TRENDS, LOCAL PERCEPTIONS AND COST OF WATERBORNE DISEASES IN RIVER NJORO WATERSHED, NAKURU DISTRICT

BY KIRAGU J. M

A Thesis Submitted to Graduate School in Partial Fulfilment for the Requirements of the Master of Science Degree in Environmental Science of Egerton University

EGERTON UNIVERSITY

AUGUST

DECLARATION

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

Name KIRAGU JOSEPH MWANGI

Signature ---------- **Date** 23/02/06

Supervisor

PROF F.K LELO

Signature ---------- Date 3/3/2006

Supervisor

DR L.W. CHIURI

Signature ---------- Date 3/3/2006

ACKNOWLEDGMENT

My heartfelt thanks go to my lecturers in the Department of Environmental Science for their support and encouragement. I am highly indebted to Prof. F..K.Lelo and Dr L.W. Chiuri for their scholastic counsel and guidance which has enabled me prepare this thesis. Lastly I wish to thank Miss Susan Wairimu, Mbugua, and Ciku who helped me in typing this report. To all I say may our almighty God bless you abundantly.

DEDICATION

I dedicate this work to my wife Jeddy and our little angel Liz.

.COPYRIGHT

ABSTRACT

River Njoro has been experiencing a gradual decline in the quality and quantity of water, resulting in various waterborne diseases among people living in the watershed. The current study covers the period between 1998-2002. The main objective of the study was to document the prevalence of waterborne diseases in River Njoro watershed and their implications on human health. Medical data from a purposive sample of three health institutions within the watershed for the aforementioned period was collected. In addition, Participatory Rural Appraisal (PRA) reports for the area were reviewed to document community's perceptions. Questionnaires were also administered to clinical officers in the sampled institutions. A data registration form was developed to collect case register data on the waterborne diseases. The study focused on four diseases, namely; diarrhoea, amoebiasis, typhoid and bacillary dysentery. The data collected was analysed using Epidemiology Information System 2002 (Epi Info 2002) and tables and graphs generated showing the annual and seasonal trends in the prevalence of the diseases. The study found out that, diarrhoea cases increased in Nessuit during the dry season as opposed to the cases in Njoro and Kapkures, which were lower during dry months. The situation is however, reversed upon the onset of rainy seasons. Diarrhoea and Bacillary dysentery were common in children below 2 years while typhoid and amoebiasis were common among adults above 20 years. This could be attributed to infective dose, responsible for various diseases. The PRA reports indicated that water-related diseases and water shortages were among the most important issues affecting residents in the watershed. Community members pointed out the revival of stalled water projects and harnessing of rainwater as some of the ways that could reduce the incidence of the diseases. The cost estimates for diarrhoea and typhoid were Kshs 568 and Kshs 2,029 respectively. These costs did not include other costs such as pain and suffering by family members. The study demonstrated there was a correlation between the incidence of waterborne disease and the quality and quantity of water in River Njoro.

TABLE OF CONTENTS

LIST OF ACRONYMS

CAPS - Community Action Plans

D.E.O - Divisional Education Officer

DfID - Department for International Development

GIS - Geographical Information System

PRA - Participatory Rural Appraisal

SUMAWA - Sustainable Management of Watersheds

ROK - Republic of Kenya

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

World Health Organization (2000) assessment report estimates that there are four billion cases of diarrhoea each year, besides millions of other cases of illnesses associated with the lack of access to clean water in the world. Report from Daily Nation (June 5, 2003) indicated that diarrhoea kills a child every 8 seconds and is responsible for 80% of the illnesses and deaths in the developing countries of the world.

Over the years, degradation of River Njoro Watershed has occurred due to high population growth rate and accompanying land fragmentation. The human population was 159,511 in 1979 and this tripled to around 450,000 persons in 1999 (Shivoga *et al,* 2003). These changes started after independence, when the government settled people on small plots. People from other parts of the country bought land in Njoro Division and subdivided it for settlement. Since then the population has been increasing, influencing land tenure and land use practices. The most notable changes have been mushrooming of slums and peri-urban settlements such as Njokerio farm, which has been subdivided into plots to construct rental houses for students and workers from Egerton University.

Many people residing in these settlements depend on water from River Njoro for their various domestic uses. The river flows from Eastern Mau hills to Lake Nakuru. The river is the only dependable water source to many people within the watershed. There has been a steady decline of quality and quantity of water in this river, as pointed out by Shivoga (2000). This decline in water quality and quantity has been hypothesized as the cause of incidences of waterborne disease among the watershed residents. These diseases include typhoid, diarrhoea, bacillary dysentery and amoebiasis. The named diseases are known to occur due to water pollution and low levels of domestic water use. Reports from District medical office in Nakuru indicate that among the diseases occurring in the district, diarrhoea, malaria, skin and eye infections are prevalent (Nakuru District Medical Data, 2004). Although poverty, which is rampant in many households, has been cited as a contributing factor, absence of adequate clean water, poor sanitation and hygiene have been noted to be the main causes.

In this research, two terms are used, faecal oral waterborne and water washed diseases. These refer to diseases classified on the basis of environmental conditions as opposed to classification based on disease causal organism (Bradley 1972). This research focused on the disease transmission routes. Factors such as land use changes, poor drinking water quality, inadequate water, improper hygiene and poor sanitation at household level are known to exacerbate the incidence of the diseases.

1.1 BACKGROUND INFORMATION OF THE STUDY AREA

River Njoro Watershed covers approximately 280km^2 with the main river being 60km in length. The headwaters originate from 3,200 m high, East of Mau Escarpment. The Watershed encompasses forested and agricultural lands as well as many small villages and towns of Njoro and Nakuru. Nakuru is the fifth largest urban settlement in Kenya. The river drains into L. Nakuru, which is a shallow saline lake, recognised as a Ramsar site for its rich bird species. There are over 300,000 persons residing within the river Njoro watershed (Shivoga 2003 *et al*, unpublished data)

The study area was divided into three zones (locations[1]) upper zone (Nessuit Location), middle zone (Njoro and Ngata Locations) and the lower zone (Barut Location). These were based on the sites where Participatory Rural Appraisals (PRAs) were conducted in the watershed (Lelo and Chiuri ,2004).

Medical data for the three zones was collected from the main health institutions in these zones. These were Nessuit Dispensary (upper zone), Njoro Health centre (middle zone) and Kapkures Community Dispensary in the lower zone (Barut Location). Figure 1 shows the position of study area.

[1] Location- administratively under the authority of a chief.

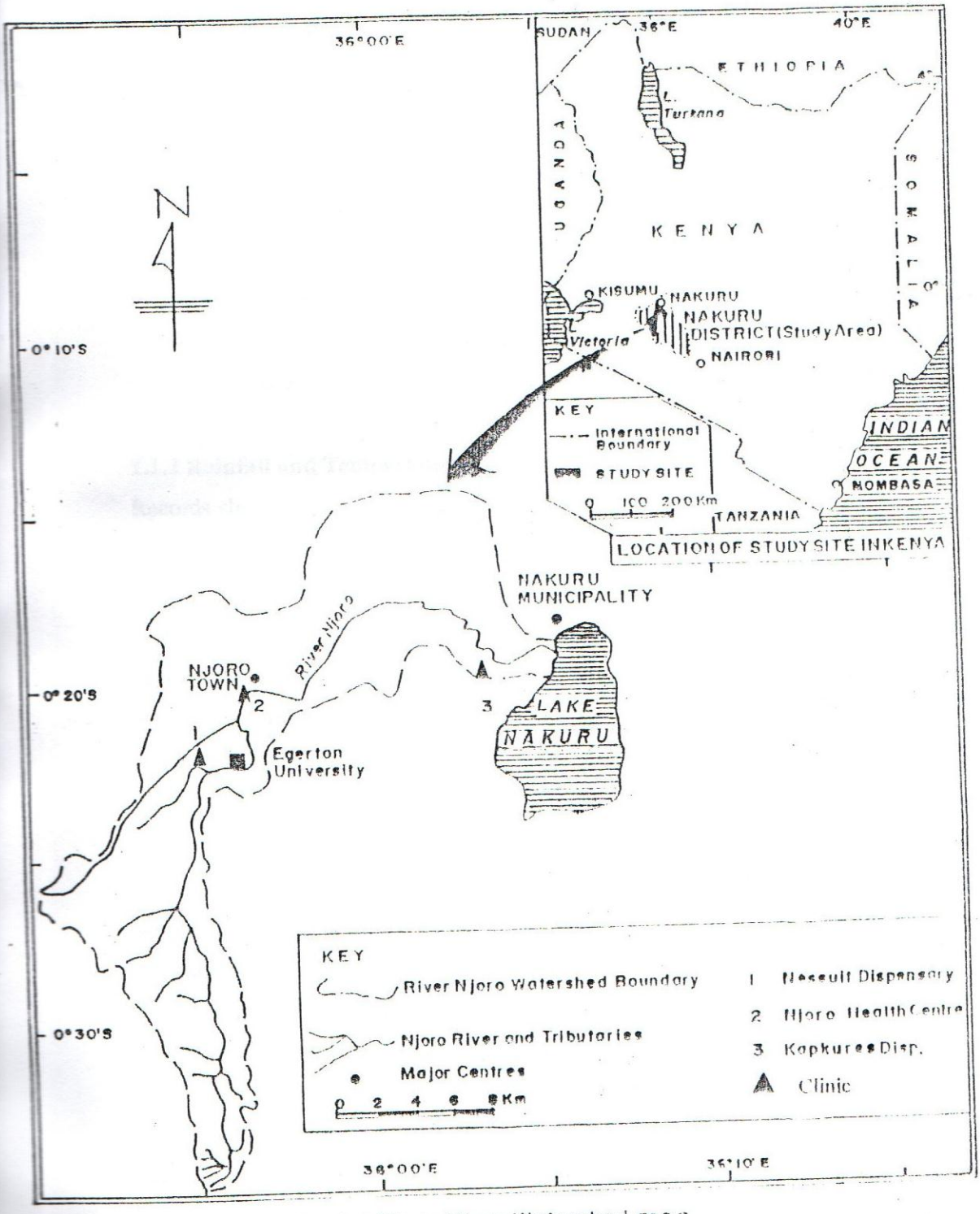


Figure 1: Map of Kenya showing River Njoro Watershed area

1.1.1 Topography and Climate

The major topographic features of Njoro division are Mau escarpment and the accompanying plateau. Areas with high altitude are characterized by cool and wet conditions. Njoro division can be broadly divided into three main climatic zones.

Zone l, rainfall of 1,270 mm per annum and cover areas above 2400 meters above sea level. This zone falls in the south western region of the division. Zone II covers areas with an altitude between 1890-2400 mm above sea level with rainfall of between 760 mm- 1270 mm per annum; this is a sub humid equatorial climate. The zone covers the largest portion of the remaining part of the division. Finally, zone III covers areas with altitude of between 1520 m-1890 m above sea level. It receives an average rainfall of less than 760 mm annually. This is a semi arid zone that covers a very small part of the division bordering Lake Nakuru National Park (Anyango, 2000)

1.1.2 Rainfall and Temperature Conditions

Records show that Njoro division receives a bimodal rainfall pattern. The long rains start in March and last until June sometimes extending to July, while the short rains begin in August and last until October sometimes extending to November. Average rainfall for the long rains is around 93.4 mm in the division compared to the district average of 77 mm per year. Temperatures vary from annual maximum of 30^0C to mean minimum of 23.9^0 C. (Republic of Kenya, 1997)

1.1.3 Population

There are over 300,000 persons residing within River Njoro Watershed (Shivoga *et al* 2003, unpublished data). The middle and lower zones of the watershed are more densely populated than the upper zone. The middle zone has the Njoro town and Egerton University whose population is relatively high. The lower zone, has a rural agricultural land (Barut Location), (Kaptembwa Location) a slum of Nakuru town with relatively high populations. The upper zone (Nessuit Location) is a newly settled area where people were allocated five acres of land to settle in 1990s, and hence the population is still small. The high population densities within parts of the watershed are continuously influencing land tenure and land use practices. Notable is the increased fragmentation and more intensive use of the land in the lower and the middle zone.

