Case study: Kenya

Kenya National Water Development Report

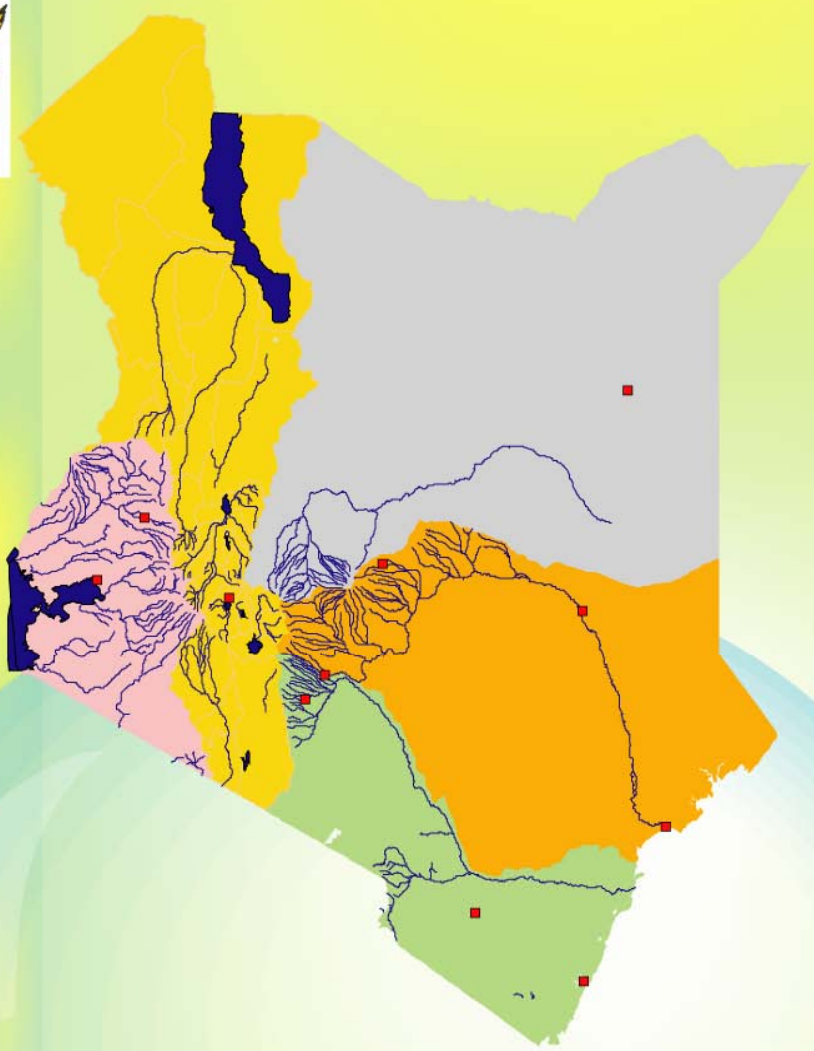
Prepared for the
2nd UN World Water Development Report

'Water: A shared responsibility'
(2006)

UN-WATER/WWAP/2006/12

Kenya Water Report

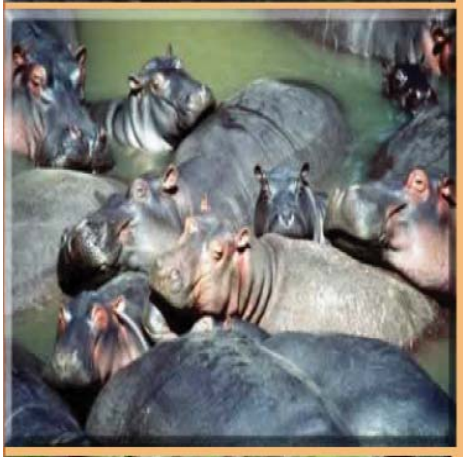
2005



Water for Wealth Creation

& Healthy Environment

For a Working Nation



ABSTRACT

Kenya is classified as a water scarce country with only 647 cubic metres of renewable freshwater per capita. The same is characterised by high spatial and temporal variability and extremes of droughts and floods.

The bulk of Kenya's renewable water resources are derived from an average annual rainfall volume of 322.77 billion cubic meters translating to annual runoff of 20 billion cubic metres. Of the ground water resources, the total safe abstraction rate is approximately 193 million cubic meters per year (National Water Master Plan, 1992). Our population was counted at 28.7 million people in 1999. Projections of the same census by CBS estimate the 2003 population at about 32.2 million.

In the past our water development has been demand driven but with the increasing depletion of the resource and degradation of the remainder focus has shifted to integrated management. This in turn calls for a more reliable knowledge base founded on more accurate data.

A substantial portion of our water resources is shared among the Nile Basin countries. Through the Nile Basin Initiative a workable modality is in the formative stage for cooperation in the development of the resources. To be acceptable and stand the test of time such a modality will inevitably depend on a sound knowledge base of our water and related resources to facilitate informed actions and decisions. The reporting framework that will be the main product of the World Water Assessment Report - Kenya Chapter will provide an invaluable tool for continuous monitoring and assessment of water resources. Quoting from the World Development Report, 1998/99 by World Bank, "Knowledge is like light. Weightless and intangible, it can easily travel the world, enlightening the lives of people everywhere". The report will definitely catalyse development by illuminating knowledge gaps and sharpening focus where need be. It is therefore a great honour and opportunity for Kenya to contribute to this global water assesment report .

Hon, Martha Karua, M.P.
Minister for Water and Irrigation

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EXECUTIVE SUMMARY FOR WORLD WATER ASSESMENT PROGRAMME REPORT-KENYA 2005

Introduction

Kenya was selected by the United Nations to participate in the World Water Assessment Program (WWAP). In this regard, Kenya therefore undertook a national project to develop a monitoring, evaluation and reporting system with support from United Nations Educational Scientific and Cultural Organization (UNESCO) and subsequently, prepared a National Water Development Report (NWDR) for input to the World Water Development Report (WWDR) II. The project is primarily for the development of a water resources monitoring, evaluation and reporting framework and involves the following specific activities: -

- Developing water sector goals and subsequent monitoring indicators for determining progress made in the Millennium Development Goals (MDG's) and other goals as set out in the national strategic plans.
- Creating, strengthening, maintaining, managing, modernizing information, data capture and processing at all appropriate levels nationally.
- Appointing agencies and focal points to monitor the indicators agreed upon.
- Formulation of a reporting process for the provision and dissemination of information to the public on water issues thereby ensuring their support in water resources management.
- The preparation of the NWDR, which is considered as a mechanism for periodically reporting on progress against set targets.

Water resources contribute enormously to economic productivity and social well being of the human populace as both social and economic activities rely heavily on the quantity and quality of water. With the increasing growth in population and the subsequent socio-economic pursuits (including urbanization, industrial production, tourism and agricultural activities) demand for water has increased rapidly. In some areas of the country a stage has reached where availability of water is the limiting factor for any development activities. In such areas conflicts have risen amongst the various competing sectors and users of water. This is further compounded by the fact that prior to 2002 water resource management responsibilities were fragmented amongst several agencies, further resulting into a multiplicity of institutions all claiming responsibility of management of the same resource, a situation which was a major impediment to integrated water resources management. Therefore, effective implementation and coordination mechanisms were not clearly defined.

In order to implement the national water policy, the then Ministry of Environment and Natural Resources begun by reviewing the Water Act (Cap 372) to spearhead the reform process. A new legislation, the Water Act 2002, was enacted and came into operation on 18th March 2003. This has necessitated major reforms that have set up new institutions in the water sector.

Professor George O. Krhoda, CBS
Permanent Secretary,
Ministry of Water and Irrigation
9th June 2005

The 1st National Water Master Plan (NWMP) by Tippets, Abbets, McCarthy and Stratton (TAMS, 1980) Consulting Engineers was an excellent study, which laid the foundation for the subsequent water development project implemented in the 1980 to 1990 Decade. It has provisions that would allow for the necessary reforms required for improved water resources management in Kenya to be achieved. Most importantly, the Water Act 2002 provides mechanisms for financing water resources protection and management. The Water Act 2002, therefore, enables the Ministry to implement the National Water Policy and, amongst other attributes establishes a new order in the sector. Table 1.1 below details the water demand for 1995 and an estimated water demand in the year 2010.

Table 1.1: Estimated Water Demand

Category	**Demand (1,000 m^3/day)**	
	1995	2010
Residential urban	747.8	1,642.8
Residential rural	468.2	932.6
Sub-Total	**1,216.0**	**2,575.4**
Non-residential, health facilities, schools, industry and commerce	593.9	986.3
Total	**1,809.9**	**3,561.7**
Livestock water	376.6	621.4
Irrigation	3.9M	8.1M
Grand Total	**2,186.6**	**4,183.2**
Source: Ministry of Water and Irrigation		

Water Resources Management Problems and Challenges

Kenya as a country is facing a number of serious challenges related to water resources management. A number of these challenges are as a result of factors both within and outside the water sector. Climate variability and increasing demand for water as a result of development and population pressure are factors that the sector may not be able to control but can initiate mitigation measures to ensure sustainable water resource development. Box 1.1 illustrates Kenya's Water Targets as a measure of tackling these challenges.

The problems and challenges facing the country include: -

Box 1.1: WATER TARGETS

•Water coverage 70% urban, 48% rural

•Commitment to meet MDGs':

•Kenya's planning target on water is to provide clean and potable water at source less than 1 km in high potential areas and less than 5 km in ASALs

• By 2010 coverage to be 85% urban & 75% rural.

•Universal access to sanitary means of excreta.

Source: Ministry of Water and Irrigation

Growing Population: The growing population increases the demand for water for domestic use, food security and industrial development. The population

Growth trend has resulted in reduction of per capita water availability as illustrated in Figure 1.1 below.

Water scarcity: Globally a country is categorized as 'water stressed' if its annual renewable freshwater supplies are between 1,000 and 1,700 cubic meters per capita per annum and 'water scarce' if its renewable freshwater supplies are less than 1,000 cubic meters per capita per annum.

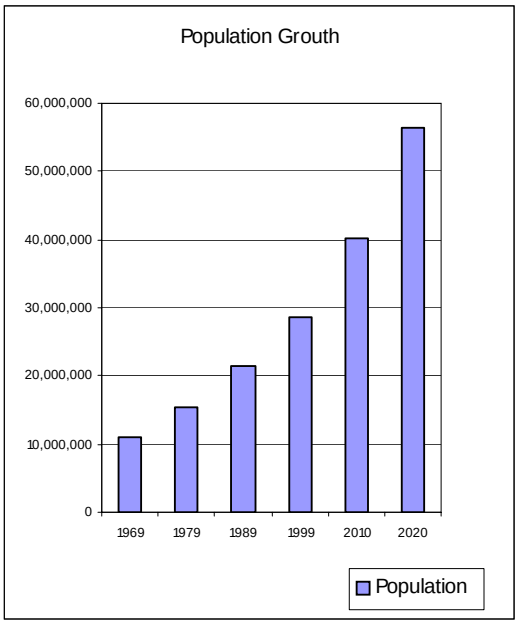


Figure 1.1: Population growth

Source: 1992 Water Master plan Projections, MW&I

Climate variability and Water Resources Degradation

Drought is a recurring phenomenon and its impact on water resources is usually devastating. Floods lead to disasters particularly in low-lying areas. Occasionally floods have caused devastating impact on the sector. Both climate variability and environmental degradation has resulted into:-

- Catchments degradation
- Drying up of Rivers
- Receding of lake levels
- Heavy siltation in dams and pans meant for both hydropower generation and water supplies
- Deterioration of water quality
- Increased water use conflicts due to competition on the available water resources
- Damaged roads, railway lines, bridges, buildings and water intakes

The impact of climatic variability and water resources degradation has manifested itself in food shortages, power rationing and damage of our infrastructure as demonstrated in the diminishing available storage per capita shown in Figure 1.2 below.

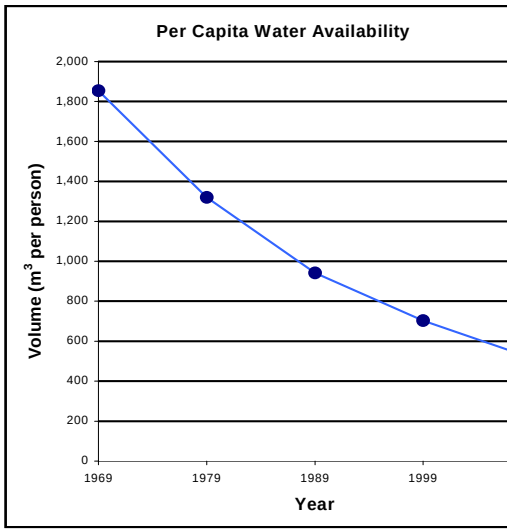


Figure 1.2: Availability of Water Per Capita

Source: Ministry of Water and Irrigation,Aftercare Stud(1998),Projeections.

In order to reverse this trend of water resources depletion under erratic climatic variations, there is need to put in place,

- Effective management of water catchment areas
- Construction of dams and pans to increase our water storage capacities
- To curb water pollution by ensuring adherence to all waste water standards before disposal into our water bodies
- Rational apportionment of our water resources thereby avoiding water use conflicts

Groundwater conservation areas are the areas where the groundwater aquifers are threatened with over-exploitation and therefore no exploitation of such groundwater shall be done without the authority of the Water Resources Management Authority (WRMA) in accordance with the Water Act 2002 and the conditions thereafter appended to such an authority.

Catchment Degradation: Catchment degradation results in increased runoff, flash flooding, reduced infiltration, erosion and siltation. Catchment degradation is a major problem, which is undermining the limited sustainable water resources base in the country. The main causes of catchment degradation are poor farming methods, population pressure and deforestation.

Invasive Species: The proliferation of invasive plants and animal species in the region including fish species and aquatic weeds is of growing concern. Weeds such as water hyacinth, fern and lettuce are degrading surface water resources particularly in Lake Victoria where water hyacinth affects fishing, irrigation, drainage, and water supply and public health developments. Table 1.2 below shows identifiable impacts and examples arising from such species in Kenya.

Four main strategies are used in the control of invasive weeds:

- Chemical
- Biological
- Mechanical
- Cultural

Plate 1.1 shows a mechanical cutter working on Water Hyacinth in Lake Victoria.

Plate 1.2 shows biological control of the water hyacinth using a biological mechanism with beetle species.

Table 1.2: Identifiable Impacts and Examples

Impact	Example
Mere nuisance	*Taraxacum officinale*
Killing native tree species	*Hedera helix*
Out competes or contaminates crops	*Euphorbia esula*
Hosts for agricultural pests	*Berberis vulgaris*
Block waterways and impair fisheries	*Hydrilla verticillata, Eichornia crassipes, Myriophyllum spicatum*
Prevent use of aquatic & wetland areas – impact water quality, nutrient levels, alter topography & soil	*Maleuca quinquenervia*

Plate 1.1: Mechanical Cutter for Water Hyacinth

Storage and infrastructure Investment: There are presently 26 large dams and about 3,000 small dams and water pans in the country with a storage capacity of approximately 124 million cubic meters. The storage capacity has been low due to the fact that investment levels in water management infrastructure have been inadequate and have been on a declining trend for many years.

Water Demand: The Study on National Water Master Plan of 1992 indicates that water demand in the important categories in domestic, industrial, agriculture including irrigation, livestock, wild life and hydropower water, will increase significantly from 2073 MCM/year in the year 1990 to 5817 MCM/year in the year 2010. The water supply and sanitation (WSS) strategy established the need for further supply development to meet the projected demands. Table 1.3 below shows a summary of the Water Sources Development Plan up to the year 2010.

