

Tampere Polytechnic

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WATER CRISIS IN DEVELOPING COUNTRIES: CASE STUDY ON KENYA

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PREFACE

The water crisis in the World will continue to persist unless we all take an initiative and active role in conserving our natural resources. Identifying the problems affecting societies in developing countries and doing something about them is one of the steps towards this goal.

Developing countries, just like developed countries each have the responsibility of making the environment sustainable. Writing this report increased my insight on the environmental challenges facing Kenya today. As an environmental engineering student, I find that we should continue to research and put into action conservation measures on our already depleting water resources.

None of all the work done here would have been possible without the help of my lecturers and friends. First I would like to thank Marjukka Dyer, the Head of our Department and Eeva-Liisa Viskari my supervisor and lecturer, for their key support and guidance in writing this thesis.

I also thank Benson Gathogo of UNICEF, for all the effort and time he took to distribute my questionnaires and give me feedback on my work, Agnes Mwakanjuki, Finland for sharing basic information on water issues in developing countries with me and aiding in my search for materials. Viivi Hakanen, Finland, thank you for keeping me on track and Robert Mhekwa, Finland, for all the moral support.

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Kagiri, Eva Muthoni Water Crisis in Developing Countries: Case study on Kenya

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Supervisor Senior Lecturer, Eeva-Liisa Viskari

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ABSTRACT

The water crisis in Kenya began reaching peak levels from the early 1980's.

Consistent drought and mismanagement of water resources have been a major concern both for the local government and globally.

The aim of this thesis is to study on the main issues that are causing the persistent water shortages and methods and ways of curbing them. The current water situation in the country is analyzed and contributing factors to say, water wastage, polluted water resources, inadequate rainfall, NGO, Government and Public involvement in trying to conserve water resources.

The main research method used was questionnaires along with books, journals and internet sources. Personal experience has also been a major factor in the writing of this work. The NGO view and Government view on how to deal with the water problems differed at some levels. These differences stretched to also to how much the government was making water issues a priority in running the country.

Most developing countries are finding themselves facing the same problems and solutions or recommendations made in this thesis could also well be applied in other places. Every government has the responsibility of promoting sustainable development, and every individual has the responsibility of conserving the natural environment around them. I will be discussing these roles in the forthcoming pages and how they work towards eliminating or minimizing water shortages in developing countries or globally.

TABLE OF CONTENTS

1. INTRODUCTION	6
2. AVAILABILITY OF WATER RESOURCES	8
2.1 LAKE VICTORIA	9
2.2 LAKE TURKANA	10
2.3 MINOR LAKES	11
2.4 RIVER RESOURCES	11
2.5 GROUNDWATERS	12
3. DISTRIBUTION OF WATER AND ITS PROPORTION	14
TO DEMAND.....	14
4. METHODS OF WATER DISTRIBUTION	16
4.1 INDIVIDUAL WATER ATTAINANCE:.....	16
4.2 GOVERNMENT: CITY COUNCILS AND MUNICIPALITIES	18
4.3 PRIVATE OWNERS AND NGO'S	22
5. QUALITY OF WATER – AT THE SOURCE AND CONSUMPTION LEVEL ..	24
5.1 WATER QUALITY AT THE SOURCE.....	25
5.2 WATER QUALITY AT CONSUMPTION LEVEL.....	27
6. MAJOR WATER PROBLEMS FACING SOCIETY	30
a) Drought	30
b) Unavailable Water Resources	30
c) Inappropriate distribution.....	30
d) Pollution	31
e) Cost:	31
f) Reducing water-table.....	31
7. REASONS CAUSING THE PROBLEMS.....	32
a) Disrupted Ecosystems	32
b) Mismanagement of Resources	32
c) Political Will	32
d) Misplaced Priorities	33
e) Economic Instability	33
f) Ignorance.....	33
g) Un-sustainable agricultural methods.....	34
8. RESEARCH ANALYSIS	34
9. RECOMMENDATIONS	40
9.1 Pollution	42
9.1.1 Human Waste.....	42
9.1.2 Agricultural Pollution and Industrial Waste	43
9.2 Depletion.....	44
9.2.1 Exhaustion.....	44
9.2.2 Inadequate Rainfall	46
9.3 Lack of Technology	47
9.3.1 Economic Instability	47
10. CONCLUSION.....	48

REFERENCE
ANNEXES

ABBREVIATIONS

UNESCO	United Nations Educational, Scientific and Cultural Organization
BBC	British Broadcasting Co-operation
CSIRO	Commonwealth Scientific and Industrial Research Organization
WHO	World Health Organization
FAO	Food and Agriculture Organization
IRIN	Investor Relations Information Network
NGO	Non-Governmental Organization
NETWAS	Network for Water and Sanitation
ITN	International Training Network
UNDP	United Nations Development Programme
MNU	Maji Na Ufanisi (Water and Development)
EAEN	East Africa Environmental Network
Ksh.	Kenya Shilling

1. INTRODUCTION

According to a report published by UNESCO, named, *The World's Water Crisis* /20/, the reality of the problems that society is facing today in regard to availability of fresh water resources has never been clearer. Kenya is one of the poorest countries in the World. Though not in the top 50 list, it is nonetheless not in the first 100 of better off countries. Lying on the equator and being semi-arid in the North, rainfall does little to relieve thousands in the population of their plight.

There are only few fresh water lakes in the country and even those are drying up. Kenya shares Lake Victoria with Uganda and Tanzania and has only 6% share on it. Even though it was to have a larger share, this would still not aid in increasing drinking water resources as Lake Victoria is mainly for fishing and navigation.

Like most developing countries, Kenya finds itself facing economic and social problems which have done nothing to improve the situation of the poor who by the way are more than half of the population. In a BBC article /21/, published 15th August, 2001, it was noted that on average, most Kenyans live on less than \$1 a day. Other than the social problems facing the country, its location means a different climate, which in this case is just two rainy seasons. The first rainy season lasts from October to November (short rains) and the second rainy season is in March-May (long rains). These rains are however not reliable and the country sometimes suffers from long periods of drought.

Climatic conditions are the things in nature that we can do little about, other than avoid disrupting them. However, corruption, economic disability, lack of technological knowledge and environmental education are problems we can eradicate. In this thesis, I mean to clearly show the current state of the country, and how all the factors, whether social, economic or physical are affecting the limited water resources.

It is very obvious that the rich benefit more than the poor in distribution of services in any country where the gap in social classes is so large. Yet, we cannot choose to

forget that while luxuries like television, holidays, electrical appliances and other things are not required for survival; water is both a necessity and a right for everyone.

We are in an age where exploitation of natural resources has been exhausted. We no longer speak of tapping new raw materials or of disposing all that we have used. The burst in population in growth, and the fact that that the world remains the same size with the same things has now led to thinking in ways like, Sustainable Development. We cannot stop developing, but we can develop without using too much and giving back very little to nature. So what is the government in Kenya doing to conserve its limited water resources? What is the population doing to survive with the little it has and what will happen to Kenya in another 50 or so years? I will discuss all these in the thesis report.

2. AVAILABILITY OF WATER RESOURCES

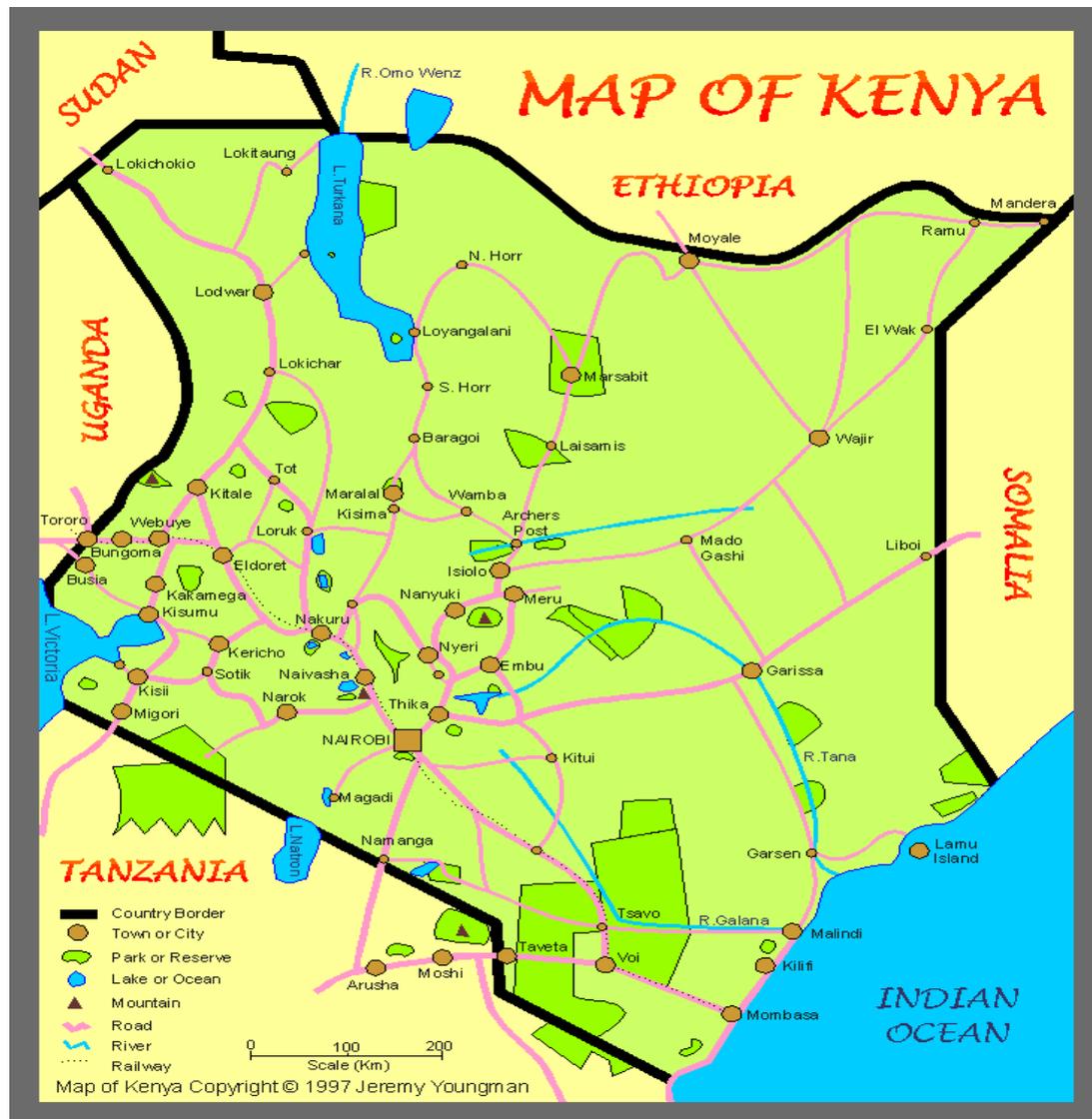


Fig. 1 Kenyan Map outlining major Lakes, Rivers and Towns. /22/

Kenya has two main Lakes and borders the Indian Ocean to the South East. It has a 6% (3785 sq km) share on Lake Victoria. The other major Lake is Turkana (Rudolph – as it was previously known). Most of its rivers are not annual, apart from River Tana, which drains into the Indian Ocean. It serves a great purpose in the Coastal region but has also been a source of conflict between pastoralists and farmers. The country is divided into 5 drainage areas. Lake Victoria Basin, Rift Valley Basin, Athi

River Basin, Tana River Basin and Ewaso Ngiro Basin. Only Tana River Basin is wholly in Kenya.