1.1.4 Socio-Economic Profile

Njoro Division is one of the former white highland areas. As in most of the recent settlements in the Rift Valley province, the majority of the settlers are people who migrated from their former ancestral land elsewhere in Kenya due to scarcity of arable lands. These people are accustomed to more intensive cropping and livestock systems both of which require sufficient water to thrive. The river supplies water to both livestock and people. These two accelerate the need to have sufficient source of water. It is common to see animals defecating directly in water and some few meters downstream, a person drawing water for domestic use. Traditional practices of open defecation in the bush and unhygienic way of water handling; make the situation worse, and have contributed greatly to deterioration of the environmental conditions leading to greater incidences of faecal-oral water-borne and water-washed diseases (Anyango, 2000).

Agriculture

Agriculture is the main economic activity within the watershed. The sector is said to support about 80 % of the population, the remaining 20 % being supported by activities like commerce, trade and some industrial employment (Anyango, 2000). Many of the residents are small-scale subsistence-oriented mixed farmers. They grow crops such as maize, beans, wheat, barley, pyrethrum, potatoes and some horticulture. Livestock rearing is also a major practice; mainly for milk, wool, meat, mutton, skin and hide production. (ROK, 1997).

Forestry

In the past a great proportion of Njoro division was under forest cover. Approximately 145,000 hectares were under gazetted forest; out of which natural forest covered an area of 115,000 hectares while the plantation occupied approximately 30,000 hectares (ROK 1997). Degazettement in of forest land 1995 and excision of large portions of the Mau forest have resulted in reduction of forest cover and development of new settlements in the watershed. The degazettement of forest has threatened the existence of river Njoro, making it a seasonal stream. This has put in jeopardy lives of many people who depend entirely on water from the river. It has also been suggested that this may be the cause of sudden appearance of various waterborne diseases (Shivoga 2000).

Water facilities

Surface water resources in the entire River Njoro Watershed are over-utilized because the resource is scarce compared to the high population (ROK 1997). Other alternative sources of water are groundwater (boreholes), pans and dams, natural springs, and rain water harvesting. Many people living along the River Njoro draw and consume water directly from the river without any treatment, thus exposing themselves to considerable health risks.

Educational institutions

There are numerous educational institutions within the watershed. Njoro Location has a total of 40 pre-schools, 15 primary schools, 10 secondary schools, one University and one special school (personal communication D.E.O Njoro). The upper zone of the watershed is on its wake to construct new schools and equip the few already existing. The literacy rate is expected to increase with the government directive to provide free primary school education from January 2003.

Health facilities

River Njoro Watershed has a number of health facilities. The upper zone (Nessuit location) has a government run dispensary; the middle zone has a health centre, a number of private clinics and Egerton University Sanatorium is open to the public. The lower zone of the watershed (Barut Location) has a government run dispensary and some private clinics. Minor illnesses in the watershed are treated in the health institutions mentioned above, but serious cases are referred to the Provincial General Hospital in Nakuru town.

Nessuit clinic is an upcoming health institution that is responding to health demands of a recently settled population and changing lifestyle of the locals. One clinician handles its operations but its outpatient population is due to increase with time. The clinic lacks essential medical services like laboratory services and maternity services.

Njoro health centre is the largest health institution in Njoro Division, it has been in existence since the colonial era. Its equipment and services such as pre and post natal clinics, Voluntary Counselling and Testing (VCT) and well equipped laboratory are more advanced compared with the other two institutions.

Kapkures community dispensary was started through local peoples initiative. They were faced with shortage of convenient health services, as the other alternative was Rift Valley General Hospital, which deals more with referral cases than with minor illnesses. As it is common with majority of projects initiated by communities with limited resources, the dispensary lacks operational laboratory, staff and other services just like Nessuit. But has since developed tremendously to a level where it is now seeking health centre status. It has acquired a functional laboratory, maternity ward and fulltime staff.

1.2 STATEMENT OF THE PROBLEM

River Njoro Watershed has undergone drastic changes in land use patterns since independence in 1963. Large scale farming has been replaced by small scale farming over the years as a result of increased population thereby land fragmentation. These changes have affected the quantity and quality of water in River Njoro. This has consequently led to increased incidences of faecal-oral water-borne and water-washed diseases such as diarrhoea, typhoid, bacillary dysentery and amoebiasis among people living along the watershed. This study therefore seeks to trace the incidences of faecal-oral water-borne and water-washed disease trends according to years, season and age over the period 1998-2002.

1.3 OBJECTIVES

The main objective of this study is to document prevalence of faecal-oral water-borne and water-washed diseases in River Njoro Watershed and the consequential implications on human health.

1.3.1 Specific objectives

1) Determine trends and patterns of faecal-oral water-borne and water-washed diseases in River Njoro Watershed for the period 1998-2002.
2) To capture community's perception on the issues of diseases in the watershed.
3) To establish the cost of being sick and hence the economic benefits from preventing the diseases.
4) Provide recommendations to be used by health workers and policy makers in management of faecal oral waterborne and water washed diseases within the watershed.

1.4 RESEARCH QUESTIONS

1) Are there remarkable differences in the incidences of faecal-oral water-borne and water-washed diseases for the different zones in the watershed?
2) Does increase in human population together with poor environmental conditions affect cases of faecal-oral water-borne and water-washed diseases in River Njoro watershed?

1.5 JUSTIFICATION

River Njoro has multiple users because it is the only dependable water source within the watershed all year round. Some people use the river water for their laundry, livestock watering, bathing and other household demands. Recently parts of the river ceased to flow for several months due to abstraction for irrigation and vegetation clearing by new settlers upstream. When the river dries up communities living along the Watershed are left without alternative water sources. They are compelled to use the dirty, unhygienic water in stagnant pools left behind when the river ceases to flow. This exposes them to a host of parasites and unhygienic faecal-oral water-borne and water-washed diseases.

1.6 DEFINITION OF TERMS

Faecal oral waterborne and water-washed diseases. Refers to diseases based on 'environmental conditions' form of classification. This classification focuses on transmission route as opposed to disease causal organisms.

Geohelminthic infections- these are intestinal worms, and easily transmitted through poor sanitation, poor excreta disposal means and in communities with no hygiene education

Health institution-any medical facility, is used to refer to clinic, dispensary, health centre and hospital

1.7 RESEARCH LIMITATIONS

Lack of operational laboratory in Nessuit and Kapkures dispensary made it hard to compare medical data for all the four diseases across river Njoro watershed health institutions. To overcome this problem, seasonal trends were drawn from data collected from Njoro health centre which had an operational laboratory. Yearly trends

across the watershed were based on diarrhoea disease alone which is mostly diagnosed based on clinical symptoms.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 LAND USE PATTERNS

The loss of tropical forests is a global problem. However, on the local scale very little is known about the complex relationships between environmental, economic, social and policy factors which induce change in land use patterns (Kammerbauer and Ardon 1999). Ehlich and Ehlich, (1970) pointed out that a given land use pattern is dictated by the efficient economic use of the land. Kammerbauer and Ardon (1999) cited agriculture as a principal economic activity in rural areas, which induces change in land use patterns. In justifying their actions, people consider the possibilities of preserving a given forest cover intact or clearing that piece of land for agricultural use in which the latter is given higher preference. By doing this the essential services provided by forest ecosystems such as green house gas regulation, water supplies and regulation, nutrient cycling, genetic and species diversity as well as recreation are compromised. Removal of forests for agriculture has been cited as the major cause of desertification which leads to unsustainable development (Kammerbauer and Ardon , 1999)

Food and Agriculture Organization (FAO, 1986) report has also outlined the marked effect of agricultural practices on land cover and landscape over a period of time. Dynamics such as slash and burn over time, shifting cultivation along rivers have also been cited as factors leading to massive loss of the forested areas Sharkloff, (1998). Deforested land suffers from water shortage because of destroyed water catchments. In addition uncovered land is known to be easily eroded by various agents, which in the long run affect the health of the people. Basically the major land use changes in the river Njoro watershed have been deforestation in the uplands, urbanisation in the central region while lower region is characterised with industrial growth (Shivoga *et al*, 2003).

2.2 HUMAN SETTLEMENT AND ENVIRONMENT

In trying to address the issue of how human population affects the ecology of our planet Islam *et al*, (2001) argues that each human individual in the course of obtaining the requisites of existence has a negative impact on his/her environment. His/her need for food causes some of the modifications and destabilization of ecological systems

associated with the practice of agriculture. An increase in human settlement is coupled with an increased need for agricultural land (Liniger, 1995).

Information from PRA reports (Lelo and Chiuri, 2004), conducted in River Njoro Watershed have revealed that community members living downstream have been accusing Egerton University as one of the many water polluters of river Njoro. The University has therefore embarked on a Community Based Constructed Wetland Project. This is a sewage water treatment by use of biological methods before releasing water into the river (Shivoga and Lelo, 2003).

2.3 ROLE OF WATER QUALITY VERSUS HYGIENE

Water is essential for the existence of life. Safe, adequate and accessible supplies of water combined with proper sanitation are basic needs and essential components of primary health care (Twort 1963). Gleick (2002) points out that failure to provide safe drinking water and adequate sanitation services to all people is perhaps the greatest development failure of the 20th century. The most dangerous consequences of this failure are the high rate of mortality among young children from preventable water related diseases. Heavy morbidity and sickness are also associated with this failure.

The median frequency of diarrhoea is 2.6 episodes of diarrhoea/child/year for those under five, while the median frequency among infants is five episodes/child/year for the whole world (DFiD 1999). However, third world countries like Kenya, and poorer communities have higher incidences and River Njoro Watershed in particular may have higher incidences than the world average.

2.4 MAGNITUDES OF WATER-RELATED DISEASE

Hofkes (1981) estimates that as many as 80% of all diseases are associated with unsafe water. Gleick, (2002) states that if no action is taken to address unmet basic human needs for water, as many as 135 million people will die from water-related diseases by the year 2020 worldwide. He further emphasizes that the public health crisis facing the world is so serious that it actually deserves far more attention and resources than it has received before.

Report by American Water Association in 2002, claims that, in order to have a significant socio-economic development of a community, an adequate supply of safe

water is a prerequisite. The report further shows that it costs more by failing to provide basic services than by providing them. In 1970, water related diseases cost Britain an estimated $ 125 billion per year through indirect medical costs and lost work time, plus the colossal social costs of lost education, family disruption, health care and shortened life expectancy (Twort 1963). A major water-related disease epidemic can cost far more medical care and lost productivity than the universal provision of safe water and sanitation (Twort 1963).

In 2004 about half a million of Kenya population suffered from contaminated water-related ailments. These illnesses were caused by water shortage and poor sanitation. 80 % of Kenyan population lacked access to adequate water supply as a result of climatic variability and destruction of natural sources such as forest (Forest conservation portal, 2004). This situation is worse in rural areas where residents get untreated water directly from wells, rivers, springs, and other such sources. River Njoro watershed in Nakuru district is in a rural setting and its residents have been experiencing declining water quantity and quality.

