown of the age distribution among respondents. These age sub-groups fall within the most productive life of human beings. Great care should be taken to house them. The low age is because of early school dropout and movement to town to seek for jobs. Because of lack of opportunities in rural areas.

Table 5.4: Age structure of Heads of Households

Age group	Respondents	
	Number	percentage
20-30	12	33
31-35	7	19
36-40	11	31
41-45	4	11
+45	2	6
Total	36	100

Source : Field Survey.

[5]Nyamweno (1993) in a study in Kisii town found that 96.7 percent of his respondents were in the age range of 20-50 years.

5.2.5 Occupation

Forty one percent of the respondent were traders involved in unspecified business, 14 percent were involved in *Jua Kali* enterprises and 10 percent were in unspecified informal jobs. A second group comprising 9 percent were engaged in trades requiring apprenticeship including mechanics 5 percent and drivers 4 percent. Nine percent were in formal employment and included teachers 5 percent and unspecified formal employment 4 percent. Most of this group had some education. Table 5.5 below show how the occupations were distributed within respondents in Daraja Mbili. From the findings above, it is clear that households in Daraja Mbili have diversified their income by taking up different jobs. About sixty five percent of the household heads work in occupations that do not demand much formal education. Fourteen percent of the respondent households had both heads not employed. The informal employment has led to unpredictable income which made decent housing inaccessible.

Table 5.5 Employment Structure in Daraja Mbili

Occupation	Respondents Number	percentage
Unspecified Business	24	41
Mechanic	3	5
Carpenter	2	3
Teacher	3	5
Driver	2	4
formal employment	2	4
unspecified Jua Kali	8	14
others	6	10
Not working	8	14
Total	58	100

Source: Field Survey.

Most of the household heads work within Daraja Mbili as indicated by 63 percent of the respondents. Table 5.6 below show the place of work of the respondents. Majority of them were involved in retail business when considered that 48 percent of the commercial respondents owned retail shops, 16 percent were charcoal sellers and 13 percent were butchery operators. This information should be compared with the distribution of occupation of the household heads. Where forty one percent of the respondent were traders and 14 percent were involved in *Jua Kali* enterprises and 10 percent in informal jobs. Heads of households were no doubt trying to combine the advantages of living close to their place of work with those of competitive rents in Daraja Mbili in selecting their place of residence.

Table 5.6: Place of occupation of Household Head

Place of Occupation	Respondent Number	percentage respondents
In Daraja Mbili	22	63
Outside Daraja Mbili	13	37
Total	35	100

Source: Field Survey.

Over half of the businesses comprising 53 percent were established not later than 4 years ago. There is some relationship with the age structure of the resident population, majority of whom (52 percent) were between 20-35 years old (Table 5.4). Indicating that most of the businesses had been started by young people, especially in the *Jua Kali* sector.

The prevailing situation may part explain the composition of urban immigrants in terms of low level of education and therefore lack competitive skills. Most end up unemployed or operate as hawkers, petty traders, casual labourers, semi-skilled and unskilled with no permanent source of income. This can also be partly explained by their low levels of education and hence their inability to compete for jobs in the formal sector. The households, find employment either within Daraja Mbili or bordering neighbourhoods where they walk to work.

5.2.6 Income

Income is a major factor influencing the ability to pay rent and housing choice. In the study it was found out that income from informal sources was not easy to quantify though the sources are important to the livelihood of Daraja Mbili residents. In spite of this fact, household heads earning Kshs.500-1000 were 22 percent while 36 percent earned income range of Kshs. 1001-3000. Twenty two percent of the household heads earned between Kshs. 3001-5000 and 19 percent earned Kshs.5000 and above. Table 5.7 show the distribution of income among the respondents. Most of the respondent household heads, comprising 58 percent of the household heads earn Kshs.500-3000 per month. These earnings are compared with government classification of incomes in 1983. Low income group should be that earning Kshs.0-2000 per month, middle income group Kshs.2001-8000 per month and high income Kshs.8,000. and above. When these incomes are adjusted for inflation between

1983 and 1996, will reveal that majority of the households in Daraja Mbili fall within the low income category[8].

Table 5.7: Structure of Household Income

Income of household	Number of respondents	percentage respondents
500-1000	8	22
1001-3000	13	36
3001-5000	8	22
+5000	7	19
Total	36	99

Source: Field Research 1996

Income level is directly related to accessibility to shelter and other services. Income also determines effective demand for services and infrastructure like storm water drainage. To this end it is important to note that people with low incomes such as the inhabitants in Daraja Mbili do not afford conventional housing. It is instructive also to note that a 20-25 percent of household income is expected to be apportioned to housing. This was not the case in Daraja Mbili.

Low levels of income in Daraja Mbili is partly explained by the statutory requirements of building standards that cannot be met by all developers be a basis of land development. It is also explained by harsh monetary and fiscal measures like zoning

[8] I his research in Kisii town in 1993 Nyamweno found that most of his respondents could be grouped under low income using Kenya government official classification. The low income may also be linked to harsh economic conditions brought about among others Structural Adjustment Programme (SAPs).

regulations, which increase the cost of land and development. Failure by Kisii municipal council to devise appropriate means to assist Daraja Mbili residents has led to high poverty that has affected built environment. The early school dropout has limited access to formal well paying jobs. Most have ended up in the informal sector which have unpredictable income. As a result Daraja Mbili residents have one option: Overcrowding in existing temporary units for residential and business use. This phenomenon was found to have spread out of Daraja Mbili into nearby Nubia village.

5.2.7 Length of Stay

About half of the respondents, comprising 51 percent have lived in Daraja Mbili between 0-5 years. Out of this group, 33 percent had lived in the area for 2 years or less and 18 percent between 3-5 years. Twenty seven percent had lived in the area for 10 years and over. The average period of stay is 8.1 years. Table 5.7 below indicate the length of stay by various households. Most of the respondent households have not stayed in Daraja Mbili for along time considering over half have stayed in Daraja Mbili for five years or less. This data collaborates with the time when the various businesses were started in the area. Fifty three percent were started at least 4 years ago. Thirty nine percent were started in 1994. This compares well with the youthfulness of the residents. The short length of stay is partly due to movement out of the area when the income of a

resident has stabilized and increased. This imply that Daraja Mbili is the entry point into urban life in Kisii town for new immigrants from the rural areas.

Table 5.8: Length of stay

Length of stay (years)	Number of respondents	Percentage respondents
0-2	11	33
3-5	6	18
6-10	7	21
+10	9	27
Total	33	99

Source: Field Research 1996

5.3 Housing Characteristics

This section presents findings and analysis of the housing situation and how it has contributed to the state of the environment especially storm and sullage management.

5.3.1 Conditions of Housing Structure

The field survey revealed that 86 percent of the respondents lived in semi permanent structures. Only 14 percent of the structures could be described as permanent, as their outer-walls were constructed of quarry stones, concrete block or bricks.

There was a high proportion of housing units with durable floors. Seventy eight percent of the floors were made of concrete and cement. Only 22 percent were made of earth[7].

---

[7] According to Kenya government classification, a floor is deemed non-durable if it is made of earth, or timber. A roof is considered undurable if it is made of tin, thatched with grass or

All roofs were durable as they were made up of corrugated iron sheets. Most of the walls were made up of block (36 percent), followed by earth (28 percent) and corrugated iron sheets (14 percent).

From these results it is clear that most of the floors are durable while most of the walls are not. In contrast, roofing materials were all made up of durable materials. This can be explained by the relatively cheaper roofing materials which has encouraged people to build undurable walls and some undurable floors but with durable roofs of corrugated iron sheets. The possible explanation for the semi-permanence of structures is because they are built on quasi-legal land with insecure tenure. And in some cases the owners have fabricated houses taking advantage of the relatively high demand for this type of housing. The type of structures in Daraja Mbili are in consonance with structures found in most low-income settlements the world over.

Most of the housing structures comprising 55 percent were located randomly in Daraja Mbili of which 33 percent were randomly congested together. Twenty two percent of the shelters were randomly dispersed all over, and 22 percent of the respondents' dwellings were systematic congested together. The various patterns came about because of lack of any form of planning control over the area. Also the presumption that the settlement fall "outside" the ambit of the law. So people built haphazardly without following any formal order or adhering to

---

plant leaves (Kenya, 1986).

minimum standard in housing layout. These building patterns make it difficult to drain sullage or dispose in a sanitary manner. It has also led to lack of storm drains as there is lack of order. Consequently sullage is disposed near the house and storm water has to find its way down the slope.

5.3.2 Occupancy

Tenants account for 94 percent in residency and owner occupiers only 6 percent. Table 5.10 below show the occupancy status of the inhabitants of Daraja Mbili. We interpret from these figures that most residents of Daraja Mbili do not own the units in which they stay[8]. This confirm that majority of the residents in Daraja Mbili are tenants. The existing structures have mainly been erected for rental purposes by "absentee owners" who do not live in Daraja Mbili and whose interest is to obtain rent for their investment. The owners have either a quasi-legal right of occupation or no rights at all.

In terms of the size of housing occupied about 86 of all households interviewed were living in one or two rooms. Out of the 86 percent 69 percent lived in one room and 17 percent two rooms[8]. The other room occupancy is as follows; 8 percent occupied three rooms, 3 percent five rooms and 3 percent occupied

---

[8] The study finding support a study done in Kisii town in 1983 which found that 24 percent of all residents in Kisii town were owner occupiers and 76 were renters (kenya, 1986).

[8] Habitat study (1986) found that 35 percent of all urban residents in countries in Africa occupied single rooms.

six rooms[10]. Table 5.8 below show the room occupancy of the respondents. Average room occupancy is a measure of over-crowdedness. The general Kenyan standard is based on the number of people in the household and the number of habitable rooms at their disposal. Housing units which have 2.5 or more persons per habitable room are considered over-crowded. Using the official occupations standard for Daraja Mbili it is obvious that there is overcrowding in Daraja mbili[11].

Table: 5.9: Occupancy (rooms occupied)

Number of rooms	No. of respondents	percntage respondents
1	25	69
2	6	17
3	3	8
5	1	3
6	1	3
Total	36	100

Source: Field Survey.

Table: 5.10 Occupancy Status (rented or owner occupied)

Occupancy status	No.of respondents	percentage respondents
Rented	34	94
Owned	2	6
Total	36	100

Source: Field Survey.

---

[10] Comparatively, Nyamweno's study in Kisii town in 1993 found average room occupancy to be 1.5 persons and the average number of rooms to be 2.6.

