

**POLLUTION EFFECTS ON HUMAN HEALTH IN MWEIGA  
MUNICIPALITY, NYERI DISTRICT, KENYA**

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## DEDICATION

I am grateful to my parents Mr. Murethi and Mrs. Irene Murethi, my brothers Shem Gichimu and to my sister Priscilla Wambui for granting me the fellowship in order to undertake this study.

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Finalizing this project would not have been possible without guidance, cooperation and acknowledgement received from a number of people and institutions.

Am first grateful to God for strengthening me and keeping me in shape undertake this research.

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## DECLARATION

I **MURETHI JOYCE NYAMBURA** (BEM/0968/31/DF), declare that to the best of my knowledge the work presented in this report is original and that it has never been submitted for award of a degree or its equivalent in any University or college.

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## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.0 Background**

Water related diseases are one of the major contributors of morbidity and mortality in Kenya, especially among children under five years of age. Diarrhea diseases alone resulting from consumption of contaminated water pose a serious threat to the health of both urban and rural populations. Only about 58% of Kenya's population has access to safe water, yet even amongst this population, water gets contaminated during the process of collection and storage.

The major response of government and non-government agencies has been to educate households on the link between unsafe and ill health and to promote boiling water for drinking. There has been no water treatment or purification solution available to households in Kenya. Population services international (PSI) intends to introduce a water purifier product called PUR. PUR is a point of use-water treatment system, developed by Procter and Gamble (P&G) that has been proven to reduce the incidence of diarrhea due to contaminated water by 50%. PSI intends to improve access to safe water by promoting and distributing PUR to families with children under five and other vulnerable populations, including people living with HIV/AIDS and internally displaced persons (IDPS), it intends to educate the public and vulnerable groups the risk of water borne diseases and the positive health impact of water treatment.

The overall objective of the "PUR safe water program" is to increase public awareness of the links between water quality and entire diseases particularly diarrhea and to introduce PUR as an affordable and effective alternative for Kenyans to treat their drinking water.

#### **1.1 Problem Statement**

Mweiga municipality that is located in Nyeri province, Kenya, north of Nairobi city, as any other municipality in the poor developing world is faced with the problem of rampant



slum development with their related environmental issues and most especially air, land and water pollution.

As the highest number of Mweiga urban dwellers are poor and live in slum areas the motion that goes “the poor people, struggling at the edge of subsistence levels of consumption and preoccupied with day-to-day survival, have limited scope to plan a head and make natural resource investments like pollution controls/ soil conservation that give positive returns after a number of years” do not exclude them. Therefore air pollution, and pollution and most evident, water pollution have greatly demurred the area that was once gifted with all year flowing river with clean water. Water related disease like diarrhea, cholera, typhoid and dysentery have claimed many lives in the area as a result of the increased levels of pollution.

### **1.3 Objectives**

#### **1.3.1 Overall objectives**

To gain an understanding about pollution effects on human health.

#### **1.3.2 Specific objectives**

- 1) To find out the sources of pollution.
- 2) To determine the effects of pollution towards the people.
- 3) To establish people’s perceptions about pollution

### **1.4 Research Questions**

- 1 What are the sources of pollution?
- 2 What are the effects of pollution towards the people?
- 3 What are peoples perception regarding pollution?.

### **1.5 Scope of the Study**

This study was conducted in Mweiga municipality, which is found in Nyeri District, approximately 15 kilometers from Nyeri town. Its naturally a dry land and experiences harsh climatic condition. The scope of this study majors on the impact of pollution in Mweiga municipality. The study was guided by the causes of pollution in Mweiga municipality. The major areas in focus are mainly the slums of Gikomo and Kiawara.

### **1.6 Significance of the Study**

This study will be very helpful in providing causes of pollution in Mweiga municipality. It will also be helpful to the public health sector, environments on the importance of maintaining pollution free environment. It will also help to determine ways of minimizing pollution. This study will also create awareness to the public regarding the dangers and continued emission of pollution. This study is also a requirement for the award of Bachelor of Science in environment Management in Kampala International University (KIU).

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.0 Sources of water pollution

There are generally two sources of water pollution

- (i) Point sources of water pollution are of definite identity with almost constant volume and fixed composition of the effluent discharged. Industrial waste waters are examples of the effluent generated from point sources of pollution.
- (ii) Diffused sources of pollution are points situated far beyond the sight having unknown composition and volume, the street runoff, agricultural runoff and other such waste are examples of the effluent produced from the diffused sources of pollution.

#### 2.1 The Water and Sanitation crisis in Africa

Water is essential to life. If our natural water resources are contaminated and polluted, however water can also take away life. This is a crisis in Kenya and Africa where most deaths are directly related to water borne diseases. (Carr-Saunders, 1997 *Environmental Pollution*, pg 2).

Developing Africa Faces enormous problems due to rapid urbanization and its accompanying overcrowding and congestion of urban areas. There is an overall lack of physical infrastructures to support growing urban populations and insufficient funds to provide good environmental living conditions for all. Informal and unplanned settlements with inadequate housing, water supply and sanitation facilities have developed to accommodate most of these people in the urban areas, the environmental conditions while not as concentrated, pose the same risks to the community.

An immediate environmental problem is poor management of human generated waste, in particular, sewerage. Many African urban areas have insufficient or no sewerage treatment systems the sewerage systems that exists usually only service a fraction of the

population and even the site in the form of pit latrines, specific tanks or in rural areas, even holes dug in the properly treated in the pit latrines or septic tank and these simply become collection site for sewerage. When full they are emptied or closed and replaced by new pits. These inadequate sanitation facilities have impact on the community in to aspects.