A water supply and sanitation project in Eldoret region has realized the dangers (water related ailments) associated with water from rivers, unprotected shallow wells and springs (Christian Community services 2001). They have initiated a solar energy water disinfector which is efficient and affordable to many.

2.4.1 Meaning of Water-related Diseases

In 1977 David Bradley and colleagues have defined water related diseases in four main categories namely; waterborne, water-washed, water based and water related insect vector. This form of classification is useful when trying to study the etiology of these diseases. Diversity on research in this area prompted the search for a more accommodating classification method, which could link various kinds of excreta-related infections to the design and implementation of particular disposal or reuse technologies. This resulted in Environmental classification of excreta related infections by Feachem *et al* (1983). Further work on Environmental classification of excreta related infections has brought about Unitary environmental classification of water and excreta related communicable diseases (Mara and Feachem 1999). Seven classes have been outlined. Of importance to this study are faecal oral waterborne and water-washed diseases. In 'faecal-oral diseases' either waterborne or water-washed

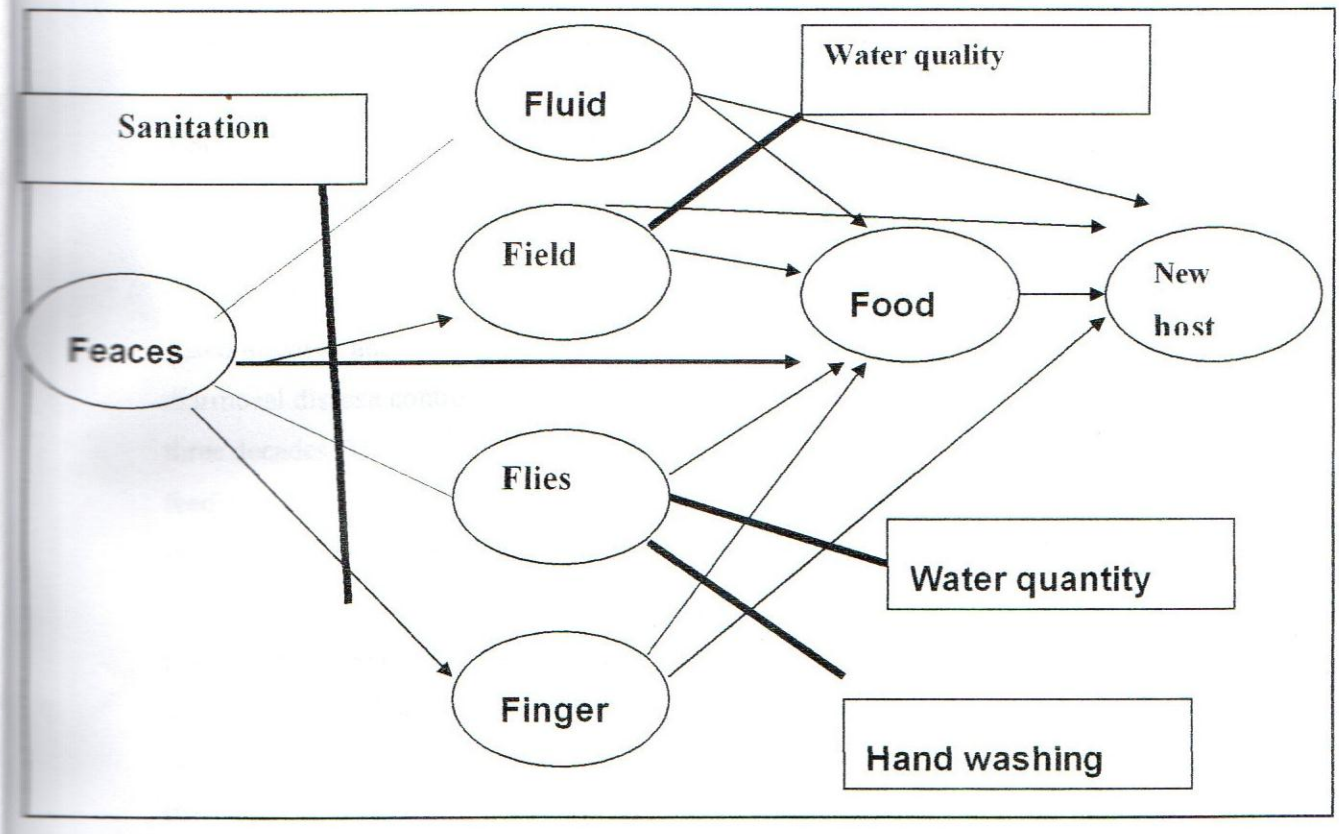
diseases can be included. In this classification there are skin and eye diseases that are water-washed, but not faecal-oral. They continue to remain in the category of water-washed diseases and they will not be considered in this study. Table 1 summarizes this unitary environmental classification of water and excreta related communicable diseases.

Table 1. Unitary Environmental Classification of Water-and Excreta –Related Diseases

Category	Environmental Transmission features	Examples	Control strategies
.Faecal-oral waterborne and water-washed diseases	• Nonlatent (except Ascaris) • No intermediate host • Infectivity:medium to low (bacteria), high (others) • Persistence:medium to high (bacteria), • Low to medium (others, except Ascaris: very high) • Able (bacteria) and unable (others) to multiply outside host	• Viral • Hepatitis A, E, and F • Poliomycelitis • Rotaviral diarrhea • Adenoviral diarrhea • Bacterial • Camplobacteriosis • Cholera • Helicobacter pylori infection • Pathogenic Escherichia coli infection • Salamonellosis • Typhoid and paratyphoid • Yersiniosis • Protozoan • Amebiasis • Cryptosporidiosis • Cylospora cayetanensis diarrhea • Enterocytozoan bienusi diarrhea giardiasis • Isopora belli diarrhea • Helminthic: • Ascariasis • Enterobiasis • Hymenolepiasis	• Improve water quantity, availability, and reliability (Water-washed disease control • Improve water quality • (Waterborne disease control); • hygiene education

Adopted from Mara and Feachem (1999: 336)

This classification is based on transmission routes rather than the biological type that is based on causal organism. This form of classification is good while designing an environmental intervention measures for diseases transmission by pathogens in an area. Faecal-oral diseases can be transmitted in a number of ways as illustrated in figure 2 below.



Source: Winblad, U and Kilama,W (1985)

Figure 2. Disease transmission pathways from Faeces

From the figure 2 above it is clear that poor sanitation and faeces disposal methods can spread diseases to new hosts through a number of ways namely fluid, fields, flies and fingers. This can either be transmitted directly or indirectly through food contamination during preparation or collection from source. Maintaining of high quality water can reduce fluid transmission method. Access to adequate water for hygiene and practices such as hand washing can also reduce transmission caused by flies and contaminated fingers.

2.5 WATER AND SANITATION

Water and sanitation can affect disease transmission modes. Availability of sanitation and good hygiene can act as 'primary barrier' by ensuring that all faecal matters are disposed safely and do not spread in the environment. In the same line good water supply accompanied by soap use in hand washing can also act as 'secondary barriers'. This can prevent further spread of contamination and infection to new host Department For international Development (DfID) (1999).

Improved water supplies tend to reduce transmission or faecal-oral water-borne and water-washed diseases. Improved sanitation facilities also reduce faecal-oral disease transmission by keeping pathogen-bearing faeces out of the environment where it can be spread by water, food, fingers, flies, and dirt. Sanitation also reduces some water-based diseases and geohelminthic infections (Mara and Feachem 1999). Research in diarrhoeal disease control programmes has been set up in most countries over the past three decades. These have been focusing on the promotion of oral dehydration, breast-feeding and hygiene. Over the same period a lot has been invested in water and sanitation infrastructure, sometimes accompanied by hygiene education (DFiD 1999). Work by Feachem *et al* in 1980s, Borghi *et al* 2002, indicates that promotion of personal hygiene can be one of the most effective and cost effective interventions for the prevention of diarrhoeal diseases. The effect of personal hygiene programmes reduces water-washed transmission of faecal-oral diseases and might also affect transmission through the water-borne route by reducing the contamination of in-house stored water (John *et al* 2001).

In Kenya, lack of sufficient clean water is a source of many health problems. A great portion of people's limited income is spent on drugs and treatment services. Many women with their children are seen moving from place to place in search of medical treatment; in the process school hours are wasted for these sick children and domestic productive time is lost for their mothers. Many productive hours are also lost by sick workers who are on sick offs attending to their medical problems arising from water related diseases. All these results in an increase of poverty cases as many human-hours are spent in unproductive ventures

2.6 CONCEPTUAL FRAME WORK

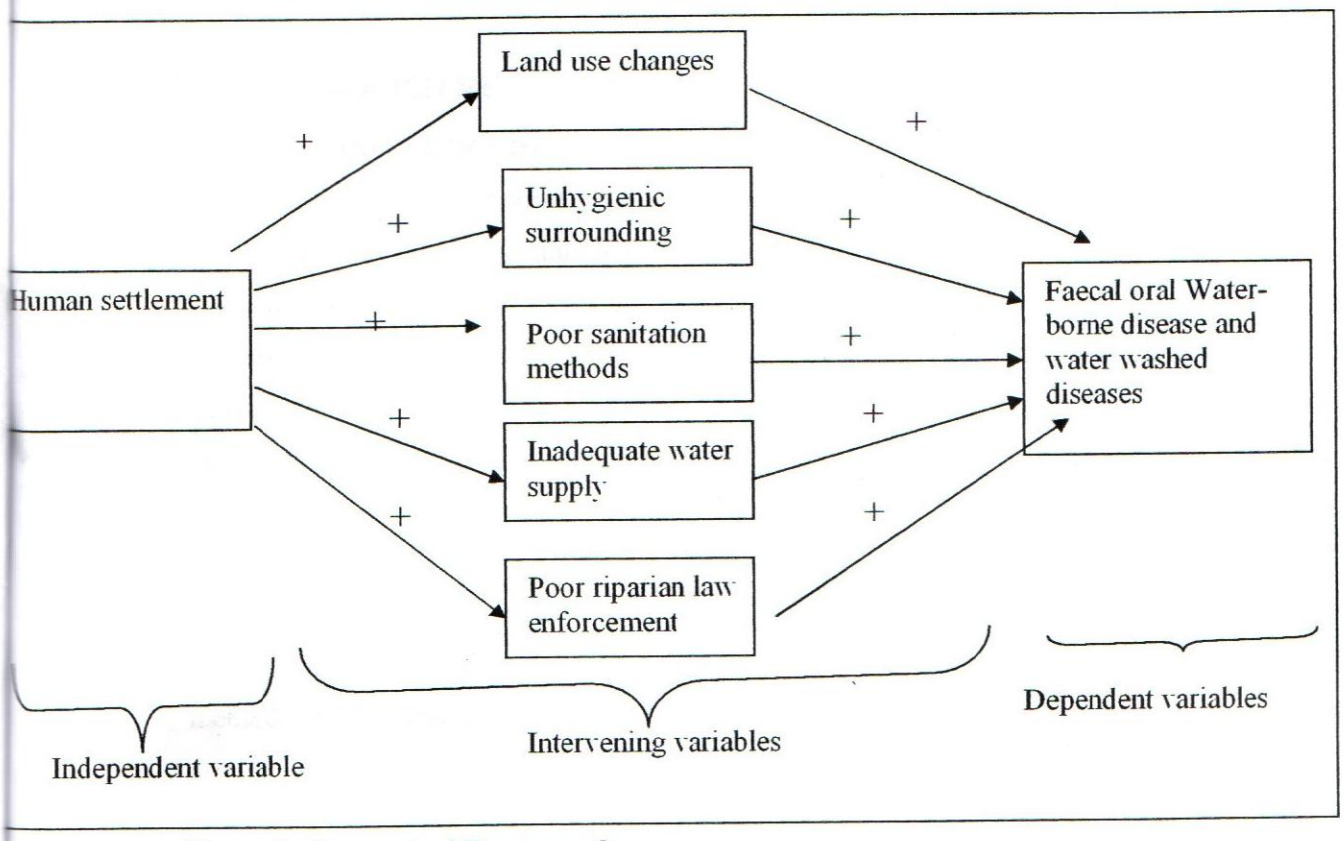


Figure 3: Conceptual Framework

In the above framework, human settlement is seen to determine the type of land use pattern to be practiced, water handling methods, sanitation methods, availability of quantity water for hygiene and how well people abide to laid down environmental related laws. The interconnection of the intervening variables is complex as none of the variable can result to faecal oral waterborne and water washed diseases alone. For example shortage of settlement land will result to overcrowding and mushrooming of slums. This kind of lifestyle is characterized by lack of adequate safe water; lack of basic sanitation and other waste disposal facilities e.g. open defecation and unhygienic water handling practices, which results to poor environmental conditions. Laxities in enforcement of laws governing riparian buffer zones have also contributed to deterioration of environmental factors causing faecal-oral waterborne and water-washed diseases.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 SAMPLING PROCEDURE