[11] According to official Kenyan standards housing units which have 2.5 or more persons per habitable room are considered over-crowded (Kenya, 1986).

5.3.3 Rent

Rents are relatively low compared to conventional housing. For example 59 percent of the tenants paid Kshs. 300 or less. Those paying Kshs. 301-500 were 9 percent and Kshs.501-700, 18 percent. Sixty eighty percent pay rent amounting to Kshs. 700 or less. Table 5.11 show the various rent amount paid and how they were distributed among respondent households. The poor and cheap materials used in house construction tended to make them cheaper, when considered from viewpoint of cost recovery. Market price for a conventional dwelling unit of these sizes is twice what is charged. This situation is related to the demand and supply situation as well as affordability.

Sixty two percent of all business entrepreneurs interviewed paid Kshs.850 or less per month. Out of this proportion 15 percent were paying Kshs.800 per month and 38 percent were paying Kshs.600 or less per month[12]. Most the dwelling units were old and dilapidated. Making it difficult to manage sullage disposal and storm water runoff.

---

[12] Nyamweno (1993) found average house rents in the town to be Ksh. 680. He observed that most of the dwelling units did not meet the minimum standards. He was of the opinion that the rents charged were a bit high compared to the quality of the dwelling units.

Table. 5.11: Rent paid

Amount (Ksh.)	No. of respondents	Percentage of respondents
200-300	20	59
301-500	3	9
501-700	6	18
701-1500	2	6
+1500	3	9
Total	34	101

Source: Field Survey.

It can be confidently concluded that the low socio-economic status of households in Daraja Mbili has limited their accessibility to decent and affordable formal housing in the market today. Consequently, most of them have resorted to the more affordable informal housing. In fact demand for informal units in Daraja Mbili was found to be high and this is a clear sign that health and social conditions in Daraja Mbili are deteriorating.

5.4 Health and Environmental Problems

In this section, data relating to lack of adequate means of disposal of storm water, sullage and solid waste in Daraja Mbili is presented. This analysis is addressed to the second research question on how bio-physical environment especially steep slopes in the area have contributed to problem of sullage and storm water management.

5.4.1 Water Supply and Sanitation

Supply of water is a vital service in an urban settlement. It dictates availability of sanitation facilities. The sources of water influence water usage. In the study it was found out that 39 percent of the households get water from springs. Other sources of water are streams (25 percent), purchase water from vendors (11 percent), and 19 percent from reticulation system. a mere 6 percent get water from shallow wells[13]. Table 5.12 show distribution of sources of water for the respondents. Households in Daraja Mbili get water from these different sources at different times for different uses. For example spring are sources for drinking water while for other domestic uses are drawn from shallow wells and streams.

The explanation for the high dependence on natural sources especially springs and streams, is the reliability of sources in terms of distance and cost. Also, as in characteristic of informal settlements like Daraja Mbili, these areas are rarely serviced with reticulated water system.

Majority of the households (64 percent) use between 60-100 litres of water daily. six percent use between 20-40 litres daily and 7 percent use between 120-160 litres. Table 5.13 show

---

[13] According to World Health Organization "reasonable access" to water in an urban area include household connections, public fountain or a stand post located within 200 metres from a house. A household is not to spend a disproportionate part of the day in fetching the family's water (Saunders and Jeremy 1976).

how water usage is distributed among the respondents[14].

As for businesses people, 38 percent use spring water, 35 percent use stream water, 3 percent shallow well. Ten percent use piped water and 16 percent buy their water from vendors. As in household water usage the source of water supply has influenced water usage. Forty one percent use 60-100 litres per day, 32 percent use over 120 litres per day and 25 percent use 20-40 litres per day. Use of water is influenced by the kind of business one is carrying out. For example eating kiosks used more water per day than retail shops. The dominance of retail shops in the area, explains the low water usage per day by businesses because they require very little water to carry out their business activities.

Sixty seven percent of the respondents were pouring waste water on the ground. Nineteen percent into open channels between structures and open drains in front of the structures. Fourteen percent is drained into a cess pool. Table 5.14 show the different ways waste water is disposed. The biggest problem is how waste water is disposed, in view of the fact that about 80 percent the water ends up as waste. The main issue is where and how waste water is drained. This problem Is complicated by the red loamy soils in Daraja Mbili which have low impermeability and the high gradient.

---

[14] According to World Health Organization standards per capita water consumption in Africa per day for housing units and public stand posts are 60 and 20 litre respectively. Water consumption in Daraja Mbili falls within these World Health Organization limits.

Various problems were associated with the way waste water was drained. Twenty six percent of the respondents indicted that the waste water led to stagnant water around the housing unit, 26 percent of the respondents indicated that the waste water led to odour. Twenty two percent of the households reported mosquitoes which come about due to stagnant water. Twenty percent reported a muddy surrounding and 10 percent presence of flies which come about due to stagnant water.

Thirty six percent of the households had communal type of bathing facilities while 28 percent had private outdoor bathing facilities, 17 percent communal indoor. Fourteen percent did not have bathing facilities. Out of these, 8 percent bath inside their houses and 6 percent on the veranda[15]. These figures are in consonance with the economic status of the residents and the kind of housing units they occupy, that is, most live in one or two rooms and a bathroom has to be outside and often used as communal facility.

The way bathing is taken has led to peculiar problems of sullage disposal because much of the water from bathing places has to be disposed or drained to disposal site. As a result, 64 percent of the households complained of water from the bathroom making pools near the houses. According to 50 percent this has encouraged conditions for mosquito breeding close to their houses. Stagnant water also stink which was experienced by 32

---

[15] In Nyamweno's (1993) study 63 percent of Kisii residents were sharing bathing facilities, 29 percent individual bathrooms, 2 percent in their sitting rooms and 6 percent outside at night.

percent of the respondents. There are cases when the water infiltrated into the ground and led to a muddy conditions close to houses.

Table 5.12: Water sources

Source of water	No.of respondents	Percentage respondents
Spring	14	39
stream	9	25
Buy	4	11
Shallow well	2	6
piped	7	19
Total	36	100

Source: Field Survey.

Table 5.13: Water usage

Amount (litres)	Households		Businesses	
	respondents	percentage	Respondents	Percentage
20-40	6	17	8	26
60-100	23	64	13	42
120-160	7	19	10	32
Total	36	100	31	100

Source: Field Survey.

Insufficient supply of water together with inadequate provisions have created favourable conditions for the presence of disease. Diarrhoea was reported by 62 percent, dysentery 4 percent, typhoid fever 6 percent and intestinal parasites 13 percent.

Many of the health problems experienced in Daraja mbili are linked to a lack of adequate facilities for the disposal of waste water and storm water.

Table 5.14: Disposal of Sullage

Disposal of Sullage	No.of respondents	Percentage respondents
On ground	24	67
Cesspool	5	14
Open drain	7	19
Total	36	100

Source: Field Survey.

5.4.2 Solid Waste

Inadequate garbage removal services by Kisii Municipal Council has led to major health and environmental problems. Refuse is disposed close to dwelling units and surrounding earth streets. This waste has accumulated and got into the storm drains and thus blocking them. This problem was experienced by 28 percent of the respondents. Consequently the drainage channels have become clogged and they overflow with garbage (plate 1). These are breeding grounds for disease vectors and pests. Table 5.15 show solid waste management methods employed by respondents. Eleven percent of respondents affirmed presence of mosquitoes at garbage dumps, 8 percent rats and 6 percent flies . The situation is attributed to absence of garbage collection services by Kisii Municipal Council. For the few times that the local authority trucks and tractors collect garbage, it's limited to clearing the open market once a month.

Appropriate garbage collection and disposal will bring about improvements in physical environment in Daraja Mbili. It will minimize blocking of the storm drains. This will lead to a marked increase in the liveability of the area. Table 5.16 show the various problems faced by respondents. These problems are related to the way solid waste is managed. The rate of waste generation in Daraja Mbili is subject to site factors such as climate, culture or food habits and the poor economic status. Sources of waste vary in Daraja Mbili. Residential composition and commercial sources and type of waste dominate. Domestic waste or residential refuse consists of household garbage and is largely of kitchen wastes. Commercial waste consists mainly of waste from stoves, markets and local hotels. This type of refuse is supposed to be handled by Kisii municipality.

Street sweepings consist of dirt and litter, and also contain appreciable amounts of household refuse.

Table 5.15: Solid waste management

Where solid waste dumped	No. of respondents	percentage respondents
Communal dump	32	44
Dustbin	4	6
Waste get into drain	28	39
Does not get into drain	8	11
Total	72	100

Source: Field Research 1996.

Table 5.16: Problems of waste getting into drain

Problems faced	No.of respondents	percentage of respondents
Blocked drains	28	29
form water pools	19	20
mosquito breeding	11	11
odour	25	26
vermin	8	8
flies	6	6
Total	97	100

Source: Field Survey 1996.

Plate 5.1: Some of the solid waste is disposed near the stormwater drains blocking them. Note the natural drains formed by storm runoff.

5.4.3 Storm water

Most of the drainage in Daraja mbili is poor and in some places there no provision at all. Consequently, 58 percent of the respondent reported that storm water drained through open ground, 22 percent by the roadside and 19 percent on the road. Where drainage was present, it was mostly in the form of open earth drains. Table 17 below show how the respondents said stormwater was drained and table 5.18 show the problems coming about as a result of the way stormwater was drained. The drains were choked with refuse blocking them, 15 percent of the respondents indicated that the blocked drains led to stagnation of water, 19 percent soil erosion and 22 percent erosion of road

surface (plate 2). Twenty percent said that the storm water flooded roads making them impassable. Sometimes the storm water collects and dump solid waste in drains, roads or open ground as reported by 23 percent of the respondents (plate 3).

Table 5.17: Storm water management

Stormwater drainage	No. of respondents	Percentage respondents
On the road	7	19
On roadside	8	22
On open ground	21	58
Total	36	99

Source: Field Survey.

Table 5.18: Problems Arising From Stormwater Drainage

Problem from storm water	No. of respondents	Percentage of respondents
Eroded road	21	22
Flood road	21	22
Dump solid waste	22	23
soil erosion	18	19
Stagnant water	14	15
Total	96	101

Source: Field Survey.