Table 1.3: Summary of the Water Sources Development Plan

Scheme	**Deficit 2010**	**Proposed Water Resource Development to meet Deficit (1,000 m^3/day)**				
		Surface	**Ground**	**Ground and surface**		**Total**
				Surface	**Ground**	
Urban	1,112	1,046	42	20	4	1,112
Rural large	36	35	1	0	0	36
Rural small	218	4	84	94	36	218
Total	1,366	1,085	127	114	40	1,366
Source: Ministry of Water and Irrigation						

Plate 1.2 Control of the Water Hyacinth:

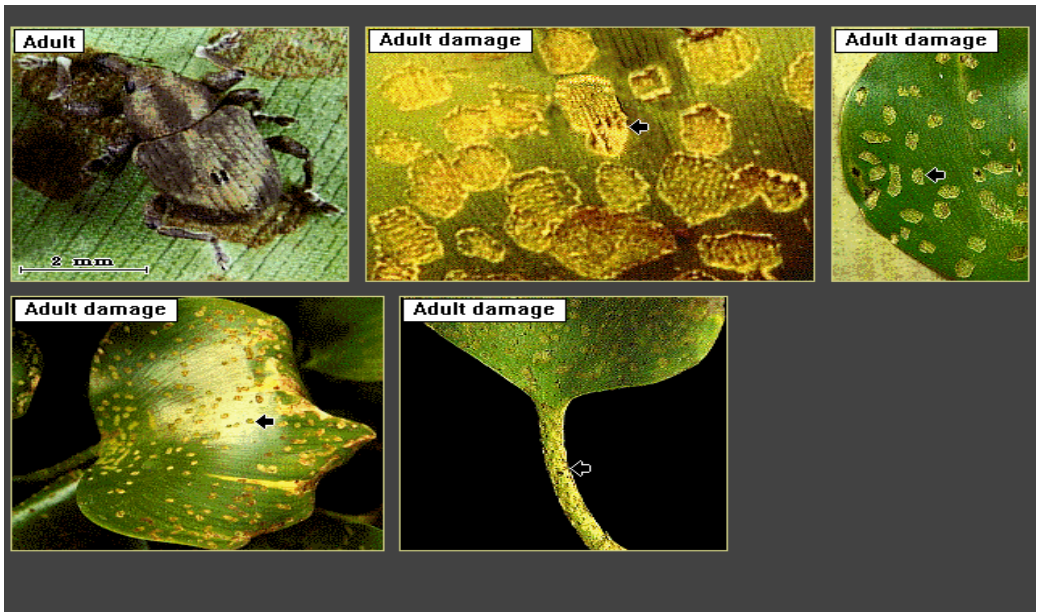
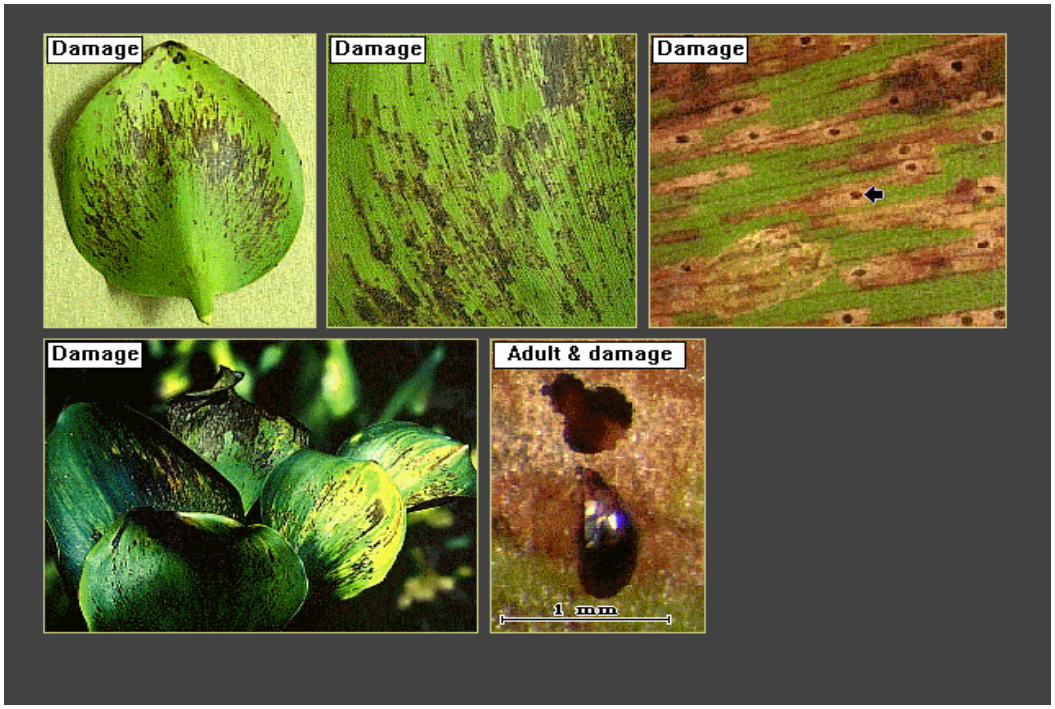


Plate 1.2 Cont.: Control of Water Hyacinth using Beetle Species



Groundwater depletion: The high demand for water, encroachment on recharge areas, lack of accurate information on groundwater potential and the poor monitoring of

groundwater in use may lead to depletion of groundwater. This in turn could result into a number of other related problems including falling water tables, seawater intrusion into coastal aquifers, and contamination of groundwater as in the case of Wajir district where the ground water has become salty due to its depletion. The ground water depletion has also caused drying up of base flows in springs and rivers and could even result in land subsidence in some areas.

Pollution: Agricultural fertilizer and pesticides eventually leach to waterways. Most municipal sewerage plants and partially treated or untreated industrial effluents in the country discharge wastewater directly into surface watercourses. These contain high levels of organics, metals and other toxic substances

Water Allocation: Water resources allocation decisions related to surface water abstractions and borehole permits issuance were made without adequate data availability. In the past it was estimated that more than 50% of water abstractions were illegal.

Aquatic Ecosystems: Lakes and riverine wetlands and flood plain ecosystems provide important benefits to the riparian communities such as flood recession agriculture, dry season water supply for pastoralist and habitat for fish and prawn cultures as well as recharge for ground water.

Resources Assessment: Kenya being a water scarce country, it is all the more important to ensure that the water resources are continuously monitored, assessed and evaluated in order to plan for water security. It is necessary to understand the climate and identify trends. Existing records are incomplete both in time and coverage of the country while the capacity for data collection, storage, analysis and dissemination is poor.

Impact on the economy: Inadequate water resources management imposes a huge cost on the nation's economy. The economic costs of poor preparedness to climate variability entails disruption in water supply, energy production and industrial output, agricultural and livestock output.

Inter/Intra Basin Water Transfer:
It is clear that water resources (both surface and groundwater) are unevenly distributed spatially in this country. Increasing human activities especially in urban areas has led to a situation whereby the demand for water is being met from water abstracted from a different catchment or drainage basin.

Water Legislation
Water use and development underpins the social and economic fabric of the Kenyan society. Improving the management and protection of water resources so as to ensure that water is available for equitable allocation for all the demands in the country including water for domestic and public use, industry, agriculture, energy, livestock, wildlife, tourism, ecosystems and other water uses is a high priority.

In order to effectively manage and protect the water resources in a sustainable manner the Management and Development have been separated through enactment of the Water Act 2002. An autonomous institutional framework comprising the Water Resources Management Authority (WRMA) and its Regional Catchment Offices is in place and the appointment of Catchment Area Advisory Committees (CAACs) and the establishment of Water Users Associations (WUAs) is ongoing. The establishment of these institutions will allow for decentralization, participation and sustainability in the management of water resources.

The WRMA, CAACs and the Water Services Regulatory Board (WSRB) became fully

operational by December 2004. Seven Water Services Boards (WSBs) have been establish ed. Figure 1.3 shows the existing Institutional Set-up as proposed in the Water Act 2002 while Figure 1.4 shows the roles and responsibilities of various actors.

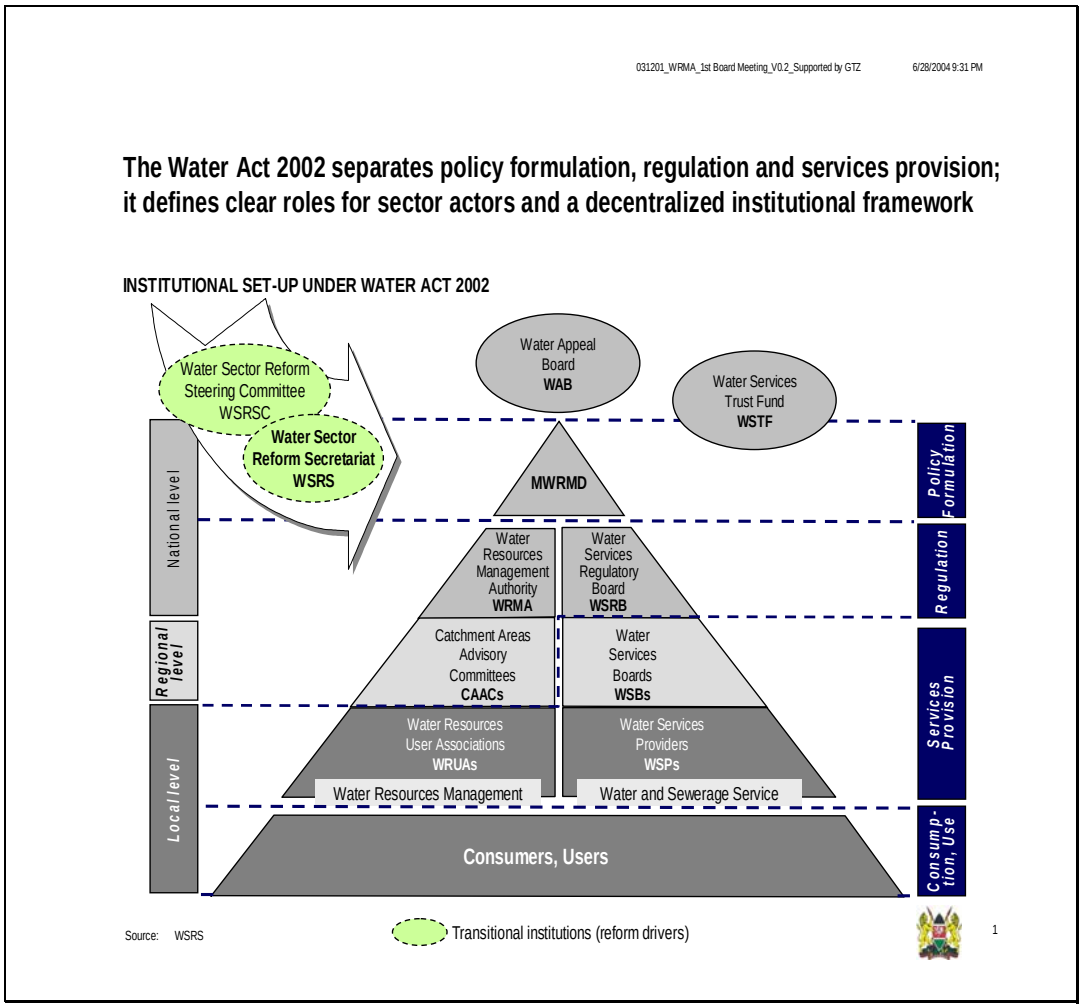
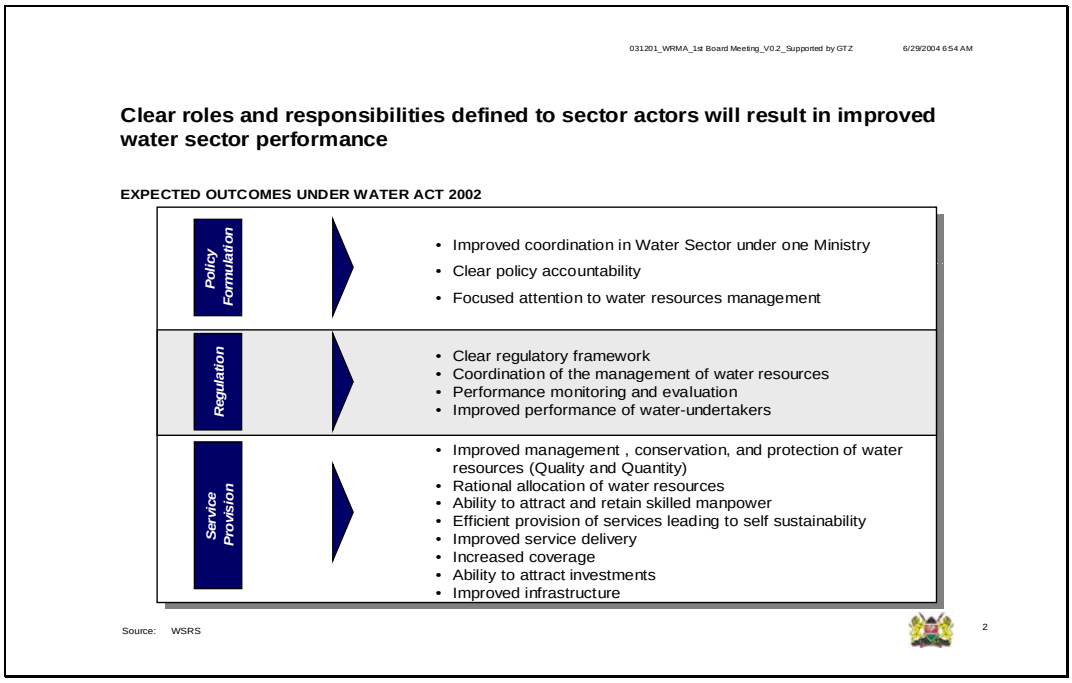


Figure 1.3: Institutional Set-up under the Water Act 2002

Figure 1.4: Roles and Responsibilities for Sector Actors



WATER RESOURCES MANAGEMENT

Water Resources Assessment

Water resources assessment comprises the continuous measurement and recording of water resources data, including their quantity and quality and the various human and other factors, which affect the resource. The purpose of the collection of information is to provide a basis for planning and management of water resources and to contribute to macroeconomic planning and sectoral planning in agriculture, industry and rural development. Table 1.4 shows the average annual water availability and abstraction by basin. The City of Nairobi receives the bulk of its water supply from the Tana River Basin, which accounts for the 15.9% water abstraction from the basin. This water is discharged through the Athi River basin. The Lake Victoria basin is endowed with the largest availability with only 2.2% abstraction.

Table 1.4: Average Annual Water Availability and Abstraction by Basin

	VOLUME (MCM/YR*)	%WATER ABSTRACTED
Lake Victoria Basin	11,672	2.2
Rift Valley inland Basin	2,784	1.7
Athi River Basin	1,152	11.6
Tana River Basin	3,744	15.9
Ewaso Ng'iro North Basin	339	12.4
Groundwater	600	9.1
National Total Water	20,291	5.4

*MCM/YR – million cubic metres per year.

Source: The aftercare study on the National Water Master Plan, July 1998.

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WATER QUALITY AND POLLUTION CONTROL

The long- term objective of the Government is to ensure that all residents in the country have access to clean and potable water, and that water is available for key economic activities such as agriculture, industry, power generation and tourism. This is only possible if the available water resources are protected from pollution.

Surface and ground water resources in Kenya are increasingly becoming polluted from both point and non-point sources caused by the activities of agriculture, urbanization, industry, leachate from mining and garbage dumps, sediments, salts, eutrophication of lakes, infiltration of fertilizer and pesticide residues, all of which increase catchment degradation. Lack of effective pollution control compromises the quality of water, posing potential health hazards, increasing treatment and maintenance costs, and affecting inland, estuarine and coastal aquatic ecosystems. Water pollution exacerbates water scarcity because it limits the use by, or imposes a higher cost for treatment on downstream users.

Conservation and Demand Management

Water conservation involves protection of water sources including catchments, ground water aquifers and wetlands. Demand management involves increasing the efficiency with which water is used. Water conservation and demand management techniques in all their forms involve: -

(a) Unaccounted-for water within water distribution systems.
(b) Efficient irrigation methods.
(c) Rain water harvesting including roof catchment for domestic purposes.
(d) Delineating and zoning areas for water conservation.
(e) Water shed management (protection against catchment deforestation and degradation).
(f) Water recycling and re-use.
(g) Protection of wetlands and important ecosystems.

Figure 1.5 shows the available water storage per capita between 1969 and 1999. There is a steady drop indicating lack of construction of new storage facilities to match the population increases.

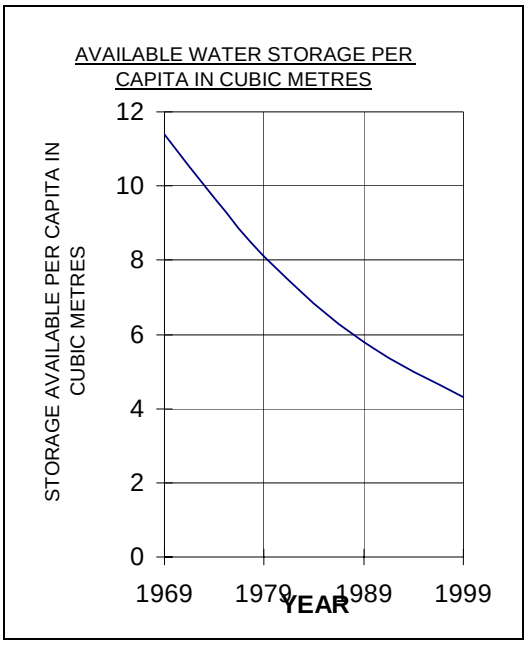


Figure 1.5: Available Water storage per capita in cubic metres

Catchment Protection

Catchment degradation is a result of the destruction of natural vegetation in a catchment through such activities as poor farming practices, (over cultivation and over grazing) and deforestation.

The causes of deforestation include forest excision for settlement and wood fuel, illegal logging and encroachment. The controversial forest excisions of years 2001 to 2002 were all in the five major water catchments of Kenya.

Effective catchment management will involve formulation of harmonized policies on land

use for agriculture, wildlife, environment, industry, forests, soils and water for improved coordination in catchment management across Government Departments.

Disaster Management – Floods, Droughts and Landslides

Floods, droughts and landslides create severe stress on the people, the economy and on already over-stretched water resources.

According to the Ministry of Water and Irrigation, the 1998-2000 drought was classified as the third worst ever and affected all sectors of the economy. The energy sector suffered huge financial losses. In the agricultural sector, rice production dropped by 40%, productive land laid furrow. The cost of implementing mitigation measures as well as financial losses due to unproductive staff-time and machinery was immense.

In time past, disaster management has not been viewed as an integral part of development planning and water related disasters were responded to in an *adhoc* manner whenever they occurred. The other elements of disaster management such as prevention, mitigation, disaster preparedness, recovery and rehabilitation were either ignored or haphazardly dealt with. Figure 1.6 shows the rainfall variability between 1979 and 2000. In the years of drought the agricultural GDP shows a massive deficit with the overall GDP following it.