This study focused on reported cases of faecal oral waterborne and water washed diseases among residents within the River Njoro watershed. Reconnaissance visits in the River Njoro watershed organized by SUMAWA-CRSP project revealed that there are six main health institutions. Nessuit clinic, Njoro Health Centre, Egerton University Sanatorium and Kapkures community dispensary are government sponsored. Huruma clinic and PCEA Njoro clinic are privately owned by catholic church and PCEA respectively.

Purposive sampling of clinics was spread across all the zones in the watershed in order to capture as much variation as possible. Other factors such as clinical diagnoses method, drug procurement process applied, and visitations by patients of all age groups were considered. The methods of medical recording and drugs procurement processes were similar in all government- run health institutions. Proximity of health institutions to one another was also considered to avoid 'double counting'. In addition to these factors each health institution selected had to be within one of the three zones earmarked for PRA study for SUMAWA-CRSP. Taking these factors into consideration three health institutions were selected namely; Nessuit Dispensary in the upper zone, Njoro Health Centre in the middle zone and Kapkures Community Dispensary in the Lower zone. Chief Medical Officer from each of the three clinics was expected to fill the medical questionnaire.

3.2 DATA COLLECTION METHODS

Medical records from these institutions between 1998-2002 were collected. Case registers (appendix 1) showing patients treated were used to source medical data. Information from these case registers specifically on four faecal-oral water–borne and water-washed diseases (typhoid, diarrhoea, amoebiasis and bacillary dysentery) was collected and tabulated as shown in result finding section.

PRA reports from the three zones were reviewed to draw information pertaining to community perceptions on faecal oral waterborne and water washed diseases.

Emphasis was placed on the following PRA data collection techniques; problem listing, problem ranking, options assessment and community action plans (CAPs).

A questionnaire (appendix 2) was used to source information from medical personnel pertaining to treatment costs and disease duration among others to help calculate economic cost. Other information such as daily wage for unskilled casuals was obtained from (SUMAWA-CRSP socio-economic report 2004) and field observation in the study area.

3.3 DATA ANALYSIS

Epidemiology information system (Epi Info 2002) computer software was used to enter the collected data into the computer. These data were then categorized into frequency tables showing yearly and seasonal trends for diarrhoea diseases. As pointed earlier Nessuit and Kapkures clinics lacked operational laboratories during the study period. It was thus impossible to rely on their medical data for typhoid, bacillary dysentery and amoebiasis, which are reliably diagnosed through laboratory tests. This therefore necessitated the use of medical data from Njoro health centre to show variability in faecal oral water borne and water washed diseases occurrence among people in different age groups.

Data from PRA sessions commissioned by SUMAWA-CRSP project were reviewed. Information on water pollution, water shortage, human diseases and waterborne diseases were studied. PRA techniques such as problem listing, problem ranking, seasonal calendars, option assessments and community action plans were used to draw community perceptions. All this information was reviewed with the knowledge that poor quality and quantity water contribute to faecal oral waterborne and water washed diseases.

Information generated from clinical officer questionnaires, recorded daily wages for casuals in the river Njoro watershed and generalized field observation were used to compute disease cost. Other forms of private cost as suggested by Rosen and Jeffrey, (2001) were also modified in disease costing. These included lost wages due to days of ill health and days travelled time to seek medical help for patients above 20 years and lost wages of another adult (caregiver) to take care of a sick patient under 20 years during days of illness.

CHAPTER FOUR

4.0 RESEARCH FINDINGS

The following section provides the findings of the research. The respective results are divided as follows; part one has quantitative results drawn from disease case registers, part two has qualitative results detailing community perceptions drawn from PRA reports, while part three has economic cost analysis for faecal-oral waterborne and water washed disease burden.

4.1 TRENDS AND PATTERNS OF FEACAL ORAL WATERBORNE AND WATER WASHED DISEASES 1998-2002

This section is aimed at satisfying specific objective (1) and it is divided into four sub sections. These sub sections are yearly trends for diseases, seasonal trends of diseases, location (sites of origin) against diseases and disease diagnosis against age. Analysis of collected medical data shows that only diarrhoea and typhoid formed remarkable trends out of the four diseases studied in yearly and seasonal trends. Therefore trends of these two diseases have been used to explain yearly and seasonal patterns against percentage disease cases as shown below. But trends of all the four diseases have been used to show how patients from various watershed locations report their water related sicknesses in health institutions within their zones. Lastly, frequency tables showing how reported disease cases affect people in different age groups are represented.

The number of outpatients visiting the studied health institutions is relatively stable. Nessuit dispensary had an average of 6,150, Njoro health centre had 15,253 while Kapkures dispensary recorded an average of 9,676 outpatients between 1998-2002 A total number of 4,375 outpatients case were recorded for faecal oral waterborne and water washed diseases during medical data collection process. Nessuit dispensary recorded 608 patients, Njoro health centre 1,958 while Kapkures dispensary recorded 1,809. (Appendix 3). Table 2. Shows the distribution of diarrhoea, typhoid, amoebiasis and bacillary dysentery in the three health institutions studied. Typhoid recorded 11.8%, bacillary dysentery and amoebiasis 14.6% while diarrhoea accounted for 73.6% of all the reported faecal oral waterborne and water washed diseases in the watershed.

Table 2. Percentage distribution of faecal oral waterborne and water washed diseases between 1998-2002 across river Njoro watershed. Own calculation

		Percentage cases for		
Clinic	Year	Typhoid	Diarrhoea	Amoebas & bacillary dysentery
Nessuit	**2000**	**23.69**	**75.14**	**1.17**
	2001	**13.79**	**50.57**	**35.63**
	2002	**1.53**	**90.42**	**8.04**
Njoro Health centre	**1998**	**1.58**	**61.76**	**36.65**
	1999	**13.11**	**76.66**	**10.22**
	2000	**10.35**	**78.11**	**11.52**
	2001	**32.61**	**41.58**	**25.81**
	2002	**24.31**	**54.97**	**20.72**
Kapkures dispensary	**1998**	**0.64**	**90.73**	**8.63**
	1999	**1.23**	**86.42**	**12.35**
	2000	**0.56**	**90.20**	**9.24**
	2001	**24.59**	**72.49**	**2.91**
	2002	**24.60**	**72.50**	**2.90**

It was observed that Nessuit and Kapkures dispensaries lacked operational laboratories where typhoid, amoebiasis and bacillary dysentery could be properly diagnosed. This therefore restricted research findings and discussion for Nessuit and Kapkures dispensary to be based on diarrhoea data. Since Njoro health centre had an operational laboratory its medical data was used to show variability in disease occurrence among people in different age brackets.

The general trend of reported diarrhoea disease in Njoro Health Centre and Kapkures clinic is declining over the years unlike that of Nessuit.this might seem to disagree with earlier statement of increased cases of waterborne and waterwashed diseases in river Njoro watershed. However the watershed experienced increased waterborne diseases but since each zone was characterised by different environmental an behavioural factors the number of reported cases in the clinics differed. These individual factors are discussed under 'yearly trends of diarrhoea' in each clinic.

4.1.1 Yearly trends for diseases

Figure 5 shows how percentage diarrhoea cases was reported across River Njoro watershed

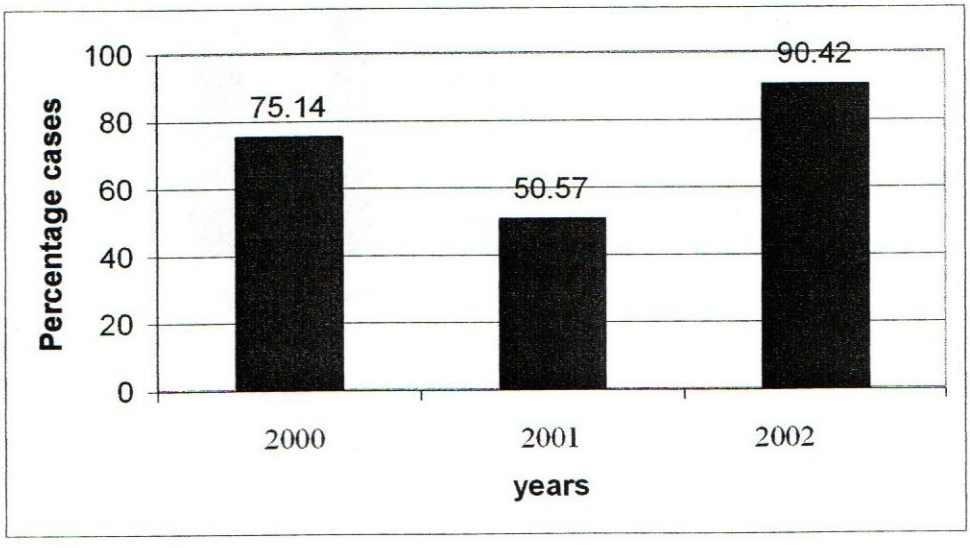


Figure 4. Annual percentage diarrhoea cases in Nessuit dispensary (2000-2002).

Nessuit dispensary started to serve the general public in early 2000, previously the area residents relied on traditional medications or went to dispensaries far away such as Njoro Health Centre and Rift Valley Provincial Hospital. The graph shows a high

percentage of diarrhoea cases in the year 2000 (75.14 %), which declined to (50.57 %) in the year 2001 but increased to (90.42 %) levels by 2002.

The trend could be attributed to 'start up' effect whereby new migrants settled in areas next to Nessuit dispensary and visited the health facility in large numbers. Increase in human population coupled with poor environmental conditions, inadequate water supply, lack of sanitation and hygiene are likely to explain some the factors which led to of the increased level of faecal-oral water-borne and water-washed diseases in Nessuit between 2001 and 2002. The differences in percentage cases of diarrhoea reported between Nessuit and the two other watershed clinics could be due to change of lifestyle from hunting and gathering to mixed farming by Nessuit residents coupled with other factors such as lack of government medications and supplies in 2001 hitting Nessuit, migration of people, clearing of forests, use of herbal medication, lack of pit latrines and poor waste disposal means. Each of these factors increased the risk of water-borne and water-washed diseases.