## **2.2 Health**

Untreated sewerage is breeding ground for disease such as cholera, typhoid, dysentery, and diarrhea. Sewerage or contaminated water from the pit latrines and septic tanks transports these diseases to rivers, dams and underground water.

## **2.3 Environment**

Flies and foulk ordors create an unpleasant living environment. Organic pollution that enters rivers and provides nutrients for growth of problematic algae and water hyacinth.

## **2.4 Chemical Hazards and their Adverse Health Effects**

If one includes tobacco smoke as an environmental hazard then it probably represents the single biggest known airborne chemical risk to health, whether measured in terms of death rates or ill-health (from lung cancer, other lung diseases such as chronic bronchitis and emphysema, and disease of heart, especially and of blood vessels and other parts of the body). To a much lesser degree of risk, these adverse effects apply to non-smokers exposed passively to side stream tobacco smoke.

General airborne pollution arises from a variety of causes but can usefully be subdivided into pollution from combustion or from other sources. The image shows the silhouette of a power station an important source of air borne products of combustion.

Combustion of coal and other solid duels can produce smoke (containing polycyclic aromatic hydrocarbons – PAH) and sulphur dioxide besides other agents such as those also produced by:

Combustion of liquid petroleum products, which can generate carbon monoxide, oxides of nitrogen and other agents. Industry and incineration can generate a wide range of products of combustion such as oxides of sulphur and nitrogen, polycyclic aromatic hydrocarbons, dioxins etc. Combustion of any fuel generates varying amounts of particular matter.

It also adds to the environmental burden carbon dioxide – an important “green house” gas but in these low concentration it does not affect health directly. Combustion of fuel can also generate hazardous substances in other ways, besides by chemical oxidation, such as by liberating benzene (from the “cracking” of petrol). Some of the primary pollutants notably ozone (an allotrope of oxygen). Find out more about air quality in relation to these substances.

Undoubtedly tens of thousands of deaths have resulted from acute pollution episodes (e.g asthmatics can be adversely affected by excursions in levels of urban pollution (notably ozone) in some major cities. What is still unclear is the extent to which urban airborne pollution in the majority of cities. What is still unclear is the extent to which urban airborne pollution in the majority of cities complying with current air quality guidelines, contributes to ill health, I.e whether the quality guidelines are stringent enough, to protect all the population.

Health effects of concern are arithmetic, bronchitis and similar lung diseases, and there is good evidence relating an increased risk of symptoms of these diseases with increasing concentration of sulphur dioxide, ozone and other pollutants. Moreover there is increasing evidence to suggest that pollution from particular matter at levels hitherto considered “safe” is associated with an increased risk of morbidity and mortality cardiopulmonary disease especially in people with other risk factors (such as old age, or heart and lung disease). These concerns are the subject of a great deal research throughout the world. Although high occupation exposure to exhaust especially from diesel, and to benzene does increase the risk of some cancers, reliable direct evidence of an increased to cancer risk to the population at large from the lower levels to which they are exposed is lacking.

Incineration can also generate hazardous substances if substances not best suited for disposal by incineration are “disposed” of in this way or incinerating is carried out at too low a temperature (for example this may generate dioxins)

Products of combustion and other harmful airborne pollutants can also be within the home. Thus nitrogen dioxide generated by gas fires or gas cookers can contribute to an increased respiratory morbidity of those living in houses. Certain modern building materials may liberate gases or vapors such as formaldehyde at low concentration but which might provoke respiratory and other symptoms in some occupants. Modern building standards for asbestos in buildings are such that the resulting airborne fiber concentrations are so small as not to present any risk at all of asbestosis. However some estimates suggest that perhaps one extra death per year might result in the UK from asbestos related cancer as a result of non- occupational exposure in buildings. The image shows an asbestos body i.e an asbestos fiber which has been coated by ferruginous protein during its residence within the human lung.

Large scale industrial releases with acute effect are fortunately rare but might recollect some vents as in Bhopal (India). Various scale events occur such as leaks from road tankers, or fires warehouses and factories. Special local environmental exposures can arise for example in communities exposed to drifting pesticide sprays containing say, organophosphates. Some natural phenomena such as volcanic eruptions can present serious risks to health. Fortunately they are rare but can be catastrophic.

Water can be an important source of chemical hazards. It can reach lead from pipes especially if the water is soft. There is good epidemiological evidence that this can have a relatively small but measurable effect especially on neurological function even at levels hitherto considered “acceptable”. Other adverse effects can arise from chemicals added to water.

Chlorination of water has probably saved millions of lives. Some concern has been raised about possible increased cancer risks in association with chlorinated water but there is as yet no proof that casual association between two exists.

Fluoride added to water reduces the risk of carries but can have unwanted effects such as mottling of the teeth.

Nitrate in water usually arising from fertilizer leaching (natural or artificial) can increase the risk of methaemoglobinaemia (blue babies) in bottle fed infants but this extremely rare. Although pesticides can and leach into water, there is no evidence that the current standards for water quality are inadequate in this respect, but most standards are based on evidence other than human epidemiology which in this context is extremely difficult to conduct.

Beyond the point of supply further problems in drinking water quality may result. Thus for example water tanks containing lead may increase the burden of this metal in water; while water softness may increase its sodium content (can be harmful for bottle fed infants).