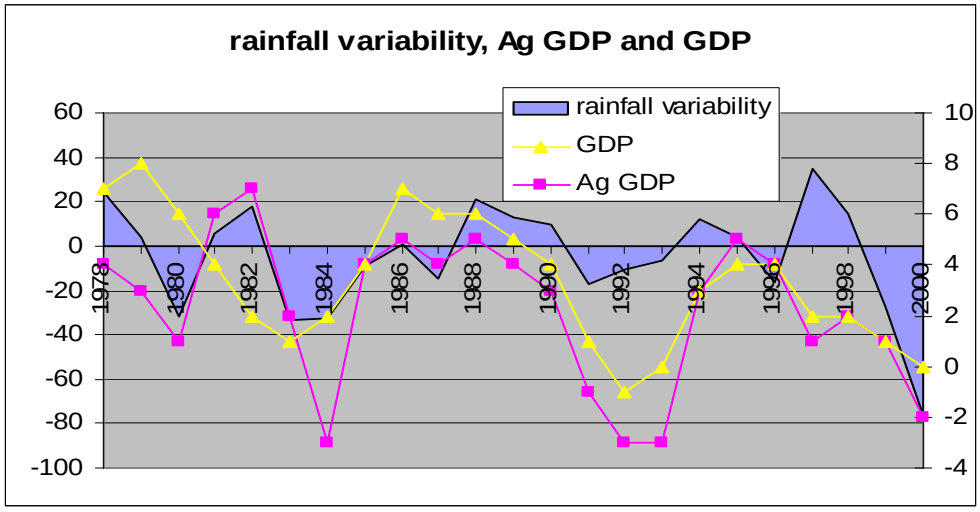


Figure 1.6: Rainfall Variability

Applied Research and Technology

Applied research in WRM related issues in the Ministry of Water and Irrigation commenced in 1989 following successes in water supply and sanitation research carried out by a research unit started in 1984 and upon the recommendations of the first National Water Master Plan of 1979-1980.

The Applied Water Research Division was created to undertake research in a wide range of hydrological and hydro-geological related fields, and in water supply and sanitation

areas. The Division was upgraded to a Branch in 1998 with additional responsibilities. However, due to a lack of capacity and insufficient funds, the Branch has not been very effective.

Research is essential if the country is to achieve its long-term development targets. Important areas of research are: -

(a) The application of appropriate and modern technology in WRM.
(b) Effective and efficient methods of catchment protection, pollution control, conservation and water use efficiency, particularly in agriculture.
(c) Efficient methods of disaster preparedness, intervention and recovery, and the creation of mechanisms for disbursing disaster contingency funds to the focal points.

International Waters

Tran boundary water resources issues are important since Kenya shares some surface and ground water resources with neighboring countries. The major water bodies which Kenya shares with neighboring countries are as shown in Table 1.5 below while Figure 1.7 shows the main drainage basins in the country.

Table 1.5: Major Water Bodies Shared with Neighboring Countries

Shared Water body	Countries
Lake Victoria	Uganda and Tanzania
Lake Natron	Tanzania
Lake Turkana	Ethiopia
Lake Jipe	Tanzania
Lake Chala	Tanzania
River Umba	Tanzania
River Sio	Uganda
River Konyao	Uganda
River Suam	Uganda
River Malaba	Uganda
River Alupe	Uganda
River Mara	Tanzania
River Daua	Ethiopia, Somalia
River Omo	Ethiopia
Various Seasonal rivers	Neighboring Countries including Somalia

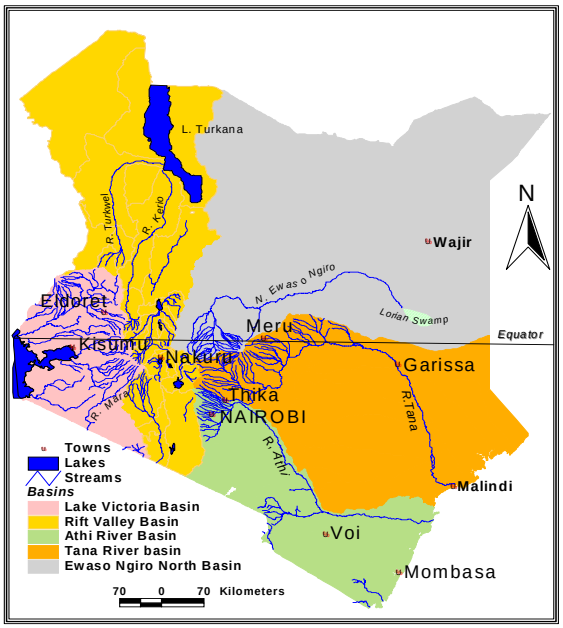


Figure 1.7: The main Drainage Basins of Kenya

At the international level, the Lake Victoria Tripartite Agreement set the stage for the Lake Victoria Environmental Management Program (LVEMP) and the Nile Basin Initiative provide the basis for cooperation of all riparian countries in the development of the water resources of the Nile Basin. The emphasis is towards the need for equitable sharing of water resources and benefits that accrue from the development of the shared water resources, the sustainability of resources, the need to build trust and co-operation between riparian countries and the need for protection of resources. As a result of these initiatives, there are great opportunities to significantly improve the management of shared water resources.

It is essential for Kenya to strengthen its capacity to negotiate and manage international waters in sharing and management issues.

The Reserve Water

The reserve water is the quantity and quality of water required to satisfy basic human needs, for all people who are or may be supplied from a particular water resource, and to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the water resource. It has priority over all water uses and the requirements of the Reserve must be met before water can be allocated for other uses. For cases where water is already allocated for use, the requirement of the ecological reserve may be met progressively over time.

The groundwater reserve shall also be determined for aquifers that are connected to both surface water and those that are not connected to surface water and where people are supplied with water from groundwater. Meanwhile the methods for the determination for groundwater reserves are being developed.

Water for Domestic and Public Purposes

The water requirements for domestic purposes include provision of water for

household and sanitary purposes, watering and dipping of livestock, for public purposes to municipalities, townships, villages, communities and small industries, and for all reasonable demands for public undertakings but not involving the use of water for generation of power or major irrigation and industrial use.

The function of providing water supplies is addressed under a separate national strategy – Water Services Strategy. The concern of this strategy document is the management of resources so that water is available to meet the needs of the country's domestic and public purposes.

The 2002 level of formal supply coverage was 70% for an urban population of 7.5 million and 48% for a rural population of 23.7 million. Many urban and rural piped water distribution systems have unaccounted for losses of up to 50% of the supply and sometimes more than 50%.

The Trend of Funding in the Water Sector

Figure 1.8 below illustrates the trend of funding in the water sector.

Water for Industry

Water is vital for industrial development as it is a major input in industrial production. However, a common problem among all industries is that of effluents discharge and pollution to the water resources and the environment. Many industries perceive water as a dilution media of harmful wastes from factories and so discharge untreated effluents directly into watercourses. Effluents need therefore be pre-treated to the acceptable standards before discharging. Also effluent volumes should be kept to the minimum through observance of clean production/operation procedures. The possibility of water recycling in some industrial processes should be explored in light of water scarcity.

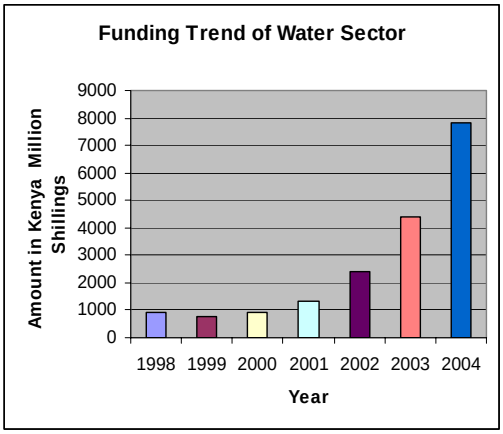


Figure 1.8: Funding Trend of Water Sector

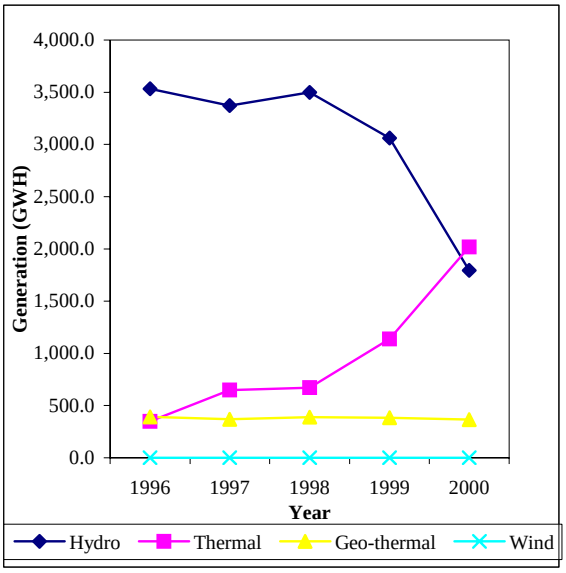
Most agro-based industries are located outside the major urban centres and near watercourses into which they often discharge their effluent directly. Such industries include coffee pulping and fermenting, sugar cane milling, sisal fibre processing, pulp and paper milling, tanneries, textile mills, canneries, vegetable oil extraction, food processing, tea processing etc. The urban-based industries which have significant reliance on water include tanneries, textile mills, breweries, creameries, paper recycling mills, chemical processing factories (paints, pharmaceuticals, plastics, soaps, detergents, glass, etc.), slaughterhouses, soft drink industries, engineering and metal fabrication, and various other small-scale industries.

Water for Agriculture

Agriculture has been the mainstay of the country's economy since independence and constitutes the source of livelihood for most Kenyans. Agriculture contributes 29% of Kenya's GDP and about 80% of Kenya's population are employed in the sector. Agriculture is predominantly rain-fed and is concentrated in the narrow middle 33% of the country, which is categorized as high to medium potential for agricultural purposes. The remaining 67% of the country, is Arid and Semi-Arid (ASAL), and is categorized as having low potential for agricultural purposes.

As of 1999 there was only 1.5 % of the cultivated area (or about 82,000 ha) under irrigation, which is about 14 % of the potentially irrigable area (540,000 ha). Private farmers cultivate 40 % of irrigated land for horticulture and export crops, and small-scale farmers along with government-managed schemes cultivate 42 % and 18 % of the irrigated land respectively, for food crops and vegetables.

Figure 1.9: Growth in various forms of power generation.



Water for Energy

Hydropower plays a dorminant role in the supply of electricity and contributes to over 70 % of the average consumption of 127 KWH per capita. Kenya imports about 18 % of its electrical energy from Uganda. Much of the local hydropower is generated from the Tana River and the Turkwell Dam hydropower schemes. Figure 1.9 below shows the growth trend in various forms of power generation while Figure 1.10 shows sources of electric power generated in Kenya. Electrification reaches only 7-9 % of the population. Demand for power is increasing at the rate of 6 % per year, while development of supply lags behind, impacting negatively on urban and industrial development. Demand is likely to remain high due to the unavailability of hydrocarbon energy resources and under utilization of the geothermal, solar and wind energy sources.

Heavy dependence on hydropower increases vulnerability due to climate variability.

In Kenya, water projects in general and hydropower projects in particular; have been adversely affected by poor resources management. Catchment degradation has adversely affected energy generation. The drought and consequent water and power shortages that occurred in year 2000 served to underscore the extent of the crisis in this sector.

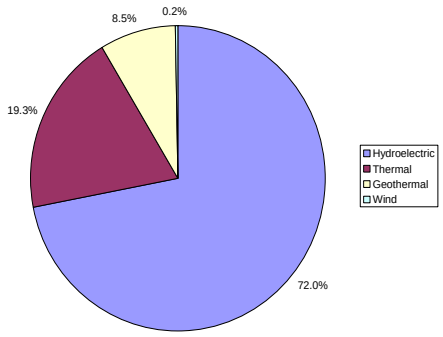


Figure 1.10: Source of electric power generated in Kenya.

Institutional Framework

There are many organizations involved in water resource management in the country. These organizations include the Ministry of Water and Irrigation, other Government Ministries, State Corporations, Local Authorities etc. These organizations have not been very successful in the management of water resources due to institutional weaknesses such as poor organizational structure, conflicting, missing or overlapping functions and responsibilities, bureaucracy, inadequate funds, lack of skilled personnel and shortage of essential facilities. The

Water Act 2002 has addressed some of these conflicts.

The institutional reforms triggered by the enactment of the Water Act 2002 have been guided by the following principles:

1. Decentralization- the decision making and operations have been decentralized from the national level to the catchment level to increase efficiency and effectiveness .
2. Devolution of responsibilities for water resources management to the Water Resources Management Authority, Catchment Boards, communities and other actors.
3. The inclusion of stakeholders and users in advisory and decision-making capacities wherever possible
4. "No responsibility without authority"- all actors now have clearly defined roles and will have delegated authority when performing their defined roles.
5. Avoiding conflict of interest - institutions and authorities should not at the same time be both "referee and player" - Separation of policy from implementation functions within the water resources management sector.
6. Clarity of mandate - Avoiding duplication of functions and confusion of competencies.
7. Human resource redeployment and development leading to more effective institutions. Redeployment of existing staff to the proposed institutions will be supported by performance based incentive schemes, promotional policies and competitive salaries and benefits. This is aimed at ensuring the availability of sufficient numbers of qualified staff of all disciplines required by the sector.

Capacity Building

Water resources management functions have not been undertaken within the Ministry of Water and Irrigation in the past to the extent required by the new national strategy. Previously, most of the functions of the MWRM&D were geared towards the provision of water supply.

There are a large number of issues to be addressed within the full scope of integrated water resources management and it is necessary to establish the required functions and then review existing skills and experiences to perform the required functions. After undertaking such an analysis, it will be possible to determine the gaps, which exist, and to design a capacity building programme to "fill the gaps". In addition to filling the gaps, a long-term programme of upgrading and developing skills and experience of all levels of personnel within the Department and the Authority will need to be developed and implemented. The human resources development programme will encompass the broad process of review and support of career development in order to meet the requirements of professionals, technicians and all staff so that it can attract and keep top staff in the service of the country.

As women play an important role in provision, management and safeguarding of water, particular attention is paid to adequately incorporating and representing gender considerations in water resource management. The issue will be addressed from two perspectives; facilitating the participation and involvement of both sexes in water resource management; and the access to water.

Private Sector Participation

In the past, water resources management has been dominated by the public sector. To date, formal involvement of the private sector has been essentially limited to consultants and contractors. The inability of the public sector to provide funding for effective management of the resources calls for providing incentives for PSP in the sector.

PSP has the potential to contribute skills and expertise, suppliers and contractors and providing private sector finances and investment in the water resources management.

There is a need to create the institutional, policy and legislative space and enabling environment to encourage the participation of the private sector.

Communication and Implementation

Communication is a two-way process requiring both the publication and dissemination of information related to water resources management. This informs the public of the activities of the water resources management institutions, and provides a channel for the stakeholder input into these institutions. Communication should transparently promote access to information so as to produce an informed and motivated public, which can participate and contribute in government programmes.

Communication is central to the ongoing functioning of the water resources management sector. There should be constant communication within the Ministry, between the Ministry and the created Authority, between both the Ministry and the Authority and other government institutions and between the water resources management institutions and the public.

Information on activities within the sector needs to be disseminated to the public and other stakeholders. Some of the recent documents on water resources and management issues which need to be published and information disseminated to the public include: -

(1) The 2003 National Strategy on Water Resources Management, which has been prepared by the Ministry of Water and Irrigation.
(2) The Water Act 2002.
(3) A number of missions and study reports which have been undertaken by the World Bank to analyze the current crisis and to identify strategies to reverse the present trends.

In the past, Radio and Television programmes have covered the World Water Day events just as a news item but the actual message and information have not come out clearly and effectively so far. The issues regarding water resources management have therefore taken a low profile in national rating. There is a need to lift this profile to get some attention. This can be done through a tool of communication, the proposed National Water Campaign.

ASAL areas

Drought is a recurrent phenomenon that affects large areas and numbers of people in the country. The cumulative effects of these droughts include the erosion of assets, decreasing ability to cope with future droughts, impoverishment of rural communities and depletion of the Government resources. It is therefore a priority of the Government to strengthen suitable drought preparedness, mitigation, response structures and activities. The effects of drought have become more pronounced in recent decades: in the 1990s there were three major droughts. The effect of the 1991/92 drought in the arid districts led to livestock losses of up to 70% of herds, and unprecedented high rates of child malnutrition of up to 50%. During this drought 1.5 million people in seventeen arid and semi-arid districts of four provinces received relief food assistance. Rains failed again at the end of 1995 up to 1996, leading to another drought situation, which affected an estimated 1.41 million people. The worst drought emergency in recent years affected Central, Eastern, Rift Valley, Coast and North Eastern Provinces, with 4.4 million people requiring food assistance in the year 2000. One cause of drought and desertification is

deforestation, which threatens the environment and people's livelihoods. The government is addressing this problem through an appropriate afforestation programme and specific legislation for forest and environmental protection.

Drought, being a recurring phenomenon in the country, has impacts on all sectors of the economy ranging from agriculture, energy, health, water, trade and industry. It is therefore necessary to involve a wide range of players in all areas of prevention, mitigation, preparedness, response and recovery by putting in place national drought mechanisms, which should include setting up of interdepartmental committees.

Drought causes food insecurity both in the country and also in the region. Mechanisms for regional coordination, for example in East Africa are essential to mitigate the effects of drought in the region. Existing structures and approaches need to be adequately coordinated.

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1

Part I: Setting the Scene

Methodology

The mandate and scope of the World Water Assessment Programme-Kenya Chapter is to formulate a reporting framework on the water sector and compile a report on the water sector as at 2003.

This is set out in the contract agreement between the Government of Kenya on the one hand and UNESCO on the other signed on 28th July 2003.

A ministerial core team was appointed on those terms comprising the Director of Water and three other officers.

Several meetings were held between the committee and the UNESCO WWAP Coordinator to set guidelines and way-forward in the programme.

The core team identified the national stakeholders in the water sector both within the government, private sector, non-governmental organizations and compiled a list of the same.

A presentation was made by the WWAP Coordinator to the stakeholders on 15th May 2003.