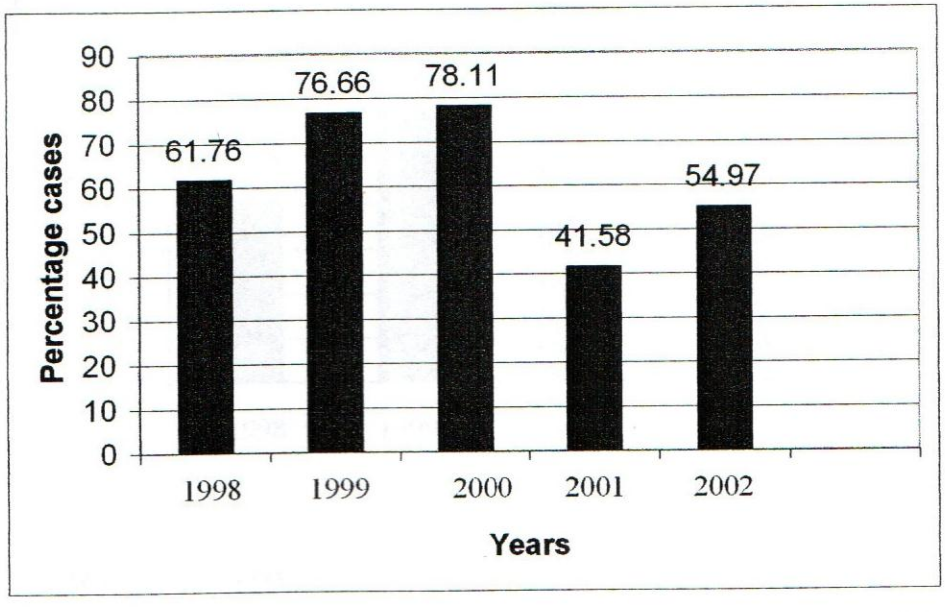


Figure 5. Annual percentage Diarrhoea cases in Njoro Health Centre (1998-2002)

Njoro health centre is the biggest health institution in Njoro division treating an average of 53.29 % patients over the data collection period compared with 33.81 % in Kapkures. The health centre also handles minor referral cases from other dispensaries. The percentage of diarrhoea cases in Njoro increased from 61.76 to 78.11 between 1998-2002, it then reduced to 41.58 in 2001, which later increased slightly to 54.97 in

2002. The year 2000 had the highest percentage of 78.11% but was followed by a decrease to 41.58 and 54.97 for 2001 and 2002 respectively.

In the year 2001 many government sponsored health institutions lacked adequate medical facilities due to delays in drug procurement. Many patients visited private clinics where they were assured of medication and proper medical attention (Nakuru District Medical Data, 2004). Presence of private clinics in Njoro town and other small towns in the region contributed to reduction in reported percentage diarrhoea cases between years 2000-2002 in the Government dispensaries. Presence of piped and treated water in neighbourhoods of Njoro town in the year 2001 also contributed to reduction in reported percentage diarrhoea cases (Nakuru District Medical Data, 2004).

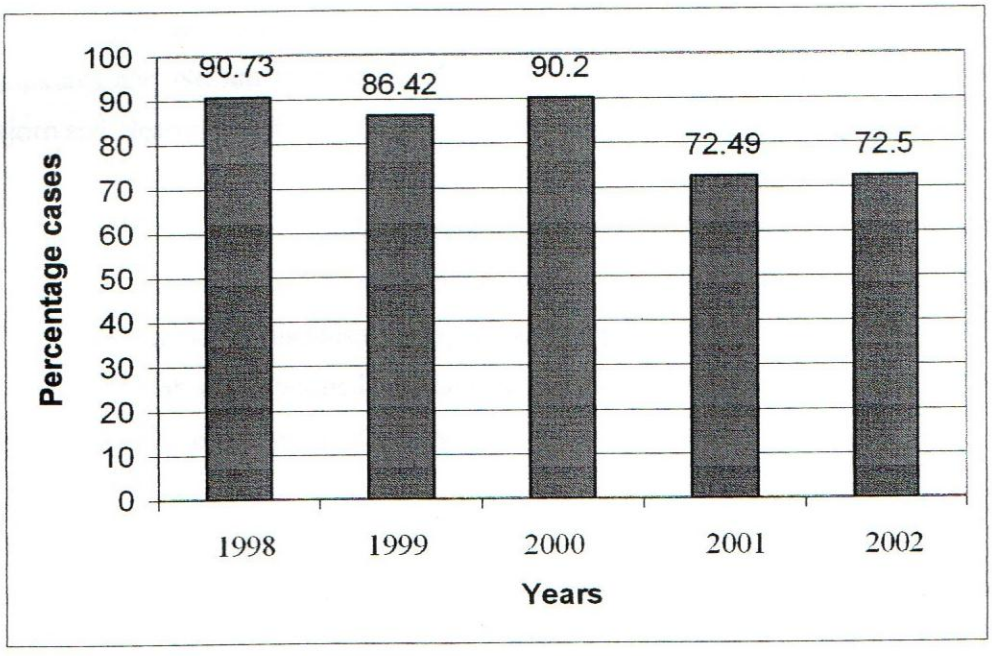


Figure 6. Annual percentage diarrhoea cases in Kapkures Dispensary 1998-2002

Diarrhoea cases in Kapkures, as in Njoro, show no observable trend, but remain relatively stable over the 5 years, at an average of 82.48%.

River Njoro regularly dries up in some parts of its lower stretch. Around Barut the river inevitably dries during dry months of the year. It is thought that the problem has been exacerbated by deforestation in upper zones of the watershed and the extensive

sand scooping operations present in the lower stretches of the river. The drying of the river happens every year in Barut, and has been an observed phenomena dating to colonial times recorded as the late 20th century in British hydrogeology reports on the Rift Valley and Lake Nakuru. Residents of Barut location who lack access to piped water supplies face water scarcity and thus use poor quality water during these periods. Some better off members buy water from Nakuru Municipal Council while others fetch water from available boreholes far away from their homesteads (Lelo and Chiuri,, 2004). These alternative water sources although not dependable all year round provide some measure of access to improved water supplies to well off residents. However, the poor residents who cannot afford the cost and alternative water sources are likely to face higher risk of faecal-oral diseases during these periods.

One-way ANOVA of percentage diarrhoeal cases between clinics showed that there was a significant difference between Kapkures and Njoro ($p=0.00043$) but not Kapkures and Nessuit ($p=0.4361$). Also there was a significant difference between Njoro and Nessuit health institutions ($p=0.000934$).

The analysis of variance above accounts for the different methods used to diagnose diseases in the three health institutions. Absence of an operational laboratory in Nessuit and Kapkures dispensary jeopardised the proper diagnose of other faecal oral waterborne and water washed diseases as diarrhoea, unlike in Njoro health centre where lab analysis was easily done and right diagnoses made.

4.1.2 Seasonal trends of disease

Medical data for year 2002 have been used to show seasonal trends, because of its completeness. In the year 2002 alone a total number of 29, 369 outpatients were treated in the three health institutions. Of these, 1,129 individuals suffered from different types of faecal oral waterborne and water washed diseases. The total number of faecal oral waterborne and water washed diseases cases reported in the three clinics were Nessuit- 261, Njoro health centre -362 and Kapkures dispensaries - 506 respectively.. Diarrhoea was the major ailment forming a staggering 75.8% of all the faecal oral waterborne and water washed diseases in the clinics. Monthly diarrhoea percentages for the three clinics are shown in Appendix 5.

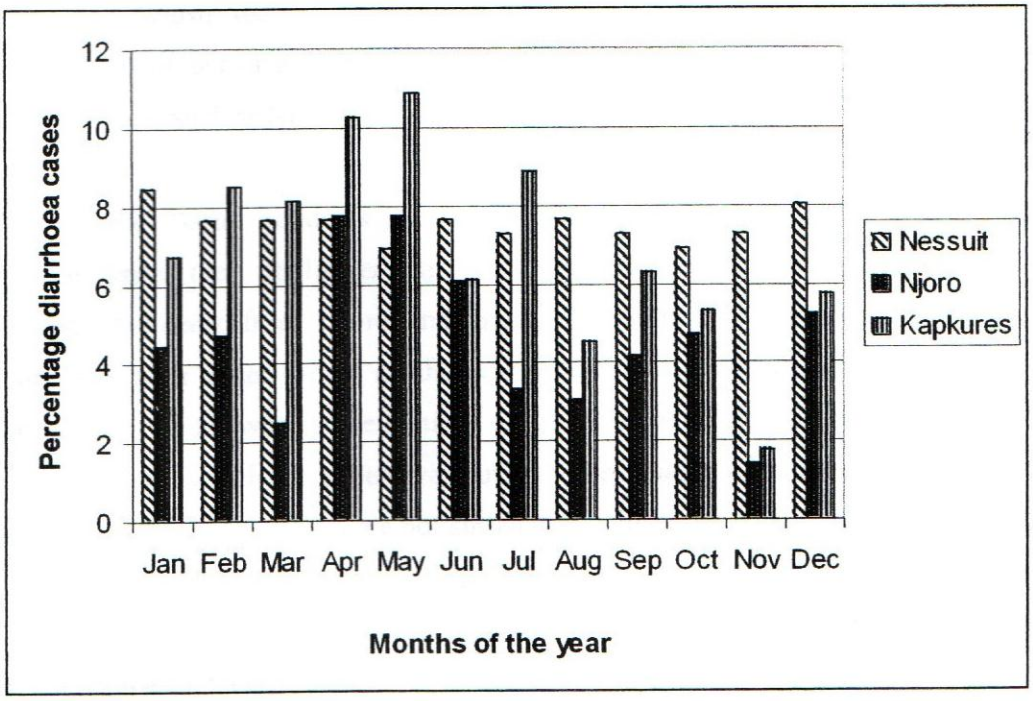


Figure 7. Monthly trends for reported Diarrhoea across the Watershed 2002

Njoro health centre had highest levels of diarrhoea in April and May (7.73 %) while the lowest occurrence was in November (1.38 %). Kapkures dispensary on the other hand experienced highest diarrhoea cases overall. It peaked in April (10.27%) and in May (10.86) while the lowest case was in November (1.77%).

Comparing the three health institutions above one realises that Nessuit experienced the highest diarrhoea percentage levels during the warm dry season (November, through early April), and consistently low levels when the rains starts in late May, right through to October. In contrast both Njoro and Kapkures clinic have two common peaks in the months of April/May and lowest peak in the month of November.

Availability of adequate quality water together with high level of personal hygiene is paramount for diarrhoea control (Feachem *et al* 1983). Nessuit community has adequate river water supply all the year round unlike Njoro and Barut Locations. In these latter areas, river Njoro ceases to flow for some months in the year. The disparity in diarrhoea occurrence in these regions is attributed to poor personal hygiene due to lack of pit latrines and poor waste disposal methods present in Nessuit

region. Warm dry seasons correspond with high diarrhoea percentages in the upper watershed. Warm weather is favourable for bacterial survival and multiplication as a result of poor personal hygiene, common in newly settled areas as in 'transition communities' such as Nessuit (Feachem *et al* 1983)

Njoro and Barut residents occupied their current land immediately after independence, they no longer experience marked land use changes like Nessuit people. Residents from Njoro and Barut regions have continued to experience unreliable river water supply all the year round. This concern is highly manifested during dry seasons when some sections of the river dry up. Residents seek alternative water sources, which are expensive, but of higher quality to supplement their water demands. These alternatives are not sustainable as they are costly and insufficient for high domestic water demands. Reduction in reported diarrhoea levels during dry seasons reflect the time when community members are using alternative and cleaner water sources in their neighbourhood.