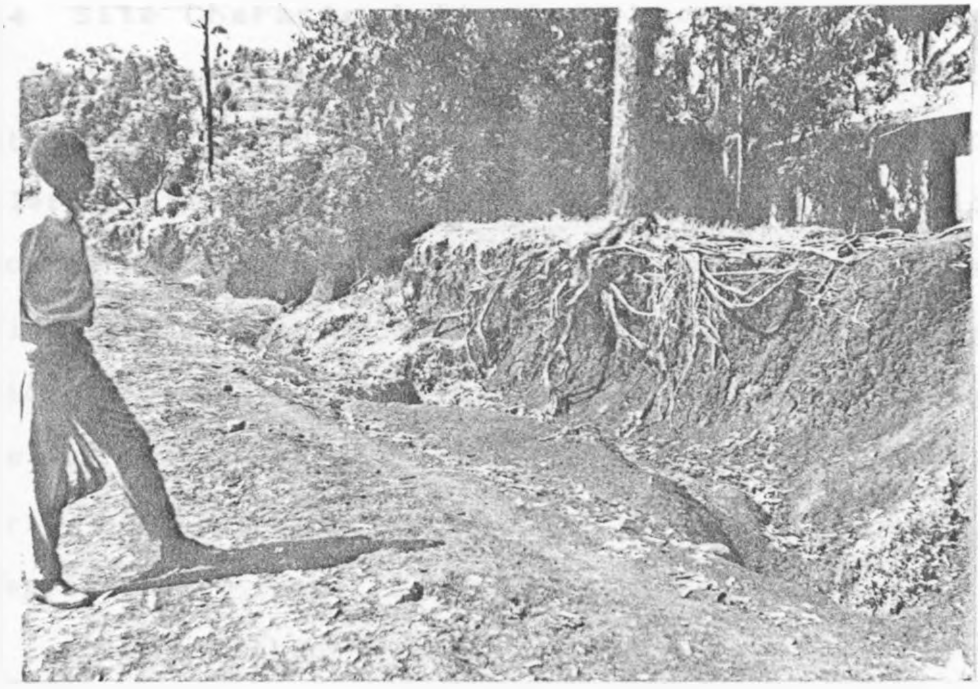


Plate 5.2: The stormwater has eroded the Daraja Mbili- Nubia road. Notice the exposed roots of the tree indicating massive soil erosion. The sides of the road form the channel for stormwater drainage.

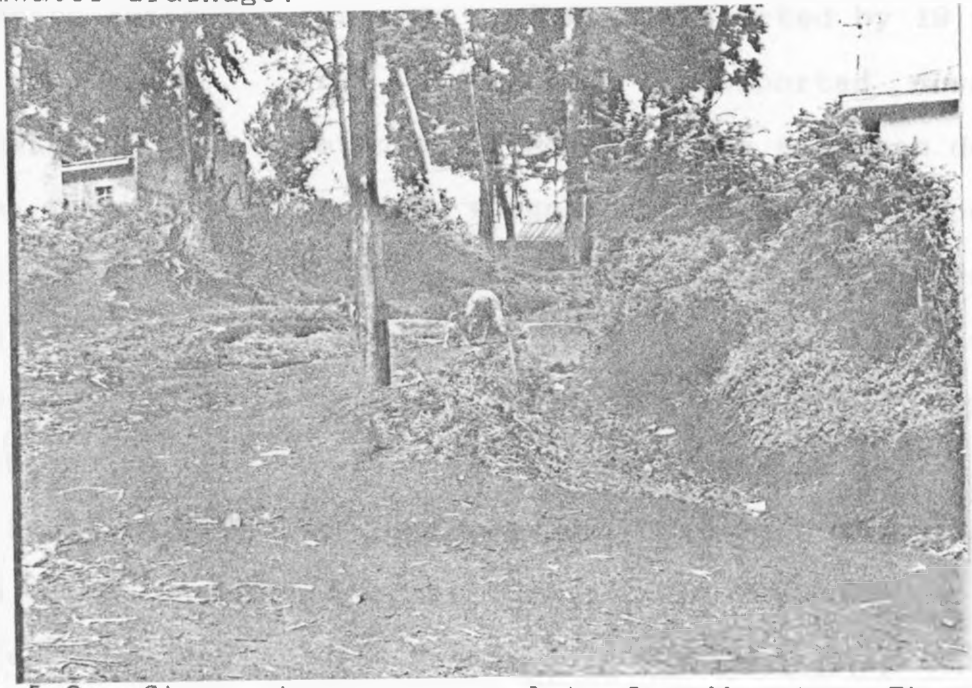


Plate 5.3: Stormwater carry a lot of sediments. The small size of the culverts constrain water passage. As a result they are blocked.

5.4.4 Site Characteristics and Location of Houses

Fifty three percent of the respondents' dwellings were located on steep sections of the landscape and 47 percent are on gentler sections. Table 5.19 show the site location of the respondents' housing units. As a result the area present difficulties to housing construction. There are also problems of erosion from storm water and sullage increased as more shelter units are built. Two issues arise so far. Firstly, because majority of the houses are sited on steep slopes, they have increased storm runoff because of reduced vegetation cover and roof catchment without gutters and tanks.

Out of all respondents 15 percent cited soil erosion as a problem that is caused by sloppy site. Large quantities of sediments enter the drainage system, as reported by 19 percent of the respondents. The sediment is transported downhill and deposited at valley bottoms. Eroded surface also has depressions which form into pools of stagnant water which flood on the gentler slopes. This stagnant water attract mosquitoes reported by 14 percent and flies reported by 5 percent of the respondents. Table 5.20 indicates problem faced by the respondents which were attributed to site location conditions of the house.

Rooftops also act as impervious surfaces which generate to storm water runoff. Overall erosion has also led to rills and gullies that are growing headwards towards built up areas.

Although interception of rainfall runoff by vegetation was not significant in Daraja Mbili, it has played a significant role

in encouraging infiltration. Sixty seven percent of the respondents indicated that they had some form of natural vegetation close to their buildings. However, significance in controlling storm water runoff is negligible as this vegetation is scanty. Thirty three percent of the respondents reported absence of vegetation close to their buildings. It was mentioned in earlier sections of the thesis that farming activities on Nyanchwa hill has led to clearing of natural vegetation and replacing it with pasture and crops (plate 4). This process has increased surface water runoff, rate of runoff and reduced infiltration.

Table 5.19: Location of Dwelling Unit

site of dwelling	No. of respondents	Percentage respondents
On steep slope	19	53
On gentle slope	17	47
Total	36	100

Source: Field Research 1996

Table 5.20: Storm and Sullage Problems Linked Dwelling Unit Site

Problem linked to site	No.of respondents	Percentage respondents
Soil erosion	16	15
Solid waste deposit	20	19
Poor drainage	4	4
Stagnant water	16	15
Eroded roads	16	15
Flies	5	5
Mosquitoes	15	14
Vermin	4	4
Unstable house site	3	3
odour	9	8
Total	108	102

Source: Field Research 1996.

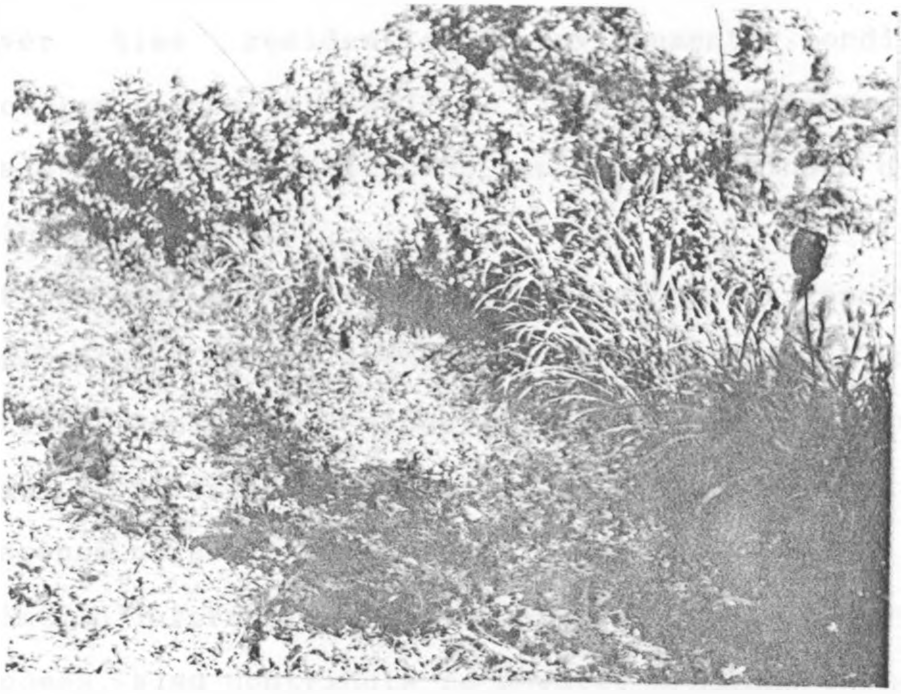


Plate 5.4: Some of the vegetation has been cleared and land put under pasture and crops. In some instances on Nyanchwa hill nappier is planted across the shambas to encourage infiltration.

5.4.5 Health Situation

Under the Local Government Act Cap 265, Kisii municipal council is empowered to provide basic services in its area of jurisdiction. However it was found out that Daraja Mbili has inadequate services, poor housing conditions and there is overcrowding. This has led to high incidence of environmental-health related diseases. In the study 62 percent of respondents reported malaria as a very common disease affecting the household, followed by diarrhoea 15 percent, dysentery 4 percent, typhoid 6 percent and intestinal related problems 13 percent. Table 5.21 show the common diseases suffered by the respondents which are attributed to the state of sanitation. These diseases reduced productivity of the residents.

Over time residential environment conditions have deteriorated in Daraja Mbili. The use of temporary building materials and lack of utilities explains continued deterioration of living conditions.

It was that there is a link between poverty and health among the residents. These infectious diseases are related to poor sanitation conditions especially sullage and storm water drainage. Uncollected garbage, lack of clean water, storm water and presence of sullage.

Limited information because of low levels of education, and low incomes, also contribute to poverty problems in Daraja Mbili.

Table 5.21: Common diseases suffered by Respondents

Common diseases linked to storm and sullage management	No.of respondents	Percentage respondents
Malaria	33	62
Cholera	2	4
Typhoid	3	6
Diarrhoea	8	15
Intestinal diseases	7	13
Total	53	100

Source: Field Survey.

In conclusion environment sanitation has had much to do with the health of the residents in Daraja Mbili.

5.5 Analysis of Third Research Question Using Chi-Square

The third research problem posed the question whether problems experienced in Daraja Mbili are linked to the way sullage and storm water is drained or disposed of. Chi-square method of data analysis was used to answer this question.