2.1 LAKE VICTORIA

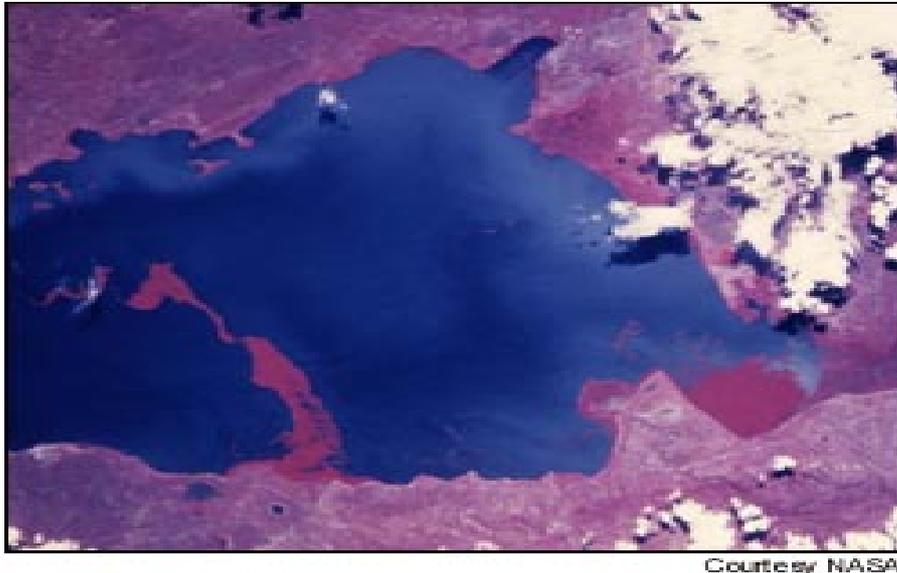


Fig. 2 Satellite picture of Lake Victoria and Hyacinth Blooms /23/

Lake Victoria is the world's second largest freshwater lake covering an area of 67,850 sq km. This vast expanse forms the headwaters of the River Nile. Kisumu, one of the major towns in Kenya and home to 80% of the country's second largest ethnic group, is 350 km from Nairobi, the capital city, by road.

Although Kenya has the lowest share, there is a busy network of waterways between the trading towns and villages which lie along the shores of the lake. Passenger boats and small cargo vessels ply daily from Kisumu as far as the Tanzanian border and north to Port Victoria near Uganda. The Lake is mostly used both for navigation and fishing. Fishing for tilapia and Nile perch provides a living for the vast population that lives along the lakeside. The fish are sold at local markets or to the processors for sale in Nairobi and for export.

In the recent times, Lake Victoria found itself facing a Hyacinth invasion. With the Rwanda genocide in the 90's the situation worsened. Mass burials in the country were

becoming impossible with the fast and intense death rates. As a result, dead bodies were disposed into the lake. With their decomposition, eutrophication increased and excess nutrients leading to an outburst of the hyacinth. Thanks to the Australian government and Dr. Mic Julien of CSIRO, with the introduction of a South American Beetle, the problem was eradicated. /24/

2.2 LAKE TURKANA



Fig. 3 Satellite Image of Lake Turkana /25/

Lake Turkana is located in the North of the country, in the Rift Valley and covers an area of 7,500 sq km. Barren volcanic lava beds surround it with little to no vegetation. Until 2 million years ago it was a freshwater lake fed from the north by the Oma River in Ethiopia. That is a long time ago. Today, Turkana has no outlet and the water is highly alkaline and barely drinkable. The area is semi-arid and the population is thus sparse. /6/

However, some nomadic groups have taken refuge in this harsh climate and practice cattle ranching. UNESCO has immersed itself in trying to reclaim this land and make it productive by making it part of the Mount Kulal Biosphere Reserve, which is for

carrying out studies on arid lands. Not too long ago, Dr. Richard Leakey in 1967 discovered the Koobi For, a fossil site on the Lake. Other than that, the Sibiloi National Park is now located on its shores. /26/

2.3 MINOR LAKES

There are other minor Lakes in the country like Bogoria whose alkaline waters have attracted massive flocks of flamingo. Lake Naivasha and Lake Baringo are the only fresh water Lakes in the country. Along the shores of these two lakes, farmers have set up homes. The presence of fresh water and good soil (loam) makes those areas very fertile and is considered the highlands of Kenya. As the name depicts, the main economic activity in the area is farming. Mostly subsistence, but where farmers have vast pieces of land, they undertake commercial farming and growing vineyards. Coffee, Tea, Pyrethrum and Pineapples can be found in plenty. Other lakes are like Lake Nakuru, Lake Elementaita and Lake Magadi. Lake Magadi has a very shallow basin and is used for mining salt. All of these Lakes can hardly be used as sources of drinking water. /27/

2.4 RIVER RESOURCES

Of all river resources in the country, none compares to the Tana River. It is 1,014km long from start to finish. The headsprings of the river rise from the slopes of Mount Kenya and the Aberdare mountains. Its waters irrigate the highlands and, where commercial farming is extensive. Farmers have come up with extensive irrigation schemes to tap this resource, and predictably, it has been facing the threat of drying up in recent years. It serves the country all the way to the coast, draining into the Indian Ocean. It has also served as a source of navigation with larger boats than most of the other rivers would allow. It is also a source of drinking water for the locals who live along its shores. /28/

The other major river in the country is the Athi River. It is denoted with three other names, depending on which part of the country one is in. It is the second largest, east-flowing system of Kenya. Rising near Nairobi, it drains the Kapiti Plains south of

Nairobi, the southern slopes of the Aberdare Mountains, parts of Yatta Plateau and the eastern parts of Mount Kilimanjaro. It has a few major tributaries that include Kiboko and Tsavo Rivers. Below Lugard's fall (near Tsavo River confluence), the river changes its name river to Galana. The lowermost course is called Sabaki. The Tsavo River, which is maintained by the Mazima Springs, is the only permanent flowing affluent of the lower drainage system. The Athi River is mostly used for the purpose of irrigation. Other minor rivers in the country are Kerio, Turkwel and Nzoia. These rivers, unlike the latter two, have not been used extensively for irrigation. They are however used for navigation by small boats.

2.5 GROUNDWATERS

The natural surface water resources in the country are by no means enough to satisfy the vast population. In various parts of the country, the water tables are quite reachable and have created accessibility and an opportune to construction of, for example, boreholes. In their book *Groundwater*, R. Allan Freeze and John A. Cherry, describe groundwater as more than a resource but an important feature of the natural environment. Its existence can lead to environmental problems or be a medium for environmental solutions. This statement proves true in the world today. Mexico, which has and still relies heavily on ground water for consumption has been termed as the “city that is sinking while it drinks”. Its water table is continuously sinking and as it is an Island, it faces a high risk of being submerged. /1/

As Kenya is considered a water scarce area (It receives an annual rainfall of 567mm and has an annual freshwater per capita of about 700 m³, compared to the World benchmark of 1000m³) most of the population, especially in the North, where the climate is semi-arid, have to rely heavily on digging boreholes. Their availability also has a lot to do with the amount of income that a household has. In most cases, groundwater projects, if not funded by the government or NGOs, have tycoons behind their existence.

This is of course one of the major problems facing the society today; a factor that will be discussed in the forthcoming pages. In line with that, I will also identify some of the causes of the current water crisis in Kenya. The availability of ground water generally has a lot to do with the hydrologic cycle. Below are two representations of the cycle and its contribution to ground water.

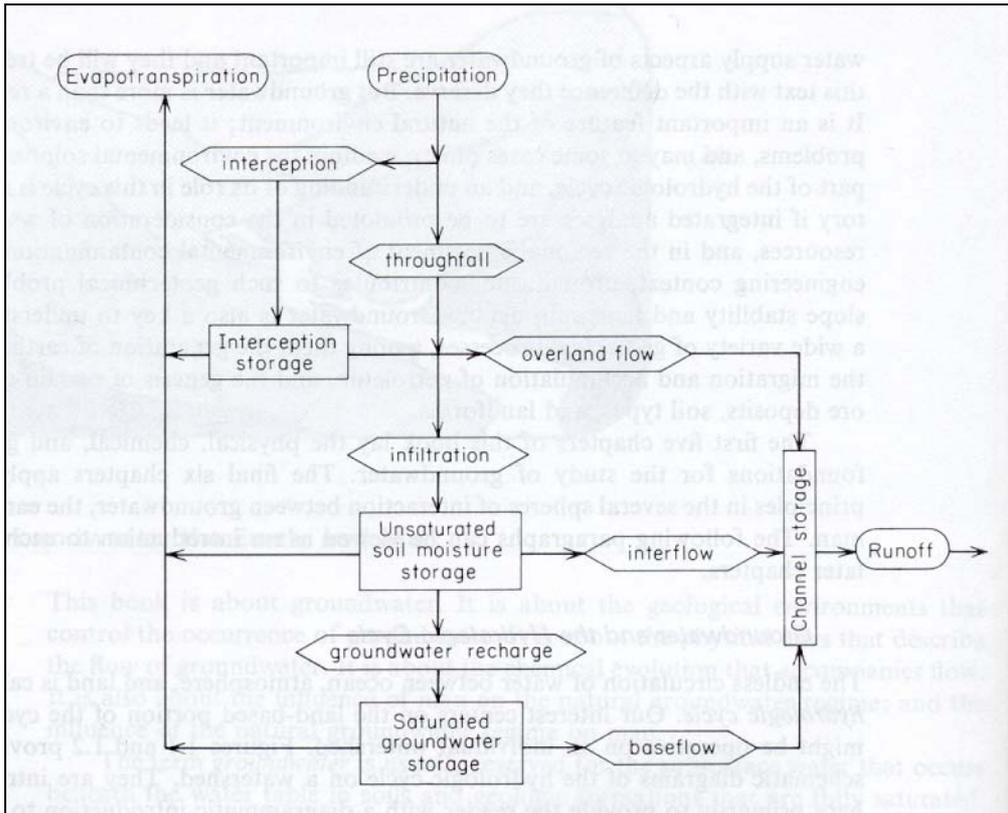


Fig. 4 Systems representation in the hydrological cycle /1/

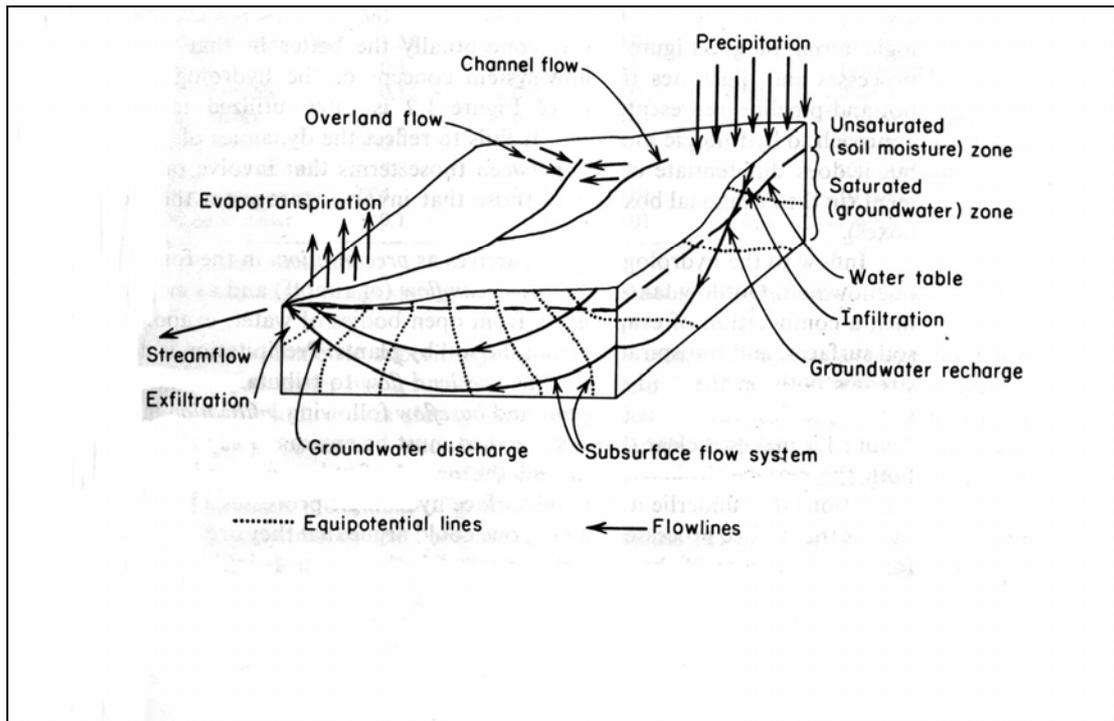


Fig. 5 Schematic Representation of the hydrological cycle /1/

3. DISTRIBUTION OF WATER AND ITS PROPORTION TO DEMAND

The greatest challenge when it comes to water issues is the fact that its rarity and unavailability cannot pass without affecting every other thing in society. The unavailability of water sometimes has absolutely nothing to do with its occurrence but its physical state. While the fact that there are only two freshwater lakes in Kenya remains, the latter problem still persists.