Upon the onset of rainy seasons, the diarrhoea cases reported in Nessuit dispensary reduced but the opposite happened in Njoro and Kapkures dispensaries. These are two possible explanations to this phenomenon, Increased storm water draining into the river Njoro diluted the faecal load responsible for diarrhoea infections along the upper stretch. On the other hand community members from Njoro and Barut areas reverted to use of river water due to its availability and affordability. Cumulative faecal load drained by storm water collecting from all parts of the watershed make Njoro and Barut residents therefore contract diarrhoea and other intestinal related ailments. This agrees with Pearson (2001) who associated high rainfall to increased waterborne diseases outbreak.

4.1.3 How Faecal Oral Waterborne and Water Washed Diseases Compare With Age

This is aimed at identifying the age group(s) most vulnerable to the four faecal oral waterborne and water washed diseases. This is important in deciding which intervention measure(s) could be applied to control diseases. As noted earlier medical data collected from Njoro health centre was used to demonstrate how various faecal oral waterborne and water washed disease vary with age. This is represented in figure 9.

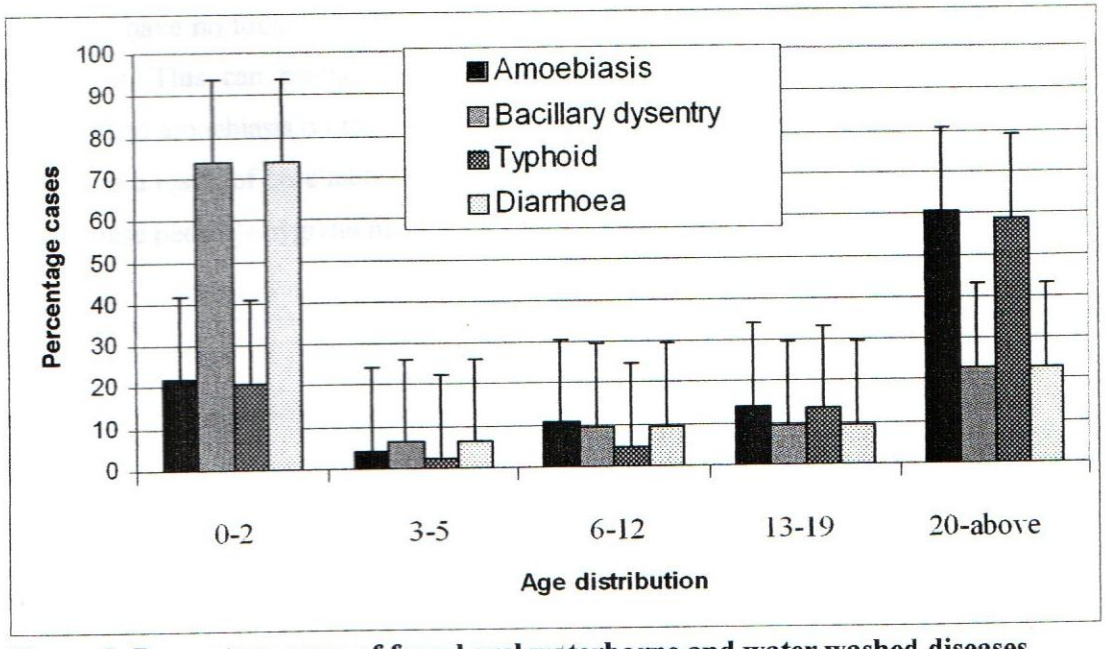


Figure 8. Percentage cases of feacal oral waterborne and water washed diseases against age in Njoro health centre

Diarrhoea and bacillary dysentery percentage cases are highest in children between 0-2 years while typhoid and amoebiasis are highest in adults 20 years plus. The four diseases do not show any age specificity between 3-19 years at $p<0.05$.

Diarrhoea and bacillary dysentery require little infective dose unlike typhoid and amoebiasis, which require a substantial infective dose to cause diseases. These could probably explain the observation from figure 9 above. In many developing countries typhoid contribute less to childhood diarrhoea mortality unlike diarrhoea and bacillary dysentery. To a great extent, mothers and caregivers of these young ones are to be blamed for the high percentages in diarrhoea and bacillary dysentery recorded. Inadequate water availability experienced in middle and lower zones could explain the above observation. Children below 2 years are known to defecate whenever and wherever they feel the need. A proportion of these children will be excreting a substantial amount of pathogens indiscriminately around domestic settings where health problems may occur to other members of the household if children are allowed to play with utensils and water containers they expose other family members to disease causing organisms around their unhygienic compounds which later cause faecal-oral water borne and water washed diseases. Children between 3-5 years fail to use available toilets because they find them inconvenient, are not encouraged by

adults or they get afraid of falling down into the pits. Some parts of upper river watershed have no toilets all together and hence area members use bushes to relieve themselves. This can probably explain why they suffer from diarrhoea diseases. Typhoid and amoebiasis on the other hand are mostly hygiene related. Poor personal hygiene as a result of unreliable water sources in many months of the year is likely to compromise people's hygiene practices.

4.2 COMMUNITY PERCEPTIONS

This section aims at satisfying specific objective (2) 'To capture community's perception on the issues of diseases in the watershed' and giving supportive information to the other specific objectives in this research. Inorder to gauge community perceptions, ranked problems touching on quantity and quality of river water cited in the PRA reports (Lelo and Chiuri, 2004)

The following problems were noted across the watershed: -

- Water pollution-upper zone,
- Water shortage-middle zone
- Human diseases-middle zone
- Insufficient water-lower zone
- Waterborne disease-lower zone

Water pollution is present across the watershed as a result of washing, bathing and direct watering of animals. In the middle zone sewerage from Egerton university ponds gets its way into the river; industrial wastes from Njoro Canning factory and Bora milk are other contributors to river pollution. Along the lower stretch the situation is even worse from accumulated surface run-offs collecting from all over the watershed and parts of Kaptembwa and Rhoda slums in Nakuru town.

Water shortage was found to be experienced in both middle and lower zones. Upper zone has adequate water sources from various tributaries draining in river Njoro, but they lack convenient means of its supply to their homesteads. Lack of adequate water is known to affect hygiene practices thus causing water related diseases (Feachem *et al*, 1983). Reduction of river volume could be as a result of continued water abstraction for building, agriculture, domestic purposes and increased deforestation of the river catchments. Water shortage is sometimes severe along the lower stretch during prolonged drought seasons.

Water related diseases, namely typhoid, diarrhoea, amoeba and malaria were common in Mwigito (middle) and Barut (lower) zones respectively. Their occurrence is felt all year round although at different magnitudes as explained by community's 'seasonal calendar'. These diseases are caused by inadequate water and use of contaminated water. Lack of adequate pit latrines for hygienic disposal of excreta together with untreated sewerage draining into the river water could also be contributing to these ailments. Poor water handling methods and lack of knowledge associated with faecal oral waterborne and water washed diseases transmission could also be contributing to the noted cases.

Despite all these problems, watershed residents have learnt the art of co-existing with their problem. Some members have been boiling drinking water while others have been using alternative water sources which are thought to be of better quality. These alternative sources are said to be unreliable due to high cost involved and increased daily human demands of water that exceeds their supply.

In order to prevent above listed problems, the communities have a number of alternatives/options, which they suggested. Among these include creation of awareness about afforestation to enhance the flow of the river, conserve riparian zones and ensure regular flow of adequate water all year round in all zones. They also suggested roof catchments as an alternative source of clean and cheaper water. This exercise has been used in some other areas such as Eldoret and Gilgil and has proved successful (Christian Community Services 2001, Lelo *et al* 1993). Stalled water projects in the watershed such as Kiptunga springs, Mwigito borehole and Ingobor dam could also be revived as they can contribute to quality water availability. In addition, the area residents suggested the use of traditional medicine to treat some of the ailments. This will help save in cost together with conservation of trees and herbs collection reserves thus maintaining riparian zones.

4.3 ECONOMIC COST FOR DISEASES

A precise method of estimating cost incurred by patients in river Njoro watershed has been developed. This is aimed at establishing the cost of being sick and hence the economic benefits from preventing the diseases. Diarrhoea accounted to over 80% of all reported faecal oral water borne and water washed diseases. This is a clear indication that diarrhoea is the greatest faecal oral water borne and water washed disease bother to the river Njoro watershed residents. Typhoid on the other hand, although it affects a small percentage of the population is said to be complex in its treatment processes thus more costly to treat.

As aforementioned, diarrhoea diagnoses was based on clinical symptoms done by clinical officers unlike typhoid, bacillary dysentery and amoebiasis, which required laboratory analysis to be properly verified. This then has made economic costing for diarrhoea to use two ways route while that for typhoid, bacillary dysentery and amoebiasis to use a six-pathway route. These pathways are hypothetical but are based on the understanding that there is likelihood of irregularities to occur when differentiating the symptoms of the four diseases. The method uses probabilities to demonstrate the different costs likely to be incurred by a patient before getting fully treated. Tree diagrams are used to show the various pathways (summarised in tables 3 and 4) respectively.

Table 3. Tree diagram showing pathways and probabilities for diarrhoea patients in the public health system in river Njoro watershed

Patient	Correct clinical diagnosis for diarrhoea (8/10)	*Diarrhoea drugs available 8/10)*	A= 8/10 X 2/10 = 64/100
Patient	Correct clinical diagnosis for diarrhoea (8/10)	*Diarrhoea drugs unavailable 2/10)*	B= 8/10 X 2/10 = 16/100
Patient	Misdiagnosis for diarrhoea, typically being typhoid, bacillary dysentery, amoebiasis or other gastro-intestinal inflammation (2/10)	Depend on the disease in question	C =Depend on disease

Adopted from Borghi (2002)

Explanation

Patients following routes A and B have their diagnosis based on clinical symptom observation only. Route C above is dependent on the kind of disease in consideration. For typhoid patients, one is likely to follow any of the six pathways shown below.

Table 4. Tree diagram showing pathways and probabilities for typhoid patients in the public health system in river Njoro watershed

Patient	Correct clinical diagnosis for typhoid (1/10)		*Typhoid drugs available (1/10)*		*i*=1/10 X 1/10 =1/100
Patient	Correct clinical diagnosis for typhoid (1/10)		*Typhoid drugs unavailable (9/10)*		ii= 1/10 X 9/10 = 9/100
Patient	Misdiagnosis of typhoid typically given as malaria (9/10)	Malaria drugs available (49/50)	Sick patient return for correct diagnosis with Typhoid laboratory test	*Typhoid drugs available (1/10)*	iii= 9/10 X 49/50 X 1/10 =441/5000
Patient	Misdiagnosis of typhoid typically given as malaria (9/10)	Malaria drugs available (49/50)	Sick patient return for correct diagnosis with Typhoid laboratory test	Typhoid drugs unavailable (9/10)	iv=9/10 X 49/50 X 9/10 =3969/5000
Patient	Misdiagnosis of typhoid typically given as malaria (9/10)	*Typhoid drugs available (1/10)*	Sick patient return for correct diagnosis with *Typhoid laboratory* test	*Typhoid drugs unavailable (9/10)*	v =9/10 X 1/50 X 1/10 =9/5000
Patient	Misdiagnosis of typhoid typically given as malaria (9/10)	*Typhoid drugs available (1/10)*	Sick patient return for correct diagnosis with *Typhoid* laboratory test	Typhoid drugs unavailable (9/10)	vi=9/10 X 1/50 X 9/10 =81/5000

Adopted from Borghi (2002)

Note. Typhoid laboratory test is reserved for patients who are misdiagnosed during the first visit, and that when path iii to vi patients return still sick after failure to respond to malaria treatment, they are then offered a lab test to check for typhoid. In this analysis, we assume the lab test is 100% correct in diagnosing typhoid. This is unlikely to be true, but for simplicity, the probabilities and implications of misdiagnosis with the lab test at this stage is not considered.