With the assistance of the WWAP Consultant the core team came up with the Project Concept Paper and the Project Work Plan.
The WWAP Consultant held a debriefing session with heads of branches, divisions and sections in the ministry.

The first workshop was held on 19th November 2003 that was meant to bring together and sensitize key player and stakeholders and solicit their commitment to provide data and information necessary for the project according to existing political, legal, administrative and functional requirements. The Ministry of Water and Irrigation took the lead role as the sector leader. The workshop also identified project requirements, challenge areas, key performance indicators, strategies, goals and objectives and harmonization of standards.

A launching meeting was held on 19th February 2004 for the task force members at which tasks were allocated and the way forward charted.

A second workshop was held from 8th to 9th March 2004 to identify the challenge areas and key indicators. Working groups were formed.

The Director of Water and the WWAP Coordinator - Kenya chapter attended the World Water Development Report II workshop at UNESCO, Paris from 31st March to 2nd April 2004 at which the Director presented the status on the progress of the Kenya chapter.

A status review workshop was held from 17th to 18th May 2004 on preparation of the national report chapters and development of sector indicators.

A writers' workshop was held from 28th June to 1st July 2004 that came up with the zero draft of World Water Assessment Report II - Kenya chapter.

A retreat comprising of ten officers from the ministry of Water and Irrigation was held from 18th to 22nd April 2005 to identify residual gaps in the draft report and address the same.

A consultant was identified through the government procurement procedure of competitive bidding and hired on 28th April 2005 to edit the report.

The edited report was circulated on 30th May 2005 to heads of departments and later discussed at a final workshop on 9th June 2005, for adopting and commissioning the report.

The report was sent to Paris on 31st May 2005.

Part 1: Setting the Scene

National Political & Legislative Framework

Introduction

Most of the African countries go down in history as countries where historical events exercised the greatest influence on geography. Kenya is such a case. The logical geographical rationale to Kenya can be gained when one takes a look into the historical events, which culminated in the creation of the country.

The making of the country Kenya started with the East African coast which, from the evidence available, has been in contact with Europe, North Africa, Arabia and Asia for nearly two thousand years (Berg 1968; Chittick 1968).

To the Greek and the Roman World, this East African coast was known as *Azania* while to the Arabs, the East African coast was known as 'The *Land of Zenj'* which meant the land of black people.

Three crucial events had permanent consequences on Kenya's geography: -

1) The appearance of the Portuguese in the area following Vasco da Gama's call at Mombasa and Malindi in 1498.
2) The permanent organized Arab rule along the coast.
3) The scramble for Africa by the European colonizing powers. Those who came to Kenya were The British, The Germans and The Italians.

British interest in what ended up to be called Kenya began in between 1823 (Ojany *et al* 1988). British interest was pioneered by private enterprise after Captain Vidal failed to convince in persuading his home government (British) to acquire interest in the area. In 1884 Sir William Mackinnon acquired a trading concession from Sultan Bargash of Zanzibar and then founded the British East African Company to trade with the inner parts of East Africa, especially with Uganda, since an established system of African government was already in place. Pioneer missionaries included Rebman, Krapf and Hannington, who helped in eradicating slave trade.

East African Protectorate

The formation of the British East African Company, gave rise to the need of providing for a safe corridor for its caravans to Uganda. This led to a pressure for the British government to take over this intermediate territory. The British Government took the territory on 1st July 1895. The British declared the land between Mombasa and the Great Rift Valley as a protectorate. This protectorate was known as The *East African Protectorate* as seen in Figure 1.1 below. By then, the transport system to Uganda was not very satisfactory; hence the decision to build a railway line from Mombasa to Kisumu was conceived and in 1901, the construction of the railway line reached Kisumu.

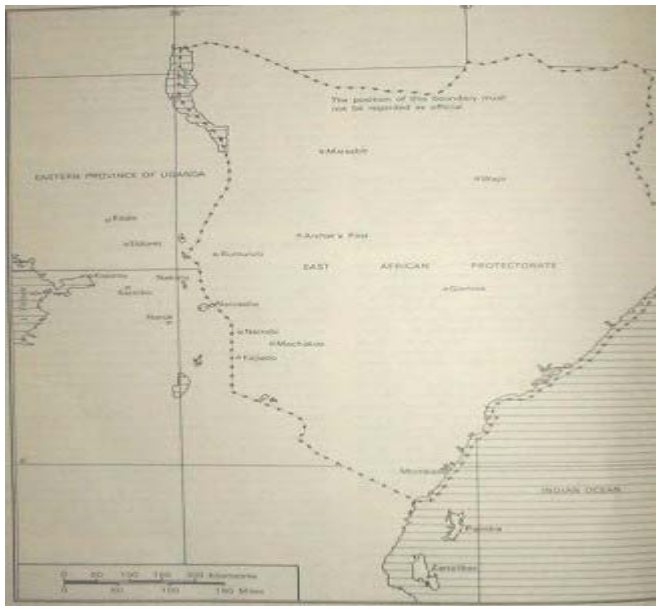

Figure 1.11: The East African Protectorate

Formation of Boundaries

The extent of the *East African Protectorate* was very vague especially from the south and north

(Ojany *et al* 1988). When more land was given to the protectorate, the land was divided into three provinces for purposes of administration *viz*: Seyidie, Tanaland and Ukambani. Each of these was divided further into a number of districts, which were named each after its main settlement. No effort was made to make the boundaries of these districts to conform in any way to the ethnic composition of the indigenous population.

In 1907 the headquarters of the protectorate were moved from Mombasa to Nairobi, which had become the headquarters of the Uganda Railway in July 1889. On the 5th March 1902, the British foreign office transferred the Eastern Province of Uganda to the East African Protectorate (Ojany *et al* 1988).

Following the gaining of independence in 1963, Kenya has since emerged as one of the most peaceful states. The country is endowed with many natural resources, beautiful sceneries and is a tourist destination.

Socio-Political Change in Kenya

Box 1.2

The evolution of Kenya as a nation

Kenya's name was coined in 1920. Kenya is among the countries that came into being as a nation after colonization by the British at the turn of the 20th Century making it part of the British Empire. Before the advent of Europeans, various tribes tended to migrate and their area of occupation remained indefinite. The first attempt of determining Kenya's boundaries begun with Anglo-German agreements of 1886 and 1890 and the final one was in July 1990 when Kenya resumed the administration of the Karapokot area.

Source: National Atlas of Kenya. By Survey of Kenya

Kenya became independent in 1963, and one year later, it become a Republic and joined the United Nations. However due to its close links with the British Government it is a member of the commonwealth countries.

Political History that led to displacement of people from the highlands and the savannahs suitable for crop production and ranching respectively

From a historical perspective, Kenya's Central Highlands were originally inhabited mainly by the Maasai and the Bantu tribes. The indigenous people were first exposed to the Europeans when explorers arrived followed closely by the Christian missionaries. Later on, the explorers determined that the highlands were suitable for their settlement and christened them the "white highlands". The British colony was declared in 1920.

Legislative History that tied water to land

A water ordinance was passed by the colonial parliament to streamline the water allocation practices. In 1952 the Water Act cap 372 was passed.

New Constitution & key Legislative Changes

Despite the fact that the new constitution is still under development, a major achievement in the sector legislative framework occurred with the enactment of the Water Act 2002. This act provides for the management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water, to provide for the regulation and management of water supply and sewerage services; to repeal the Water Act (Cap. 372) and certain provisions of the Local Government Act; and for related purposes.

Republic of Kenya's Commitment to WWAP

One of the keys to successful Integrated Water Resources Management (IWRM) is the availability of good quality information. This is recognized in the Water Act, 2002: -

i. Section 8 (1) (h),
ii. Section 18 and

iii. Section 50.

As the custodian of Water Resources in Kenya, the Ministry of Water and Irrigation (MW&I), seeks to ensure and enable sound, sustainable and effective water management for the country. This would require the establishment of a national monitoring and information system for the water sector as soon as possible. The monitoring and information system should provide for the collection of appropriate data to assess progress against set targets.

One method of fulfilling some of these requirements is through the development and use of suitable indicators that provide a means of communicating information about progress towards a goal (such as Millennium Development Goals) in a significant but simplified manner.

To enable the country to participate effectively in the global-level reporting, MW&I has obtained the support of the WWAP through an appropriately structured project.

Policy and Legislation

The government in the past has formulated a series of policies, which have impacted on the water sector both positively and negatively. The first positive step was a water supply driven interventions policy to redress colonial era misallocation of resources. This was followed by a policy that saw numerous schemes put in place by the government and self-help groups. This policy was however not sustainable as it put too much strain on the government budget and as a result has left many utilities performing below expectation.

The definitive policy for the sector was promulgated in April 1999 *as Sessional Paper No. 1 of 1999*. This is the National Policy on Water Resources Management and Development which calls for de-centralization of operational activities from the central government to other actors, including local authorities, the private sector and increased involvement of communities in order to improve efficiency in service delivery. *Sessional Paper No. 1 of 1999* also tackled issues pertaining to water supply and sanitation facilities development, institutional framework and financing of the sector. To enable sustainable water supply and sanitation services, there is need to apply alternative management options that are participatory through enhanced involvement of others in the provision of these services but particularly the private sector. The government would ensure an enabling environment through appropriate policies and regulation.

In line with the above principles of the water policy, the Water Act 2002 section 46 establishes a board to be known as Water Service Regulatory Board to oversee the provision of water services. While, section 51 requires the establishment of Water Services Boards, which in effect decentralizes water services management in the country. Section 55 requires the WSBs to arrange for the exercise and performance of all or any of their powers and functions under license by one or more agents, the Water Service Providers.

The overall policy objective is to lay the foundation for a rational and efficient framework for meeting the water needs for national economic development, poverty alleviation, environmental protection and social well being of the people through sustainable water resource management.

Development goals

The National Rainbow Coalition (NARC) government elected in December 2002 set out a blueprint for economic reconstruction and growth in the comprehensive Economic Recovery Strategy for Wealth and Employment Creation (ERS) in June 2003. This strategy is to chart the country's economic course from 2003 to 2007. The ERS also addresses poverty reduction by building on the Poverty Reduction Strategy Paper (PRSP).

The Economic Recovery for Wealth and Employment Creation (2003-2007) recognizes that the current institutional arrangements are inappropriate and form a bottleneck to achieving the set poverty reduction objectives. It proposes adopting a programmed approach to the water

sector putting a strong emphasis on providing services to the poor while ensuring adequate water for the various competing demands. It therefore, proposes to undertake comprehensive institutional reform to facilitate "pro-poverty water and sanitation programmes".

The PRSP recognizes that water is a basic need and an important catalyst for both economic and social development of the country. It states that "*access to water for human consumption, agriculture, and livestock use is a major problem in rural areas. The water supply situation in rural areas has deteriorated over the years to a point where demand cannot be sustained with current systems. Access to piped water has not increased since 1989 and those accessing other water sources have increased from 14 to 29 percent during the same period*". The PRSP commits providing water and sanitation to majority of the poor at reasonable distance defined to be 2 Km. The proposed strategy is to involve communities and local authorities more actively in the management of water and sewerage services.

Kenya is a signatory to the Millennium Declaration and The Millennium Development Goals (MDGs). There are eight (8) MDGs related to halving poverty, reducing hunger, achieving universal primary education, promoting gender equity, reducing child mortality, improving maternal health, combating the HIV/AIDS pandemic, ensuring environmental sustainability and developing a global partnership for development. The MDGs are expected to be central to development planning and resources allocation and will thus be fully incorporated into the MTEF budget process. For this reason, the Economic Recovery Strategy (ERS) was structured to implement initiatives that would facilitate the achievement of the MDGs

The MDGs and the outcomes of the WSSD underlined that the global water crisis is a threat to economic development, poverty reduction and the environment and, hence, to peace. The UN Millennium Declaration and the preparatory process for WSSD further affirmed the role of water as a key to sustainable development, and the urgency of immediate action. Of necessity to the sector under review is Goal 7 Target 10 whose aim is: "*To halve by 2015 the proportion of people without sustainable access to safe drinking water and sanitation services"*.

To achieve the MDGs by 2015 in the Water and Sanitation sector, the people without access to safe water and improved sanitation need to be halved. It is envisaged that an 80% nationwide coverage of safe water supply and 96% coverage of improved sanitation by 2015 will meet the target population.

Programs and Actions

Increasing water supply to serving 84% of the urban (11 million people, 2003) and 74% of the rural population (23 million people, 2003) by 2015

Increasing the urban water supply to serving 84% of the urban and 74% of the rural population by 2015 allowing for higher levels of water consumption and meeting acceptable standards may be achieved through the following:

- Reducing unaccounted for water
- Rehabilitation of existing schemes
- Expansion of schemes to areas presently not being served
- Introducing demand management
- Construction of new water supply schemes

▪ *Reduction of unaccounted for water*

Reduction of unaccounted for water is the most cost effective way of supplanting the supply of water. The means for reduction of unaccounted for water include physical means for improving the efficiency of the water delivery systems from the water source to the households and reducing leaks through out the network; and means for reducing the technical, management and social losses. This is mainly accomplished by rehabilitation of the dilapidated systems, laying new pipes, standard fittings, detecting and fixing leaks, and installation of pressure control valves, zonal and bulk meters at key points in the system.

The most effective measure for reducing social losses is by making water affordable, available

and accessible to the poor. Effective metering (including in rural areas) of water delivered to kiosks and households will be coupled with strict enforcement of regulations to prevent damage to meters and pipelines and to enable access to the meters by meter readers.

By 2010 unaccounted for water will have been reduced from the current average of 70% to 25% and thereafter maintained at levels not exceeding 25%.

Rehabilitation and expansion of existing schemes

Most of the current operating urban schemes have long passed their economic life which increases the unaccounted for water. Furthermore, the schemes are serving more people than they were initially designed for. Emphasis is on rehabilitation and augmentation of the existing water supplies to increase water production to at least 80% of the design capacities within five years, and to reach coverage of 84% and 74% in urban and rural populations respectively by 2015.

Demand management

In the light of large water losses in the systems and water scarcity and increasing demands, managing the demand for water and increasing the efficiency of water use is of critical importance. In few cases, this needs to take a priority over building new supplies. Lack of demand management in the water schemes has contributed negatively to economic value in use of water. It has also led to investments and requests for investments that could have been or can be deferred. The need for water utilities to put demand management in practice cannot therefore be over emphasized.

Construction of new water supply schemes

New and additional water sources are required for some urban centres and rural areas, while other market towns have developed over the years in urban centres requiring urban water supply systems. By 2015 new water supply projects will have been initiated in urban centres and rural areas without water supplies and at least 50% of those projects are completed and operational providing the specified per capita water requirements to the Kenyan standard (KS) 150 of water quality.

Increasing the urban waterborne sewage collection, treatment and disposal coverage to 39% (5 million people)

Increasing the urban water borne sewage collection, treatment and disposal coverage to 5 million people in urban areas includes providing water borne sewage collection, treatment and disposal schemes for 3 million people in formal urban setting and cesspool, septic tanks and other on-site appropriate sewage systems for 2 million people in informal urban settings. This includes:

- Rehabilitation, augmentation and expansion of existing urban sewage collection, treatment and disposal systems
- Construction of new urban sewage collection, treatment and disposal systems
- Construction of appropriate on-site water borne sewage systems in informal urban areas
- Systematically increasing user connections to cover all potential areas

Increasing the water borne sewage to 8.7% of the rural population (2.6 million people)

Increasing the water borne sewage solutions to rural population with adequate water supply (house connections) will be mainly through on-site systems such as cesspits, septic tanks and other appropriate technology developed. The target will be to reach 2.6 million rural people by 2015.

In rural areas and informal urban settlements, sanitation is mainly by pit latrines. Coverage is estimated at 40 %. The construction and use of improved pit latrines shall be promoted in rural settlements that are not covered by piped water supply systems. Table 1.6 below shows indicators and progress status as at 2003.

Table 1.6: Indicators and Progress

Activities	Targets/Indicators	Progress Status - 2003
200 hydrological and water quality monitoring stations to be rehabilitated	Rehabilitation of hydrological and water quality monitoring stations	45 hydrological and water quality monitoring stations rehabilitated
1,200 water samples analyzed per year	Analyzes of water samples	6,189 water samples collected and analyzed
* Unaccounted for water and wastage reduced by 25 percent * 300 rural water supply schemes to be rehabilitated	* Rehabilitation and augmentation schemes in major urban towns * Rehabilitation of rural water supply schemes	* 35 - Urban water supply schemes rehabilitated and augmented * 83 - Rural water supply schemes rehabilitated
100 small dams and water pumps rehabilitated	Rehabilitation of small dams and water pumps	Targeted to rehabilitate 163 small dams and water pans in 44 districts in 2003.
Implementation of the enacted Water Act 2002	Operationalisation of the Act and establishment of the necessary institutions	Modalities in place to put up the institutions i.e. - Water Resources Management Authority (WRMA), the Water Services Regulatory Board (WSRB), the Water Services Trust Fund (WSTF) and Water Service Boards (WSB).
500 boreholes drilled and rehabilitated	Drilling and equipping, and rehabilitation of boreholes	39 boreholes drilled and equipped and are in the process of being handed over to ASAL communities during 2003

Box 1.3:
Close inter-linkage of water to land, health, economy and environment arising from water requirement for irrigation, power generation, industrial and public use.