As of 2000, Kenya's population had reached a maximum peak of 30 million (plus or minus). In 1989, the density population per square kilometre was 37. This figure has greatly risen to the heights of 50-55. The birth rate in the country is much higher than the death rate. While the population is on an onward increase, the water resources in the country remain the same. Most people use about 40 – 80 liters per day. /29/

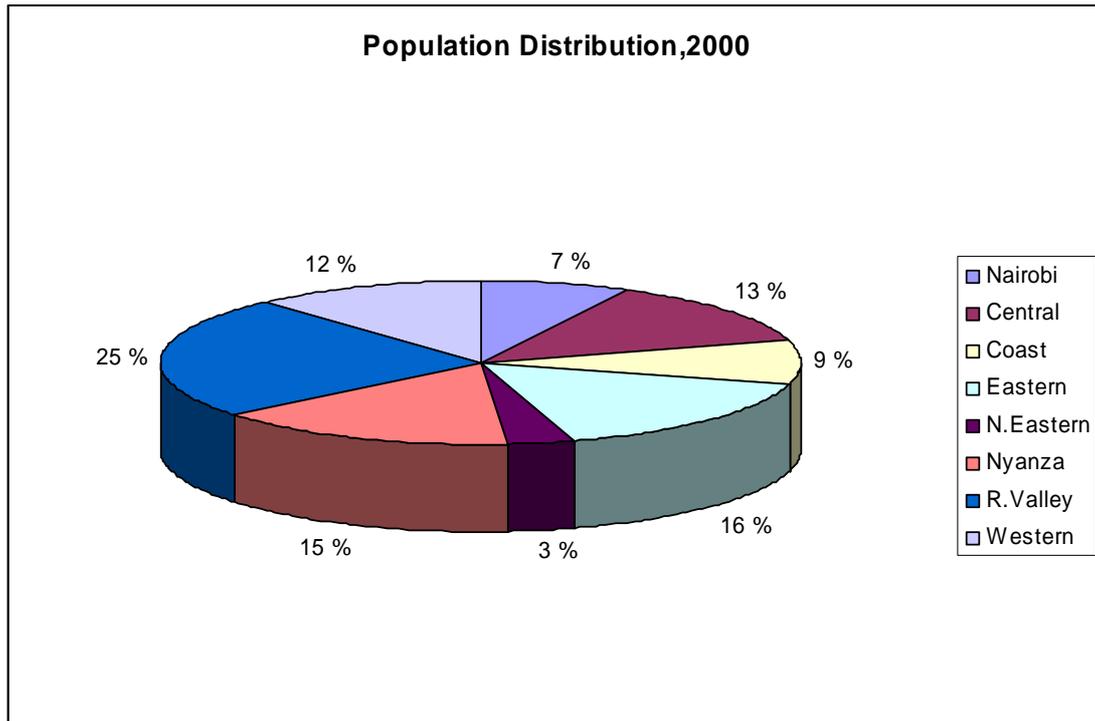


Fig. 6 Population Distribution in Kenya/Province

From the above chart, it is easy to note that the highest population resides in the Rift Valley. The Rift Valley has River Tana and Ewaso Ngiro flowing through. While places like North Eastern have the lowest population, it is due to the climatic conditions that render the place arid and therefore less favorable for human occupation. The few people residing there are among the worst hit by water problems.

According to Ezra Maritim, the vice chancellor of Kenya's Egerton University, Kenya has currently the least access to safe water in East Africa, a report he clearly made to Kenya's leading newspaper, The Daily Nation. While countries like Tanzania and Uganda provide 3,000 and 2,700 cubic metres/citizen respectively; Kenya only provides 647 cubic metres. He accounts these low values with various problems, most of which I will discuss later. The idea is to note that the Mt. Kenya region (part of the highlands) is the country's most important source of water, meeting up to 50% of the country's need for fresh water. Increasing ecological destruction and changes in land use around this area is bringing sever pressure on the mountain's rivers. /30/

To understand the ratio between distribution of water and its demand, it is best to note the various ways in which water is distributed in the country, from the source to the

consumer. Water resources itself is an inter-disciplinary undertaking in Kenya. The Central government, town councils and municipalities, institutions, private organizations and individuals mostly do distribution and attaining water.

4. METHODS OF WATER DISTRIBUTION

The method used to attain water highly depends on its source and occurrence. Most people living in the highland areas rarely face lack of water, but with the current changing climate and human activities, this will soon prove to be a national disaster. Most other people, for instance in the Northern parts have to live in semi-arid conditions. As a result, water is very rare and most have to learn to survive with as little as possible. Generally, the whole country is in no way on the safe line and the water crisis is prevalent everywhere.

4.1 INDIVIDUAL WATER ATTAINANCE:

a) Rain water collection

Everywhere around the world, availability of water is solely due to rain. That is why disturbance of the ecosystem has such tremendous effects on the water cycle. Even ground water (as shown in the previous topics) is affected by the water cycle.

Most families in Kenya have come to rely solely on the availability of rain. The country has two rainy seasons, the long and short rains. During these times, households let out collection units to collect as much water as they can. Furthermore, homes have been built to accommodate this idea. Most rooftops are equipped with water collection troughs, which lead to a storage tank.

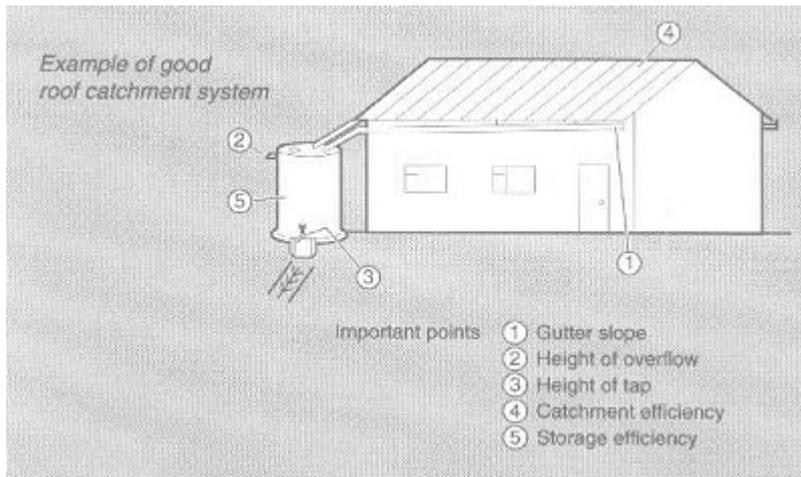


Fig. 7 Example of a good roof catchment system /31/

© John Gould and Erik Nissen-Petersen
Rainwater Catchment Systems for Domestic Supply

The Maasai, who are known to be one of the few African tribes to maintain its long-term traditional way of living have adapted to the difficult times. They can no longer be pastoralists and have been forced to lead settled lives. Their old time 'manyattas' have been fashioned to accommodate the lack of water. Below is a pictorial view of the new design of their houses.



Fig.8 New designs of the traditional Maasai homes. /32/

b) Fetching from rivers

Rivers are sometimes known to overflow during the heavy rainy season. Rivers in the highland areas are quite clean, and were it not for the lack of knowledge of people in those regions on water pollution, they would remain so. Where rivers are prevalent, households use a different method of filling up their storage tanks. One reason being that homes in rural areas are still so 'traditional', they lack the simple technology of water collection troughs; and where they occur, they are crudely structured.

The role of women in fetching water in rural society still remains. It is the duty of women and children to fetch water from the river. This is mostly done using barrels of up to 20 litres and 5 litres for young children. Women in rural society are the backbone for the survival of most societies. They are the source of manpower. In a survey done by WHO (World Health Organisation), 26%-50% of people in Kenya need to travel more than half an hour to fetch water and return home. Most of these people are in rural areas.

In the same research, termed "Fetching a pail of water", halving the population of Africans without access to an improved water supply and an improved sanitation would save the United States \$1.2 billion on health treatment costs. Universal access for Africans to a piped water supply and sewerage connection in their homes would save them \$6.4 billion /32/. What then is better; to eradicate the source problem or to curb the consequences?

4.2 GOVERNMENT: CITY COUNCILS AND MUNICIPALITIES

a) Sources and Consumption

The government in more than one case tries to take an active role in distributing water to the vast population. Distribution by city councils and municipalities is mostly done in urban areas, where people are not close to direct sources. When drought prevails, there is such a negative impact on the water supply in the cities that consumers are sometimes forced to buy from vendors.

A direct example of government involvement is in the capital city Nairobi. The water sources for Nairobi are Sasumwa, Ruiru and Thika Dams. The water production capacity is about 519,000m³/d. This production capacity was expected to live up the year 2006-2007. The demand is estimated to be 371,000m³/d and the dams only get to supply about 346,600m³/d. There is definitely no surplus here.

In an article written by Eng. Dan Owore of Nairobi City Council, January 2004, he argues that the potential of the dams is not exploited fully (a contradiction to my earlier statement). According to him, it is due to distribution problems. Pumped water from the dams is transmitted to a number of reservoirs for treatment (in most cases, addition of Chlorine). From these reservoirs, Nairobi is served almost entirely by gravity due to the general topography of gentle falling gradients from North to South and West to East. He goes on to say that consumption is highest within domestic use, the least being industrial /33/. Below is a short table showing the consumption percentages in the capital city.

Table 3.1 Percentages of water consumption rates in Nairobi /33/

Consumers	Percentage rate
Domestic	64%
Commercial	13%
Public institutions	12%
Industrial	11%

b) Means of Distribution

The irony of living in a country like Kenya is the gap between the rich and the poor. What is considered to be just a way of living by the upper classes is in fact the plight of more than 50% of the population. The lower classes in the community consume the least and yet seem to pay the most for all resources. For instance, it has been estimated that on average, people living on informal settlements and low class houses consume 50 lpcd (litre per capita) of water per day, while those in the middle classes

consume about 150 lpcd. The upper classes consume 250 lpcd. It is clear to see the strain the lower classes have to put up with.

As with financial stability, so does water priority differ among the groups. Most of the lower class groups live in slums (which are forever on an increase) while the upper class live in posh housing. The methods of attaining water also vary depending on home locations, which in this case are not defined by preference but by financial abilities.

c) Distribution of water in slums

The latest shocking news for the Kenyan government was not realizing that IMF would be cutting down on funds, but that the biggest slum in Africa is actually in its capital city. Kibera, situated to the South of Nairobi is home to 700,000 people. There are 3,000 people per hectare. If this is not congestion, I do not know what is. The other shocking news is that there are another 198 slums in existence. It is estimated that 3.5 million people practically inhabit slum areas.