The problem is to decide whether there is a significant difference between the problems related to storm water management and the problems related to dwelling site.

The aim is to know whether the differences observed among the sample proportions are only due to chance. If the difference is significant, it is concluded that environmental problems experienced arise from site characteristics of the dwelling and other factors. But if the difference is not significant then storm water problems experienced do not arise from site characteristics of the house. The objective is to determine whether problems arising from the way storm water is disposed of and those arising from the location characteristics are dependent or independent of each other.

In table 5.22 below is a contingency table prepared to show the response rate for various problems attributed to the two situations. Table 5.23 show the expected frequencies of the problems experienced.

Table 5.22: Observed frequencies

Factor	erode road	flood road	dump waste	soil erosion	water pools	total
storm water	21	21	22	18	14	96
House site	16	4	20	16	16	72
Total	37	25	42	34	30	168

Source: Field Survey.

Table 5.23: Expected frequency

Storm water	21.1	14.3	24	19.4	17.1	96
House site	15.9	10.9	18	14.6	12.9	72
Total	37	25	42	34	30	168

Source: Field Survey.

$X^2 = 9.5$

Degree of freedom = 4 x 1 = 4

Tabulated X^2 with 4 d.f. at 0.1 probability level is 7.8.

Therefore problems experienced due to storm water management and location of the dwelling unit are different but the differences are not very significant.

The data from the five samples is combined to estimate the proportions of the total problems (total sample) affected by storm water.

$$\text{Proportion affected by storm water} = \frac{21+21+22+18+14}{37+25+42+34+30} = 0.57$$

0.57 is the estimate of problems experienced which are attributed to storm water drainage, then 0.43 is the estimate of problems faced due to dwelling site. Estimation of the population in each problem category who are expected to be affected by storm water or dwelling site, this information is given in table 5.24 below.

Table 5.24 Observed and Expected households affected by problems

Affected by S/water	Eroded road	flooded road	Dumped waste	Soil erosion	Water pools
Actual	21	21	22	18	14
Expected	21	14	24	19	17
Affected by H/Site					
Actual	16	4	20	16	16
Expected	16	11	18	15	13

Source: Field Survey.

Interpretation

Because the difference between the set of observed and expected frequencies is not very large, it is concluded that there is differences in proportions of the problems attributable to the two variables, however, difference is not very significant because of the small differences.

To test how problems experienced because of the way sullage is disposed of are related to problems experienced because of the site of the dwelling unit. Table 5.25 show the frequency of observed problems.

Table 5.25: Observed frequencies

Factors	Pools of water	Odour	Mosquitoes	Muddy	Flies	Total
Sullage	21	21	18	16	8	84
House site	16	9	15	20	9	69
Total	37	30	33	36	17	153

Source: Field Survey.

Table 5.26 below show the expected frequencies from the observed frequencies in table 5.25.

Table 5.26: Expected frequencies

Sullage	20.3	16.5	18.1	19.8	9.3	84
House site	16.7	13.5	14.9	16.2	7.7	69
Total	37	30	33	36	17	153

Source: Field Survey.

Computed $X^2 = 4.8$

Tabulated X^2 at 0.1 probability level is 7.8

Interpretation

The problems experienced because of the way sullage is disposed of and problems due to landscape units are significant. Therefore both factors significantly affect the environmental status of Daraja Mbili. The alleviation of the problems should be considered as very necessary.

To test whether problems experienced because of the way storm water is drained, sullage is disposed of, problems which come about because of the dwelling site and how solid waste is disposed of are related.

Table 5.27: Observed frequencies

	Soil erosion	Waste deposit	Flood road	H2O pool	eroded road	Vermin	Odour
Runoff	18	22	21	14	21	0	0
Sullage	0	0	16	21	16	26	21
Site	16	20	4	16	16	24	9
Solid dispose	0	28	0	19	0	25	25
Total	34	70	41	70	53	75	55

Source: Field Survey.

The following are the expected frequencies from table 5.27.

Table 5.28: Expected frequencies

Runoff	8.5	17.6	10.3	17.6	13.3	18.9	13.8	96
Sullage	7.5	15.4	9	15.4	11.6	16.5	12.1	84
site	9.4	19.2	11.3	19.2	14.6	20.6	15.1	105
Solid dispose	8.6	17.8	10.4	17.8	13.5	19	14	97
Total	34	70	41	70	53	75	55	382

Source: Field Survey.

The calculated x^2 = 166.8

Degree of freedom = 18

Tabulated X2 at 0.1 probability level = 26

Interpretation

There are significant differences in problems experienced in Daraja Mbili which come about due to the way storm water is drained, sullage is disposed of, the location of the dwelling unit and the way solid waste is disposed of. Problems experienced are independently attributable to the four factors. Therefore each should be addressed in order to effectively manage their environmental consequences.

5.6 Summary of Analysis

A substantial proportion of Daraja Mbili population face serious economic, social and environmental problems. All these have led to poverty. Residents are cramped in inadequate housing at a site that is too steep and therefore unsuitable for housing without high cost in building technology.

The houses are precarious, cramped and overcrowded and allow insects and rats to inhabit them. There are no basic services such as storm drains, garbage dumping and collection points and sullage disposal facilities. Garbage is rarely collected and sullage is inadequately disposed. It was found out that 67 percent of the respondents pour sullage close to their houses.

Daraja Mbili is an environmentally fragile area due to steep and nature of ground surface. A concentration of population has led to degradation of environment. It was found out that 15 percent of the respondents experienced soil erosion problems, storm water deposits solid waste in terms of soil sediments by 19

percent, leading to stagnant water and road erosion (30 percent).

To a large extent, the health and environmental problems experienced in the area stem from congestion, from deficient urban infrastructure and from inadequate provision of basic services, and on this, the urban poor in Daraja Mbili are both victims and factors in this.

CHAPTER SIX

TOWARDS ALTERNATIVE PLANNING AND MANAGEMENT APPROACHES

6.1 Introduction

This chapter summarises the major findings on stormwater drainage and waste water sanitation. The environmental situation is related to socio-economic situation and environmental problems experienced. Alternative strategies to remedy the situation are also suggested.

6.2 Summary and Conclusions

6.2.1 Socio-economic Factors

Most of the population of Daraja Mbili belong to the low income category. Fifty eight percent of the household heads were earning monthly income of between Ksh.500-3000. Most of this income came from the informal sector with only 9 percent of the respondents working in formal employment. The rest were working in the informal sector. As a result most of the residents do not afford housing with acceptable standards.

The average household size was 3.3 persons. Fourthly five percent of the respondents had household size of two members and 10 percent had a size of three members. Sixty nine of the respondents were inhabiting one room. This is compared to the official Kenyan categorization which consider a house overcrowded if a room has resident membership of 2.5 persons or more. Therefore most of the households were overcrowded.

Fifty two percent of the household heads were within 20-35 years age category. The average age of household heads was 28 years. This category of population is the most productive and require special housing requirements. Eighty six percent of the household heads were married and the 14 percent who were not married were conspicuously women. The housing requirements of single women and married households differ to a great extent. Of all the respondents 86 percent had primary school education. Limited education has restricted access to well paying jobs and therefore limited their access to formal housing.

6.2.2 Housing Characteristics

Most of the households stay in informal housing. Eighty six percent of the respondents were living in semi-permanent houses. The low socio-economic status of the residents has limited access to affordable decent housing. Most of the dwellings are randomly laid out in Daraja Mbili with 55 percent of the respondents indicating that their dwellings were randomly laid out. The haphazard housing pattern does not leave space for utility infrastructure facilities such as storm drains and also led to limited access for provision of services. This has come about due to lack of planning control over the area.

The houses are very cheap to rent compared to conventional housing. For example 59 percent of the respondents were paying monthly rent of Ksh.300 or less. The dilapidated nature of the housing made them affordable to low income people.

It is clear that Daraja Mbili play a significant role in providing housing for low-income households in Kisii town. This has come about because of the inability of the formal sector to provide affordable decent housing for the low income groups.

6.2.3 Environmental Factors

Daraja Mbili is environmentally fragile. The steep slopes are not protected against storm water runoff. Fifty eight percent of the respondents reported that storm water drain through open ground because of lack of storm drains. The people who have settled in Daraja Mbili have cleared vegetation and have not taken any environmental management method. Environmental degradation has surged through flooding and soil erosion during the rainy season. As a result of the site location of the dwellings units, 15 percent of the respondents experienced soil erosion, 15 percent erosion of the road. This was because 53 percent of the respondent were settled on footslope without any environmental management.

6.2.3.1 Topography

The steep slopes have limited on-site sanitation options. Storm runoff from the steep slopes right from the hill top at Nyanchwa and unstable loamy-clay top soils has resulted in soil erosion. Modern farming methods On Nyanchwa hill have been used to some extent to protect top soils and in controlling erosion.

6.2.3.2Roads Construction

Construction of Daraja Mbili-Nubia road aligned to the hill and the general trend of footpaths and tracks going straight uphill has caused erosion and sedimentation problems. Disturbed soils at the road margins are not revegetated. However 67 percent of the respondents had some vegetation close to their buildings but were scattered and therefore not effective in controlling storm runoff. Roads are of excessive length of slope and lack adequate culverts or mechanisms to interrupt the flow of water over the road surface. Many of the negative environmental effects of road construction can be avoided by choice of road locations, road design and construction methods.

6.2.4 Sanitation Infrastructure Facilities

The main source of water was natural sources. Thirty nine percent of the households got their water from springs and 25 percent from streams. Comparatively, 38 percent of the business people got their water from springs and 35 percent from streams. Sixty four percent of households use between 60-100 litres of water daily, comparatively 41 percent of business people use such an amount. Much of the waste water comprising 67 percent of the respondents disposed it on the ground around the house.

Inadequate sullage disposal facilities has led to sources of water supply to become polluted. Improved water supplies provide more water for personal hygiene improving public health, but also create potential for pollution from sullage disposal.

The solid waste generated at the market and from households is rarely collected. Much of the garbage accumulate on the street and pathways blocking the storm water ways. Only 22 percent of respondents indicated that the waste does not get into the storm drains. Better garbage collection will improve the physical environment and limit garbage interference with storm drains.

Storm water drains through natural storm drains. In fact 58 percent of the respondents indicated that storm water drained though the open ground because there was no provision of storm drains. Much of this water flow through the road side eroding it.

Most people lack basic services and infrastructural facilities to get rid of stormwater and wastewater and other related facilities like dustbins and solid waste dumps whose absence has affected storm water and sullage management.