The stakeholders that are associated with the water sector can be classified into the following categories:

- The general public and comprising of the entire population of the country (29 million people) as water is an every day requirement of at least 40 litres per day (see design manual for water supply in Kenya, page 27)
- Government (public) sector institutions comprising of Government ministries, state corporations, regional (basin) development authorities that have mandated roles touching on various issues in water affairs or are influenced by, any aspects of water management.
- Legislators (central and local authorities) as representatives of the people, whose role is setting policy, law, and allocation of resources for implementation of societal programmes. It is, therefore, not surprising that in addition to the Water Act, other acts including the Agricultural Act, Trust Land Act, Public Health Act, Irrigation Act, Malaria Prevention Act, amongst many others have specific provisions dealing with water affairs.
- Community based organizations that act at local levels.
- Enabling institutions that provide supporting services particularly in the form of technical support, monitoring, communication, capacity building, and technology transfer.
- International organizations involved in both political and technical decision-making;
- Water management institutions responsible for the management and delivery of water services;
- Investment agencies that provide financial support for the implementation of water development projects;
- Industry/User sectors that make use of water and impact on the resource and the environment; and
- Neighbouring countries that share boundaries or watercourses with Kenya.

Source: Water Sector Actors Survey 1998. By MWRM&D consultancy services tender No. WSAS 1/96-9 .(Seureca Ingenieur Conseil – Paris France.

Location, Size and Topography of Kenya

Geographical location

The republic of Kenya is located within the eastern side of the vast continent of Africa, where if forms an important part of East Africa. It shares boundaries with Republic of Uganda to the west, and The United Republic of Tanzania to the south, and is also bordering the following countries: Ethiopia in the north, the Republic of Sudan in the north - west and the Republic of Somalia in the east. Kenya is bordered in the southeast by the Indian Ocean, which serves the Republic as an important outlet and means of international maritime contact, Figure 1.11 below.

The republic of Kenya lies approximately between Latitudes 5° 0' N and 4° 40' S and between Longitudes 33° 83' E and 41° 75.5' E it is almost dissected by both the equator and by Longitude 38° 0' E. Kenya has a single time zone which is GMT +3.

Size

Kenya has an area of about 582 646 km^2. Water occupies about 1.9 % or 11,230 km^2 leaving 571,416 km^2 of the dry land of which more than two-thirds is either semi desert or desert. This then means only between 142,314 and 189,562 km^2 of the land can be used profitably by the country's estimated 33 million (2004) inhabitants.

The greater part of the more habitable area of the republic is situated in the wetter south - western area, although there is a narrow strip of the land along the Indian Ocean coast, which is also habitable.

Figure 1.12: Kenya Map and surrounding neighbours

Country of tremendous topographical diversity

The equator bisects the country into almost two equal parts. Practically every landform type ranging from glaciated and permanent snow above 4 600 metres altitude to a true desert landscape is present. Similarly, all stages of landscape evolution from Cambrian planation surfaces; to extremely recent volcanic and tectonic are all well represented. The entire landscape while possessing great amplitude or relief from sea level to 5 900 metres is dominated by a flight of plateaux which somewhat convey the impression of extensive upland plains rather than mountainous environments.

Socio-Economic Character of Kenya

By 2003, poverty levels were on the increase all over the country and estimates put those living below poverty line as 64%.. As of 2005, the fraction had rolled back to 58%.
The population of Kenya in 1999 was 29 Million *(Central Bureau of Statistics)*. According to the same report Kenya's social indicators of development either had not improved or had declined. There is still a wide income disparity with the poorest 20% of the rural population receiving only 3.5% of rural income in 1994. Life expectancy at birth has decreased from 59.5 years in 1989 to 52 years in 1999 and 50 years in 2004, this has been partly attributed to HIV/AIDS; the major cause of death among the youth and middle aged in Kenya. The enrolment rate in primary schools had declined from 95% in 1989 to 77% in 1997, while transition rates between primary and secondary schools in 2003 stood at less than 45%. Infant mortality had doubled between 1992 and 1998, while maternal mortality rate in 2003 stood at 400 per 100,000 births up from 150-300 in 1992. Poor working conditions, including inadequate or obsolete equipment, inadequate drugs and low salaries have been the cause for increasing exodus of skilled staff to the private sector and even out of the country.

Education

The Government continued to increase resources allocated education in an effort to provide basic and higher education in 2004 gross expenditure on Education was Kshs86,123.14 million, representing an increase of 12.2 per cent from KSh.76,724.78 million in 2003. The highest expenditure was in general administration and planning (73.7 per cent) while Primary and Higher education accounted for 11.3 and 12.0 per cent of the total expenditure respectively. Recurrent expenditures on Technical Education increased by 32.0 per cent while that to Polytechnic Education in 2004. Similarly, there was an increase in recurrent expenditure for Primary and Higher education by 10.3 and 30.3 per cent respectively.

Enrolment in primary schools by standard and gender saw about t 267,000 more children enrolled in primary schools in 2004 compared to the enrollment in 2003. Total enrolment in primary schools was 7.4 million in 2004, up from 7.1 million in 2003. This represents a Gross enrolment Ratio (GER) of 104.5 per cent of the school going age population in 2004. The Current Net Enrolment ration (NER) is 84.5 per cent of the school going age population, indicating that there are still children between 6 and 13 years who are yet to access free primary education. To enhance access to free primary education, the Government supported Non-Formal Education Schools (NFS) especially those that cater for children in urban slums. The introduction of Free Primary Education in 2003 contributed to the rise in primary school enrollment. The completion rate also improved from 52.0 per cent in 2003 to 56.0 percent in 2004. Cases of class repetition still exist with about 9.0 per cent of the pupils repeating a class in 2004. The annual school dropout rate improved from 5.0 per cent in 1999 down to 2.0 per cent in 2004. The number of registered KCPE candidates increased by 13.1 per cent from 570,047 in 2003 to 644,810 in 2004.

Demography and Migration

Key demographic variables indicate that the quality of life of the population has been on the decline despite the gains made in the demographic transition. Kenya with a population of 33 million (2004 estimate) faces enormous challenge of providing water and sewerage services to the increasing population. In the 2004 population estimate, most of the population live in rural areas (24 million), while 9 million live in urban areas out of which more than halve live in informal settlements. Access to safe water is estimated at 89% in urban areas and only 49% in rural areas.

The distribution of the population by five-year age groups, according to sex and urban–rural residence, reveal that the sample constitutes 49 per cent males and 51 per cent females. There are more persons in the younger age groups than in the older groups for both sexes.

The population age-sex structure is wide-based despite evidence that the percentage share of the younger population has been falling, while those aged 15-64 has been increasing.

The share of the population under 15 years of age accounts for 45 per cent while those aged 15-64 constitutes 52 per cent. The remaining 3 per cent are those aged 65 years and above. This means that the dependency ratio in Kenya currently stands at 92 per every 100 economically active persons, down from 127 in 1999.

The morbidity disease pattern for Kenya indicates that over 60% of the diseases are waterborne, water related or sanitation related. Malaria is leading with 32.6% followed by the respiratory system 24.6%, skin diseases, diarrhea and intestinal worms which are more prominent as far as water and sanitation are concerned can be classified as number three with a morbidity of 17%. Improving hygiene, water supply and sanitation readily controls diarrhea; the simple act of washing hands with soap and water can reduce sanitation related deaths by up to 35%.

Living Standards and Poverty levels

Poverty remains a pervasive national problem presenting formidable challenges, which call for urgent action. A credible measure of poverty can be a powerful instrument for focusing the attention of policy makers on the living conditions of the poor, and inform the design of policies intended to reduce poverty. For policy purposes, comparative analysis of the incidence of poverty is especially important in order to develop anti-poverty programmes and monitor development progress and growth strategies. Poverty measurement and diagnostics therefore, help examine the levels and patterns of poverty, and shows how these vary geographically and, are therefore fundamental to influencing the implementation of poverty reducing policies and programmes.

The poor constitute more than half of the population of Kenya (at least one in every two Kenyans is poor). Poverty is multidimensional. It includes inadequacy of income and deprivation of basic needs and rights, and lack of access to productive assets as well as to social infrastructure and markets. Poverty adversely effects participation in social and political processes and denies life choices while the poor are particularly vulnerable to natural disasters. Inequitable access to the measures of the means of production (land and capital), the distribution of wealth reduced access to economic goods and services and remunerative employment are all caused of poverty.

It is estimated that 58% of the Kenyan population live below the poverty line. Poverty line is conceptualized as a minimum standard required by an individual to fulfill his or her basic food and non-food needs. The absolute poverty line has been set at K.Shs 2, 648 per adult equivalent per month in urban areas and at K.Shs 1,238 per adult equivalent per month in rural areas.

Poverty headcount index among the country's constituencies ranges from 16.9 percent for the least poor to 81.8 per cent for the most poor. Kabete in Central province turns out to be the least poor constituency in Kenya, while Ganze, in Kilifi district, Coast province, is the poorest.

At province level the poverty headcount indices stand are as shown Box 1.4 below.

Box 1.4: Poverty Headcount Indices per Province

Coast Province –poverty headcount index ranges from 31.2 per cent for Bura in Tana River District to 81.8 per cent for Ganze in Kilifi District

Eastern Province – poverty headcount index ranges from 36.0 per cent for Ntonyiri in Meru North District to 74.4 per cent for Kitui South in Kitui District

Central Province – poverty headcount index ranges from 16.9 per cent for Kabete in Kiambu to 44.2 per cent for Mwea in Kirinyaga District

Rift Valley Province – poverty headcount index ranges from 34.1 per cent for subukia in Nakuru District to 65.8 per cent for Turkana Central in Turkana District

Western Province – poverty headcount index ranges from 49.8 per cent for Amagoro in Teso District to 69.6 per cent for Ikolomani in Kakamega District

Nyanza Province – poverty headcount index ranges from 46.8 per cent for Uriri in Migori District to 79.5 per cent for Kuria in Kuria District

In the recent past, conditions for the poor have worsened in many places especially in Arid and Semi Arid areas. Structural adjustment, deregulation and commercialization, and increased reliance on the private sector have reduced the scope or changed the nature of government interventions on behalf of the poor. This has given rise to a myriad of other conditions and does not augur well for growth and poverty reduction.

The low per capita spending on health and the resultant poor access to quality health services resulted in the resurgence of certain diseases that had been formerly controlled (STIs, TB, Typhoid, Malaria etc), and this has further been worsened by the HIV/AIDS menace. The effect of this heavy diseases burden has been the diversion of more resources from directly productive sectors to unproductive sectors.

The Government of Kenya subscribed to the Poverty Reduction and Growth Facility (PRGF) in 2000 and embarked on the preparation of the Poverty Reduction Strategy Paper (PRSP) at the same time. This preparation was undertaken through wide-ranging consultations and dialogue in order to build consensus on priority actions and activities necessary for economic growth and poverty reduction. In December 2002, the government embarked on the process of preparing an Economic Recovery Strategy for Wealth and Employment Creation (ERS). The ERS presents a road map for economic recovery during the next five years(2000-2007) and takes into account existing government policy documents, particularly the PRSP, the National Development Plans to provide strategic directions for economic recovery and wealth creation.

The Government through the Economic Recovery Strategy for Wealth and Employment Creation and the Poverty Reduction Strategy Paper has acknowledged that Kenya's economic performance has been declining during the last two decades plunging 58% of the population below the poverty line. The implementation of the ERS is integrated with the MTEF budgeting process to improve and link planning and resource allocation towards implementation of policy priorities addressing economic growth and poverty reduction.

Employment Status

Employment opportunities in the water sector are lower for women than men in both rural and urban areas. Major factors that have contributed to this phenomenon include imbalances in training and access. Retrogressive cultural practices bar women from taking up positions in certain spheres of employment as well as lack of a supportive legal framework. The government has made attempts to raise the level of quality participation of women and youth in the water sector through the community water based organizations and water resources user associations.

Fetching water for domestic use in Kenya is mainly the responsibility of women. In performing this task, they receive assistance from children (in particular girls). Sometimes men will take the livestock to the water source, men will also collect water if it is for sale (particularly young men in urban areas) or if they are employed to do so. In times of extreme hardship the men may assist in the collection of water for domestic use, but they will bring it back using a donkey or bicycle.

Education and Skills Base

Education is a fundamental strategy for human resources development. The Government and other stakeholders have invested significant resources over the years to expand and improve education at all levels. The Ministry of Water and Irrigation has been very proactive in water sector reforms, guided by the Water Act 2002. Among the strengths the Ministry has is a highly skilled technical cadre of staff with the capacity to spearhead the reforms in the water sector and continued development of the sector, and the support of the multilateral and bilateral donors in providing both financial and technical assistance

Education under the water sector reforms focuses on:

- Popularization of Water Act 2002. The National Water Policy and the Integrated Water Resources Management Strategy is necessary for stakeholder support.
- Understanding the diverse and multiple views. This is essential for addressing the

needs for joint management of a limited resource.
- Awareness creation. This is a necessary ingredient for utilizing and managing scarce resources in a sustainable manner.
- Need for stakeholder consultation and participation in water resources management. This is essential for ownership of the process.

In assessing the water needs of this nation, the situation cries for knowledge on efficient water use, hygiene, wealth creation, environmental integrity, to name a few. Sometimes the sheer irony of want amidst plenty is so obvious for comfort. When rains come, floods run rampage sweeping off everything including people leaving in its wake devastation, and after the floods have done their part, drought sets in.

Communications is a two-way activity requiring both the publication and dissemination of information related to water resources management, which informs the public of the activities of the water resources management institutions, and provides a channel for the stakeholder input into these institutions. Communications should transparently promote access to information to produce an informed and motivated public, which will participate in government programmes and contribute in meeting the demands, which face the country in relation to water resources management.

Communications is central to the ongoing functioning of the water resources management sector and there should be constant communications within the Ministry, between the Ministry and the proposed Authority, between both the Ministry, the Authority and other government institutions and between the water resources management institutions and the public.

Information on activities within the sector needs to be disseminated to the public and other stakeholders. Some of the recent documents on water resources and management issues will be published and information disseminated to the public. These will include:

- Country Strategy on Integrated Water Resources Management
- The Water Bill.
- Water Sector Reform Communication Strategy

Historically Radio and TV programmes have covered the World Water Day events just as news items but the actual message and information has not come out clearly and effectively. The issues of water resources management have therefore taken a very low profile in national issues. There is a need to lift this profile to get some attention. This can be done through a tool of communication, the proposed National Water Campaign.

The development of human capital, which involves equipping people with the right skills and providing adequate incentives to perform, is key to sustainable development and achieving the government's policy objectives in water resources management. It is therefore necessary to develop a comprehensive training and career development programme for personnel working in the sector.

The NWW strategy recognizes the people and water users as the custodians of Kenya's Water. It places emphasis on the active role and participation of water users in the planning and management decision-making. It promotes the involvement of the private sector, NGOs, other stakeholders and river users associations in the management of water resources by direct involvement in decision making or by engaging in forum for dispute resolution.

The water campaign will spread the message and get everybody involved and initiate the efforts to meet the central challenge to ensure that the strategy and the new legislation are implemented without which all the work that has been done will be to no effect. It will not be possible for the government to implement the strategy on its own and it will be necessary that every person who uses water, every industry, every farmer, or public official needs to play their part. The campaign will be the mechanism, which will provide a 'Window of Opportunity' to get things done, and it is therefore very necessary to highlight the issue and create political and institutional commitment, and to generate public awareness.

Climatic Variation and Long-term Climatic Change

Kenya's climate and rainfall patterns are influenced by the movement of the Inter-Tropical Convergence Zone (ITCZ) as modified by topographic features. Annual average rainfall in the country is approximately 630mm, ranging from less than 200mm in the northern ASAL areas to 1,800mm in the western region. Air temperature varies from 40^{o} in the low altitude arid areas to below freezing point on Mt. Kenya. The topographic features are mainly Mt. Kenya, the Aberdare ranges, the Rift Valley, the Mau Complex and Mt. Elgon. These mountain ranges form the water towers and together with the Rift Valley influence the drainage patterns in the country. In this respect therefore, Kenya has five drainage basins viz. Lake Victoria Basin, the Rift Valley, Tana River, the Athi and the Ewaso Ng'iro Basins.

The average annual available water is estimated at 20.2 Billion Cubic Meters (BCM) distributed within the five drainage areas. This available water if divided equally to an estimated population of 33 million people in 2004, the endowment of water is 612 cubic meters per person per year. By global categorization Kenya is therefore classified as a water scarce country. Arising from the uneven distribution of water resources in space and time and with the increase in the frequency of extreme weather events, Kenya suffers water scarcity and will certainly need to invest more on water resources management and conservation.

Kenya is chronically water scarce with a limited natural endowment of fresh water. From Table 1.7 and Figure 1.13 the per capita availability is projected to fall to 359 cubic meters by 2020 as the population is increasing and could be even less if the resource continues to be depleted.

Water is becoming scarce simply because of the limited natural endowment, the growing needs of an increasing population as well as serious water resources degradation. In addition to the scarcity, Kenya is highly vulnerable to rainfall variability; droughts are now endemic and floods occur quite frequently. Demand is high and growing rapidly in many sectors of the economy.

The growing population increases the demand for water for domestic use, food security and hydropower to the point where the needs are outstripping supply. This makes orderly economic and social development, which depends on reliable water resources more difficult to achieve.

Table 1.7: Water availability per capita

Year	Population	Per capita water availability M^3/yr
1969	*10,942,705	1853
1979	*15,327,061	1320
1989	*21,448,774	942
1999	*28,686,607	704
2010	**40,311,794	503
2020	**56,481,427	359

*Sources: - * GOK Census; **1992 Master plan* Projections

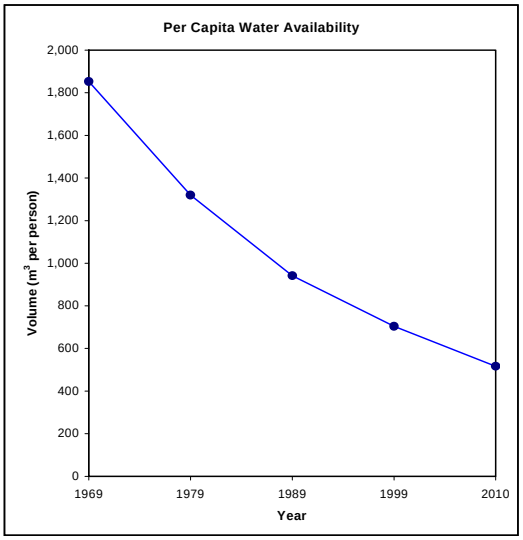

Figure 1.13: Availability of Water Per Capita

Kenya water resources are not only scarce but this resource base is vulnerable to depletion while the country's socio-economic development is highly dependent on water. Water is Life.