Most people in slum areas hardly get any water. The government does little to ease their poverty and in most cases, if it were not for NGO's, they would live on very little. In slum areas, living conditions are very bad, and running tap water is a luxury, which cannot be attained even though it was possible. This is mostly due to the poor structures ejected by landlords for profit making in the name of providing homes.

Most of the water in slum areas is from private vendors – the people have to buy water from the streets. Government involvement in water provision is not singly but with collaboration of various NGO's like *Maji na Ufanisi* and NETWAS, which I will discuss in the latter pages. In 2003, during the International year of fresh water, the United Nations drew facts on the world situation. This is what they had to say about people living in informal settlements and government involvement in water distribution:

“As previously mentioned, people living in informal settlements are the first hit by water related diseases. Without access to adequate water supplies, people often get water from unsafe sources. Often, the only way to get drinking water is to buy it from private vendors, at up to 10 times the cost of water delivered by pipe. In many African cities, up to 80% of the population is serviced by small-scale informal private sector water providers. According to UN-Habitat, in Namibia, up to 15-20% of families’ incomes is spent on water. In addition to this, families have to pay to visit the toilet.

To cope with a growing demand for water supply and sanitation, some governments have privatized water and sanitation utilities in their cities. But, if the contract between public authorities and private companies is not based on a policy of connecting the poor to water supply and sewage systems, slum dwellers are likely to be disadvantaged by privatization. Connecting the urban poor is not an easy or a profitable task – it is difficult to lay sewers in informal settlements because the streets are narrow and irregular. Even when slum areas are connected after water services are privatized, their inhabitants are likely to pay more than others, because they rarely enjoy individual connections.”/34/

d) Distribution in Middle and Upper Class settlements

Water distribution in Middle and Upper class settlements is better by far compared to that of slums. In these areas, the population is more or less able to pay water fees imposed by the government and the homes are in better shape. Most of the water is distributed through pipelines after treatment to various households. Before the country’s economic declination, households were installed with meters and charges were paid depending on usage. This system has long since faltered due to a number of reasons like a mismanagement and lack of water.

Households that have access to government water distribution are mostly in the urban areas. Most other homes have to rely on various other methods. Even with government distribution, the system is quite unreliable and since demand is higher than supply, almost everyone has to obtain other means of attaining fresh water.

4.3 PRIVATE OWNERS AND NGO'S

There are numerous NGO's registered in the country and whose work in helping society come to grips with poverty and diseases does not go unnoticed. Other than that, the country faces a very wide gap between the rich and the poor. This kind of living has crept even to the most sensitive and essential matters like access to drinking water.

Those who can afford have been known to dig boreholes and use them as a source of income by selling water to their immediate communities. Where the government has failed, NGO's have taken over and where NGO's are yet to get, private vendors have taken advantage.

a) Non-Governmental Organizations (NGO's)

One of the biggest NGO's in the country involved in helping poor societies attain water is NETWAS (Network for Water and Sanitation). NETWAS International was established in 1986 in Kenya as a regional water and sanitation center for Eastern Africa. It is part of the global International Training Network for Water and Waste Management, also known as the ITN. ITN is a program that was established through the initiative of the UNDP-World Bank as a contribution to the International Drinking Water and Sanitation Decade of the 1980s. This Program's mandate was to establish several regional centers in Africa, Asia and Latin America to support capacity building activities including information dissemination. There are currently a number of active centers in Asia (Philippines, India and Bangladesh) and a strong ITN Africa network.

NETWAS has been known to merge communities and involve people in attaining drinking water. For instance, the Nguuru-Gakirwe Water Project they activated was designed to provide a sustainable water supply for domestic and irrigation purposes, to support the livelihoods of about 430 households. The project, located in Tharaka

District, in Eastern Province, (one of the dry areas of Kenya) has been implemented in 3 phases through grants from the Italian government and the European Union through the Community Development Trust Fund (CDTF), a joint Government of Kenya/ European Union (EU) poverty alleviation programme. Phase I and part of Phase II were funded by the Italian Government (Kshs. 44,884,093.00) while Phase III and remaining works under Phase II were completed through a CDTF grant of Kshs. 19,492,009.00.2 /35/

One other renowned NGO due to its involvement with water issues is *Maji na Ufanisi* (Water and Development). They thrive to facilitate the development of appropriate, sustainable water and sanitation (WATSAN) services to the urban and rural poor. Like NETWAS, it merges communities and through common effort and public involvement creates water sources. Their main concern is in distributing water in slum and poor areas and the arid and semi-arid regions. /36/



Fig. 9 Photo showing public involvement in MNU's water projects /37/

b) Private Owners

As I pointed out earlier, it is at this point that the economical state of most people in the community comes to light. Most private owners dig boreholes and sell the water to

the public. Since digging boreholes is very expensive, only companies or wealthy people can afford to do this.

How the water is attained depends on the owner. In some cases, people have to get it from the location of the borehole. Other times, water pipes are connected to the interested parties' households and they pay a fee every end of month. The most prevalent is collection at the source. Families have to sometimes travel up to 10 km, just to attain a barrel.

Transportation businesses have sprung up to ease the load and also to enable households to buy larger quantities of water. It is not surprising to see donkeys with carts attached to their necks, transporting large barrels of water to homes. Attaining water from private vendors is very expensive and unfortunately, the poor seem to be the ones to suffer from this plight. They pay more for basic resources than those who can afford.

5. QUALITY OF WATER – AT THE SOURCE AND CONSUMPTION LEVEL

One of the biggest problems facing third world countries is waterborne diseases. Cholera, Typhoid, Malaria, Bilharzia (*Schistosomiasis*) are just few of the ones that exist. According to the United Nations World Health Organization, 2002-report, 1.7 people die each year in the world due to unsafe drinking water. 90% of the people who die from water borne diseases globally are from Sub-Saharan Africa. /38/ Kenya is by no means left out in this circle. Most of the drinking water in the country is highly polluted, both with microbes and solids.

With such alarming figures, an emergent need which most people rarely think of resurfaces – treating water. Kenya is a developing country. This aspect limits greatly economic stability in the country. Advanced technology on treating drinking water is yet to reach that side of the world. Still, that is by no means a reason to be ignorant on other basic methods of water treatment, which I will discuss later.

5.1 WATER QUALITY AT THE SOURCE

Absolutely pure water is never found in nature and it is increasingly rare to encounter a source of water that requires no treatment before being supplied. Most water impurities can be classified as suspended, colloidal and dissolved. The nature of their occurrence of course also highly depends on the source of the water.

Most water supplied in Kenya is either underground (boreholes) or from rivers. Below are some of the impurities bound to be found in most of the country's water sources.

a) Suspended matter:

Running water will most likely carry floating debris, but it also has the capacity to pick up and transport solid particles of greater density than water; the higher the velocity the bigger the particle can be transported. Rivers are normally at their most turbid during flood because of the increased velocity. The table below indicates the soil particles through which water is transported. /2/

Table 4.1 Size of soil particles and corresponding velocity of water.

Material	Diameter of Particle (mm)	Velocity of Water (m/s)
Fine sand	0,4	0,15
Medium sand	1,1	0,23
Coarse sand	2,5	0,3
Gravel	2,5-25	0,76
Shingle	25-75	1,2

b) Colloids

Colloids are fine particles that do not settle and which are electrically charged. The particles have a similar electrical charge, normally negative, which prevents them from coalescing together to form larger, more settled particles. They are not visible to the naked eye but they can impart colour and turbidity to the water. Most Kenyan rivers are not clear and are highly brown due to silt, and possibly colloids. /2/

c) Organic Matter

Pollution from organic matter can be serious, particularly for groundwater sources that receive little treatment. Faecal pollution, whether from animals or humans is of particular concern, given the risks of disease transmission. Take for instance a slum like Kibera, situated in Nairobi; a research carried out on poverty eradication showed that toilet facilities cost Ksh 5 (6US cents) per visit per family member to visit the toilet regardless of the nature of the call. 5 Ksh is quite a sum. This high cost of essential needs leads people to other alternatives like use of water sources as toilet facilities. /2/

d) Microbiological parameters

The greatest short-term threat to human health from drinking water derives from pathogenic micro-organisms. Most of these organisms are due to faecal pollution. Since identifying directly for viruses can be difficult, it is best to identify bacteria that are known to be present in human faeces and to treat their presence in the water source. /2/

e) Tastes and Odours

These two are perhaps the most obvious signs of contaminated water. I cannot think even of one surface source in Kenya that does not suffer from either or both. Water in its true sense is supposed to be odourless and tasteless.

These characteristics can be influenced by for instance, the presence of algae, which is present on most surface waters. Removal of algae is essential and often difficult. Odours and taste can also be due to Chlorination, which is one of the most popular ways of treating water in the country. /2/

f) Minerals

Underground water in Kenya has been known to carry quite high amounts of minerals. For instance, the levels of fluoride are said to be above 1.0mg/l, which is the level needed to protect tooth decay. Any levels above 1.5mg/l affect bones and cause mottling of teeth.

Other minerals are sulfates, chlorides and bromides. Minerals like Calcium and Magnesium are also quite prevalent and cause water hardness, when they are

carbonated (example, Calcium Carbonate). The sulfates of magnesium and sodium if present in excess, act as laxatives. Chlorides in concentrations above 600mg/l tend to give the water a salty taste. /2/

Arsenic is a metalloid substance commonly found in ground water. It may also be a possibility in borehole water sources in Kenya. Arsenic pollution through water can cause liver and nervous system damage, vascular diseases and also skin cancer.

5.2 WATER QUALITY AT CONSUMPTION LEVEL

For any drinking water to be deemed fit for consumption, there of course has to be a binding parameter set aside to determine its level of suitability. Water from different sources is treated differently. In 1975, an EU directive concerning the quality of surface water intended for the abstraction of drinking water in the Member States (75/440/EEC) classified surface waters into three classes:

- a) Category A1 water requires simple physical treatment and disinfection
- b) Category A2 water requires normal physical treatment, chemical treatment, and disinfection; and
- c) Category A3 water requires intensive physical and chemical treatment, extended treatment and disinfection. /2/

These same guidelines are more or less used in treatment of water in Kenya. However, lack of good technology and water treatment facilities limits the levels to which water is well treated for consumption. As discussed earlier, most water in Kenya is either groundwater or from rivers rising from the highland areas. Below are two diagrams representing water treatment from boreholes and upland rivers.