Improvement in facilities that have accompanied development such as buildings, streets, open market areas, etc has resulted in increased runoff and considerably increased flood risks by increasing imperviousness.

6.3 Recommendations

This section gives recommendations to alleviate environmental problems brought about by inadequate disposal of storm water and sullage. And also to better manage storm water and sullage.

6.3.1 Socio-economic Situation

From the research findings, most of the residents of Daraja Mbili belong to the low income category. For example 58 percent of the respondents were earning between Ksh. 500-3000 per month. For environmental management measures to be effective they should take into consideration the low economic status of the residents. Therefore, environmental management programmes and projects designed should involve limited financial resources unless the financiers are external for example Non Governmental Organizations or government agencies. Clear priorities will have to be set for allocations on environmental management measures in the most cost-effective manner. Community self-help organisations should be mobilised for significant environmental improvement at minimal cost to the authorities. The environmental management process in Daraja Mbili can take advantage of this resource.

This consideration will play an important role in planning for the disposal of stormwater and sullage. Plans prepared in close collaboration between storm and wastewater planners and Daraja Mbili residents, could avoid errors and improve the chances of successful plan implementation.

6.3.2 Housing situation

The study found out that informal sector has played a significant role in providing housing for the urban poor. The local authority has however not accepted or supported this kind of development. This brings into consideration the issue of

tenure. Generally a significant effort goes into environmental improvements in squatter areas where some kind of security of tenure has been arranged. The same should be extended to the residents of Daraja Mbili to create a sense of belonging in order to stimulate environment improvement and management.

A formal plan should be made for the area to guide and control development. The plan should consider the layout of the proposed housing development with regard to the steep topography.

6.3.3 Environmental Factors

Environmental factors consider natural environment and landuse activities influencing storm water and sullage drainage.

6.3.3.1 Sustainable Agriculture on Nyanchwa Hill

Sustainable approaches to agricultural practices should be emphasized Emphasis should be laid on more sustainable agricultural practices such as terracing, crop-pasture rotation, farm woodlot, contour farming, and permanent pasture.

This is important because Nyanchwa hill forms the catchment area of Daraja Mbili. The agriculture practices should discourage storm runoff which cause environmental degradation in Daraja Mbili. The variables that offer the most hope for controlling storm runoff are; rapid increases in forest area and forest productivity; and a reduction of overgrazing, with better management of grazing areas to ensure sustained yields.

The above variable variables should be addressed through the following measures.

6.3.3.2 Community-based Forestry Programmes

There should be formal institutionalising and supporting of traditional forms of community natural resource management.

The infrastructure to support these forests include the establishment of village nurseries and distribution of seedlings. Other approaches include input subsidies on efficient cook stoves, which decrease the demand for wood, encourage preservation of forests, and encourage stormwater infiltration lessening negative environmental effects in Daraja Mbili.

These suggestions are based on assumption that community-based forestry systems form a key link in reducing storm runoff which has contributed to environmental degradation downhill in Daraja Mbili and also to increase agriculture production.

6.3.3.3 Storm Water Management On the Steep slopes

The main purpose of an urban drainage in Daraja Mbili is to convey stormwater and wastewater to the receiving waters with a minimum of nuisance, danger and damage. Goals for urban drainage management should be as follows:

(a) to ensure that floodwater inundation of Daraja Mbili occurs only on rare occasions and that the velocity/depth conditions during these events are below prescribed limits;

(b) to provide convenience and safety for pedestrians and traffic by controlling stormwater flows within prescribed limits; and

(c) to retain within each catchment as much incident rainfall and runoff as is possible given the planned use of the catchment terrain and its biotic and engineering characteristics.

Temporary flood storage will reduce drainage costs in two ways:

(a) peak flood flows are attenuated, thereby reducing downslope drainage capacity requirements; and

(b) temporary storage provides recreational and aesthetic benefits and thereby, increases land values.

The steep slopes discourage natural storage occurring through infiltration or wetting on natural vegetation and in surface depressions. The storage act to reduce the peak of the storm hygrograph by increasing the time of concentration and by varying and spreading the range of concentration times from the individual contributing areas like Nyanchwa hill. It therefore lessens downslope flooding and the size of the designed drainage system necessary to handle a given storm event.

Storage, therefore, will augment insufficient natural storage in the area to avoid aggravating downslope capacity in Daraja Mbili. Storage may be concentrated or distributed. The following methods should be used to manage storm water runoff in the area.

Detention

This technique use temporary storage to collect and hold run-off for a short period of time and then release it through a controlled outlet into the normal drainage system at a reduced rate. The peak outflow is lessened and the drainage system in Daraja Mbili is more easily able to carry the storm flow. This is illustrated in figure 6.1 below. Which is a detailed illustration of detention ponds suggested in the final plan proposal map for the area given in figure 6.5. The plan proposal on how it can be incorporated in planning of Daraja Mbili is summarised in figure 6.5. The following two techniques may be used for provision of water detention.

(a) Tanks

All conventional roofs of buildings in Daraja Mbili should be fitted with gutters and water tanks which would gather and store the house stormwater. The water could be used for domestic purposes. Since the tank in this system is to be placed at the very source of a major component of the stormwater runoff, the savings accrue to all components of the drainage system. Thus there could be overall economic benefits by introducing a tank detention system for each household in the area.

(b) **Retarding basins**

These are downslope detention basins. Each area used for the temporary storage of runoff should be designed to discharge its storage more slowly than the rate of inflow, thereby providing attenuation to the hygrograph as it passes through the storage.

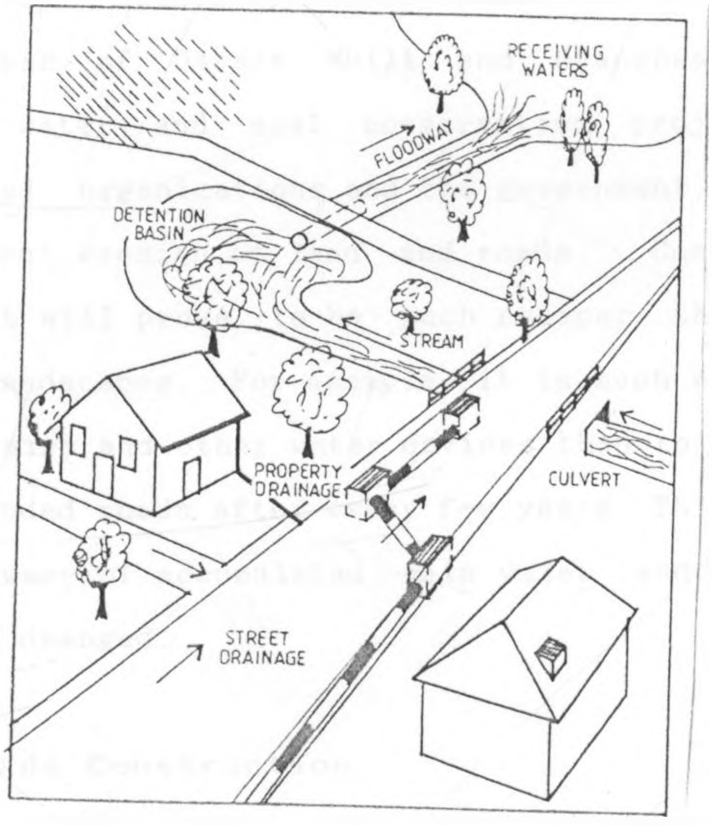


Figure 6.1 Detailed example of an Urban Stormwater Drainage System With Detention Basin to Control Velocity of Runoff. Plan proposals for the area are shown on figure 6.5.

The local authority should also protect the environment through public awareness campaigns. The local authority can stimulate the preservation and improvement of urban environment in Daraja Mbili through careful planning. Every plan the council approves either on Daraja Mbili or any other environmentally vulnerable area should have a paragraph on how such a plan influences the environment, how negative aspects could be reduced to a minimum and how the environment could be protected.

The local authority should coordinate tree planting on the steep slopes of Daraja Mbili and Nyanchwa hill by school children, water and soil conservation projects through Non governmental organizations and the government. These strategies will prevent erosion of land and roads. Constant care for the environment will prove to be much cheaper than restoration of degraded landscapes. For example, it is much more economical to install drains and other water devices than to have to repair the heavily eroded roads after every few years. This will reduce the erosive power of accumulated rain water and protect the roads from being damaged.

6.3.3.4 Roads Construction

Daraja Mbili-Nubia road aligned to the hill and the general trend of footpaths and tracks going straight uphill has caused soil erosion. The two kilometre Daraja Mbili-Nubia road presents excessive length of slope which encourage soil erosion because of uninterrupted storm water runoff. Lack of adequate culverts or

mechanisms to interrupt the flow of water over the road surface encourages soil erosion further. Many of the negative environmental effects of road construction can be avoided by choice of road locations, road design and construction methods. The planning of road networks in Daraja Mbili should consider the area's slopping topography, geology, soil and hydrology to determine optimal road alignment. The roads should not be constructed with a direct downslope alignment. To minimise soil erosion and adequate road drainage drains and culverts among others should be provided. Road construction be done during the dry-season to minimise erosion and siltation. To reduce the impact of Stormwater drainage on flood control, the following design principles in figures 6.2, 6.3, and 6.4 should be used to overcome this problem. The first model (figure 6.2) show the existing situation which should be avoided.

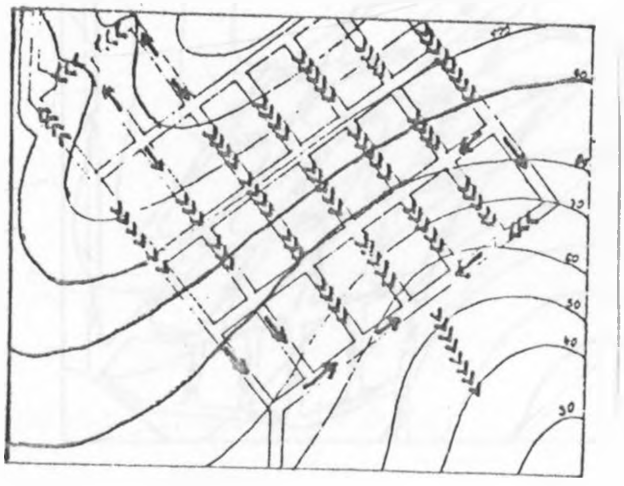


Figure 6.2: Roads layout which follow steep gradients, causing high water velocities and resulting erosion. This is an incorrect plot and road system layout from the point of view of drainage Source:UNCHS (Habitat, 1986).