Deposition of solid hazardous waste can result in harmful substances leaching into water supplies, becoming airborne or being swallowed or otherwise absorbed directly (for example because of children playing on the sites). If the sites are well contained to prevent leaching into water supplies and segregation from human activity then the risk to human health is usually immeasurably small. However were the position of disposal sites and their contents are unknown and houses are proposed to be built on them that are to be developed in other ways, extensive prior investigation may be needed in an attempt to estimate health risks.

Biological Hazards, and their adverse health effects

These generally fall into two categories: those which produce adverse health effects through infection and those, which produce adverse effects in non-effective (allergic) ways.

As regards microbiological hazards in water, substantial improvements in the health of the population have resulted historically from the supply of drinking water free from disease causing organisms such as cholera. Similar improvements can be expected in the health of the inhabitants of developing countries if microbiologically safe water is provided by avoidance of contamination, and outbreaks of waterborne infection still arise from contamination of drinking water by soiled water (usually coliforms).

There can be other opportunities for further bacterial contamination. Thus legionella can grow in sumps or dead legs in the plumbing system and may then disperse as aerosols from showers.

Recreational water which is heavily contaminated with pathogens, notably coliform bacteria has been shown to be associated with increased risk of gastrointestinal and other infectious illness, usually self-limiting.

So called “clinical” waste is not merely an occupational hazard of health care workers but is becoming increasingly more important risk, for example for children finding blood stained needles.

Many allergens as grass pollens, or faecal material from house dust mites may cause attack of asthma or “hay fever” (allergic rhinitis). There is evidence that high exposure to these allergens early in life, increase the risk of suffering from asthma later on.

An increasing number of studies suggest that air borne chemical pollution can act synergistically with naturally occurring allergens and result in effects on lung function at concentrations lower than those at which either allergen or chemical irritant on its own would have produced an adverse effect.



Water is relatively more prone to pollution than air because it is more viscous molecular distance than air. Air being available in the environment in the much larger proportions as compared to water, the pollutants in the air are quickly diluted and dispersed away along the down wind direction. Pollution load is thus drastically reduced in the air. (Prof PIR Trivedi, Environmental Biology, pg 322).

The equal distribution of water on the surface of the earth and the fast declining availability of fresh unusable water per capita, per year, due to increasing population, are the major causes of concern in terms of the quantity and quality of water. Water pollution problem is more delicate and severe than that of air. The fundamental difference between the pollution of air and water is as such.

Air pollution is of wide spread nature whereas water pollution remains more or less confined. Therefore, the latter is localized in nature. Air pollutants are known to travel thousands of kilometers without losing their identity and therefore are not matters of immediate concern. The pollutants in water undergo many reactions and subsequently sometimes turn into hazardous forms. The study of air pollution is costly but the principles involved are relatively simple than in water pollution studies and management. Water may be present in the rivers, ponds, lakes and in the ground reservoir. The surface water bodies get easily polluted whereas ground water reservoirs become polluted only after prolonged exposure.

Among the surface water bodies, the rivers become polluted, complete and costly techniques for control of such pollution are needed. The same is true in case of ground water pollution, which is difficult to treat when and where such problems exist. So far as the effects of pollution on the living biota are concerned, they are again of conflicting nature. The rivers disperse away the pollutants immediately in the down stream and thus become free from pollution; but the effects of pollution become established and detectable more easily in rivers than in ponds and lakes because the biota in river are generally less tolerant to pollution whereas the biota living in the stagnant water bodies are more tolerant to pollution.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.0 Research Design**

The research work basically followed a general survey research design. A general survey research design was chosen because of the time frame and nature of the study. The study being more of descriptive study, qualitative research methods were employed. These included in- depth interviews and questionnaires which were face-to-face and personally administered respectively.

#### **3.1 Sample size**

Because of the nature of the study and time frame together with the financial attachments, a total of 20 people were randomly selected from the study area. The study area consisted of Gikomo and Kiawara slums, and on the household basis and gender considerations were kept in mind. A simple random sampling technique was used.

#### **3.2 Method of actual Data collection**

The methods used during data collection included questionnaire and interview, photography, direct observation and literature review.

##### **3.2.1 Questionnaire and interview**

A logically designed set of questions was used to investigate the sources of drinking water available, drinking water collection and storage habits, people's perceptions about safe drinking water and levels of awareness of the risk of contaminated water particularly to children in Mweiga municipality. The questions were both open and close-ended in nature. They were designed on the following variables, finding out the sources for drinking water available, establishing the drinking water collection and storage habits, establishing people's perceptions about safe drinking water and finding out the levels of awareness of the risk of contaminated water particularly to children.

The questionnaire was used in a way that the researcher held face-to-face interview with the selected respondents and asked the questions in the questionnaire, while filling in the respondents answers. The method was used partly because some respondents were unable to read or write or both. This helped the researcher to get first hand information from the real affected persons, and avoiding the non-returned questionnaires as in the other methods of administering questionnaires.

### **3.3.3 Photography**

The method of data collection using photography was used to help in the backing up the study findings by providing a rich detail about the extent of disposition of sediments in the river Honi basin, settlement patterns in the slum areas, sewage disposal methods and collection of contaminated water, all these aid the study report user to appreciate the real conditions that exist in the area.