These representations are not always the case. Many of the vital steps in the treatment are normally skipped and consumers are always encouraged to boil drinking water before consumption. Amoebiasis, which occurs in places with poor sanitation, is quite rampant in the country. In most situations it is due to untreated water sources. /39/

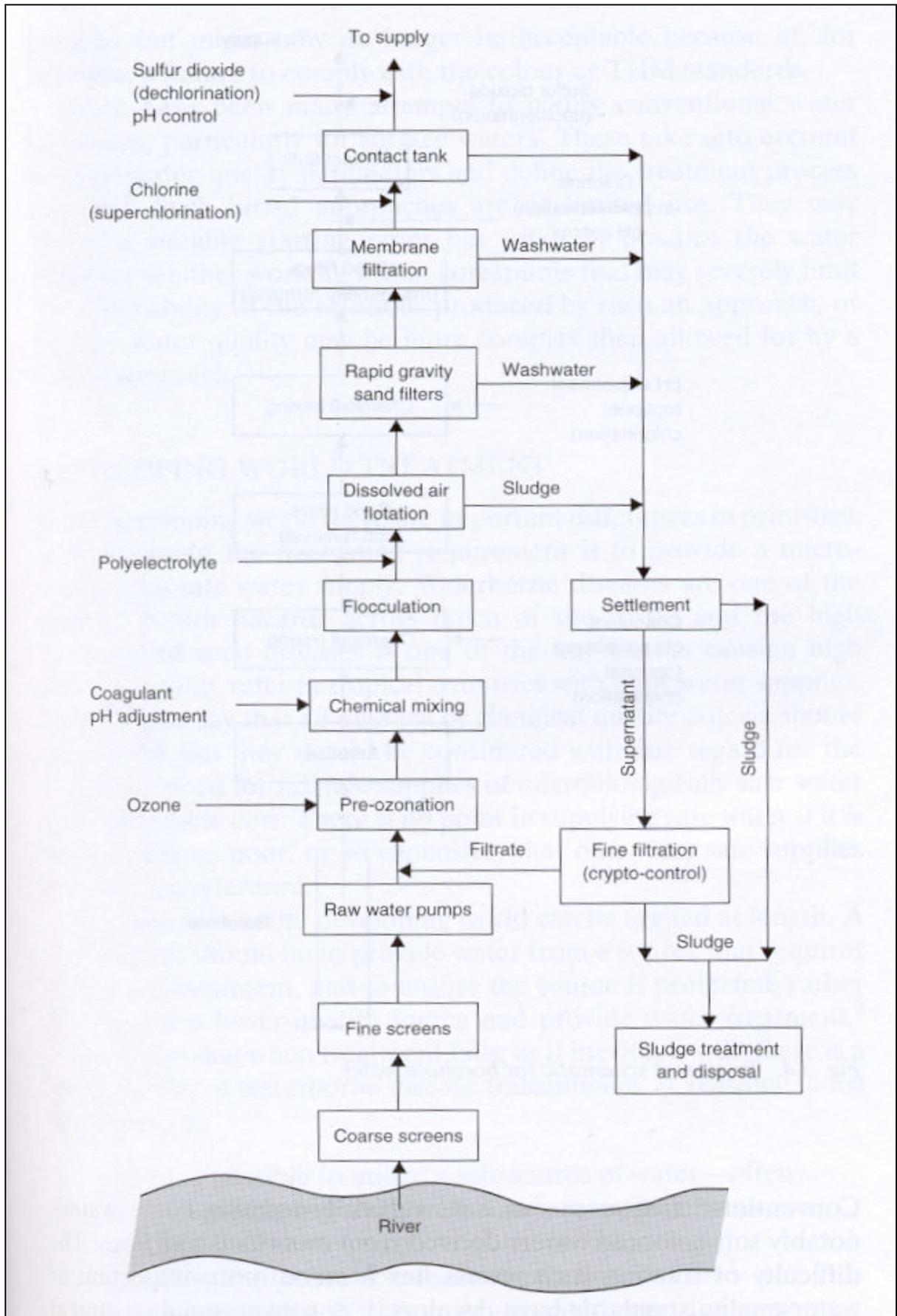


Fig. 10 Water treatment from Upland River sources /2/

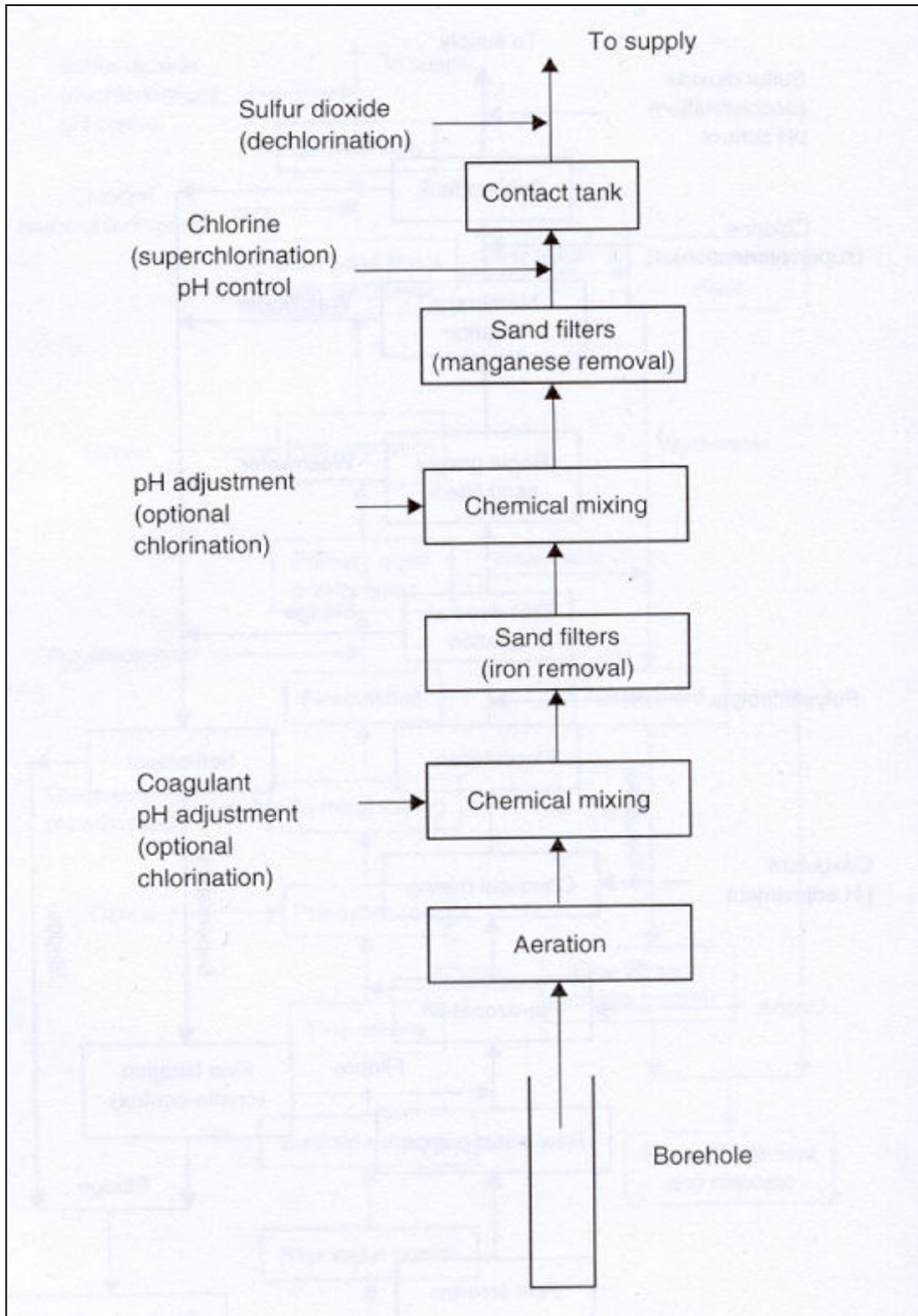


Fig. 11 Basic Water Treatment of Borehole Water resources. /2/

6. MAJOR WATER PROBLEMS FACING SOCIETY

a) Drought

Michael Allaby in his book Drought states that it is a word without precise definition. Three weeks without rain can be enough to trigger a drought emergency in Britain. In other countries, no talks of drought until several rainless months have passed. However, the most obvious effect of drought arises from the lack of water itself.

Kenya has sometimes faced this long spasm of dry weather, and has also experienced at some point the El-Nino. Lack of water can, as we will see later, be as a result of human activities. Where it is solely due to climatic conditions, people have to come up with ways of coping with it. Allaby goes on to give examples of how this can be done, for instance dry farming, mulching, using water efficiently, plastic sheeting on farmland and irrigation. Other methods of water conservation will be discussed later.

/3/

b) Unavailable Water Resources

Each environment or country has different physical water resources. Countries in the West, for instance in the Northern parts have plenty of Lakes and water resources. Scandinavian countries are a good example. Other countries, for instance in the North of Africa are purely deserts and have 3 more or less main rivers. Egypt for instance has only the Nile River as its main source of water, both for farming and energy production. Kenya does not many lakes or rivers either. Its main river is Ewaso Ngiro and a red alert has already been issued as the river is drying up /4/. There is also the problem of uneven distribution in space and time resulting in only 20% of the country being well watered.

c) Inappropriate distribution

The distribution methods prevalent in the country have been discussed in detail above. For a population of 30 million, the 670 cubic meters/person is not enough and that

may only be accounting for the middle and upper classes. Distribution problems are mostly associated with corruption, broken water pipelines, mismanagement, lack of accessibility to homes (for instance slum areas) and lack of technology.

d) Pollution

Many river resources in the country are highly polluted, as there is lack of basic sanitation in most areas. Treating this water requires interest, commitment and of course economic ability. Use of chemicals on farmland has also been a cause for polluted water resources. Misuse and intentional polluting is one area that the government has to take a major interest in to curb some of the problems.

e) Cost

The cost of basic drinking water seems to be on a continuous high. The poor are the most affected as on average, it has been noted more than 50% of Kenyans survive with under 1 dollar/day. The high cost of water is what leads people to consuming from polluted resources, or even continuous pollution by using rivers for multi-purposes like washing, sanitation, drinking, cleaning at the main source.

f) Reducing water-table

This problem only came into the limelight when the rivers began drying up and other options had to be put into consideration. According to EAEN (East African Environmental Network), deforestation is one of the causes of the depleting water table. /40/ Deforestation in the country has been mainly due to lack of renewable energy resources, increased population, extensive agriculture and corruption where the government has been found to sell protected forest areas to rich individuals. As the rivers continue to dry up, more and more boreholes are being dug to sustain the population. Renewing the underground water resources has been a problem with the water cycle being greatly disrupted. As a result, the water has continued to be used and none given back.

7. REASONS CAUSING THE PROBLEMS

a) Disrupted Ecosystems

An ecosystem involves a collection of living things and the environment in which they live. The link between shortage of water and disrupted ecosystems is closely related to the behavior of organisms (whether humans or animals) and how it affects water resources. Take for instance human activities like agriculture. They cause deforestation, water pollution and water exhaustion (irrigation). This in turn may lead to drought (reduced rainfall), death of aquatic life and terrestrial life, vegetation (desertification).

b) Mismanagement of Resources

One of the biggest problems in developing countries is the way in which governments manage the natural resources. In many cases, decisions made on conservation are influenced by economic agendas and distinctive social classes. The Nobel Prize winner Wangari Maathai had to face up to a severe political struggle while trying to conserve the Karura Forest (one of the few forests left in the country) /5/. The simple attitude that government officials have towards resources and their connection to social problems has been going on for decades since independence.

c) Political Will

As mentioned above, most conservation activities have to be executed and encouraged by the government. However, there has been very little political will to do so and if it were not for pressure groups like the Green Belt Movement, United Nations, IUCN, very little would be done. Officials spend more time with political power struggles than they do in running the country.

d) Misplaced Priorities

The Kenyan government has for a while now been outdone by countries like Tanzania, which are of a lesser economic stability, in making water issues a first priority. During my research, one of the questions in the questionnaire was what percentage of the budget does the government allocate to conservation of water resources. While most people were not sure on the exact number, they all pointed out that the figure, whatever it could be is not enough. As long the government constantly ignores the water crisis and pays more attention to other lesser issues, the country will continue to sink into poverty. (See annex 2).

e) Economic Instability

The third world is perceived to be locked in a permanent state of crisis of politics, economics environmental degradation. Before recent years, more focus was placed on the underdevelopment of third world countries than on environmental issues. These two are however inseparable. A country's lack of capital and finances is also the cause of poor environmental management. The economic instability of the state is measured with the populations' economical status. More than 50% of Kenyans are under the average level. As a result, there is lack of proper housing, affordable energy sources, sanitation, waste management, and many other environmental issues affected by economic status. /6/

f) Ignorance

While conducting the same research for the thesis, my often asked question was on what the government was doing to involve the public in water conservation. Most answered – introduction of environmental education in schools. Now this is a very good method and is highly appropriate, yet most adults are still very environmentally ignorant. They are unable to link, for instance, use of pesticides and chemicals during farming with water pollution problems. A survey done by UNICEF indicates that 82% of adults are literate; they therefore lack information and not inability to read.

g) Un-sustainable agricultural methods

Many institutions and scholars believe that agricultural expansion is the major factor contributing to deforestation in developing countries. It is estimated that by the 1980's, 70% of the disappearance of closed forests in Africa was due to increase agriculture. In the period 1074-1992, Kenya's forest land dropped by 13.5%. On another side, use of herbicides and pesticides like DDT still continues. Fertilizer application is encouraged to increase yields to serve the mass numbers. These un-sustainable farming methods have been a cause of depleting water resources. In the same article on drying rivers stated earlier, it is also mentioned that Kenya overtook Israel as the leading horticultural exporter to Europe. Agriculture continues to be on an increase while water resources are depleted. /7/

Along with all these factors contributing to the crisis, minor problems occur which intensify the extent at which people are affected. Poverty, corruption, climatic conditions, global warming are some of the things which also contribute to water shortages. Separating social issues with environmental issues is not entirely possible. Each can cause the other to be affected and vice versa.