- Besides having limited water resources, Kenya is highly vulnerable to rainfall variability; droughts are now endemic and floods occur quite frequently.

- Kenya's socio-economic development goals are highly dependent on availability of good quality and quantity water. It is important for

food production, hydropower generation (65-70% of electricity), manufacturing, fisheries and livestock, tourism as well as basic human health and well being. Sustainable utilization, development and management of water resources therefore fundamentally underpin the achievement of long-term socio and economic goals.

- The Water Master Plan indicates that water demand for important uses (domestic, industrial, irrigation, livestock, wildlife and hydropower) would increase from 2073 m^3/year in 1990 to 5817 m^3 /year by 2010. Current demand stands at 3,900 million cubic meters per annum.

- Only about 13% of run-off in rivers can be obtained without regulation works such as dams and reservoirs. It is estimated that water resources storage would need to be increased 30-fold of current levels to meet demand. The present level of safe water coverage is estimated at 89% for the urban population of 7.5 million but 50% of the water supplied is not accounted for. Less than 50% of the 23.7 million people live in the rural areas. Although irrigation is not yet practiced extensively, water demand for irrigation accounts for over 75% of total water demand in the country. In light of large water losses in water supply systems and rising demand, managing the demand for water and increasing efficiency of water use is of critical importance.

- 12% can be used for rain-fed agricultural production.

- Informal or low-income households account for 30 – 70% of the urban population, depending upon the city or town and comprise the fastest growing segment of the urban population. Between 1993 and 2000 the percentage of the total urban population below the absolute poverty line rose from 27% to 49%.

Water Sector Reforms

Kenya has a population of 33 million (2004 projections). It faces an enormous challenge of providing water and sewerage services to the increasing population. Access to safe water is estimated at 89% in urban areas and only 49% in rural areas.

Over the last thirty years there has been inadequate funding for rehabilitation, upgrading and expansion of water supply and sewage facilities. In recognition of past neglect the Government has initiated a process of reform for the entire water sector. The sector is now under radical transformation driven by the national policy on separating water resources management and development from water services delivery. This conforms to the Poverty Reduction Strategy Paper, the Economic Strategy for Wealth and Employment Creation and backed up by the Water Act of 2002 in an attempt to meet the Millennium Development Goals.

The main thrust of the reform is to separate water resources management and development from water services delivery focussing the Ministry's role on policy, leaving the detailed regulation to a number of Parastatals bodies that report to boards, representing different stakeholders' interests. Provision of water services is to be on commercial basis taking into account social concerns, by Water Service Providers (WSP) both from the private and NGO sectors. Once the reform is complete, service providers will compete for the delivery of services. It will be the responsibility of the newly established institutions, working in concert with Local Authorities, CBOs, NGOs, and the private sector, to ensure the implementation of the strategy.

Implementation of the water sector reform process will comply with the following guiding principles:

- Separation of regulatory functions from services delivery functions,
- Separation of assets ownership from direct operations,
- Introduction of performance targets and commercial principles,
- Ring fencing water services revenues and hence allowing ploughing back of revenue collected,
- Redeployment of existing staff to the proposed institutions supported by performance based incentive schemes, promotional policies and competitive salaries and benefits to ensure the availability of sufficient numbers of qualified staff of all disciplines required by the sector.

In line with these principles the following activities will be undertaken:

- Establishing and operationalizing the new institutions and restructuring existing institutions in accordance with the Water Act 2002 and developing rules and regulations for their operation with clear responsibilities for actors

- Restructuring the functions within the MWI, NWCPC, and other existing water undertakers in accordance with water sector reform,
- Undertaking intensive human resources redeployment and retraining,
- Undertaking affirmative action to ensure that women not only participate but are represented as well,

- Mobilizing financial resources from local sources and development partners to increase and improve access to water services,

- Transferring assets from Director of Water and NWCPC to the WSBs and management and operations to WSPs latest by June 2006 in accordance with the Transfer Plan,

- Identifying the actual poor that would benefit from targeted subsidized water provision latest by July 2006.

National Water Services Strategy (NWSS) was prepared in response to the current water supply crisis, and appreciating that water supply and sewage services must be elevated and recognized as a national priority, that underpins all of Kenya's social and economic development, and requiring increased investment. The urgency of implementation of the NWSS cannot be overstressed. Key challenges that must be addressed through the strategy implementation include:

- Lack of effective and autonomous water institutions,
- Poor management including poor financial skills,
- Poor operation and maintenance of facilities,
- Inadequate funding for rehabilitation, upgrading and expansion of water supply and sewage facilities.

The above have resulted in to: -

- Dilapidated water and sewerage infrastructure,
- Low level of coverage of water supply and sewage services,
- High levels of unaccounted for water,
- Low revenue collection; diversion of water revenue to unrelated activities; and non-payment for water services by GoK departments and public institutions.

The Government is implementing reforms in the water sector to restructure and improve the sector performance and address the problems associated with the management of the resources and delivery of water and sewerage services. The long-term objective of these reforms is a significant reduction in the poverty levels in the country and especially in the rural areas through a well managed and sustainable water sector.

The Water Act 2002 itself as a legal framework has given the Ministry the mandate to carry out reforms, by bringing together all water sector players to ensure that there is harmony and each stakeholder plays their role to ensure actualization of the reforms.

The above is being achieved through devolving the authority for Water Supply and Sewerage to the Water Services Regulatory Board (WSRB), and that of Water Resources Management to the Water Resources Management Authority (WRMA). The established Water Services Boards (WSBs) will manage the provision of water and sanitation services in a given area as licensed by WSRB on satisfying the Regulatory Board of the competence and financial soundness of the services provider it has procured to supply the water and sewerage services.

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2

Part II: Water Availability in Kenya

PART II: WATER AVAILABILITY IN KENYA (A look at the National Freshwater Resources)

Part II: Water availability in Kenya

Goal, Objective and Targets on Water availability

Goal: Water to be available in sufficient quantity and of acceptable quality for use so as to contribute to the socio -economic development of the country.

Objective: Assured water availability for water use and water development to meet the various water needs in all parts of the Country.

Targets: Water Pollution control, controlled water allocation, water catchments protection, enforcement of water quality and waste water standards, construction of water storage structures to meet demands during the dry periods and for flood control, periodic assessment of water resources, monitoring of water resources, inter-basin transfer from water surplus to water deficit areas, up to date documentation of water resources data.

General hydrological characteristics

The main river system in Kenya is as shown on the drainage map below. Two thirds of the Country is arid or semi arid and so most of the rivers are seasonal only carrying water during or shortly after rains. The Lake Basin has the highest concentration of perennial river systems.

The five main water towers from where the major river systems originate are as shown on the drainage map, (Fig 2.1).

Table 2.1:"water towers" of Kenya

Forest	Ha.
Mt. Kenya.	199,558
Aberdares.	103,315
Mau Complex.	400,000
Mt. Elgon.	73,089
Cherangani.	128,000
Total	903,962

Source:Forest Department, Ministry of Environment and Natural Resources.

Figure 2.1:.Kenya Drainage system

Source: Ministry of Water and Irrigation.

The area under forest in the five water towers of Kenya is as in Table 2.1.

Variability of Mean annual runoff and Proportion used:

The average annual surface water availability by drainage basin and the amount abstracted is summarized in the table below:

From the table, Lake Victoria Basin, which is the smallest in size, has more than 50% of the National surface water resources. Another notable feature is that a very small proportion of the surface water potential is exploited indicative of low level of water development.

Availability of Hydrological observation stations

Flow measuring stations have been severely neglected during the 1990's because of lack of funds for maintenance and expansion. Even where stations were operational, there were insufficient funds to obtain readings. By the year 2001, 78% of the registered rivers gauging stations were not in operation (see Table 2.3).

The inadequate maintenance of the hydro-meteorological data collection network makes it impossible to carry out meaningful water resources planning, design, operations, and management. As a result, water allocation and abstraction decisions and investment decisions are based on inadequate water resources data.

Table 2.2.Spatial Variability of Average annual surface water availability

Drainage area	Volume in million cubic meters per year	Percentage of water abstracted
Lake Victoria	11,672	2.2
Rift valley	2,784	1.7
Athi River	1,152	11.6
Tana River	3,744	15.9
Ewaso Ng'iro	339	12.4
National	20,291	5.3

Source: The aftercare study on the National Water Master Plan, July 1998

Table 2.3: .Status of Hydrometric stations in Kenya

Drainage Basin	**Registered stations**	**Stations operating by 1990**	**Stations operating in 2001**	**% Reduction from registered stations**
Lake Victoria	229	114	45	80%
Rift Valley	153	50	33	78%
Athi	223	74	31	86%
Tana	205	116	66	67%
Northern Ewaso Ng'iro	113	45	29	74%
National	923	399	204	78%

Source: Report on Towards a Water secure Kenya (April 2004)

Table 2.4:.General Hydrological characteristics

ISSUES	**TARGETS**	**INDICATORS**
▪ Inadequate monitoring stations ▪ Inadequate Funding to maintain/expand hydro network ▪ Limited Equipment, Transport) O& M ▪ Vandalism of installed monitoring equipment ▪ Flood related damage to installed stations ▪ Recession of lakes/shifting river courses	▪ Reconnaissance of all hydro monitoring stations to determine status /rehabilitation programme/maintenance ▪ Expansion of hydro Network ▪ Regular river flow measurements ▪ Modernization (automation of some key stations) ▪ Develop hydrological models	▪ -No. of stations rehabilitated ▪ -No. of new Hydro stations established ▪ -No of Q measurements taken ▪ -No. of stations installed (automated) ▪ -No. of models developed

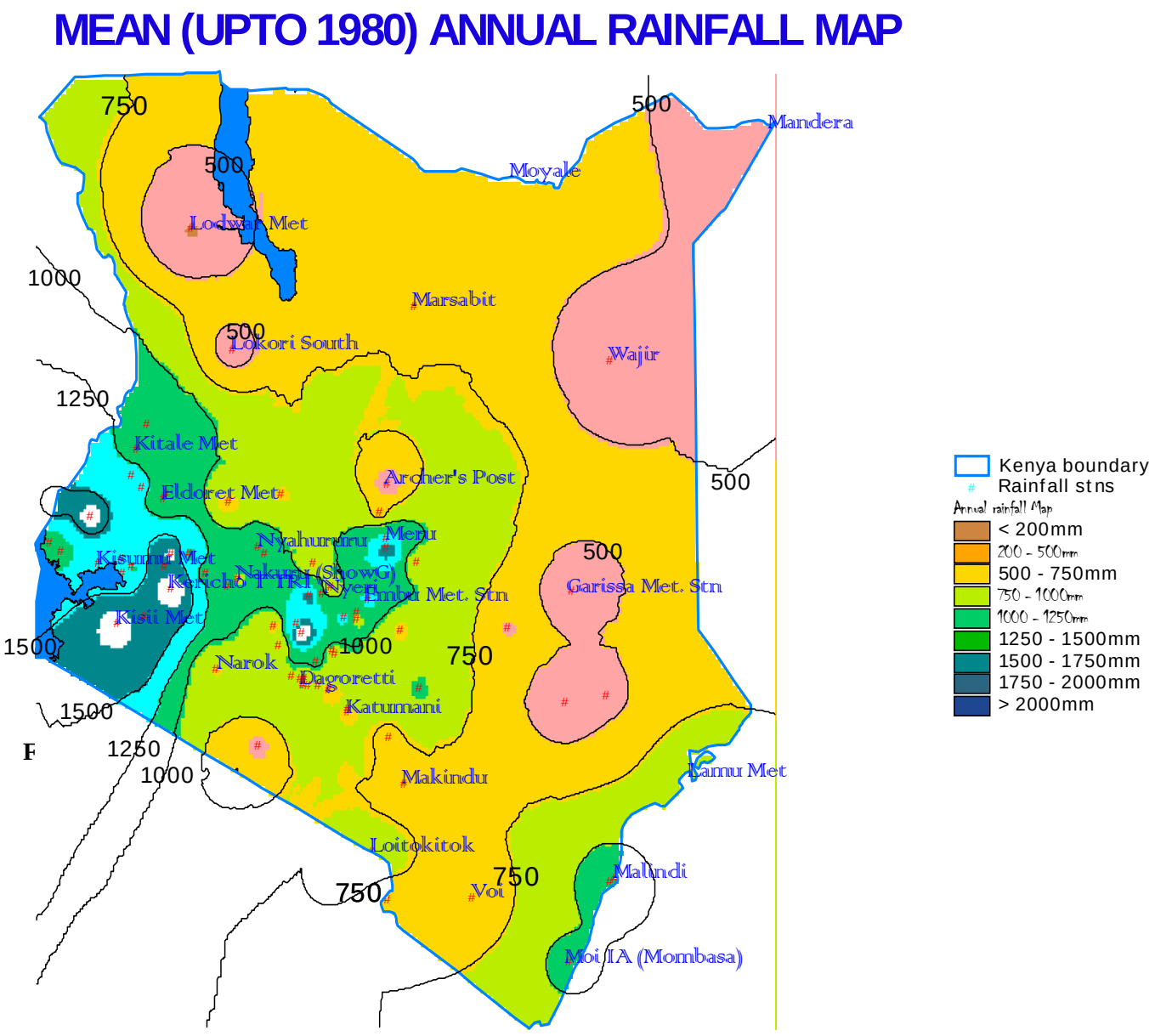

Figure 2.2:.Distribution of river gauging stations in Kenya

Table 2.5: Summary Indicator Table

	1992	1996	2003	2005
No. of RGS's	399		204	242
No. of Gaugings taken at RGS		-	-	
No. of Miscellaneous Gaugings				
No. of Full Hydrometer Stations				

General geo-hydrological characteristics

Main groundwater aquifers in Kenya

Kenya consists of three major rock types and the major hydro-geological areas are classified as follows:

- volcanic,
- metamorphic basement and intrusive rocks
- Sedimentary rocks.

The hydro-geological areas of Kenya can be regarded as simplified geological areas. The main groundwater aquifers are closely linked with the three (3) major rock systems indicated above.

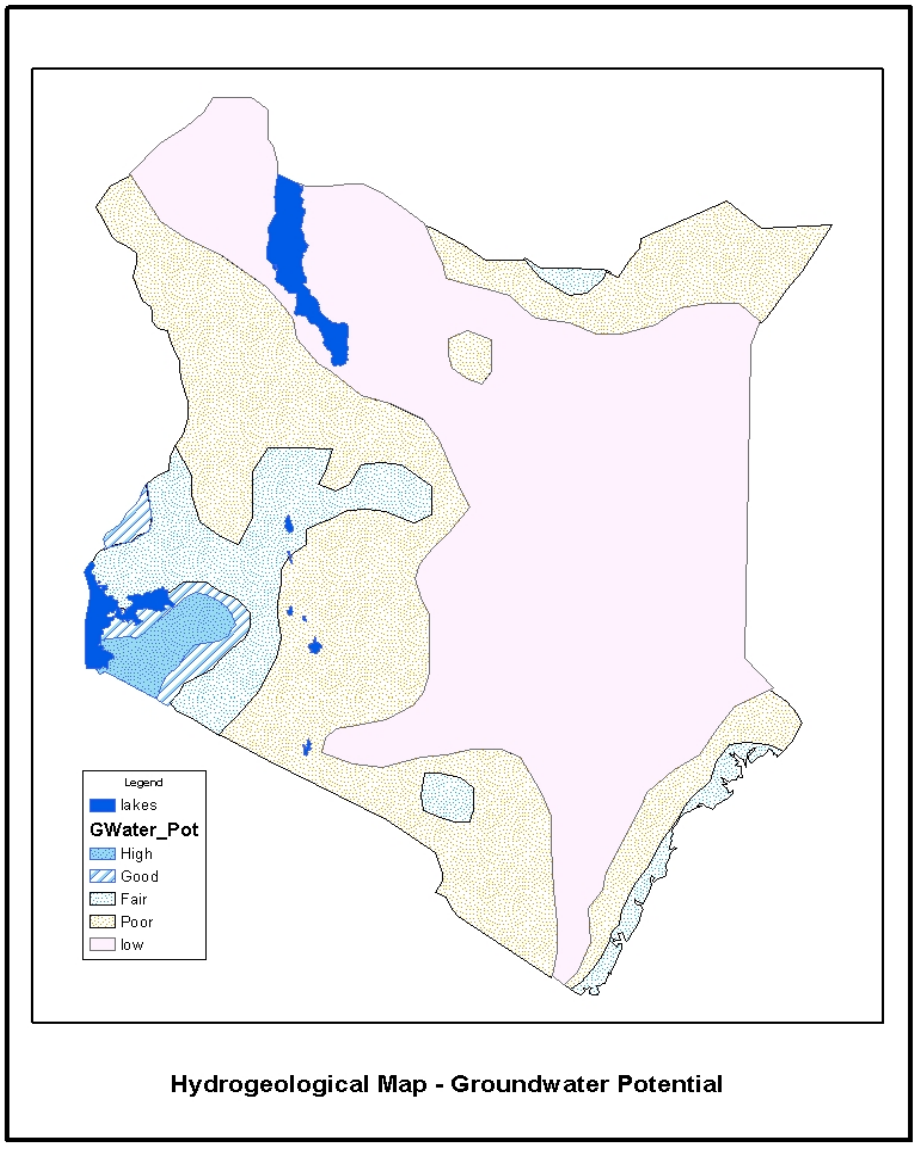

Figure 2.3: Hydro geological map of Kenya

Groundwater Development and use

The scale of groundwater used is summarized in table 2.6.showing estimates of water abstracted, whereas the level of groundwater development is as summarized in table 2.7 showing number of boreholes by use. According to records at the Ministry Headquarters by December 2003, there were about 14,000 bore holes in Kenya.