### **3.2.3 Direct observation**

The method of observation involved systematically viewing and recording of the on ground evidenced impacts of pollution in the area, so as to come up with first hand data to justify what the respondents gave in during the interview and questionnaire. The method further assisted the researcher to relate the information availed in the literature review with what is existing in the study area, thus determine the levels and trends of pollution for a long lasting and sustainable set of recommendations.

### **3.2.4 Literature**

This method involved the use of other related and already existing information on the pollution as it exists impacts and controlled else where on the global, regional and local level. This can as well be refereed to as secondary data and included texts, photography, journals, reports and other documentaries. The sources of such information includes; ministry of natural resources, ministry of Environment and the library of Kampala International University and Nairobi University.

## CHAPTER FOUR

### PRESENTATION AND DISCUSSION OF RESEARCH FINDINGS

#### 4.0 Introduction

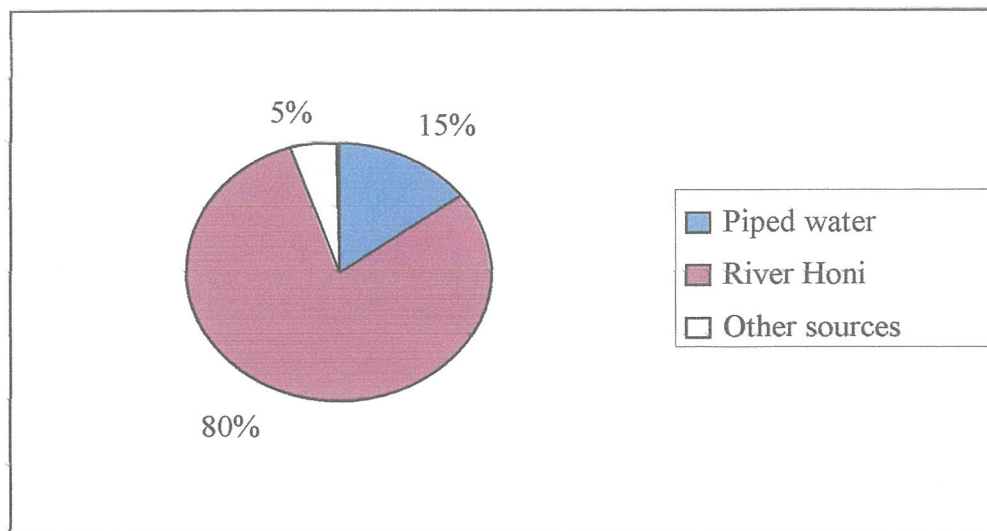
In my research work found out that people living in the surrounding area of Mweiga had a major problem of accessing to safe water. This contributed to the fact that many people living in this area are slum dwellers and have less knowledge about sanitation. Most households done have piped water and the river (Honi river) is their only water source.



**Figure 1: Gikomo Slum settlement in Mweiga municipality**

**Table 1: Source of Domestic Water**

Source of water	Frequency (f)	% age
Piped water	3	15
River Honi	16	80
Other sources	1	5
Total	20	



The residents in these areas use the river to wash clothes, others clean their dirty utensils in this river, most people also do a lot of their bathing in this river and so at the end of the day the river becomes unsafe for water collecting. Due to limited awareness and knowledge of how to use the river people who collect water from this river end up acquiring water borne diseases such as cholera, typhoid and also dysentery.





**Figure 2: River Honi as the source of polluted water**

#### **4.1 Waste Disposal**

I also found out that the areas have lacked proper waste disposal. Litter is disposed off any how the residents and some of these waste contained containers which had liquids in them and therefore after there is a down pour this dirt is carried along as it heads towards the river. This also adds to the problem of air pollution because after the rubbish starts to decay there's bad odor in the environment. This kind of pollution makes it uncomfortable for people living this region.



**Figure 3: Poor solid waste management of non-biodegradable materials**

## 4.2 Sewerage

Untreated or inadequately treated municipal sewerage is major source of surface or underground pollution since the biological degradation of organic materials that is discharged with municipal sewerage into watercourses uses substantial amounts of oxygen. So called biochemical oxygen demand, upsetting the ecological balance of rivers and lakes. Sewage also carries microbial pathogens; fecal coli form levels may be very high in the sewage contaminated river. In this region, drinking water does not usually receive excessive multi-stage treatment before being supplied to the consumer. This therefore shows how people around this area are taking polluted water that is not treated and that continues to affect the people's health.



**Figure 4: Water from Honi river is cloudy with sediments from poor waste water management disposal**

#### 4.4 Food Contamination

Food is essential to a healthy life, but it can also be a major exposure route for many pathogens and toxic chemicals. These contaminants are mostly introduced in food during cultivation, harvesting, processing, storage, transportation and final preparation.