8. RESEARCH ANALYSIS

a) Method

The main research method used was questionnaires (see annex 2). To avoid bias on the issues, I obtained answers from an NGO, in this case UNICEF, and from a government representative in the Nairobi City Council.

I sent out 10 questionnaires to UNICEF (United Nations Children's Fund) and the Nairobi City Council respectively. I received back 8 questionnaires from UNICEF but only 1 from Nairobi City Council. The poor feedback, I was told by the one representative of the Council was lack of interest from other would be participants. My analysis therefore will be more inclined to the NGO view in contrasting form to answers obtained from the council.

b) Analysis

In the analysis, my primary concern was on the government and public role in water conservation. I was keener to find out what activities, plans and how much interest the government has been placing on the water crisis in the country. The three main questions were therefore:

- a) Ways in which the government has tried to conserve water resources.
- b) Difficulties the government faces in implementing its strategies.
- c) Future plans outlined to help curb water problems.

Representation of the analysis will be in graphical forms and short discussions.

i) Main Water Problems

When asked on the two main problems affecting water resources in the country, 5 out of 8 answered pollution. 3 also accounted the problems to fast depletion. Other reasons were lack of proper management, under-utilization, lack of technology, lack of education on water conservation and deforestation. Below is a pie chart demonstration of the answers obtained:

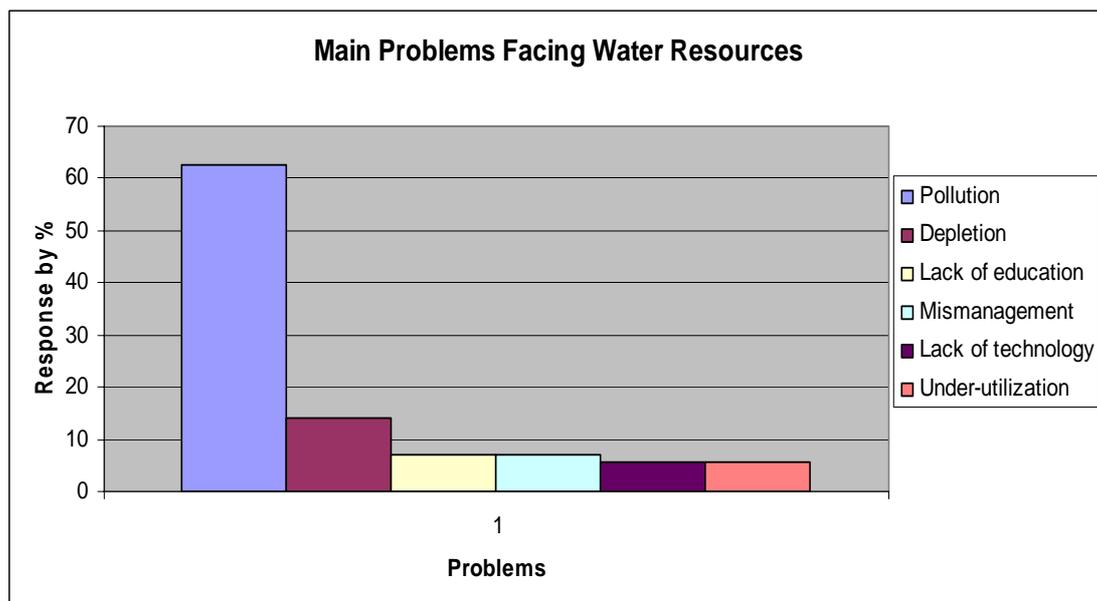


Figure 11. Percentage demonstration on the main problems affecting water resources in Kenya.

The city council representative termed deforestation in water catchment area and contamination of water masses as the main problems affecting water resources.

ii) Government Involvement in Water Conservation

a) View from NGO

This is perhaps the most vital of all issues as it projects interest both on a local and global level. The question was on what the government is doing to conserve water resources. Most of the answers given were in relation to setting up laws and regulations on resource use, education in schools and afforestation. What I found missing was any implementation of alternative energy production methods or sustainable agriculture.

The global population of 6 billion is increasing at the rate of 1.3% or 73 million persons/year. At the present growth rate, the population will reach 7.5 billion by 2020 and 9.4 billion by 2050. More than 50% of these will be from developing countries. Agriculture is the backbone of Kenya's economy and highly relies on water resources. Like many other countries, the primary concern in agriculture production should be factors like:

- a) Food security due to a rapid increase in the population
- b) Soil degradation by land misuse and soil mismanagement
- c) Water conservation and management in farming.
- d) Anthropogenic increases in atmospheric greenhouse gases /8/

Most people stated out government involvement to be in form of laws and education. 75% in each case wrote down either improvement of legislation involving water conservation or creation of a legal framework for water conservation. The Water Act under Cap 372 of the Kenya laws was quoted. 62.5% pointed out education to the public and school curriculums as an important way of government involvement. In some cases, both methods were stated. Other ways in which the government has tried to conserve water resources were:

- a) Punishment and fines to those who break conservation laws.
- b) Rewarding those with successful water conservation programmes.

- c) Support of water conservation projects.
- d) Afforestation.
- e) Protection of water catchment areas.
- f) Involving the private sector in water conservation activities.

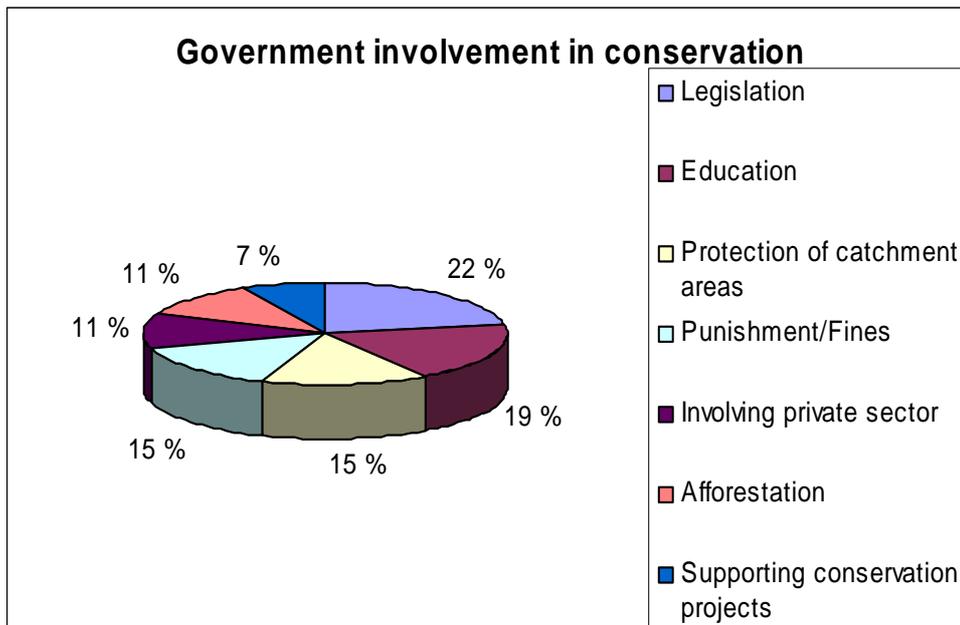


Figure 12. Pie chart demonstration of government involvement in water conservation.

b) View from the City Council

The city council had almost similar answers with just a few additional methods. Below is a table showing the comparison and contrast between some of the answers obtained from the NGO and those of the council.

Figure 13. Government Involvement in water conservation.

City Council	Non-Governmental Organization
Protection of catchment areas	Protection of catchment areas (50%)
Instituting policy on illegal tree felling	Legislation (75%)
Fencing of forest areas	Supporting conservation projects.
Intensified afforestation	Afforestation (37.5%)
Discouraging farming along water banks	Punishment and fines on law breakers.
Gazetting all water catchment areas	Education/Information (62.5%)

Although the government has tried to put some conservation programmes into place, most participants noted that budget allocation is very minimal and quoted it as either less than 1%, or very low. However the council quoted budget allocation as 30% to the Ministry of Environment and Natural Resources. How much of that is spent on water issues we are yet to know.

iii) Difficulties in implementing government policies

When drafting this question, I had in mind the idea that there must be problems associated with the running of conservation projects or ideologies, for if there were none, the crisis would not exist. My main interest was in whether they were related directly to the public or it was a case of political will. It turned out to be both. Most of the problems seemed to be related to corruption, mismanagement, in-efficiency and economic disability.

Other than that, in relation to the above, I asked how willing the public was in co-operating with the government on water conservation issues. The choices were

- a) Always b) Reluctant c) Rarely (Refer to annex 2)

All participants answered reluctant apart from the council representative whose answer was rarely. This further affirmed my belief that the public and the government do not work hand in hand in reducing the water problems.

Below is a representation of the answers in graphical form. In the “others” column, I represented the number of people who included other differing reasons in their answers. Some of the other stated reasons were:

- a) Few people are involved in real water conservation programmes.
- b) Local people who are not willing to change behavior.
- c) Growing need for agriculture thus increased irrigation.
- d) Growing population.
- e) Multi-cultural nature of the country hinders implementation of the legislation (foul play and discrimination).

- f) Negative politicking
- g) Lack of consolidation in the various government departments.
- h) High level of illiteracy
- i) Perpetual long dry weather zones

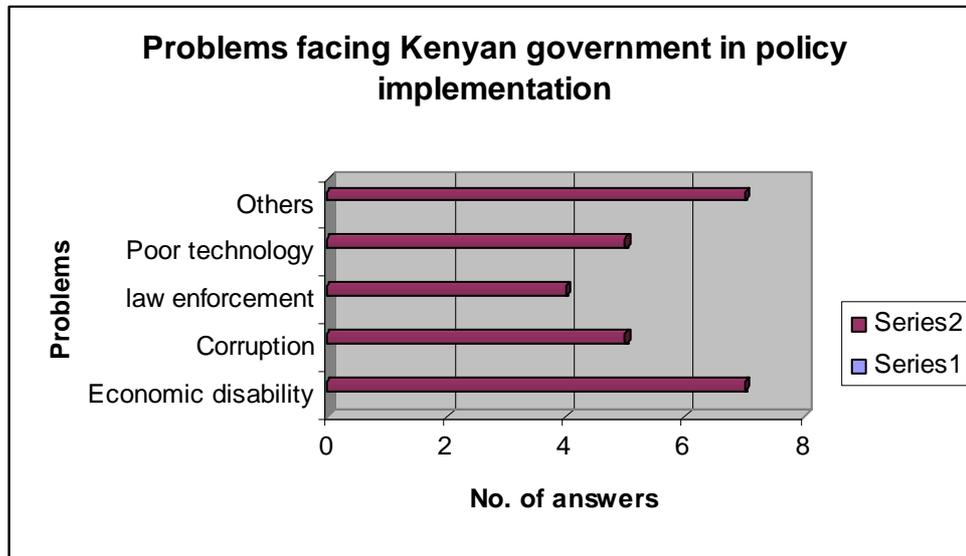


Figure 14. Demonstration of the difficulties facing the government in implementing policies.

iv) Future plans on curbing water problems

Since the water problems are already known and began to be solved, it only goes without question that the government should look towards improving what they have already implemented or what they have not. I went on to find out about this in the last question on future plans that the government has outlined to help curb water problems.