Table 2.6: Estimated abstraction rates by use (NWMP-1992):-

Bore hole use	Abstraction in million cubic meters per year	Percentage of total
Agriculture	11.75	24.17
Public water supply	11.13	19.45
Domestic (Private)	3.46	6.04
Livestock	1.07	1.87
Exploratory	0.1	1.17
Observation	0.08	0.14
Others	7.89	13.79
Unknown	19.65	34.35

Table 2.7: The number of boreholes by use (NWMP-1992):-

	Borehole use	No. of boreholes	Percentage (%)
1	Public Water Supply	2137	22.6
2	Agriculture	948	10
3	Domestic (Private)	434	4.6
4	Industrial and Commercial	224	2.4
5	Livestock	177	1.9
6	Observation	62	0.6
7	Exploratory	52	0.5
8	Other	973	10.3
9	Unknown	2496	26.4
10	Undescribed	1959	20.7
	Total	9462	100

.Table 2.8: Estimated Potential compared with amount abstracted

Estimated groundwater potential in million m^3/Year (Safe yield *)	Estimated abstracted groundwater in million $m^{3/}$ Year	% of available exploitable groundwater that is abstracted
632.3	57.2	9

Source: National Water Master Plan report (1992)

* Safe yield is the amount of water that can be abstracted without causing undesirable effects to the aquifer

Typical Groundwater Yields

The categories of aquifers and their characteristics are summarized in the table 2.9 below:

Table 2.9: Aquifer characteristics

Rock type	Elevation (m)	Total depth (m)	Water level Struck	Rest(m) (m)	Pumping test Yield (m^3/hr)	Drawdown (m)	Specific Capacity (m^3/hr/m)
Volcanic(V)	1762.74	124.70	93.96	48.68	7.45	37.05	0.20
Basements (B)	1266.59	79.59	55.30	26.40	4.54	31.08	0.15
Sediments(S)	439.59	81.22	54.25	34.80	5.55	17.39	0.32
(V) over (B)	1079.47	82.53	54.39	28.53	7.39	25.87	0.29
(S) over (B)	1073.65	91.28	51.16	25.97	5.67	32.28	0.18
(S) over (V)	1265.85	90.44	63.22	28.98	7.57	24.14	0.32
(V) over (S)	1332.28	106.71	79.37	26.60	10.76	41.22	0.26
Others	1054.23	103.95	63.00	38.88	4.58	19.39	0.24
Unknown	1391.61	78.66	55.76	25.68	4.89	24.44	0.20

Source: The NWMP 1992

Table 2.10: Summary Indicator Table

	1992	1996	2000	2003
Number of GW monitoring boreholes in place				100
No of assessment reports on various aquifers				20
No. of BH installed with meters/piezometers				-
No of GW models developed				5

Table 2.11: General Hydrogeological characteristics

PROBLEMS	TARGETS	INDICATORS
▪ Weak enforcement of regulations governing g/w use ▪ Limited GW data for management decisions ▪ Inadequate – GW data base ▪ -Limited GW survey equipment ▪ -Non-existent GW monitoring network ▪ Limited knowledge on GW potential ▪ -Limited GW modeling capacity	▪ Sustainable use of GW resources – by establishing GW monitoring networks, assessment of g/w resources ▪ Installation of water abstraction meters, piezometers, protection of GW against pollution – monitoring g/w quality, gazettement of GW conservation areas ▪ Develop ground water modeling as tool for use in allocation decision/capacity building for modeling ▪ Enforcement of laws governing g/w use ▪ Establishment of up-to-date GW data base	▪ Number of GW monitoring boreholes in place ▪ No of assessment reports on various aquifers ▪ No. of BHs installed with meters/piezometers ▪ No of GW conservation areas gazetted ▪ No of GW models developed ▪ No. of incidences of violation of GW use ▪ GW data base established ▪ No. of GW modeling experts

Source: Ministry of Water and Irrigation.

Spatial variance of water availability

Location of Water Resources versus uses

The Spatial variation of water availability is directly dependent on the rainfall distribution pattern. Kenya's mean annual rainfall is about 500mm., which varies from under 250mm in the arid areas in the North and the East to over 2000mm on the Central highlands (mountain ranges) and Western Lake Region. The low rainfall in the ASAL region coincides with high evaporation rates and hence limits the available water in these regions.

Similar to Surface Water, Kenya's groundwater resource is equally influenced by rainfall/runoff and hence the mean annual rainfall available for groundwater recharges (effective rainfall).

The distribution of water resources in Kenya by drainage basin and the main water uses is shown in the table 2.12.

Table 2.12: Distribution of water resources and uses

Drainage	Size in Km^2	Estimated ground water potential in million cubic metres	Estimated Surface water potential (Mean annual surface runoff) in-billion cubic metres	Percentage of total National water resources potential	Main Water uses
Lake Victoria	46000	115.7	11.672	54.1	Domestic, Industrial, small scale irrigation (HEP development in progress)
Rift Valley	130000	125.7	2.784	3.4	Domestic, Industrial Livestock, Large & small scale irrigation, HEP
Athi	67000	86.7	1.152	4.3	Domestic, Livestock, Industrial, Large & small scale irrigation
Tana	127000	147.3	3.744	32.3	Domestic, Large & small scale irrigation, Livestock, Industrial, major HEP
Ewaso Ngiro	210000	142.4	0.339	5.8	Livestock, domestic, Major & minor irrigation

Source of figures: National Water Master Plan 1992.

The Lake Victoria Drainage Basin;

Area (46,000 km^2)

This comprises the whole area west of the Rift Valley, which mainly drains into the Lake. Victoria. The rivers in this basin are: Nzoia, Yala, Nyando, Sondu and Kuja. These rivers drain an area of high

agricultural potential with high population density, and several urban centers and are heavily polluted by:

a) High sediment load due to soil erosion and run-off from agricultural areas,
b) High agrochemical residuals that increase nutrients which has resulted in eutrophication of Winam Gulf of Lake Victoria and
c) Discharge of untreated or semi-treated industrial as well as municipal effluents

Lake Victoria is a fresh water lake found in this basin. It provides a livelihood to several million people from several countries. The Lake's environment is highly stressed by a range of anthropogenic activities; both near the lake and in the catchment areas High siltation, influx of pesticides and excessive use of fertilizers, industrial pollutants, and the discharge of raw untreated sewage from towns, all contribute to the worrisome state of the lake. The increase in nutrients has resulted into eutrophication with excessive occurrence of the water hyacinth.

Through the support of Global Environmental Facility/World Bank/FAO Programmes, a tripartite agreement between Kenya, Uganda and Tanzania has been reached. This agreement has established the Lake Victoria Environment Management Project (LVEMP) with the aim of rehabilitating the Lake Victoria ecosystem and its catchments.

The Rift Valley Basin;

Area (125,000 km^2)

This basin consists of a number of closed basins. These include those discharging into Lake Turkana in the North through the Turkwel and Kerio rivers and mainly those draining into Lake. Natron in the south through the Ewaso Ngiro South River. There are others also pouring into smaller lakes such as Lake Baringo, Lake Bogoria, Lake Nakuru, Lake Elementeita, Lake Naivasha and Lake Magandi.

Unlike the Lake Victoria Basin, the Rift Valley Basin drains an area that is:

a) Sparsely populated,
b) Poorly urbanized and industrialized,
c) Low to medium potential in terms of productivity.

Kerio River is the main river in this Basin and has a total length of 354 km, with an average width of about 5.7m. The maen depth river is 0.21m and it's mean flow is 4.47m^3/s

Nearly all the major lakes of Kenya are found in the Rift Valley. Their water quality varies from fresh (L. Naivasha and L. Baringo), through brackish (L. Turkana) to saline (L. Magadi). Lake Naivasha (Ramsar Site) supports a highly significant horticultural industry and some fisheries, providing many jobs. Drinking water for hundreds of thousands of people as well as for livestock in the region is sourced from here. Its water is also used by the Ol Karia geothermal power plant, which provides 20% of the country's electricity. The Lake's environs, including its rich biodiversity, are highly attractive for tourism. Unfortunately, the use of the lakes resources, notably its water and riparian lands, are largely uncontrolled and serious concern has arisen about the sustainability of the activities. For

example, the **Sher Agencies** that specializes in and the world leader in selling Rose Flower, has reclaimed over two hundred acres land from

Lake Naivasha and put it on flower farming. The Lake's ecological integrity is threatened by eutrophication, agricultural pollution and waste disposal from Naivasha town. To address these problems, as a community based initiative, the long existing Lake Naivasha Riparian Owners Association (LNROA) together with the pastoral communities, the Lake Naivasha Growers Group have developed The Lake Naivasha Management Committee with the aim of implementing the Lake Naivasha Management Plan (gazzetted on 1st October 2004 as a legal instrument to safe guard the Lake resource). This Committee closely collaborates with Government Agencies, including the Kenya Wildlife Service (KWS- as the Custodian of the Ramsar Convention in Kenya), and the International Union for the Conservation of Nature (IUCN). Lake Nakuru, the other Ramsar Site, is a soda lake well known for its unique large populations of the Lesser Flamingo. The lake's surrounding wilderness has a very high biodiversity and the whole area is within a National Park managed by KWS. The park forms a major attraction for tourists. The lake is threatened by siltation and extreme fluctuations in water levels due to extreme drought. The other threats to the lake are nutrients from local farms, and chemicals and silts from Nakuru town through the surface run-offs.

To solve these problems, World Wildlife Foundation (WWF) and KWS have undertaken community development by planting trees to check erosion on the slopes. Awareness campaigns are being carried out in close collaboration with other Government Departments, NGO's, Egerton University and the Communities. Also the Nakuru Town Municipality has established a large sewage treatment plant with technical assistance and funding of the Japanese International Cooperation Agency (JICA).

Just like Lake Nakuru, Lake Baringo has been affected by siltation. Table 2.13 below shows the general status of Kenyan Lakes

Table 2.13: The General Status of Kenyan Lakes.

NAME OF THE LAKE	RIVERS DRAINING INTO THE LAKE, Length in km	SURFACE AREA KM²	MAXIMUM DEPTH M	WATER QUALITY	LAKE UTILIZATION	THREAT TO THE LAKE
Lake Victoria	Nyando (170), Yala (219), Sondu (170), Kuja (221), Mara(270), Sio(25), Awach (26) Kibos (58), Nzoia (336)	68,800 (3,500 Kenya territory)	84	fresh	Source of water, navigation and transportation, recreation (yachting) and fishing	Domestic, industrial and pollution, siltation from the catchment area, water hyacinth weeds.
Nakuru	Njoro, Enderit, Njoro, Ngosur, Lamuriak, Makalia	26-62	1.100	saline	National park, Sightseeing and tourism	Domestic, industrial and pollution, siltation from the catchment area
Baringo	Perkera (80), Molo(100), Sukal, Ndoo, Tangulbei	130	10	fresh, with hig	Source of water, recreation (yachting) and	Domestic pollution, siltation from the catchment area
Bogoria	Wasseges and Geysers	34	10	Saline	park, Sightseeing and tourism	Siltation from the catchment area
Naivasha	Malewa(75), Little Gilgil(55), Karati	138-297	7	Fresh	Source of water, irrigation, recreation (yachting)	Siltation from the catchment area, agricultural chemicals and pesticides, municipal sewage, invasive weeds
Ol'Bolossat	Ewaso Ngiro North	Seasonal	shallow	Fresh	Source of drinking water and irrigation	Siltation from the catchment area, over abstraction
Chala	Underground recharge	2	90	Fresh	Source of drinking water	Ground water pollution
Jipe	Lumi, Njoro kubwa	13-28	2	Fresh	Source of drinking water and irrigation	Siltation from the catchment area, floating, vegetation and weeds
Turkana	Omo (Ethiopia), Turkwel(380)	6405	120	brackish	Source of drinking water and irrigation	Siltation from the catchment area
Magadi	Ewaso Kedong	100	0,5	saline	Mining soda ash	Siltation from the catchment area
Elementaita	Mereroni	18	1.1	saline	National park, Sightseeing and	Siltation from the catchment area, pollution from diatomite mines
Amboseli	Namanga	Seasonal	shallow	saline	Tourism and wildlife	Siltation from the catchment area
Kamnarok	Kerio			fresh	Source of drinking water	Siltation from the catchment area, pollution from fluorspar mines
Logipi	Kerio	Seasonal	shallow	brackish	Source of drinking water	Siltation from the catchment area
Lorian Swamp	Ewaso Ngiro North	swamp	shallow	fresh	Source of drinking water and livestock.	Siltation from the catchment area

Source: Ministry of Water and Irrigation, 2005.

Athi River Basin; Area (67,000 km^2)

This comprises the southern part of the country east of the Rift Valley, and drains the southern slopes of the Aberdare Ranges and the flanks of the Rift Valley, to form the Athi River finally flowing into the Indian Ocean. This River Basin drains an area that is very active with high potential in terms of agriculture and industrial basis. The area is also urbanized.

Athi River whose length is approximately 591 km, has an average width of 44.76 m, average depth of 0.29m and average flow rate of 6.76 m^3/sec. It is the main river traversing this basin. The river tributaries traversing urban centers such as Thika and Nairobi City have poor water quality due to untreated or semi-treated municipal and industrial discharges.

Tana River Basin; Area (127,000 km^2)

This drains the eastern slopes of the Aberdares range, the southern slopes of Mt. Kenya and the Nyambene hills, and discharges through the Tana River into the Indian Ocean. Just like the Athi River Basin, Tana River Basin drains an area that has high population, is highly urbanized and of high agricultural activities.

The main river traversing this Basin is Tana River whose length from the furthest source to Indian Ocean is approximately 1050 km, with an average width of 39.3 m, mean depth 2.5m and an average flow rate of 41.98 m^3/sec. Its mean annual discharge at Garissa is five billion cubic meters. The River traverses four provinces, which are Central, Eastern, North Eastern and Coast over a catchment area of 127,000 km^2. The total population within the Basin is 5.8 million people. Tana River Basin is among the highest coffee and tea producing areas in the country, yielding 62% and 55% of the country's coffee and tea harvest respectively. Other products from this basin include export flowers, horticultural crops, rice, and food crops such as cereals, bananas, potatoes and livestock products such as milk, beef, mutton and pork. However, it is important to note here that about 80% of this basin is arid or semi arid that would require some form of irrigation in order to grow crops.

The River is the major source of hydropower generation potential in the country, estimated at 960 MW. Currently the installed capacity in the basin is 480 MW.

Tana River is polluted by silt, industrial effluents, agrochemicals such as fertilizers, insecticides and herbicides, and municipal as well as domestic wastewaters. This has made the River water unsafe for use in addition to increasing treatment costs for the same. Other problems afflicting this river are water short falls arising from excessive abstractions of water for coffee and horticultural irrigation, water conflicts arising from water use between Upper Catchment Irrigation and Hydropower, and the Lower Tana Irrigation and Livestock Development.

The Government has entrusted to TARDA the integrated management of the basin's water resources to reduce conflicts and to promote the economic well-being of the basin's residents. TARDA also is supposed to ensure water is available for ecological maintenance and for hydropower to the national grid. TARDA Act, Cap 443 has been recommended for amendment to provide for enforcement of water quality and pollution control

The Ewaso Ng'iro North River Basin; Area (209,000 km^2).

This comprises the Northern part of Kenya, and drains the northern slopes of the Aberdare Range and Mt. Kenya. Even during the flood season, Ewaso Ng'iro River is absorbed in the Lorian swamp, though in some years its flow continues into Somali Republic. In this Basin, there is increasing demand for irrigation water, which in turn is posing a threat of water conflicts.

As a summary, Table 2.20 below lists the main features of the12 major rivers in the five Basins. This table gives the river name, catchment area, minimal annual rainfall, stretch (kilometre) from the delta, river morphology, the districts that it transverses and the human activities both within and along the river

The need for Dams and their role in managing risk and variability

Dams in Kenya are used for a number of purposes which include water supply, HEP, irrigation. Major dams also serve as flood control structures.

Big cities such as Nairobi and Eldoret have water supply systems relying on dams. In the Tana catchment several dams have been constructed for HEP generation.

Dams in Kenya, therefore, play an important role in providing a sustainable and reliable water supply source and are an important component in public water supply and hydroelectric schemes.