4.3.1 Costs Estimate associated with each pathway

A cost estimate takes into consideration the following: consultation fee, medication fee, transportation, microscopic analysis for laboratory analysis for typhoid and indirect cost in terms of lost working hours through sick offs and care giving of the patient. The following standardized costs are based on livelihood status and travel distance of Njoro watershed people and information derived from responses from questionnaires administered on medical officer.

Direct cost

- Consultation fee Ksh 100
- Medication fee[1]
- Transport to and from clinic Ksh 100
- Microscopic analysis (widal test) Ksh 100
- Diarrhoea drugs Ksh 300
- Typhoid drugs Ksh 500
- Malaria drugs Ksh 100

Average duration of illness

- Diarrhoea 5 days
- Typhoid 14 days

NB 3 and 8 days were considered to be the maximum number for inability to work for a patient suffering from diarrhoea and typhoid respectively.

[1] is included in consultation fee, if drugs for the disease in question are available in the health institution

Indirect cost (adapted from Rosen and Jeffrey 2001)

- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 years (use Ksh 100 daily unskilled wage in watershed)

  Ksh.100 X 8 =Ksh 800

- Lost wages of another adult to take care of sick patient under 20 years during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 4 =Ksh 400

4.3.2 Estimated costing for diarrhoea and typhoid

This section compiles the treatment, transportation and lost wage cost estimates for each pathway assuming the patient is either an adult over 20 years or under 20 years. For an adult over 20 years of age 3 and 8 working days are lost as sick off for diarrhoea and typhoid diseases respectively. Costs for a person under 20 years of age assume no lost wages for the patient. But, 'under 20 years' patients require another adult to take care for them when sick. In this case a half-day attention by an adult caretaker will be needed for 3 and 8 days respectively.

Diarrhoea costing

A

- Consultation /Medication fee -Ksh 100
- Transport to and from clinic- Ksh 100
- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 years (use Ksh 100 daily unskilled wage in watershed)

  Ksh.100 X 3 =Ksh 300
- Lost wages of another adult to take care of sick patient under 20 during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 1.5 =Ksh 150

A = (100 +100+ 300+150)

= Ksh 650

B

- Consultation /Medication fee -Ksh 100
- Transport to and from clinic- Ksh 100

- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 years (use Ksh 100 daily unskilled wage in watershed)
  Ksh.100 X 3 =Ksh 300
- Lost wages of another adult to take care of sick patient under 20 during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 1.5 =Ksh 150
- Diarrhoea drugs purchase on open market = Ksh 300

B =(100 +100+ 300+150+300)
=Ksh 950

4.3.3 Expected Costs of diarrhoea Disease for Patient Households

The expected cost privately borne by households with a diarrhoea case is computed by summing the probability-weighted costs of each of the two pathways as follows.

64/100 X 650 = 416
16/100 X 950 =152

Thus the average cost for diarrhoea to a household is = Ksh (416 +152)
= **Ksh. 568**

Typhoid Costing

The expected cost privately borne by households with a diarrhoea case is computed by summing the probability-weighted costs of each of the two pathways as follows.

i

- Consultation /Medication fee -Ksh 100
- Transport to and from clinic- Ksh 100
- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 years (use Ksh 100 daily unskilled wage in watershed)
  Ksh.100 X 8 =Ksh 800
- Lost wages of another adult to take care of sick patient under 20 during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 4 =Ksh 400

i = (100 +100+ 800+400)

= Ksh 1,400

ii

- Consultation /Medication fee -Ksh 100
- Transport to and from clinic- Ksh 100
- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 (use Ksh 100 daily unskilled wage in watershed)
  Ksh.100 X 8 =Ksh 800
- Lost wages of another adult to take care of sick patient under 20 during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 4 =Ksh 400
- Typhoid drug purchase on open market = Ksh 500

ii =(100 +100+ 800+400+500)

=Ksh 1,900

iii

- Consultation /Medication fee -Ksh 100
- Transport to and from clinic- Ksh 100
- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 (use Ksh 100 daily unskilled wage in watershed)
  Ksh.100 X 8 =Ksh 800
- Lost wages of another adult to take care of sick patient under 20 during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 4 =Ksh 400
- Transport for 2nd visit to the clinic after disease misdiagnosis = Ksh 100
- Typhoid test=Ksh 100
- Typhoid medication is provided free as a result of 1st visit consultation fee

iii =(100 +100+ 800+400+100+100)

=Ksh 1,600

iv

- Consultation /Medication fee -Ksh 100

- Transport to and from clinic- Ksh 100
- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 years (use Ksh 100 daily unskilled wage in watershed)
  Ksh.100 X 8 =Ksh 800
- Lost wages of another adult to take care of sick patient under 20 during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 4 =Ksh 400
- Transport for 2nd visit to the clinic after disease misdiagnosis = Ksh 100
- Typhoid test=Ksh 100
- Typhoid drug purchase on open market = Ksh 500

iv = (100 +100+ 800+400+100+100+500)
=Ksh 2,100

v

- Consultation /Medication fee -Ksh 100
- Transport to and from clinic- Ksh 100
- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 years (use Ksh 100 daily unskilled wage in watershed)
  Ksh.100 X 8 =Ksh 800
- Lost wages of another adult to take care of sick patient under 20 during days ill (use Ksh 100 daily unskilled wage in watershed but only ½ day attention is needed) Ksh.100 X 4 =Ksh 400
- Purchase of malaria drugs on open market = Ksh 100
- Transport for 2nd visit to the clinic after disease misdiagnosis = Ksh 100
- Typhoid test=Ksh 100
- Typhoid medication is provided free as a result of 1st visit consultation fee

V =(100 +100+ 800+400+100+100+100)
=Ksh 1,700

vi

- Consultation /Medication fee -Ksh 100
- Transport to and from clinic- Ksh 100

- Lost wages due to days ill and days travel time to seek medical help, for patients over 20 years (use Ksh 100 daily unskilled wage in watershed)
  Ksh.100 X 8 =Ksh 800
- Lost wages of another adult to take care of sick patient under 20 during days ill (use 100% daily unskilled wage in watershed but only ½ day attention is needed)
  Ksh.100 X 4 =Ksh 400
- Purchase of malaria drugs on open market =Ksh 100
- Transport for 2nd visit to the clinic after disease misdiagnosis = Ksh 100
- Typhoid test=Ksh 100
- Typhoid drug purchase on open market = Ksh 500

vi=(100+100+800+400+100+100+100+500)

=Ksh 2,200

4.3.4 Expected Costs of Typhoid Disease for Patient Households

The expected cost of typhoid privately borne by households with a typhoid case is computed by summing the probability-weighted costs of each of the 6 pathways are as follows.

1/100 X 1,400 = 14

9/100 X 1,900 =171

441/5000 X 1,600 =141

3969/5000 X 2,100 =1667

9/5000 X 1,700 =3.06

81/5000 X 2,200 =35.60

Thus the average cost =(14+171+141+1667+3.06+36)

=Ksh 2,029

4.4 ECONOMIC COSTINGS

Tables 4 and 5 above show the probable pathways followed by diarrhoea and typhoid patients in river Njoro watershed. In figure 4, one realises that for every 100 patients complaining of diarrhoea 80 are correctly diagnosed while the remaining 20 are misdiagnosed for typhoid, amebiasis and bacillary dysentery. To those correctly diagnosed for diarrhoea, 80% access drugs from the clinic and the remaining 20% to buy them privately from the pharmacies. Out of the 20% misdiagnosed for diarrhoea, about

10% suffer from typhoid (own calculation from recorded medical data). Tree diagram in figure 5 above shows that in every 100 patients visiting the clinic suffering from typhoid, 90 are misdiagnosed and treated for Malaria. In this way Malaria drugs in the clinics are wrongly prescribed without helping their intended consumers, in contrast after correct diagnoses for typhoid is done, these consumers are made to buy typhoid drugs, which are unavailable in the clinics. Diarrhoea drugs are available in the watershed clinics unlike those for typhoid whereby only 10% of the patients correctly diagnosed access the drugs many patients are made to purchase from pharmacies where they pay more.

The model shows for one to be fully treated for diarrhoea and typhoid, assuming the lab diagnostic is 100% reliable; he/she has to pay, on average, Ksh.568 and Ksh 2,029 respectively. This amount represents about 5% and 20% of the annual income of Ksh. 10,000 of an average Kenyan household (ROK, 2001)[1]. This does not include costs borne by the patient's family. There are government subsidies through provision of medical staff and subsidizing on drugs. The public costs of the water-related disease burden in the watershed have not been estimated, but studies suggest they are significant (Rosen and Jeffrey, 2001). There are other private non-monetary costs, which hit greatly but can only be expressed qualitatively. These include pain and psychological suffering experienced by the sick individuals and their family members.

According to Nakuru District medical records for 2004 the top five leading diseases in the District for year 2002 are diarrhoea diseases (29,981), Respiratory system diseases (162,563), Malaria (153,195), and skin diseases (51,421) (Nakuru District medical records 2004). Medical data analysis shows that diarrhoea and typhoid cases constituted 71% and 15 % of all diarrhoeal diseases reported respectively. This can thus mean out of 29,981 diarrhoeal cases reported in Nakuru district, 21,287 and 4,497 cases were from diarrhoea and typhoid patients. In river Njoro watershed alone a total of 3,555 and 545 patients suffered from diarrhoea and typhoid respectively during the study period. Therefore to treat 3,555 diarrhoea cases a staggering amount of Ksh. 2,019,240 was drawn from peoples' pockets. These figures show that a lot of people's income is used in treatment of preventable diarrhoeal diseases. This expenditure could be reduced if investments were made on low cost preventative interventions e.g. instead of simply supplying drugs to treat the diseases.

CHAPTER FIVE

5.0 CONCLUSION

Due to differential availability of equipments there are differences in the way patients are treated in the clinics within the River Njoro watershed. Only Njoro Health Centre provide both clinical and laboratory analysis in diseases. There are also variations in seasonal trends across the watershed. These are attributable to increase in human population, poor personal hygiene, inadequate water availability and poor environmental conditions. All the four faecal oral waterborne and water washed diseases showed variability with age. Diarrhoea and bacillary dysentery had high percentage cases in children 0-2 years, while typhoid and amoebiasis showed high percentage levels on individuals 20 years and above. The infective dose causing for each disease was found to be responsible for the observed variability.

PRA reports revealed that water shortage and poor river water quality were top among the problems experienced across the River Njoro Watershed. Majority of the residents felt that many of water related diseases in their midst were as a result of inadequate river water and water pollution upstream and midstream. The community members suggested that if stalled water projects were revived, rainwater harvested and continued use of traditional medicine maintained, then their problems could easily be reduced.

Disease costing showed that diarrhoea treatment was a major economic burden to households. Diarrhoea was the leading cause of childhood mortality. This is in addition to the high cost involved in its treatment and rehabilitation. This is more sad considering that with proper intervention measures and sensitisation, diarrhoea can be controlled easily at a lower cost. It is further shocking to note that large percentage of malaria drugs meant to benefit patients in the clinics were wrongly given to unsuspected patients misdiagnosed for typhoid. This by itself results to wastage of government funds used to buy drugs together with increased risk of drug poisoning to the unsuspected patients.