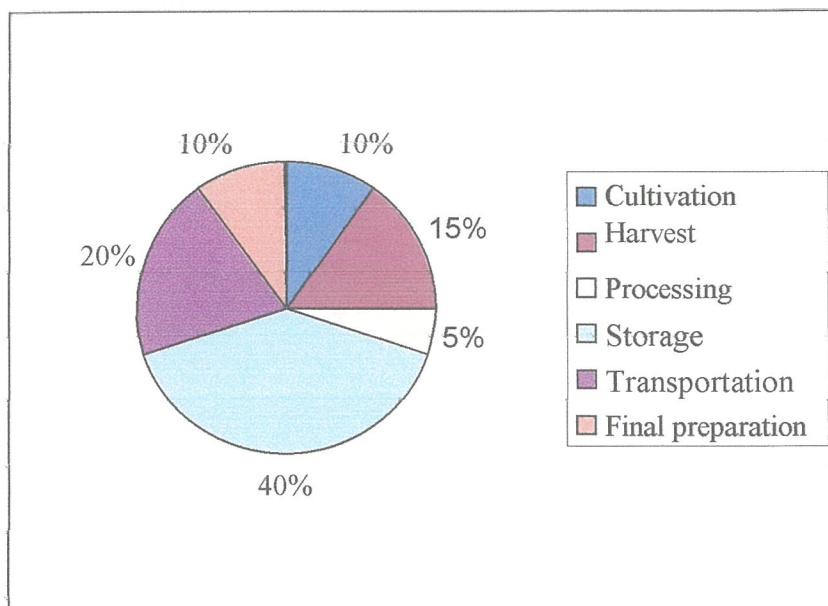
Inspection and monitoring of food quality is therefore necessary to ensure food safety and this rarely happens in this region because of ignorance from the farmers. They end up selling food crops that are contaminated and the leftovers which they retain for their own consumption is also contaminated.

The people who are affected by unsafe food are the poor, who are also vulnerable to lack of food and under nutrition. Health impacts range from mild indisposition to life threatening illness. From my research, I found out that sources of biological contamination of food are diverse and include polluted water, e.g waste water, irrigation and household water, dirty hands, flies, pests, domestic animals, dirty cooking pots, and utensils and human and animal excreta. Food themselves are also frequently the source of contaminants as they may harbour pathogens, naturally or may have been derived from infected animals. Cross contamination of foods can also occur.

**Table 2: Source of food contamination**

Activities	Frequency	% age
Cultivation	2	10
Harvest	3	15
Processing	1	5
Storage	8	40
Transportation	4	20
Final preparation	2	10
Total	20	





According to the interviewed correspondents, food contamination mainly occurs during storage, transportation and harvesting respectively.



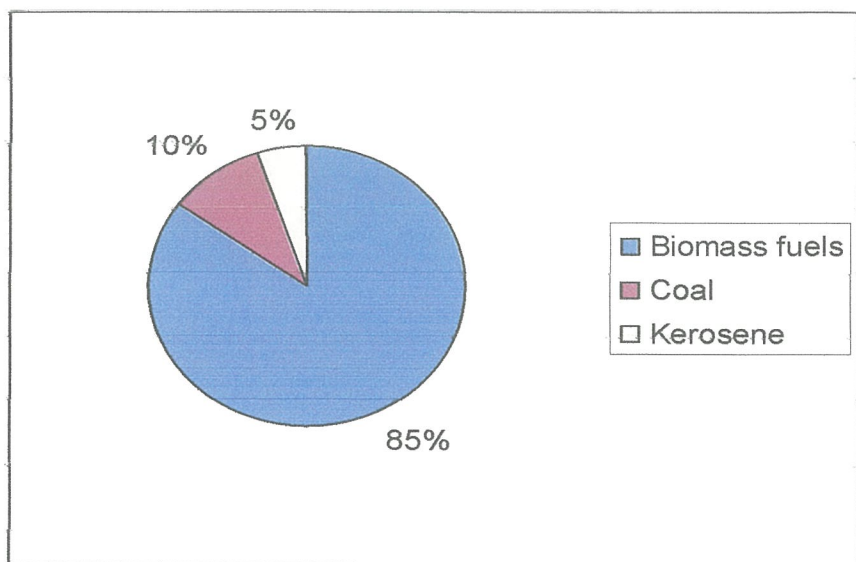
**Figure 5: Field gardens affected by Polluted water**

#### 4.5 Indoor air pollution

I also found out that there was the problem of indoor air pollution. High levels of indoor air pollution arising from the use of open fires, unsafe fuels and inefficient stoves for cooking or treating probably represents the single most serious health impact from air pollution in the region. The domestic combustion of biomass fuels, coal, and kerosene by poor communities lead to extremely high levels of indoor air pollution. This poses special risks to the respiratory health of women and young children who are most exposed and vulnerable. Even the use of gas stoves may result in increased levels of nitrogen inside homes.

**Table 3: Sources of Indoor Air Pollution**

FUEL	NO OF RESPONDENTS	% age
Biomass fuels	17	85
Coal	2	10
Kerosene	1	5
Total	20	



According to the interview, many people are Biomass fuels, which causes the highest percentage of indoor pollution.

I also observed that indoor air pollutants other than those associated with fuel combustion are also of concern in some circumstances. They include asbestos fibres from insulation materials or asbestos, cement organic solvent used in building materials, wood preservatives and cleaning agents and radon gas. The use of household cleaning products stains paint strippers and thinners, and other volatile organic substances can lead to toxic concentrations of certain pollutants. Exposure to such pollutants is difficult to quantify and depends on ventilation rates and personal behavior.

I also noted that environmental tobacco smoke is another major factor influencing the quality of indoor air and the health of individuals in the indoor environment. Pollution from traffic and industry also influence the quality of indoor air pollution in Mweiga town.

#### **4.6 Chemicals in drinking water**

As I was coming out of my research, I realized that both naturally occurring and human made chemical substances in drinking water can have serious effects on health. A variety of acute and chronic health effects have been reported. Actual risks are determined by the chemical concentration in drinking water. Thus many toxic substances, if present below a certain threshold level, do not pose a health hazard. When assessing the potential health risk of a chemical constituent, identification and quantification of all the major routes of exposure is important. This because the tolerable level of the chemical in drinking water can then be determined.