I received numerous answers in this section. One participant was not sure of any plans from the government. The most detailed was from the city council, but I attribute this to the fact that the participant had more access to government information and data. The most prominent future plans were:

- a) Introduction of Environmental Education from low levels to high levels in the education system.

- b) Enactment of an Environmental act that overrides the other.
- c) Sinking at least 300 boreholes per year (a 5 year plan).
- d) Enhancement of the general forest covers from the current 2% above the recommended 10%.
- e) Building of more water dams.
- f) Lowering electricity tariffs to reduce wood dependency for fuel.
- g) Enactment of a new authority named Water Resource Management Authority.

Whether or not this will actually be put into action, I am not sure. However, the Water Resource Management Authority is already in existence. I emailed them in a bid to forward my questionnaires but they had no access to any information and they forwarded me to the City Council. It is not enough to form an organization, it has to implement and work towards the goals that are the cause of its formation.

Cap 372 of the Water Act has been reformed under the changes in the new constitution. The old Cap 372 was stated as part of the reason for poor water distribution and availability (See annex 3 and 4). Other than constitution reforms, practical action like digging wells and boreholes was popular among the answers. So was control of environmental factors like soil erosion and deforestation, which was all summed up in the government efforts to change the legal framework of the country.

9. RECOMMENDATIONS

At this point, we have already identified numerous reasons why there is lack of adequate water supply. To reduce environmental problems, we always have to look at the root cause. Take for instance pollution of water resources, we cannot barely state and inform people that they should abstain from dumping waste in rivers and lakes.

The human reaction of doing that must be for a reason, and so it is with deforestation and other issues. In the recommendation part, I would like to discuss alternative methods and ways of reducing social problems which I believe are the main cause for the environmental problems and vice versa.

The figure below is an illustration of the main problems and how each leads to other problems. From the research, I have come to the conclusion that the greatest threat to the water resources is pollution and depletion, which is crowned by lack of education, political and public will.

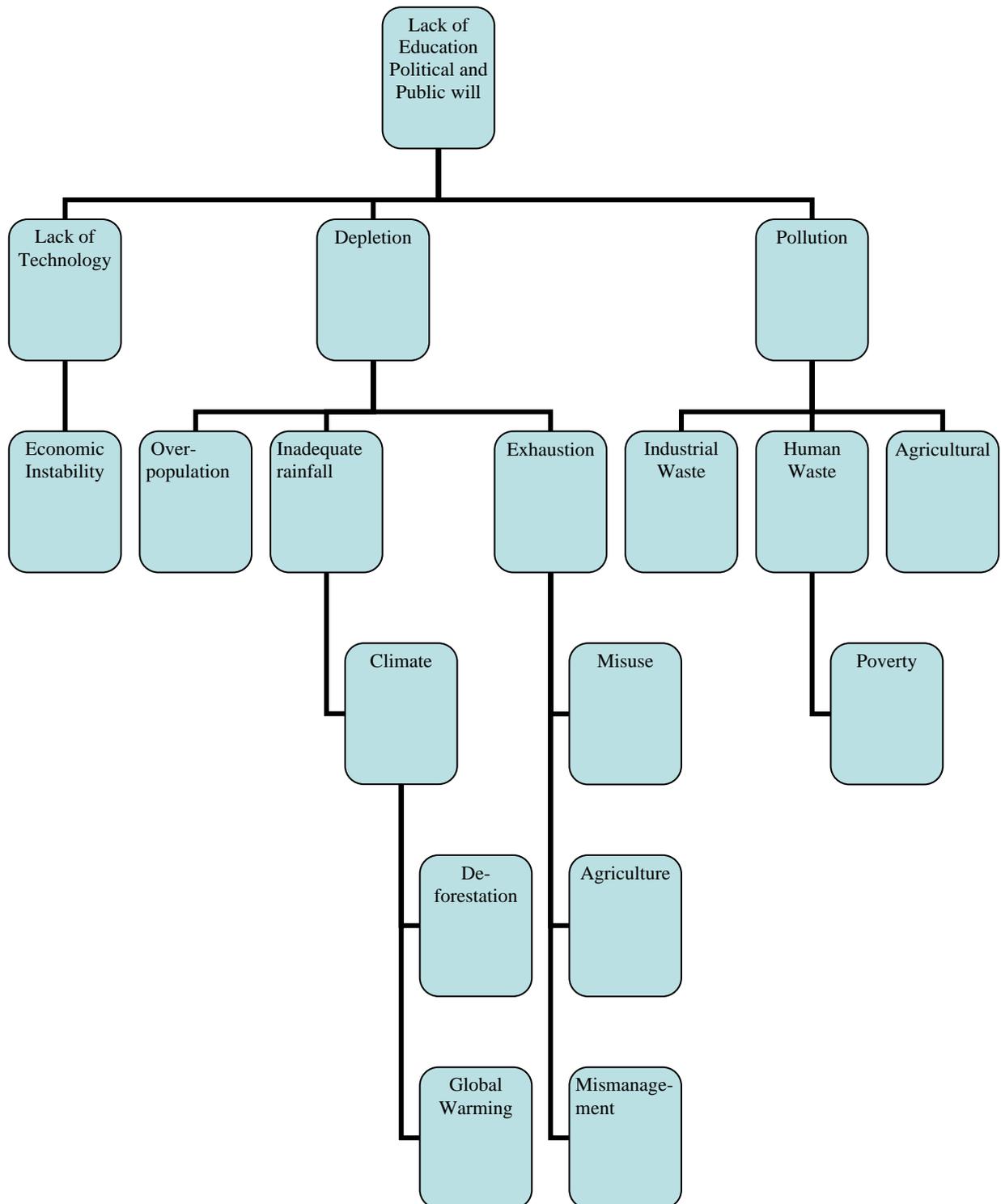


Figure 15. Chart showing the major problems facing water resources and their causes.

Recommendations will be based on root problems and how they can be reduced so as to enable people to sustain their environment. Since from the table we can see what the deficiency of one thing causes, by suggesting alternative methods or new method of curbing an already existing problem would be a step towards development.

9.1 Pollution

9.1.1 Human Waste

In developing countries, a substantial amount of environmental degradation is a result of poor people searching for the basic essentials of life: food, water, fuel and fodder. The majority of these poor masses press upon the marginal lands, destroying the very resources upon which they depend and contributing to the processes of soil erosion, desertification, deforestation and water shortage. /9/

Pollution due to human waste is a major problem in water resources, especially on surface water. Most of the human waste is from households and faecal. This is because people lack basic sanitation and there is a poor solid waste management system in practice. Where WC toilets exist (Water Closet), the issue is disposing of the waste water in sewages.

Recently, the campaign for dry toilets has increased globally. Dry toilets help to reduce water use and waste water unlike water closet systems. Unlike pit latrines, the waste does go to a sewage system. Dry toilets produce about 500 liters of dry fertilizer and 5000 liters of liquid fertilizer as they transform the excrement and urine of a family in one year. The economic and environmental benefits of dry toilets pose a good alternative for the government in installing them in public places and encouraging their use in homes. In slum areas, they would reduce the cost of using a toilet (earlier discussed in the report) and they could also be installed in numbers /10/. Introducing the dry toilets will in help to reduce the number of people using water resources for sanitation purposes.

For areas where WC remains prominent, then we have to think about recycling of waste water. Most countries tend to discharge the waste water either untreated or partly treated into the hydrological system. Every cubic meter of waste water discharged into water bodies or water courses contaminates and degrades 8 to 10 cubic meters of good water. Treatment of waste water in most cases will depend on its character, sources, levels in raw waste water, desired levels in drinking water, feasibility of treatment and effects of recharge. /11/

On dumping solid waste, the problem comes with perhaps over-crowding which is a result of over-population. It is difficult to control the population of a country unless there is public will. The main issue is then to be able to control the amount of waste being produced by households. One such method would be recycling.

Plastic bags are widely used in the country for packaging. Perhaps because their production is cheap as they are synthetic. Their disposal poses a problem however, and in most households, they are dumped along with bio-degradable while they are burnt by residents in suburb areas. Paper recycling can be initiated by the government or companies offering a small sum of money to people who bring their waste paper for recycling. This will initiate interest as well as be an income earning method for thousands who lack economic stability.

Educating the masses on how organic waste can be used for agricultural purposes will also help to reduce organic waste dumping. Otherwise, in urban areas, collection by the city council should be more synchronized. Making clean water a priority will be the goal and blue-print in helping waste reduction.

9.1.2 Agricultural Pollution and Industrial Waste

The industrial sector in Kenya is not highly based on technology. This is because the country is more a raw material provider than a manufacturer. However, the small industrial sector produces its share of pollution to water resources. For instance, the manufacturers of newspapers and packaging paper could be one source of industrial waste. Waste treatment as discussed above would be more with recycling and on an

individual level, adherence to waste disposal policies in the country. Complying with laws and regulations is influenced mostly by corruption. The government has to reduce corruption. According to a UN report from the office of Drugs and Crime, the initiative has already been installed. /12/

Agricultural pollution mostly affects ground water as a result of leaching of excess nutrients from inorganic and organic fertilizers. Pesticides and herbicides may also be leached into the soil. Nitrate is the principal contaminant arising from agricultural activities. It arises mainly from use of fertilizers and mineralization.

One method of reducing nitrate pollution is allowing free range cattle herding. The theory behind this is that the faeces and urine of the animals get deposited in a disseminated manner. In such a situation, the soil bacteria can readily degrade the animal waste and there is little risk of contamination of groundwater due to faecal bacteria. /13/

Organic manure as a source of fertilizers will not only reduce agricultural costs but will also reduce ground water pollution due to fertilizers. Biological farming methods can be used to control pests and weeds. Crop rotation, poly-cultures, natural soil amendments are but some. /14/

9.2 Depletion

9.2.1 Exhaustion

One of the EU directives to help reduce pollution rates in member states is the “Polluter pays principle”. This principle initiates responsibility for pollution rates and when any member country exceeds the maximum allowed pollution levels, they have to pay for it. So it is if a member country pollutes the environment of another country, they have to pay for incurred damages.

This same principle should be applied to the public in Kenya on water use. Paying for water services should be in measure to the amount used. The meter system should be

re-installed to monitor each household. This will reduce the amount of water being misused and will also help in increasing available water for other people.

At the beginning of the 20 century, irrigation accounted for 90% of all water use. It was expected to reduce to 60% in this century. This implies that more food has to be grown with less water. This would mean a more intensive agriculture with greater use of fertilizers and pesticides, which is what we are trying to reduce as drillable fresh groundwater is 67 times more than surface water in the world. /15/

Conservation of water will have to come through reservoir management. Irrigation of farmland by tapping water straight from the source should be replaced with irrigation from reservoirs. The Mt. Kenya rivers are on a threat of drying up because of irrigation schemes by farmers along the banks. As an alternative, tapping water during rainfall and re-directing it to storage tanks for irrigation purposes could be initiated. This will reduce the consumption rate and not disrupt the hydrological cycle. /15/

The type of soil in an area can also determine how much water is consumed when land is irrigated. Water generally moves in water in three ways in different types of soil (fine sand, sandy loam, silt loam, clay loam, clay):

- a) Saturated flow – when water is moving through soil in which all pores are filled with water. It can be in any direction.
- b) Unsaturated flow – when water moves from pore to pore in a situation where only some pores are filled with water. It takes place in response to gravity.
- c) Vapor transfer – movement of water as vapor within the soil from soil to soil atmosphere. Rate of movement is determined by the relative humidity, temperature gradient, porosity and permeability. /11/

Having knowledge on the type of soil and how much water it can retain, should be used as a key factor in determining what kind of farming should take place in certain areas. Some farmers insist on growing crops which require high water holding capacity soils in deficient areas. As a result, a lot of water is spent irrigating these farmlands.