6.0 RECOMMENDATIONS

The foregoing discussion has shown that there are variations in disease trends among clinics in River Njoro Watershed. The area residents are also faced with water related problems ranging from waterborne diseases and unavailability of adequate water supply. This therefore provoked the following recommendations:-

a) Health managers from Ministry of Health and Stakeholder involvements members in SUMAWA-CRSP project should carry out community education on diseases across the watershed.

b) Present water supply such as boreholes, existing dams, watering points should be improved and protected from animal destruction. Community members should also be encouraged to utilize alternative water sources such as roof harvesting.

c) The findings of this research should be used for proper management and control of faecal oral waterborne and water washed diseases. Tabulated disease trends both yearly and seasonally from each zone should be availed to respective clinics i.e Nessuit, Njoro Health centre and Kapkures where it can be used to educate the residents. The SUMAWA-CRSP project should also ensure that the same information is availed to opinion leaders from all over the watershed through seminars and workshops.

d) The difference observed between Njoro health centre, Nessuit and Kapkures clinics should be probed further to ascertain whether the observed disease patterns remains or disappear with setting up of operational laboratories in Nessuit and Kapkures clinics.

REFERENCES

American Water Works Association, (1990). *Water Quality and Treatment, A Handbook of Community Water Supplies;* McGraw Inc. New-York.

Anyango C .(2000). *Awareness and Response by Small Holder Women Farmers to Soil Erosion. A Case of Njoro Kenya. Unpublished* M.A Thesis Egerton University, Njoro.

Borghi.J, Guinness, L, Ouedrago, J and Curtis. V (2002). *Is Hygiene Promotion Cost Effective? A Case Study in Burkina Faso* in Tropical Medicine and International Health Volume 7. No.11 Pg 960-969

Bradley, D.J., White, G.F, and White, A.U (1972*) Drawers of Water :Domestic Water Use in East Africa.* Chicago, University of Chicago Press.

Christian Community Services, (2001), *Solar Disinfection of Water, a Case Study from Kenya.*

Daily Nation June 5, (2003) Diarrhoea a Silent Killer

DFID (1999). *Guidance Manual on Water Supply and Sanitation.* Department for International Development, London.

Ehlich ,P.R and A.H. Ehlich (1970*). Population Resources Environment*, W H Freeman and Company, San Francisco Environmental Programme

Epidemiology Information system (2002): *Computer Software*

FAO (1986). *Strategies, Approach and Systems in Integrated Watershed Management*; UNDP/FAO 881025 *Government of Baglandesh*, Dhaka; 70-72.

Feachem, R.G. (1977). *Water Supplies for Low Income Communities*: Resource Allocation, Planning and Design for Crisis Situation in R.G. Feachem, M Mcgarry and D. Mara, Eds Water, Wastes and Health in Hot Climates, John Willey, London.

Feachem, R.G, D.J, Bradley, G Hemda and D.D. Mara (1983). *Sanitation and Disease Health Aspects of Excreta and Waste Water Management,* John Wiley and Sons. Chichester.

Forest Conservation Portal, (2004). *Waterborne Disease Afflict Half of Kenya's Population*. www.angolapress-angop.ao/nilicia-e.asp (downloaded on 21st Sep 2004.

Gleick H.P,(2002). *Dirty Water: Estimated Deaths From Water-Related Diseases 2000-2020* Pacific Institute for Studies in Development, Environment and Security. www.pacinst.org 10/11/02

Hofkes, E.H. (1981). *Small Community Water Supplies Technology of Small Water Supply Systems in Developing Countries,* John Wiley & Sons, Chichester-New-York

International Water Association (2002). *Industry as a Partner for Sustainable Development, Water Management,* Beacon Press, London United Nations. Rome.

Islam K.R. *et al* (2001). *Deforestation Effects on Vegetative Regeneration and Soil Quality in Tropical Semi-Evergreen Degraded and Protected Forests of Bangladesh in Land Degradation and Development Jan-Feb* (2001), Wiley. Interscience.

John Thompson et al (2001). *Drawer of Water II.* 30 Years of Change in Domestic Use and Environmental Health in East Africa. Russell Press. Nattingham

Kammerbauer, J and Ardon C. (1999) *Loss of Tropical Forest in* Agriculture, Ecosystems and Environment. No.75:93-100

Liniger, H. (1995*). Endangered Water, A Global Overview Degradation, Conflicts and Strategies for Improvement; Centre for Development and Environment.* University of Berne, Switzerland

Lelo, F.K, Ayieko,J.O and Muhia, N. (2000) *Egerton PRA Field Hand Book for Participatory Rural Appraisal Practitioners*, Egerton University. Njoro. Kenya

Lelo, F.K. and J.O.Ayieko, (1993*). People, Drought and Wildlife. A PRA Case Study of Gilgil Community, Nakuru.* Egerton University Press, Njoro, Kenya

Lelo, F.K and Chiuri, L.W (2004), *Synthesis of River Njoro Watershed PRA Reports* – SUMAWA-CRSP Project.

Mara, D.D and R.G.A. Feachem (1999) *Water and Excreta-Related Diseases: Unitary Environmental Classification* in Journal of Environmental Engineering, Vol.125, pg 334-339, No.4, April, 1999

Nakuru District Medical Records (2004) *Patients Records for Health Institutions in Nakuru District.*

Republic of Kenya (1997). *Nakuru District Development Plan 1997-2001,* Government Printers; Nairobi

_____(2001). *Population Distribution by Administrative Areas and Urban Centres.* Central Bureau of Statistics, 2001, Nairobi, Kenya.

_____ (2001).[1] *Statistical Abstract* Central Bureau of Statistics. Ministry of Finance and Planning.

Rosen S. and R.V. Jeffrey (2001). *Household Water Resources and Rural Productivity in Sub-Saharan Africa. A Review of the Evidence*. USAID Bureau for Africa.

Sharkloff, R. (1998). *Water Scarcity on Kikulwalte, The Social Causes and Consequences of Environmental Degradation in Highland Uva Village of Sri-Lanka* in World Development CAB International

Shivoga, A.W. (2000). *Environmental Issues as They Relate to National Water Policy in Poverty Alleviation in Provincial Workshop on The National Water Policy as Relates to Poverty Alleviation*, Rift Valley, Nakuru.

Shivoga, A.W., F.K.Lelo, Maina –Gichaba, Chiuri L.W, C . Lusenaka, Jenkins M and Miller, S.N (2003). *Integrated Stakeholders Participation in Watershed Assessment in River Njoro Watershed, Kenya Unpublished Proposal Manuscript* submitted to CRSP.

Shivoga, A.W. and F.K.Lelo, (2003). *Community-based Wetland Project for Wastewater Treatment* Unpublished Proposal Manuscript submitted to UNDP-GEF small Grants Programme

Shivoga, W.A., F.K Lelo, C .Maina-Gichaba, M.W. Jenkins, and S.N.Miller, (2002.) *Integrated stakeholder participation and Watershed Assessment in the River Njoro Watershed, Kenya.* Poster presentation to the Global Livestock Collaborative Research, program conference, October 9-12, 2003, Washington, DC.

SUMAWA-CRSP Socio Economic Reports, 2004: *Progress Report*

Tim Pearsons (2001). *Extreme Precipitation Linked to Waterborne Disease Outbreaks.* Johns Hopkins University Bloomberg School of Public Health

Twort, A.C (1963). *A Water Supply,* Edward Arnold; A Member of the Hodder Headline Group, London.

Winblad, U and Kilama,W (1985). *Sanitation Without Water*, Manillians

WHO. (2000). *Global Water Supply and Sanitation Assessment 2000 Report*. Available

http//www.who.int/water_sanitation_health/Globassessment/GlobalTOC.htm (downloaded August 2002)

APPENDICES

Appendix 1

NAME OF THE CLINIC _____ **SHEET NO** ------

COLLECTED BY---------- **DATE**_____

YEAR		AGE		SEX (M,F)	DIAGNOSIS D, T, A, B	LOCATION	CODING
	MONTH	YEARS	MONTHS				
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Appendix 2

Questionnaire for medical officers

NAME OF THE HEALTH INSTITUTION----------

1. Provide information on the following

- Size of operations (number of qualified medical staff)
- ……
- Number of consultation rooms
- Laboratory
- Pharmacy
- Other medical facilities not indicated above.

  ……

  ……
- Number of patients treated per year……
- Opinion or perception of staff about main health problems seen/treated (5 top most frequent occurring diseases, ranked in increasing order) and any trends or changes over the last 5 years or longer.

  ……

  ……

  ……
- Service zone (where do patients come from, translate this into distances and estimated travel times in hours)
- Distance in (Kilometers)……
- Travel time in hours ……
- Waiting time for patient to be treated …… hours
- Time when the health institution was opened----------

2. How is the diagnosis for each of the following 4 diseases done, if only by symptoms, provide the clinical symptom considered.

Typhoid

Diarrhoea

Amoebiais

Bacillary dysentery

---

3. Provide a detailed breakdown of your clinic total expenses and income

- Average cost breakdown at centre to see and treat a patient having each of your 4 diseases:
    - Consultation fee
    - Lab fee
    - Medications prescribed (Y/N)
    - Typical medication cost for each diagnosis

    Amoebiais……

    Typhoid……

    Diarrhoea……

    Bacillary dysentery……

    - Any other cost? Specify ----------

      ---

4. Any changes in operating policies or circumstances that might have affected patient usage of the centre or diagnosis of the 4 diseases over the period 1998-2002.

Appendix 3

Clinic	Year	Typhoid	Diarrhoea	Amoebas & bacillary dysentery	Total recorded medical data
Nessuit	2000	41	130	2	173
	2001	24	62	88	174
	2002	4	236	21	261
Njoro Health centre	1998	7	273	162	442
	1999	59	345	46	450
	2000	44	332	49	425
	2001	91	116	72	279
	2002	88	199	75	362
Kapkures dispensary	1998	2	284	27	313
	1999	4	280	40	324
	2000	2	322	33	357
	2001	76	224	9	309
	2002	70	421	15	506

Appendix 5

	Nessuit		Njoro health centre		Kapkures dispensary	
Months of the years: 2002	Diarr case	% cases	Diarr case	% cases	Diarr case	% cases
Jan	22	8.429119	16	4.41989	34	6.719368
Feb	20	7.662835	17	4.696133	43	8.498024
Mar	20	7.662835	9	2.486188	41	8.102767
Apr	20	7.662835	28	7.734807	52	10.27668
May	18	6.896552	28	7.734807	55	10.86957
Jun	20	7.662835	22	6.077348	31	6.126482
Jul	19	7.279693	12	3.314917	45	8.893281
Aug	20	7.662835	11	3.038674	23	4.545455
Sep	19	7.279693	15	4.143646	32	6.324111
Oct	18	6.896552	17	4.696133	27	5.335968
Nov	19	7.279693	5	1.381215	9	1.778656
Dec	21	8.045977	19	5.248619	29	5.731225
	236		199		421	

Appendix 6: Njoro Health Centre: Diagnosis and age

	Diagnosis							
Age in years	**Amebiasis**	**% Cases**	**Bacillary dysentery**	**% Cases**	**Typhoid**	**% Cases**	**Diarrhoea**	**% Cases**
-1	0	0	0	0	0	0	0	0
0-2	57	21.8	10	73.9	61	20.8	702	73.9
3-5	11	4.21	3	6.06	7	2.39	82	6.06
6-12	28	10.7	7	9.4	13	4.45	128	9.4
13-19	37	14.1	6	9.5	39	13.3	129	9.5
20-above	158	60.5	22	23.05	172	58.9	312	23.05
Total	261	100	48	100	292	100	1353	100