#### **4.7 Water Related Vector Borne Diseases**

In this region of Mweiga its noted that the aquatic environment provides an essential habitat for the mosquito vectors and intermediate snail hosts of parasites that cause human diseases. Among these diseases malaria out-ranks all others in severity and distribution. Vector borne diseases have of course always affected humans, even in pristine environments.

Health issues linked to irrigation development have become a particular focus of attention, but increased transmission is also linked to the construction of dams and reservoirs to changes in land use patterns and poor water management in urban areas of Mweiga.

Lack of financial resources has often been implicated in mismanagement of water resources development. In the case of irrigation, rising costs have often obliged planners to omit certain components to make proposed schemes economically viable. Poor intersectoral collaboration has been another contribution factor. Mweiga has no established procedure for involving the health sector at the planning and design stages of water resources development. This has reduced the apparent need for engineers and public health experts to collaborate on water resources projects.



**Figure 6: A polluted drainage depositing waste into the river**

#### **4.8 Health risks of solid waste**

From my region's point of view, I realized that solid wastes can come into direct or indirect contact with human beings at several stages in the waste cycle. The groups at risk



are therefore broad and numerous and include: the population of unserved areas, especially pre-school children; waste workers, workers in facilities that produce infections and toxic material, people living close to waste disposal facilities, and pollutions whose water supplies have become polluted due to waste dumping or leakage from landfill sites. Additionally, industrial dumping of hazardous waste that has become mixed together with household solid waste can expose populations to chemical and radioactive hazards.

The health risks of uncollected solid waste are obviously most severe for those actually living in unserved areas. Notably, pre-school children are at risk of injury, intoxication or infection since they are likely to be exposed to uncollected waste in streets or at unofficial dump sites. Uncollected organic domestic wastes in particular pose serious health risk since they ferment, creating conditions favorable to the survival and growth of microbial pathogens, and especially if they become intermixed with human excreta due to poor sanitation. Organic wastes also provide feeding stock and a natural environment for insects, rodents and other animals which are potential carriers of enteric pathogens.

Uncollected solid wastes can also obstruct storm water run-off resulting in flooding or creation of stagnant water bodies which become habitats and breeding place for water borne vectors of tropical diseases. It has been noted that, even if solid waste is collected it may create health risks for large numbers of people if disposed off improperly. Ground water used for drinking purposes for instance, can become chemically or microbiologically polluted if wastes are disposed off in or near water sources. Direct dumping of untreated solid wastes in rivers, lakes can also result in accumulation of toxic substances in the food-chain due to river uptake by plant and animals.

Handling of solid waste obviously entails health risks, potentially leading to infectious and chronic disease and accidents. Disposal of health wastes require special attention since it can create a major health hazard, the best document of which is the transmission of viral infections, such as hepatitis B and C, through wounds caused by discarded syringe needles. All too often, infectious wastes from hospitals other health care

establishments, medical laboratories and research centres and small scattered sources are disposed off together with regular waste. The people most at risk are health care workers, waste handlers and hospitals maintenance personnel.

Waste treatment and disposal sites themselves have the potential to create health hazards for neighboring populations. Landfills are a source of gases, dust smoke, noise and disease vectors as insects rodents and stray animals and incinerators cause air pollution through emission of particulates, toxic chemicals and heavy metals such as cadmium, lead, mercury and zinc ideally, waste treatment and disposal sites be controlled and located at an adequate distance from settlements the boundaries of landfill sites confined and sealed so that drinking water sources are protected from infiltration of leachate of runoff.

Recycling too, although in principal a good approach of waste management, carries health risk if proper precautions are not taken. Waste workers dealing with recycling waste that has a high metal or chemical content may experience toxic exposures. Scavengers and their families are also at risk because they often build their homes very close to or on landfill sites. As well as being exposed to a wide variety of waste health hazards they are also frequently subject to social and economic abuses from waste recycling traders. Health surveys show their life expectancy far below national averages.

## 5.1 Recommendations

The researcher recommend that there be better monitoring and implementation of waste management in the municipality. Secondly, burning of residues should be done far from people's residential areas as this posse great health risks to the people inhaling the fumes.

Strict measures and rules should be put especially to parties polluting water sources as this act as the best and fastest way to bring about illnesses related to pollution.

People should be taught on how to handle waste and they should be enlightened on how to protect themselves from acquiring some of these pollution related disease for example diarrhea, cholera, typhoid, dysentery etc.

Last but not least, better health facilities should be established and made affordable to all individuals living in this municipality.

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## APPENDICES

### Appendix A

<b>SOURCES OF DRINKING WATER</b>		
I would like to ask you a few questions about the water that you are currently using		
Q001	What is the main source of water for your household?	<p><b><u>Piped water</u></b></p> <p>House connection/yard tap</p> <p>Public tap/Kiosk</p> <p><b><u>Hand pumps</u></b></p> <p>Private shallow well</p> <p>Private deep borehole</p> <p>Public deep bore holes</p> <p><b><u>Surface water</u></b></p> <p>Protected spring</p> <p>Unprotected spring /open well</p> <p><b><u>River/stream</u></b></p> <p>Pond / lake</p> <p>Tanker truck</p> <p><b><u>Rain water tank / drum</u></b></p> <p>Bottled water</p> <p>Other (specify) .....</p>
Q002	What is the main source of drinking water for members of your household?	<p><b><u>Piped water</u></b></p> <p>House connection/yard tap</p> <p>Public tap/kiosk</p> <p><b><u>Hand pumps</u></b></p> <p>Private shallow well</p> <p>Public shallow well</p> <p>Private deep boreholes</p> <p>Public deep borehole</p> <p><b><u>Surface water</u></b></p> <p>Protected spring</p>