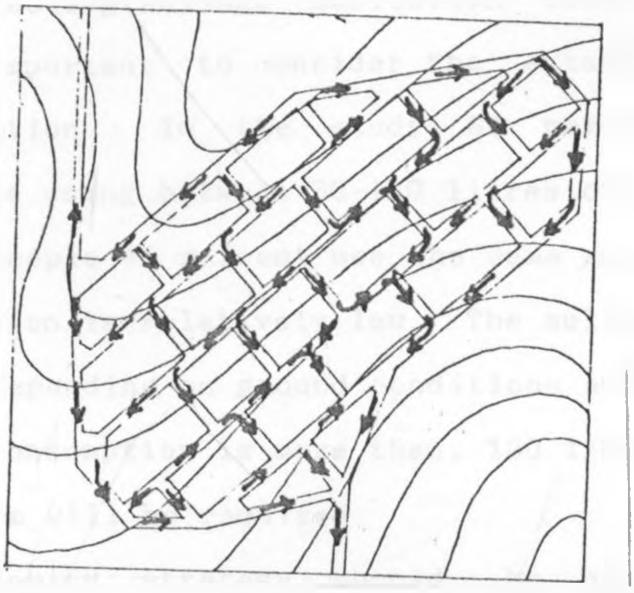


Figure 6.3: Design principle 1: To reduce water flow velocities the layout should lead to frequent changes in the direction of water, thus reducing the length of sections with steep gradients.
Source:UNCHS (Habitat, 1986).

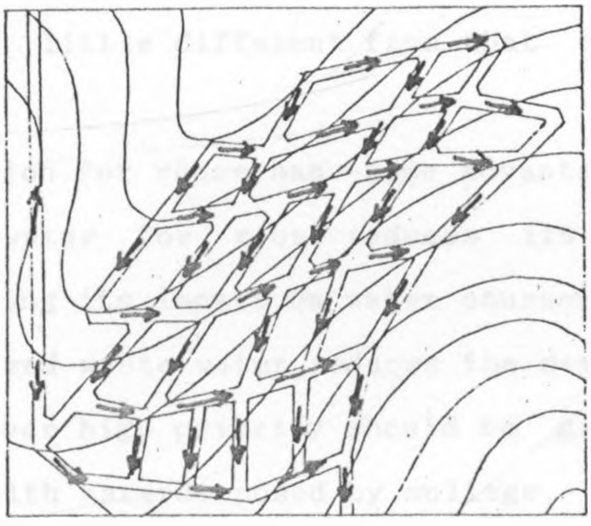


Figure 6.4: Design principle 2: Gradients on all road sections should be kept similar so that water velocities are less than critical value.
Source: UNCHS (Habitat, 1986).

6.3.3.5Alternative options for Sullage Disposal

When selecting sullage sanitation technology for Daraja Mbili it is important to consider the existing and anticipated water consumption. In the study 64 percent of respondent households were using between 60-100 litres of water per day. As for business people 41 percent use the same amount of water. This water consumption is relatively low. The sullage can be disposed off on site depending on ground conditions and building density. If the water consumption is more than, 100 l/cap/day some sort of sewerage system will be required.

The following strategy should be used to achieve an appropriate way of disposing of sullage.

Reuse of Wastewater

The collection of the wastewater and their treatment for reuse is very little different from that required for treatment for disposal.

Reclamation for reuse has some advantages. The reclamation of the wastewater for reuse reduces its pollution potential, thereby reducing its impact on water courses below the area. The use of reclaimed waste water reduces the demand for high quality water. However high priority should be given to the control of potential health hazards posed by sullage.

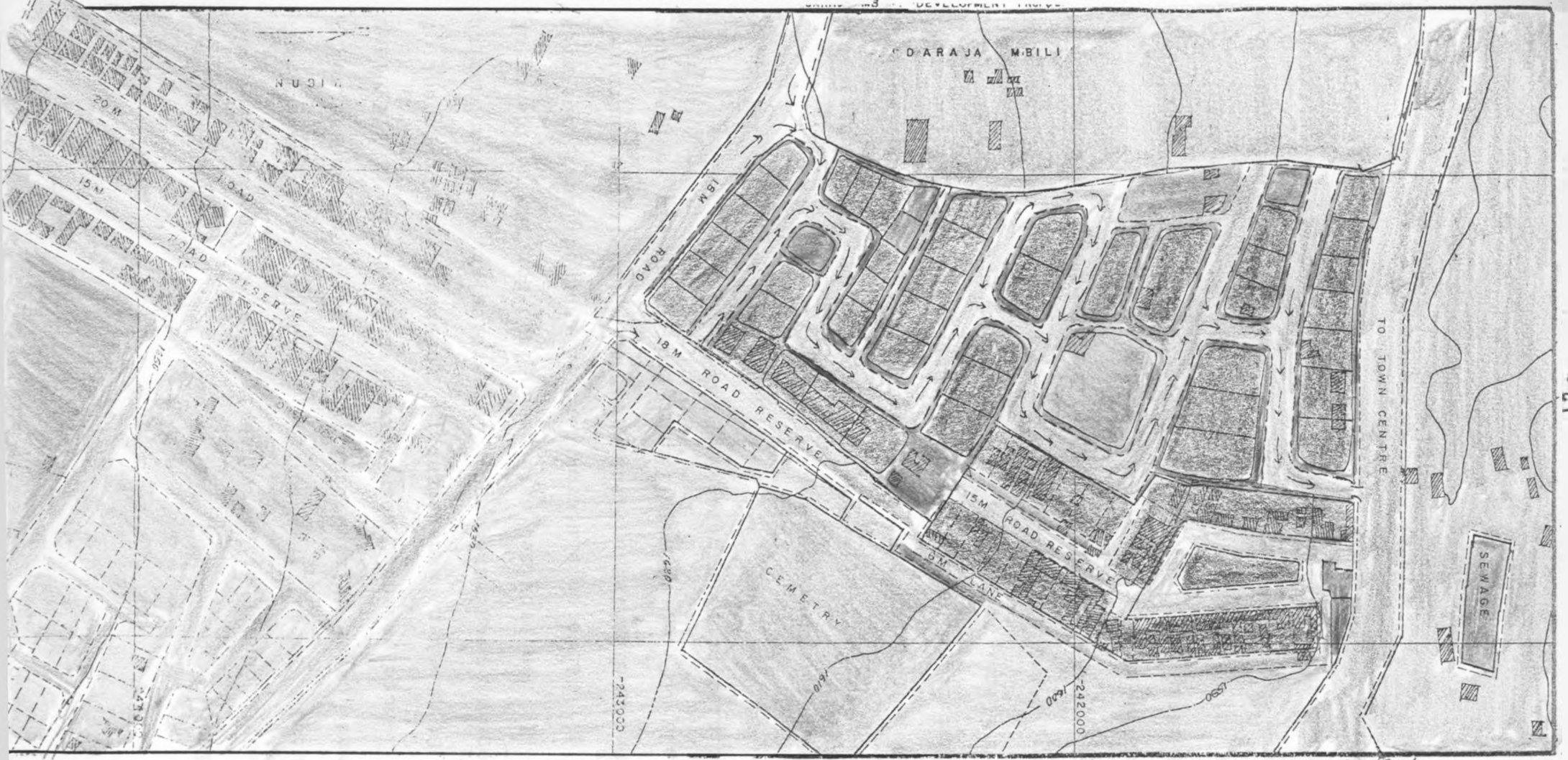
6.3.3.6 Alternative Solid Waste Management Options

Accumulation of refuse in stormwater drains has caused or aggravated flooding in Daraja Mbili and also provides a habitats for flies, rats and other vectors for a variety of diseases and is a cause of water and air pollution. Twenty eight percent of the respondents indicated that solid waste blocked storm drains. A well organised solid-waste management plan is therefore one of the basic needs of Daraja Mbili.

Rubbish and silt should not be allowed to accumulate in the channels and the river because these facilities will not be capable of satisfactorily fulfilling their primary function - the removal of stormwater runoff and sullage.

Communal storage facilities are particularly appropriate because the area is densely populated with limited access and little or no yard space available for individual storage. The location of communal storage should be away from storm drains and its maintenance may strongly influence the quality of citizen utilisation. Large refuse containers (for instance 5 cu. m containers) should be placed strategically in the residential area as well as commercial area. The walking distance should not be long. The containers should be frequently picked up by tractors or trucks and hauled to dumping ground outside the area.

Figure 6.5: Plan Proposals for alleviating Environmental Problems Posed by Inadequate Stormwater and Sullage Drainage.



LEGEND

Storm Runoff

Commercial

Vegetation / Recreation

Residential

6.4 Conclusion

The study found that most people need basic services and infrastructural facilities to get rid of stormwater and wastewater and other related facilities like dustbins and solid waste dumps whose absence complicated the problem of efficient drainage. Stormwater management is an essential component of urban development programmes and, in particular, of urban health programmes. It can provide, safe urban land for the residents of Daraja Mbili. Also once stormwater is managed well, the area will be a much healthier environment than when it was undrained and is likely to report significant reductions in vector-borne diseases and diarrhoeal diseases.

6.5 Areas for Further Research

Requirements for effective landuse planning and sustainable resource use in Nyanchwa hills require a land suitability classification based on the physical characteristics of the area. This will allow planners to identify areas that need revegetation, complete protection, controlled forestry, and various types of agriculture. Also required is a measure of social acceptability

Hazard-zone mapping, another useful technique for land planning in hill areas, should be used to assess the magnitude, serenity, and extent of environmental hazards and their possible consequences downhill. Mapping involves in-depth investigation of many factors related to the land resource base as well as

information relating to current land use pattern: once zones are identified as currently or potentially hazardous, public policy can come into play by banning or restricting specific activities within the zone.

REFERENCES

Alder, G. (1995) Tackling Poverty In Nairobi's Informal Settlements: Developing an Institutional Strategy. Environment and Urbanization, Vol.7 No. 2, October.

Anderson, R.T. (1964): Comprehensive Planning for Environmental Health . M.A. Thesis, Cornell University.

Beumer Han,R.C., (1988): Suggestions for Development of Kisii Town.

Boyce, J.K. (1990): Birth of a Mega Project: Political Economy of Flood Control in Bangladesh, in Environmental Management, Vol.14, No. 4 July-August

Campell, T. (1989): Environmental Dilemmas and the Urban Poor, in Development Strategies for a Common Agenda. U.S.A.- Third World Policy Perspectives, No. II.