9.2.2 Inadequate Rainfall

Inadequate rainfall can be influenced by many things. One of the factors being the climate (primarily). Climatic changes are however, in some cases due to human activities. For instance, deforestation affects the hydrological cycle (see figure 4 and 5). We depend so much on natural activities to retain water and the eco-system that disrupting them in most cases causes extreme problems. It has been discovered that reduction of green house gases is possible just by planting trees. Reason – they help in carbon fixation.

The issue on global warming and its effects on climate came into the public light in the early 1950's. It is however only recently that the major effects and interest has arisen. Africa, though not highly industrialized, faces the same threat as other countries of climatic change, one such event being the *El-Nino* that caused major flooding and structural damage in Kenya in 1997-1998. /41/ The United Nations Environmental Programme has also reported that damages due to climatic change (if carbon levels double) in developing countries is could be almost as twice as high in developed countries. /16/

Deforestation issues are however a big problem in most of Africa. In the questionnaires, most participants suggested that the government could increase protection of catchment areas (forests) as a way of conserving water resources. Deforestation in most of Kenya has been in a bid to increase agricultural area or attain firewood as an energy source. While the government should continue to increase areas of protection to avoid farming, alternative energy resources should be introduced. Another way could be reduction of tariffs on electricity to increase affordability among the people.

For a developing country, nuclear energy would be a too expensive venture. However, here is a state whose main economic activity is agriculture – the most practical, affordable and sustainable energy source would be bio-gas (Methane). Methane is a gas that contains molecules of methane with one atom of carbon and four atoms of hydrogen (CH₄). It is also a major component of the "natural" gas used in many homes for cooking and heating.

The same types of anaerobic bacteria that produced natural gas also produce methane today. Anaerobic bacteria are some of the oldest forms of life on earth. They evolved before the photosynthesis of green plants released large quantities of oxygen into the atmosphere. Anaerobic bacteria break down or "digest" organic material in the absence of oxygen and produce "biogas" as a waste product. (Aerobic decomposition, or composting, requires large amounts of oxygen and produces heat.) Anaerobic decomposition occurs naturally in swamps, water-logged soils and rice fields, deep bodies of water, and in the digestive systems of termites and large animals. /17/

Artificially, anaerobic processes can be managed in a "digester" (an airtight tank) or a covered lagoon (a pond used to store manure) for waste treatment. The primary benefits of anaerobic digestion are nutrient recycling, waste treatment, and odor control. Animal waste, grass, fodder or even human waste can be used to generate bio-gas. Since farming is such a major economic activity, this energy source can be used as replacement to firewood, especially in rural areas where electricity is not attainable. /18/

9.3 Lack of Technology

9.3.1 Economic Instability

In the last decades, the IMF, World Bank and other renowned donors have been pumping funds into the third world. In the last decades, the third world has moved only a few inches up the development ladder. Reason – in ways more than one, they rely heavily on the West for sustenance, be it basic needs or secondary.

When asked the most important thing to think about in development issues, Heikki Wihuri of IEEB (Institute of Environmental Engineering and Biotechnology, Tampere) answered “realism”. We have to be realistic about how much we are able to do and how well we can do it. The Western world should adopt new strategies of teaching the third world how to be independent. For instance, in controlling population bursts which is an incentive to socio-economic and environmental problems. Economic instability comes from lack of political will, corruption and mismanagement. Perhaps more strict measures and control of donor funding (usage and distribution) will cause the leaders to alter their thinking.

10. CONCLUSION

The questionnaires were a very good way of attaining information. Finding books was rather difficult, but the greatest set back was being unable to access any of the Ministries' websites. No information is posted on them and no email addresses to any contact persons. Kenya has to learn the benefit of transparency. It is the only way that donors like the IMF (International Monetary Fund), EU (European Union) and World Bank (among others), will appreciate the effort being made in improving the country. From the analysis, it was obvious that the government and people in general are truly aware of the problems facing the country. Polluting water resources seems to be a major factor, and that can be seen from previous discussions on inaccessibility to fresh drinking water. Social factors affect every other aspects of livelihood.

Each problem outlined is inter-twined to another. The NGO view on the current water crisis was very important in this report. Mostly because the lowest social classes in the country depend on NGOs to help in building water projects or in providing direct access to drinking water. The lowest social classes make up more than 50% of the population. Most others are in the middle classes while the minorities, who by the way get full access to fresh drinking water, are less than 10%.

Government involvement in curbing the problems is the most important issue. The fact that we are a developing country should not be an excuse to limit efforts in improving the situation. How willing is the government in co-operating with NGOs to help society? That is a question of political will and having public interest at heart.

The response on public involvement was rather bleak. While a government may have its soul purpose to serve its people, it can never work on its own. The public must take an active role in conserving resources. Participation has to begin at an individual level, at home, to the community and then to a national level. Saving water in the homestead, adhering to laws and regulations and taking responsibility for our own actions. Let us stop Kenya from being a statistic; the resources we conserve now could be the source of sustenance for years to come.

“Sherlock Holmes and Dr. Watson went on a camping trip. As they lay down for the night, Holmes said, “Watson, look up the sky and tell me what you see”.

Watson: “I see millions and millions of stars”

Holmes: “And what does that tell you?”

Watson: “Astronomically, it tells me that there are millions of galaxies, and potentially billions of planets. Theologically, it tells me that God is great, and that we are small. Meteorologically, it tells me that we will have a beautiful day tomorrow. What does it tell you?”

Holmes: “Elementary my dear Watson! Somebody stole our tent” /19/

Our inability to develop or sustain ourselves in society sometimes comes from the approach we use towards dealing with our problems. Complex issues do not necessarily mean complex answers. Conserving water resources does not depend on up to date technology but is actually quite basic. Before developing elaborate models, let us check whether there might be a simple explanation for the phenomena we observe.

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ANNEX 1. COVER LETTER

ANNEXES

WATER ISSUES IN DEVELOPING COUNTRIES:

RESEARCH QUESTIONNAIRE ON THE WATER CRISIS IN KENYA.

REF: TO ALL THE PARTICIPANTS

The world today is facing a high risk of depreciating water resources while the population growth is on an increase. Developing countries are finding themselves, once again, curbed by problems linked to lack of fresh drinking water. As a research for my final thesis, in collaboration with Tampere Polytechnic/University, I would like to address the current water situation, ways and methods in which we can improve the livelihood of the concerned societies.

In order to accomplish this, I kindly request for your help in filling out the questionnaire attached to this letter. It is confidential and will only be used for the purpose of this research. No names are required. Please try to be as frank as possible. I highly appreciate your interest and effort.

Sincerely,

EVA KAGIRI

ANNEX 2. FINAL THESIS QUESTIONNAIRE

FINAL THESIS QUESTIONNAIRE

- 1) What are the two main problems affecting water resources in the country?
 - a)
 - b)

- 2) In which ways has the government tried to conserve water resources?
 - a)
 - b)
 - c)
 - d)
 - e)
 - f)

- 3) What difficulties does the government face in trying to implement them?
 - a)
 - b)
 - c)
 - d)
 - e)

- 4) How willing is the public always in co-operating with the government on water Conservation? (quote the letter that denotes the answer)
 - a) Always willing
 - b) Reluctant
 - c) Rarely

- 5) Does the government emphasize on environmental education in schools and to the public?

- 6) Do you think that culture in society affects to great lengths the issues concerning water?

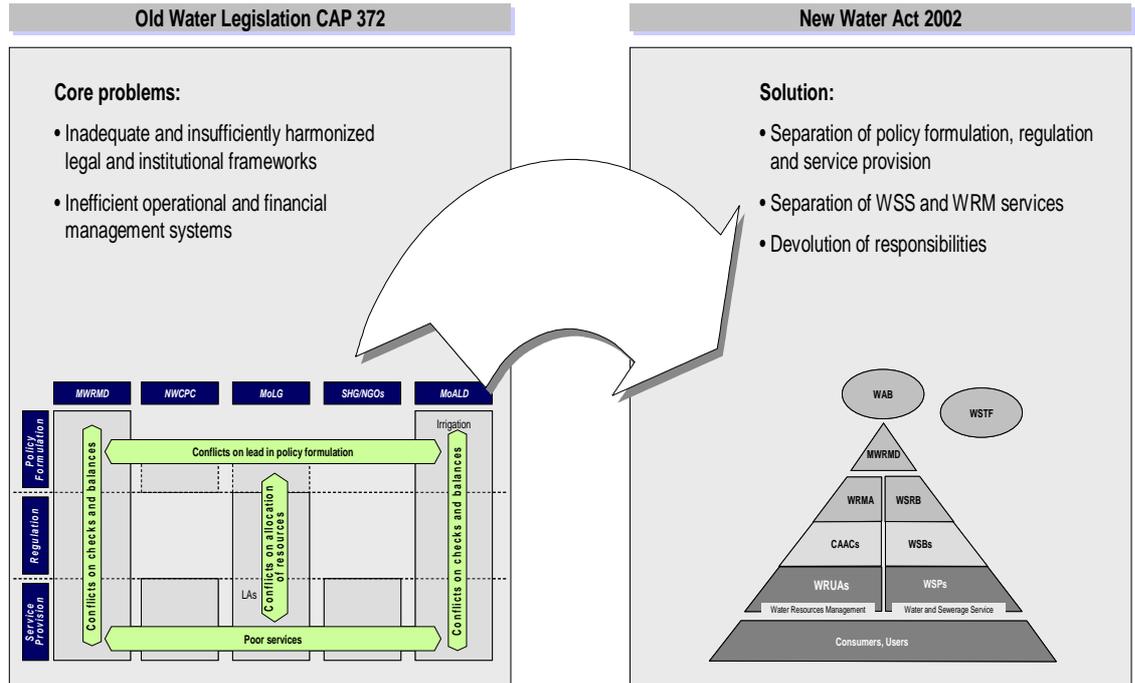
- 7) Who are most affected by water deficiency in the country? e.g countryside dwellers, urban areas, the illiterate, the poor etc.

- 8) How much money in the budget does the government allocate to conservation of water resources?

- 9) Is it enough?

- 10) What are some of the future plans that the government has outlined to help curb the water problems in the country?
 - a)
 - b)
 - c)
 - d)
 - e)

ANNEX 3. Comparison of the old and new water act.



Source: WSRS



Source: Ministry of Water and Irrigation, March 7th and 8th, 2005. Available from the World Wide Web:

http://www.ucl.ac.uk/dpu/pui/research/current/governance/outputs/Nairobi_regional/36,3,Slide 3

Old Legal and Institutional Framework, CAP 372 and others

- **Many legal provisions (Acts of Parliament) dealing with Water, (27, including CAP372) often conflicting, hence difficulties in enforcement**
- **Many different actors, whose activities conflict, and no mechanism for resolutions**
- **Ministry of Water handles policy, regulation and service provision**
- **No Distinction between Water Resources Management, Development and Service Provision**
- **A Supply-driven environment, with serious consequences on sustainability and efficiency of usage of the resource.**



Source: Ministry of Water and Irrigation, March 7 and 8th, 2005. Available from the World Wide Web:

http://www.ucl.ac.uk/dpu/pui/research/current/governance/outputs/Nairobi_regional/Mangiti%20Improving%20Governance%20in%20Peri-Urban.ppt