		Unprotected spring/open well <b>River stream</b> Pond/lake Tanker truck <u>Rainwater tank/drum</u> Bottled Water Other specify
Q003	How many times in a week do you obtain drinking water from this source?	Once a week Twice a week Three times a week Four times a week Five times a week Six times a week Everyday
Q004	What mode of transport do you use to that source? (MULTIPLE RESPONSES POSSIBLE)	Walking Public vehicle Private / own vehicle Bicycle Motorcycle Other specify .....
Q005	How long does it take to go there, get water and come back?	15 minutes
Q006	Do you have to pay for the water?	Yes No
Q007	How much do you have to pay?	a).....per 20 litter jerrykan (convert any other quantities in to 20litter jerrykan) OR b) .....per..... (specify period in months) Free

Q008	Why do you use this particular source of water?	Near / convineint The only one available Has clean / safe water Its cheap Its free Other specify) .....
Q009	What are the other sources of water available to your household? (MULTIPLE RESPONSES POSSIBLE)	Piped water House connection / yard tap Public tap / kiosk Hand pumps Private shallow well Public shallow well Private deep borehole Public deep borehole <b>Surface water</b> Protected spring Unprotected spring/open well River stream Pond / lake Tanker truck <u>Rainwater tank/drum</u> Bottled Water Other specify
Q010	Do you use these other sources for drinking?	Yes No
Q011	Why do not use these sources for drinking?	Too far away Too expensive Water runs out Too busy / congestion at source Bad smell Bad taste

		Bad appearance People get sick Children get sick Other (specify).....
<b>COLLECTION, STORAGE AND USE OF DRINKING WATER</b>		
Q012	Do you store your drinking water?	Yes No
Q013	How many containers do you use for drinking	Number                      3
Q014	What type of containers do you use for storing water? (MULTIPLE RESPONSES POSSIBLE)	Bucket Water jug Jerry can Clay pot Calabash Other (specify)
Q015	Why do you use this type of container to store drinking water? (MULTIPLE RESPONSES POSSIBLE)  DO NOT READ ANSWERS	Prevent contamination Cheap Easily available Easy to pour water Sturdy (strong) Keeps water cool Other (specify)
Q016	After drinking water is collected from the source, is it poured into the drinking water storage container directly?	Yes No
Q017	How is water processed / treated before putting it in the drinking water storage container?	Boiling Adding chlorine Sieving water Add purifying solution Add purifying tables Other (specify) ... We don't have time

Q018	Are there times when water for drinking is not processed / treated?	Yes No
Q019	Do you use the water in this container for other uses than drinking?	Yes No
Q020	For what do you use this water? (MULTIPLE RESPONSES POSSIBLE)  DO NOT READ ANSWERS	Cooking Washing vegetables Cleaning plates and utensils Washing clothes Bathing Other (specify) .....
Q021	Is drinking water poured out into a glass or cup from these containers or does a person have to use a glass or a cup to scoop water out?	Water is poured out Water is scooped out Other (specify) .....
Q022	What is used to scoop drinking water out of the drinking container that you are using today?	Cup Pitcher what is this? Bowel Bucket Other (specify)
Q023	Which people obtain / get water from the container?	Adults only (12+) Children (under 12) Both adults and children
Q024	How many people obtain water from these containers?	Number .....4
Q025	How much drinking water is consumed in your house everyday?	20 liters
Q026	What type of container should be used to store drinking water?	Open container Container with narrow width Closed container Separate container Other.....

		Don't know
Q028	Why should this kind of container be used? (MULTIPLE RESPONSES POSSIBLE) DO NOT READ ANSWERS	Prevents contamination Cheap available Easy to pour water Surdy (strong) Other (specify)
<b>WATER QUALITY</b>		
Q029	Is there quality of water for drinking that is available from (INSERT NORMAL SOURCE SEE QN 402) DO NOT READ ANSWERS	Very poor Poor Reasonable Good Very good
Q030	How do you tell that the quality of drinking water available to your household is good or poor? USE RESPONSE FROM Q601 (MULTIPLE RESPONSES POSSIBLE)	Smell Taste Appearance People get sick Children get sick Other (specify)
Q031	Can Water have germs in it even if it looks clear?	Yes No Do not know
Q032	What are the consequences of drinking water that is of poor quality? (MULTIPLE RESPONSES POSSIBLE)	Causes poor health Causes Cholera Causes Diarrhea Causes typhoid Other (specify) All the above
Q033	What are the diseases that can result from drinking poor quality water? (MULTIPLE RESPONSES POSSIBLE)	Diarrhea Cholera Typhoid Cough Intestinal worms