Doorkamp, J.C. The Earth sciences and Planning in the Third World. Liverpool Planning Manual 2. Liverpool University Press in association with Fairstead press.

Duchhart,I. (1989): Manual on Environmental and Urban Development. Government of Kenya and Agricultural University, Wageningen. The Netherlands

Gidman, P. (1995): Public-Private Partnership in Urban Lorentzen,J. Infrastructure Services, Urban Management Programme Blore,I and Working Paper Series 4, for UNDP/UNCHS/World Bank Schuttenbelt Urban Management Programme, Nairobi.

Gitonga (1980): Urban Sewage Disposal Report: Project Paper on Environment and Development. Prepared for Kenya Government/UNEP/UNDP. Nairobi.

Great Britain [1978]: Environmental Planning in Britain. London

Grimes,F.O. [1976]: Housing for Low-Income Urban Families. Washington D.C.,John Hopkins University Press.

Haeringen, V.R. (1988): Integration of the Natural Environment in the Local Authority Development Programme (Kisii Town). Agricultural University, Wageningen. The Netherlands.

Hasan, A. (1989): "A low Cost Sewer System by low-income Pakistanis" in Building Community: a Third World Case Book. edited by Bertha Turner. Habitat International Coalition. Mexico City.

Hollsteiner, M. R. (1977): `People Power: Community Participation in Planning of Human Settlements´ in Assignment Children No.40 October-December PP.13-15.

Huq-Hussain, S. (1995) Fighting Poverty; The Economic Adjustment of Female Migrants in Dhaka. Environment and Urbanization, Vol.7, No.2, October

Jimenez, D. and A.C. Velasquez (1989):"Metropolitan Manila: Framework for its sustained Development" in Environment and Urbanization Vol.I,No.1 April,PP.51-58.

Kenya, Republic.(1994): Kisii District Development Plan (1994-1996) Government Printer. Nairobi.

Kenya, Republic.(1994): National Environmental Action Policy.

Kenya, Republic.(1989): Kisii District Development Plan (1989-1993) Government Printer. Nairobi.

Kenya, Republic.(1994):[1994] 1989 National Census Report, Volume II, C.B.S. Nairobi

Kenya, Republic.(1966): Sessional Paper No.10. on African Socialism and its Relevance to Development in Kenya.

Kenya, Republic.(1972): Kenya's National Report to the U.N. on the Human Environment.

Kenya, Republic.(1978) Rainfall Frequency Atlas of Kenya. Ministry of Water Development. Nairobi.

Kenya, Republic.(1983): Urban Housing Survey. C.B.S. Nairobi.

Krhoda, G.O. (1991): Urban Development and Storm Water in Infrastructure, Environment, Water and People, 17th WEDEC Conference. UNCHS (Habitat) Nairobi.

Kulaba, S. (1989): "Local Government and the Management of Urban Services in Tanzania, in African Cities in Crisis. Boulder, Co, Westview Press

Leitmann, J. (1994): Rapid Urban Environment Assessment-Lessons from cities in the Developing World Volume 2-Tools and Outputs. World Bank, Washington, D.C.

Leonard, J.H. et al. (1989): Environment and the Poor: Development Strategies for a Common Agenda. U.S.-Third World Policy Perspectives No.II, Transaction Books. New Brunswick, U.S.A.

Levin, R.I. (1981) Statisytics for Management. Prentice Hall. New Jersey.

Linn,S. [1983]: Cities in the Developing World, World Bank, Oxford University Press

Mangin, W. [1967]: Latin American Scutter Settlements: A problem and a Solution. Latin American Research Review pp.65-98.

Mueller, C.C. (1995) Environmental Problems Inherent To a Developement Style: Degradation and Poverty in Brazil. Envrionment and Urbanization, Vol.7, No.2, October.

Nyamu,H.N. [1983]: Environmental Considerations in Human settlements. National Settlement Environment Secretariat, Nairobi.

Nyamweno,I.M. (1994): The Role Of Infrastructure in Spatial Growth and Development of Environmentally Sustainable Urban Human Settlements: A Case Study of Kisii Town. Unpublished M.A. Thesis, University of Nairobi.

Obudho, R.A. and C. Mhlanga (1987): Slum and Squatter Settlements in Sub-Saharan Africa: Towards a Planning Strategy. New York Praeger.

Obudho, R.A. [1987a]: Shelter and Services for the Poor in Nairobi, Kenya. Paper Presented at Expert Group Meeting on Shelter and Services for the Poor in Metropolitan areas, Nagoya, Japan, 12-16 January

Omwando,Z. (1991) Environmental planning Manual

I. Ingrid Agricultural University, Wagenigen and Ministry of

F. Grootenhuis. Local Government and Physical Planning.

Oyebande, L. (1990): Aspects of Urban Hydrology and the Challenges for African Urban Environment, in African Urban Quarterly Vol.5, Nos.1 & 2, Feb. and May PP.39-65.

Peterson, G., (1994):Multisectoral Investment Planning. Working
G.T. Kingsley Paper Series 3. For UNDP/UNCHS/World Bank
J.P. Telgarsky Urban Management Programme. Nairobi.

Phantumvanit, D . and W.Liengcharernsit (1989): Coming to terms with Bangkok's Environmental Problems, in Environment and Urbanization, Vol.1, No.1 April. pp.31-39.

Pouliquen,L.Y. (1991): New Beginnings, in Urban Edge Vol.15 No.7 September-October

Ramachandran, A. [1983]: "Review of the Global situation in Human

Rojas, E. and M. Greene (1995) Reaching The Poor: Lessons from the Chilean Housing Experience. in Environment and Urbanization, Vol.7, No.2, October 1995. Nottingham. Russel Press.

Sinnatamby,G. (1990): "Low-Cost Sanitation" in The Poor Die Young: Housing and Health in the Third World Cities, edited by Sandy Cairncross and others. Earthscan, London.

Sivaramakrishnan, K.C. and L. Green (1986): Metropolitan Management: The Asian Experience. Oxford University Press, for the World Bank, London.

Sukhamte,P.V. and Sukhamte, B.V. [1970]: Sampling theory of Survey with Applications.Iowa University Press N.York.

Sygga, P.M. and J.M. Malombe (1995) Developement of Informal Settlements in Kenya: Case Studies of Kisumu and Nakuru Towns

Timberlake, L. (1985): Africa in Crisis -The Causes, the Cures of Environmental Bankruptcy. Earthscan Paperback.

U.N. (1971): Improvement of Slums and Uncontrolled Settlements. U.N. New York

UNCHS (habitat) (1989): Urbanization and Sustainable Development in the Third World; An Unrecorded Global issue. UNCHS (Habitat), Nairobi.

UNCHS (Habitat) (1990): Human Settlements and Sustainable Development. UNCHS (Habitat), Nairobi.

UNCHS (habitat) (1988): Shelter for the Homeless, The Role of NGOs. Nairobi.

UNCHS (habitat) (1987): National Human Settlements, Institutional Arrangements. Selected Case Studies. UNCHS (Habitat), Nairobi.

UNCHS/Habitat [1992]: Delivery of Basic Infrastructure to Low Income Settlements: Issues and Options.

UNCHS (Habitat) (1991): Human Settlements Development Through Community Participation. UNCHS (Habitat), Nairobi.

UNCHS (Habitat) (1991): Storm water Drainage and Landuse Reclamation for Urban Development. UNCHS (Habitat), Nairobi.

UNCHS/Habitat [1992]: Water Supply in Low income Housing Projects, the Scope for Community Participation, Habitat, Nairobi

UNCHS (habitat) (1987): Global Report On Human Settlements. Oxford University Press, New York.

UNCHS (Habitat) (1985): Guidelines of Design of Circulation in Low Income Urban Settlements. Nairobi,Kenya.

UNCHS (Habitat) (1982):Survey of Slum and Squatter Settlements. Published For UNCHS (Habitat) by Tycooly International Ltd, Dublin.

UNCHS (Habitat) (1986): Delivery of Basic Infrastructure to Low income Settlements: Issues and Options. UNCHS (Habitat), Nairobi.

UNEP (1979): Report on NGO Activities on Environmental Issues Related to UNEP Programmes. UNEP, Nairobi.

UNEP (1989): Integrated Management of Resources in Africa. Edited by Michael Atchia and Rugumayo. Nairobi, Kenya.

UNEP/UNCHS (Habitat) (1987): Environmental Guidelines for Settlement Planning and Management. Vol.III. UNCHS (Habitat), UNEP. Nairobi.

Wenner,C.G. (1981): Soil conservation in Kenya. Ministry of Agriculture.

World Bank [1991]: Local Concerns Voiced On Urban Environment in: *Urban Edge* Vol.15 No.7. Sept/Oct.

Yabs, K.S. (1983) 'Community Participation in Katchi Abadi Upgrading' in Between Basti Dwellers and Bureaucrats edited by Schoorl et al. Pergamon Press, Oxford

Yapi-Diahou, A. (1995) The informal housing sector in the metropolis of Abidjan, Ivory Coast. In Environment and Urbanization, vol.7, No.2 October 1995

Zajac, V. et al. (1984) Urban Sanitation Planning Manual Based on the Jakarta case study. World Bank, Washington, D.C.

Zajac, V. et al. (1984) Appropriate Technology for water Supply and Sanitation, World Bank, Technical Paper No. 18. Washington, D.C.

----------[1987b]: Urbanization and Low-income Housing in Nairobi, Kenya: Towards a Planning Strategy

APPENDIX I

HOUSEHOLD QUESTIONNAIRE

ENVIRONMENTAL PLANNING AND MANAGEMENT OF INFORMAL LOW INCOME URBAN COMMUNITIES : CASE STUDY OF DARAJA MBILI, KISII MUNICIPALITY, KENYA

1. Questionnaire No.....
2. Date of interview.....
3. Name of the place.....
4. Name of respondent.....

A SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENT

5. Sex of the respondent [a] Male [b] Female
6. Relation to head of household [if not head].....
7. Marital status
   (a)married (b)single (c)divorced [d]separated.
8. Please fill the table below about the household members you are staying with.

Member	Sex	Age	Occupation	Education level
1.Father				
2.Mother				
3.				
4.				
5.				
6.				
7.				
8.				

9. Where do you carry out your income generating activities?
   [a] Within Daraja Mbili [b] Outside Daraja Mbili
10. What are your sources of income
   [a] Formal [specify].....
   [b] Informal [specify].....
   [c] Both [specify].....
11. What is the monthly income of household head in Ksh.....
12. May you give a break down on how the household spends the income you spend.
   [i]..... [ii].....
   [iii]..... [iv].....
13. For how long have you lived in Daraja Mbili?.....
13. Where were you living staying before you settled in daraja Mbili?.....

14. What influenced your choice to stay in Daraja Mbili?
[i]..... [iii].....
[ii]..... [iv].....

B TOPOGRAPHY

15. Where is your dwelling situated ?
[a] Steep hill side [b] Flat plain [c] Other [specify]
16 .[i] Is there any Natural vegetation and/or fauna and why ?
[a] Yes [b] No
[ii] If no, what have you done to ensure there is vegetation
[i]..... [ii].....
[ii]..... [iv].....
17. What kind of problems do you face in connection to waste and storm water disposal which are linked to the site ?
[a]..... [b].....
[c]..... [d].....
18. Who is responsible for solving storm and waste problems?
19. What has been done?
[a]..... [b].....
[c]..... [d].....
20. What is your role in solving these problems?.....
21. What should be done now to alleviate the problems in que.19
[a]..... [b].....
[c]..... [d].....

C DESCRIPTION OF RESIDENTIAL UNIT

22. What type of dwelling unit do you live in?
[a]. Swahili [b]. Shanty [c]. Other [specify]
23. What is ownership status of the dwelling unit?
[a]. Owner--occupied [b]. Rented [c]. Other [specify]
24. If rented, how much do you pay per month?.....
25. If owned, how did you acquire the land site where you have built?.....
26. How many rooms are in your dwelling unit?.....

Common construction materials

27. What materials have been used on the floor?
[a] Earth [b] Wood [c] Concrete and cement
28. Outer walls
[a] Blocks [b] Bricks [c] Wood [d] Tin [e] G.C.I
29 Roof
[a]. Thatch [b]. Tin [c]. Corrugated iron sheets

State and condition of the dwelling unit

30. What is the physical appearance of dwelling unit
[a] Very bad [b] bad [c] good
31. What is the pattern of residential units like?
[a]. Random and congested [b].Random and sparse
[c].Systematic but congested [d]. Systematic but sparse.

D WASTE WATER DISPOSAL AND SANITATION

32. What is the source of water for domestic use
    (a) buy (b) from the river/stream (c) bore hole
    (d) spring (e) well (f) water pipe (g) others (specify)
33. What is the average quantity of water consumed per day?
    [a]. 1-2 jerricans [b]. 3-5 jerricans [c]. 6-8 jerricans
34. Where do you dispose domestic waste water?
    [a] Sewerage [b] Septic tank [c] Cesspool
    [d] Pour on ground
    [e] Open drainage [f] Any other [specify]
35. If on a public site, how far is it from your house?.....

36. What problems do you face because of the way you dispose of domestic waste water?
    [i].....[ii].....
    [iii].....[iv].....
37. What have you done to solve the problems in question 36 above?
    [i]..... [ii].....
    [iii]..... [iv].....
38. What has the local community done to solve problems in question 36 above?
    [i]..... [ii].....
    [iii]..... [iv].....
39. What has Kisii Municipal Council done to solve problems in question 36 above?
    [i]..... [ii].....
    [iii]..... [iv].....
40. In the table below fill in your suggested solutions and agency/organization to carry them out to solve problems of waste water disposal.

Suggested solution	Agency
1.	
2.	
3.	
4.	
5.	
6.	
7.	

41. Where do you take your bath/shower?
    [a] Private indoor [b] Private outdoor [c]Communal indoor
    [d] Other [specify]
42. Where does all waste water from Daraja Mbili end up?.....
43. What problems do you face because of the way you dispose wastewater from the bathroom.
    [i]..... [ii].....
    [iii]..... [iv].....
44. What have you done to solve the problems in question 43 above?
    [i]..... [ii].....

[iii]..... [iv].....

45. What has the local community done to solve problems in question 43 above?
[i]..... [ii].....
[iii]..... [iv].....

46. What has Kisii Municipal Council done to solve problems in question 43 above?
[i]..... [ii].....
[iii]..... [iv].....

47. In the table below fill in suggested solutions to problems of disposal of waste water from the bathroom and the possible agencies/organizations to carry them out.

What can be done	Agency
1. 2. 3. 4.	

E SOLID WASTE MANAGEMENT

48. Where do you dispose your solid waste?
[a] Private dustbin [b] Communal dustbin [c] Communal dump
[d] Other [specify]

49. Does some of the solid waste get disposed to the drains?
[a] Yes [b] No.

50. What are the problems associated with the waste getting disposed to the drains?
[i]..... [ii].....
[iii]..... [iv].....

51. What have you done to solve the problems in question 50 above?
[i]..... [ii].....
[iii]..... [iv].....

52. What has the local community done to solve problems in question 50 above?
[i]..... [ii].....
[iii]..... [iv].....

53. What has Kisii Municipal Council done to solve problems in question 50 above?
[i]..... [ii].....
[iii]..... [iv].....

54. In the table below fill in suggested solutions to problems of disposal of solid waste and the possible agencies/organizations to carry them out.

What can be done	Agency/Organization
1. 2. 3. 4.	

F STORM WATER MANAGEMENT

55. Where does all storm water from Daraja Mbili drain?
    [a] Open drainage [b] Underground [c] None
    [d] Other [specify]
56. What problems are experienced because of the way storm water is drained?
    [a]..... [b].....
    [c]..... [d].....
57. What have you done to solve the problems in question 56 above?
    [i]..... [ii].....
    [iii]..... [iv].....

58. What has the local community done to solve problems in question 56 above?
    [i]..... [ii].....
    [iii]..... [iv].....
59. What has Kisii Municipal Council done to solve problems in question 56 above?
    [i]..... [ii].....
    [iii]..... [iv].....
60. What in your opinion can be done and by who to solve the problems in question 56 above?

What can be done	Agency
1. 2. 3. 4.	

G HEALTH

61. What are the common sicknesses your household members usually suffer from?
    [i]..... [ii].....
    [iii]..... [iv].....
62. What do you think are the possible causes of these diseases?
63. How can they be prevented or reduced?

64. List all services you expect Kisii Municipal council to do for all residents of Daraja Mbili in the local authority area?
[i]..... ... [ii].....
[iii]..... [iv].....

65. what should You do for yourself to improve your conditions
[i]..... ... [ii].....
[iii]..... [iv].....

66. What should residents of Daraja Mbili do for themselves to improve their conditions of living?
[i]..... ... [ii].....
[iii]..... [iv].....

THANK YOU FOR YOUR COOPERATION

RESEARCH ASSISTANT.....

APPENDIX II

BUSINESS ENTREPRENEURS QUESTIONNAIRE

ENVIRONMENTAL PLANNING AND MANAGEMENT OF INFORMAL LOW INCOME URBANMUNITIES : CASE STUDY OF DARAJA MBILI, KISII MUNICIPALITY, KENYA

1.Interviewee.....
2. Data.....
3. Place.....
3. Nature of business.....
4. When was the business established?.....
5. Who owns the premises where the business is located?
   [a] Owner occupied [b] Rented
6. How much do you pay per month, if the premises is rented?.....
7. Where do you obtain your water for domestic use?
   (a) buy (b) from the river/stream (c) bore hole (d) spring
   (e) well (f) water pipe (g) others (specify)
8. What amount of water do you use daily?
   [a]. 1-2 jerricans [b]. 3-5 jerricans [c]. 6-8 jerricans
9. Where do you dispose of waste water?
   [a] Sewerage [b] Septic tank [c] Cesspool [d] Pour on ground
   [e] Any other [specify]
10. What problems do you face because of the way you dispose of waste water?
   [i].....[ii].....
   [iii].....[iv].....
11. What have you done to solve problems in question 10 above
   [i]..... [ii].....
   [iii]..... [iv].....
12. What has the local business community done to solve problem?
   [i]..... [ii].....
   [iii]..... [iv].....
13. What has Kisii Municipal Council done to solve problems in question 10 above?
   [i]..... [ii].....
   [iii]..... [iv].....
14.In the table below fill in your suggested solutions and agency/organization to carry them out to solve problems of wastewater disposal.

Suggested solutions	Agency/Organization
1. 2. 3. 4.	

15. Where does all Storm water from Daraja Mbili drain?
    [a] Open drainage [b] Underground [c] Other [specify] [d] None
16. What problems are experienced because of the way storm water is drained?
    [a]..... [b].....
    [c]..... [d].....
17. What have you done to solve the problems in question 15 above?
    [i]..... [ii].....
    [iii]..... [iv].....
18. What has the local business community done to solve problems in question 15 above?
    [i]..... [ii].....
    [iii]..... [iv].....
19. What has Kisii Municipal Council done to solve problems in question 15 above?
    [i]..... [ii].....
    [iii]..... [iv].....
20. Where do you dispose of your solid waste?
    [a] Private dustbin [b] Communal dustbin [c] Communal dump [d] Other [specify]
21. Does some of the solid waste get disposed to the drains?
    [a] Yes [b] No.
22. What are the problems associated with the waste getting disposed to the drains?
    [i].....[ii].....
    [iii].....[iv].....
23. What have you done to solve the problems in question 21 above?
    [i]..... [ii].....
    [iii]..... [iv].....
24. What has the local business community done to solve problems in question 21 above?
    [i]..... [ii].....
    [iii]..... [iv].....
25. What has Kisii Municipal Council done to solve problems in question 21 above?
    [i]..... [ii].....
    [iii]..... [iv].....

THANK YOU FOR YOUR COOPERATION

RESEARCH ASSISTANT.....

APPENDIX III

MEDICAL PRACTITIONERS QUESTIONNAIRE

ENVIRONMENTAL PLANNING AND MANAGEMENT OF INFORMAL LOW INCOME URBANMUNITIES : CASE STUDY OF DARAJA MBILI, KISII MUNICIPALITY, KENYA

1. Name .....

2. Specialization.....

3. Where do most of your patients come from.....

4. What are the most common diseases you always attend to

   [i]..... [ii],.....

   [iii]..... [iv].....

5. In your opinion what do you think could be the cause of these diseases?

   [i]..... [ii].....

   [iii]..... [iv].....

6. What is the proportion of your patients?

   [a] Children dominating [b] Adults dominating

   [c] Men dominating [d] Women dominating

7. What could be the possible cause of that dominion?

   [i]..... [ii].....

   [iii]..... [iv].....

8. How best do you think these diseases could be controlled and prevented?

   [i].....

   [ii].....

   [iii]..... [iv].....

THANK YOU FOR YOUR COOPERATION

NAME OF RESEARCH ASSISTANT.....