		Other diseases (specify)
Q034	<p>Which sources of water are most likely to be of poor quality?</p> <p>DO NOT READ ANSWERS (MULTIPLE RESPONSES POSSIBLE)</p>	<p>Piped water</p> <p>House connection/yard tap</p> <p>Public tap / kiosk</p> <p>Well water</p> <p>Private shallow well</p> <p>Public shallow well</p> <p>Private deep borehole</p> <p>Public deep borehole</p> <p><b>Surface water</b></p> <p>Protected spring</p> <p>Unprotected spring/open well</p> <p>River stream</p> <p>Pond / lake</p> <p>Tanker truck</p> <p><u><b>Rainwater tank/drum</b></u></p> <p>Bottled Water</p> <p>Other specify</p>
Q035	<p>Which sources of water are most likely to be of good quality?</p> <p>(MULTIPLE RESPONSES POSSIBLE)</p>	<p>Piped water</p> <p>House connection/yard tap</p> <p>Public tap / kiosk</p> <p>Well water</p> <p>Private shallow well</p> <p>Public shallow well</p> <p>Private deep borehole</p> <p>Public deep borehole</p> <p><b>Surface water</b></p> <p>Protected spring</p> <p>Unprotected spring/open well</p> <p>River stream</p> <p>Pond / lake</p>

		Tanker truck <u>Rainwater tank/drum</u> Bottled Water Other specify
Q036	Can water from an open well have germs or be contaminated?	Yes No Don't know
Q037	Can water from a tap have germs or be contaminated?	Yes No Don't know
Q038	Can water from a river or pond have germs or be contaminated?	Yes No Don't know
Q039	Can water from a deep borehole have germs or be contaminated?	Yes No Don't know
<b>MEASURES FOR IMPROVING WATER QUALITY</b>		
Q040	Is there any way of improving the quality of water that is drunk?	Yes No Don't know
Q041	What are the ways of improving the quality of water that is drunk? (MULTIPLE RESPONSES POSSIBLE)	Boiling Add chlorine Sieve water Add purifying solution Add purifying tablets Other (specify) not sure
Q042	Does the quality of water drunk in your household need to be improved?	Yes No
Q043	Do you or any household member regularly do something to improve the quality of water that is drunk?	Yes No



Q044	What do you or another household member regularly do to improve the quality of water that is drunk?	Boiling Add chlorine Sieve water Add purifying solution Add purifying tablets Other (specify) not sure												
Q045	Have you or has any household member ever done anything to improve the quality of water that is drunk?	Yes No												
Q046	Why do you or another household member not do anything to improve the quality of water that is drunk? (MULTIPLE RESPONSES POSSIBLE)	Water quality is good Too expensive Too time consuming Method not available Method difficult to carry out Don't know what to do Not possible to improve water quality Other (specify)												
Q047	Do you think.....? (READ ABOUT RESPONSES) Treated water is safe for drinking. Boiled water is safe for drinking Treated and boiled water is safe for drinking	<table> <tr> <td>Yes</td><td>No</td><td>D.K</td></tr> <tr> <td>1</td><td>2</td><td>3</td></tr> <tr> <td>1</td><td>2</td><td>3</td></tr> <tr> <td>1</td><td>2</td><td>3</td></tr> </table>	Yes	No	D.K	1	2	3	1	2	3	1	2	3
Yes	No	D.K												
1	2	3												
1	2	3												
1	2	3												

	Social Norms	Strongly Agree	Agree Somewhat	Disagree Somewhat	Strongly Disagree
1.	Most people in the community often take precautions to drink safe water	4	3	2	1
2.	If I saw a friend washing hands after	4	3	2	1

	visiting the toilet I would think they were responsible				
3	Most people in this community often wash their before eating	4	3	2	1
4	Most people in this community often wash their hands with soap and water after visiting the toilet	4	3	2	1
5	Elders in the community support washing hands before eating	4	3	2	1
6	Elders in the community support washing hands after visiting the toilet	4	3	2	1
7	If I saw a friend washing hands before eating I would think they were being responsible.	4	3	2	1
8	Most of my friends drink unsafe water.	4	3	2	1

**In the next couple of questions I am interested in hearing your opinion on certain issues. Please tell me if you “agree” or disagree with these issues.**

**Note: Interviewer to probe if they agree strongly somewhat and if they disagree strongly or “disagree somewhat” (INTERVIEWER EXPLAIN: When I say the word I in statement I mean you”)**

	<b>RISK PERCEPTION</b>	<b>Strongly Agree</b>	<b>Agree Somewhat</b>	<b>Disagree somewhat</b>	<b>Strongly Disagree</b>
9	I feel anxious when I think about diarrhea	4	3	2	1
10	I am less likely than most people to get diarrhea	4	3	2	1
11	Diarrhea can kill people	4	3	2	1
12	People like me are at very low risk	4	3	2	1

	of getting diarrhea				
13	I am motivated everyday to avoid getting diarrhea	4	3	2	1
14	I have bigger concerns than getting diarrhea if don't make my water safe	4	3	2	1
15	Children under five are most likely to get diarrhea	4	3	2	1
16	People in my family are less likely to get diarrhea	4	3	2	1
	<b>Locus of control</b>				
17	Diarrhea is normal infection it cannot be avoided	4	3	2	1
18	Diarrhea is normal among children it cannot be avoided	4	3	2	1
	<b>Outcome Expectations</b>				
19	Boiling water is effected from preventing diarrhea	4	3	2	1
20	Treated water is effective for preventing diarrhea	4	3	2	1
21	Water can be safe without boiling	4	3	2	1
22	Piped water is safe for drinking	4	3	2	1
	<b>Self-Efficacy</b>				
23	Boiling water all the time is difficult for me	4	3	2	1
24	It is not relay up to me whether the water is boiled or not	4	3	2	1
25	Drinking water all the time is important to me	4	3	2	1

**THIS IS THE END OF THE QUESTIONS**