Table 2.14: Distribution of medium to Large Dams in Kenya by Drainage area *

Drainage Area	No. of Dams	Total capacity in cubic meters
Lake Victoria	7	6,000,000
Rift Valley	6	1,671,000,000
Athi River	9	8,000,000
Tana River	7	2,416,900,000
Ewaso Ngiro	None	
Country total	26	4,101,900,000

(Source: National Water Master Plan,1992)

- Medium to Large dams are those with Capacity of over 100,000m^3, and height of over 10m)
- Small dams are those with storage capacity equal to or less than 100,000m^3, and a height of up to 10 m

Table 2.15: Total number of small dams and pans per province

Drainage areas	No. of small Dams*/Pans	Total storage capacity(m3)	Use
1.Rift Valley	1333	52,735,878	Water supply, Irrigation, and Livestock
2.Central	277	191,537,171	
3.Eastern	1345	27,488,604	"
4.Western	90	9,166,740	"
5.Coast	408	5,858,290	"
6.North- Eastern	230	5,038,395	"
7.Nyanza	419	9,546,330	"
8.Nairobi	29	2,538,330	"
Total	**4,102**	**303,909,738**	

Source: Ministry of Water and Irrigation, Water Conservation Division (2005)

Dams and Reservoirs

Sediment deposition in water storage reservoirs reduces storage capacity, causing water shortages and reducing the valiability of water supply to the nation. In managing the water resources of the country, it is important to preserve the sustainability of both the natural water resource and other water resource infrastructure (dams, pipelines, etc). The sustainability of water resource infrastructure can be ensured by following reservoir life cycle management approach. This allows the country to maximize the benefits from its existing dams and reservoirs, as well as that of new dams and reservoirs.

Masinga Dam

Masinga Dam has a catchment area of 7,355km^2 and has created the largest storage and regulatory structure on the Tana River for regulating flows for four downstream hydropower dams. Its original capacity was estimated as 1,560 million m^3. A survey carried out in 1988 found that the reservoir has lost 5.57% of its storage capacity due sedimentation. This indicates that the average sediment yield from the catchment upstream of Masinga Dam by 1988 was in the order of 1,750 t/km^2/yr. The survey carried out in December 2001 indicates that the total current reservoir capacity is approximately 1,100 million cubic meters. Subtracting this from the original estimate of storage capacity (1,560 million m^3) implies a total loss in storage of 460 million m^3 since construction of the dam. This dam was designed on the basis of annual sediments input of 3 million tons/yr and commissioned in 1981.

Ruiru Dam

Ruiru dam, located on the Ruiru River and commissioned in 1950 has a catchment area of 66.80 km^2 and supplies water to the city of Nairobi. The reservoir's original capacity was 2.98 million m^3. The survey conducted in the year 2001 indicated that the current reservoir storage capacity is 23,496,762 m^3 which is a loss of 483,238 m^3 that have occurred over the last 52 years. This indicates that the average sediment yield

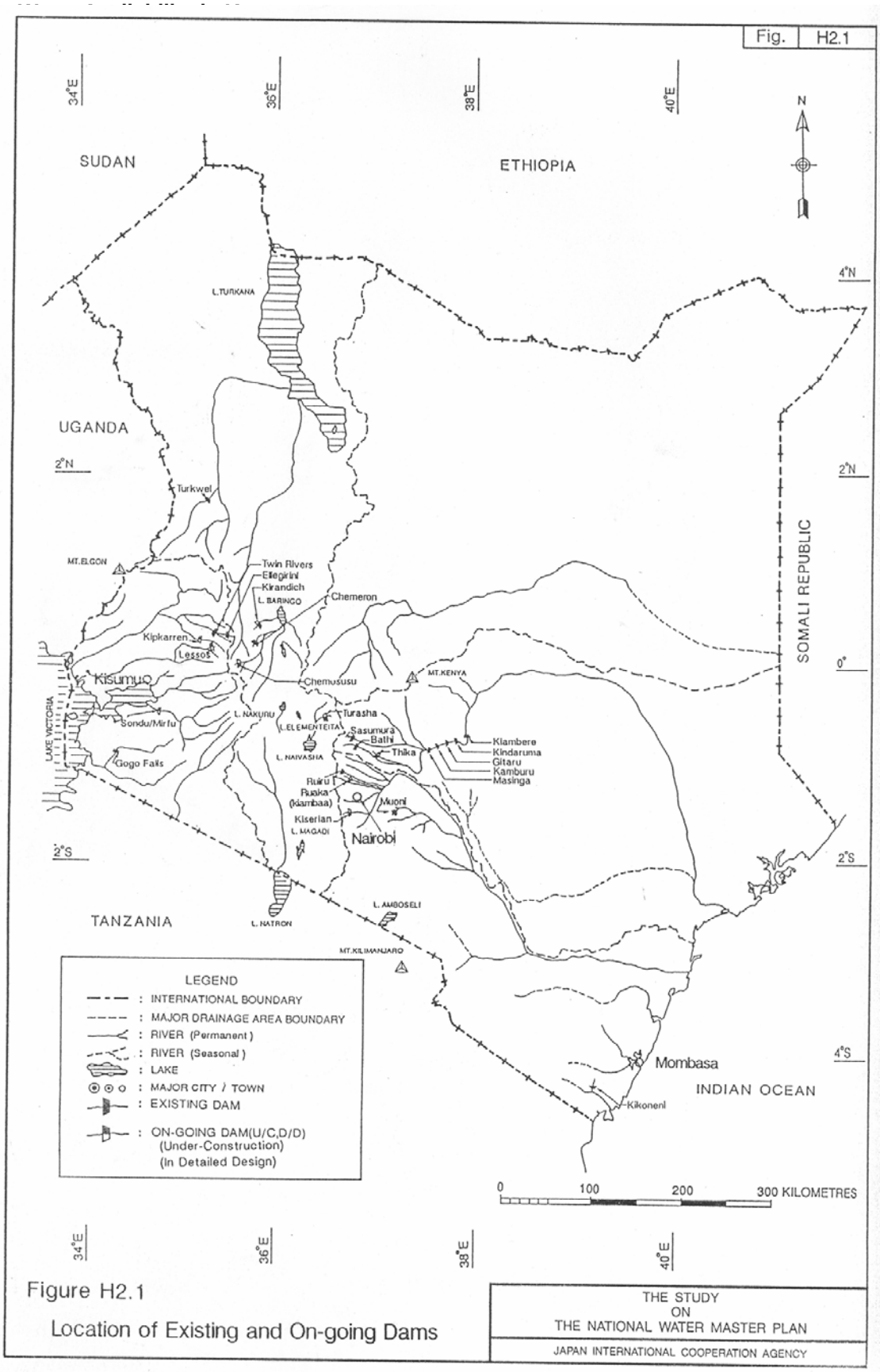

Figure 2.4 Existing and on-going dams

from the catchment upstream of Ruiru Dam is in the order of 180 t/km^2/yr.

Ndakaini Dam (Thika Dam)

Ndakaini Dam (also known as Thika dam) is located on the Thika River and has a catchment area of 71 km^2. The dam supplies water to the city of Nairobi. The reservoir behind the dam's original capacity was 70 million m^3. The dam is relatively new, and if any storage loss due to sedimentation occurred, it is likely to be very low.

Sasumua Dam

Sasumua Dam located on the Chania River and originally commissioned in 1956 has a catchment area of 12,800 ha and supplies water to the city of Nairobi. The reservoir's original capacity was 7.57 million m^3. The dam was raised over the period 1965 to 1968, increasing the total capacity to 13.25 million m3.

Intervention

The World Bank has developed a computer programme known as RESCON that can be used at pre-feasibility level to identify technically feasible techniques for managing sediment and, once identified, conducts an economic optimization to identify the optimal strategy for use of the dam and reservoir in perpetuity. The programme can assist the Government in development of management plans for the sustainable use of water resources infrastructure. Following here below is a brief discussion on sedimentation problem of a few dams in Kenya.

Nairobi Dam

It has a depth of 15m and was built in 1953 as an alternate water reserve for the Nairobi city, and for recreation purposes. It has steadily evolved from a polluted pond in the 1980s to a larger tract of hyacinth coating the surface to the chagrin of water sports enthusiasts enjoying the patronage of a sailing club. Kibera slums and Nyayo high-rise flats residents believe that the dam has become the grave of murder victims, aborted fetuses and dumping pond for toxic wastes merchants. The dam is dead with unknown horrors lurking in the depths of the frothy pond, if what scientists and residents suspects is true. A water hyacinth carpet has choked the dam to death and hence whatever is deposited in it stays underneath before it sinks to the bottom.

The major pollutants of this dam include:

(1) Water hyacinth whose weight doubles in less than two weeks due to increased fertilizer residue levels
(2) Industrial effluent toxins like lead, zinc, chromium, copper and calcium,
(3) Agro chemicals like fertilizer residues and ammonia
(4) Solid waste and silt.
(5) Huge volumes of detergents used by the dam side communities that discharge waste directly into the dam.
(6) The dam also contains all sorts of wastes both industrial and domestic, including aborted fetuses that have sunk to the bottom.
(7) Municipal as well as domestic effluents
(8) Animal dung, animal remains like blood and bones from Dagoreti slaughterhouses.

Interventions

UNEP together with the Friends of Nairobi Dam have proposed draining and dredging of the dam to restore it to its original state.

Table 2.16: Spatial variance of water availability

PROBLEMS	TARGETS	INDICATORS
▪ Current storage capacity of existing dams not known ▪ Catchment degradation ▪ Lack of comprehensive W.R.A reports ▪ Lack of adequate resources ▪ Evaporation & high siltation levels in water storage structures ▪ Spatial & temporal variation of water availability	▪ Assessment of water resources availability in the country ▪ Identification of potential dam sites in the country ▪ Determination of status of existing dams ▪ Create 5million cubic metres dam storage capacity annually with priority being for ASAL areas ▪ Geo-reference location of existing dams expansion ▪ Inter basin transfer of water from water surplus to W/g deficit areas ▪ Conservation W/G catchment areas ▪ Development of sub-surface and sand storage dams in ASAL ▪ Establishment of provincial dam maintenance units	▪ No of WRA reports made ▪ No of dams/sites identified ▪ No. of existing dams surveyed ▪ Capacity – created through new dams ▪ No. of dams geo-referenced ▪ No. of inter-basin transfer schemes implemented ▪ No of dam maintenance visits established

Table 2.17: Summary Indicator Table

	1992	1996	2000	2005
No. of WRA Report Published	8			14
Determined Dam Storages(M^3)		124M		303,909,738
No. of Dams so far developed.		3,000		4,128
Capacity of water moved in Inter-basin Transfers (m^3)	420, 001	420 001	420 001	420 001
No. of dams washed away.	No Records			No Records

***Source:Country Strategy on Integrated Water Resources Management*, March, 2002.**

Table 2:18: Drainage basins of Kenya

No	Drainage Area	Area Km^2 *1	% of Total Area	Mean Annual Rainfall (mm)	Mean Annual Discharge (BCM)
1	Lake Victoria	42,229	8.4	1368	11.7
2	Rift Valley Inland	130 452	21.8	562	3.3
3	Athi	66 837	12	739	1.3
4	Tana	127 000	22.7	697	3.7
5	Ewaso Ng'iro	579 000	35.1	411	0.34
	KENYA	583	100	500	20.3

Source: National Water Master Plan 1992

Main surface water systems

Kenya is divided into five drainage basins namely: Lake Basin Drainage area system, Rift Valley Inland Drainage system, Athi Drainage system, Tana Drainage system and Ewaso Ng'iro North Drainage system. The areas and their spatial coverage are as listed in table 2.18.

Table 2.19: Issue: main surface-water systems

PROBLEMS	TARGETS	INDICATORS	RECOMMENDATION/ CONCLUSION
▪ Changing river regimes due to changes in land use ▪ Unregulated upstream diversions ▪ Diminishing lake sizes leading to negative socio-economic effects	▪ Survey to determine status of surface water systems with regard to regime of rivers ▪ Mapping lakes to determine sizes ▪ Enforcement of laws governing S.W. use	▪ No of surface water systems surveyed ▪ No of lakes surveyed	Effective catchment management practices should be put in place.

Table 2.20: Summary Indicator Table

	1992	1996	2000	2003	2005
No. of RGS	399	-	-	204	242
No. of WRA Reports Published	8			14	14

Source: Ministry of Water and Irrigation.

Main Kenya Rivers

These Basins contain the bulk of Kenya's surface water resources and are focal points for regional development. In terms of quantity, however, only Tana and Lake Victoria Basins could be said to have surplus water resources while the rest of the Basins have water deficits. The vision of the Ministry of Water and Irrigation according to the new changes in the water sector is "Assured Water Resources Availability and Accessibility by All". In accordance with this vision, therefore, from January 2005 the management of these Water Basins, which have been protected by various institutions whose activities and mandates are uncoordinated, overlapping and therefore ineffective, were taken over by the Water Resources Management Authority. This will help in the implementation of the Ministry's vision, which puts emphasis on the application of the Integrated Water Resources Management and Development through Stakeholders participation to ensure water availability and accessibility to enhance National Development.

Table 2.21: Main Features of the twelve major rivers in the five basins

River	Catchment area	River Length	Mean annual rainfall (mm)	Stretch (km) from Delta	Geography/River Morphology	Districts	Human activity/Land use
Nzoia	12,696	315	1,350	0 – 20	Meandering on a flood plain, Yala swamp, pouring into L. Victoria. Has 16km dykes downstream of Luambwa bridge	Busia &Siaya	Rather intensive agriculture, especially at Bunyala Pilot irrigation Scheme for rice, with livestock farming and fishery. A lot of human settlements along the river
				20 – 135	Meandering river on a narrow valley bottom in a hilly land	Siaya, Kakamega & Bungoma	Subsistence agriculture and grazing. A few human settlements on the valley bottom
				135- 257	Slightly meandering river, forming a V-shaped valley on a highland area	Kakamega, Bungoma, T. Nzoia & U. Gishu	Grazing. Few human settlements on the valley bottom
Yala	3,262	261	1,500	0 – 25	Original meandering river in Yala Swamp relocated along the hills south to the swamp, and pours into Lake Victoria. Between 16 km and	Siaya	Intensive agriculture in a part of Yala Swamp, Yala swamp Farm- area I. However, few human settlements in the swamp area.
				25 – 125	25km points provided a right dike (1971 completed)	Siaya & Kakamega	Subsistence agriculture and grazing. A few human settlements on the valley bottom.
				125 - 190	Meandering river on a narrow valley bottom in a hilly land Slightly meandering river, forming a V shaped valley on a	Nandi & U. Gishu	Grazing. Few human settlements on the valley bottom

					highland area		
Nyando	3,450	153	1,400	0 – 45	Meandering river on a flood plain, named K plain, including swamp area. Pours into Lake Victoria. There is 2km dikes completed by now downstream of Ahero Bridge	Kisumu	Intensive agriculture, especially at Ahero Pilot Scheme, with livestock farming and fishery. A lot of human settlements on the plain
				45 -75	Meandering river on a narrow valley bottom in a hilly land	Kisumu & Kericho	Subsistence agriculture and grazing. A few human settlements on the valley bottom
				75 - 109	Less meandering river, forming a deep V-shaped valley in mountain area of Mt. Londiani	Kericho	Subsistence agriculture and forestry. Few human settlements on the valley bottom.
Sondu	3,489	176	1,480	0-15	Meandering river	Kisumu & south Nyanza	Subsistence agriculture, grazing and fishery. A lot of human settlement on the fan
				15-25	Straight river in deep v-shaped valley running down the escarpment	Kisumu & south Nyanza	Less human activities. Few human settlements in the valley
				25-121	Slightly meandering river, forming a v-shape on a hilly land	Kisumu, south Nyanza,Kisii & Kericho	Subsistence agriculture and grazing. A few human settlements oin the valley bottom
Kuja	6,868	180	1,340	0-20	Meandering river on a fan with swampy area. Pours into L.	South Nyanza	Subsistence agriculture, grazing and fishery. A lot of human settlements on

					Victoria		the fan
				20-80	Slightly meandering river on a narrow valley bottom in a hilly land.	South Nyanza & Kisii	Subsistence agriculture and grazing. A few human settlements
				80 -128	Slightly meandering river, forming a v-shape valley on a highland area	Kisii	oin the valley bottom Subsistence agriculture and grazing. A few human settlements in the valley bottom
Mara	9,574	198	980	0-125	Meandering river on the ASAL plain, flowing into Tanzania	Narok	Normadic grazing. Few human settlements on the plain
				125-138	Slightly meandering river, forming a v-shape valley on a highland area	Kericho	Less human activities. Few human settlements on the valley bottom
Turkwel	20,283	390	530	0-158	Meandering river with limited riverine forest on the ASAL plain and pouring into L.Turkana	Turkana	Less human activities. Few human settlements on the plain
				158-212	Braiding river on a wide valley bottom between highlands		Grazing and limited farming at Katilo, Juluk and Nakwamoru irrigation schemes. Few human settlements on the valley bottom
				212-338	Slightly meandering river, forming a deep v-shaped valley in a mountain area.	Turkana and West Pokot	Less human activities. Except for hydropower generation. Few human settlements on the valley bottom
Kerio	14,172	403	450	0-130	Meandering river with limited riverine forest on the ASAL plain, pouring into L.Turkana	Turkana	Normadic grazing . Few human settlements on the plain
				130-354	Braiding river on a wide valley bottom between highlands	West Pokot, Elegeyo Marakwet and Baringo	Normadic grazing . Few human settlements on the bottom
Ewaso Ngiro	8,534	213	760	0-60	Meandering river on the ASAL plain,	Kajiado	Normadic grazing . Few human settlements on the

South				60-90 90-180	flowing into Tanzania Straight river in a deep v-shaped valley running down the escarpment Slightly meandering river forming a v-shaped valley on a highland area	Kajiado Narok	plain Less human activities. Few human settlements on the valley. Subsistence agriculture and grazing. Few human settlements on the bottom.
Athi	36,905	631	610	0-55 55-150 150-598	Braiding river on a narrow valley bottom in a hilly land, pouring into Indian ocean. The river mouth is slightly clogged by sand Slightly meandering river forming a u-shaped valley on a highland area Slightly meandering river forming a v-shaped valley on a highland area. There are a number of falls	Kilifi Kilifi Tana river, Taita Taveta, Kitui, Machakos, Kiambu and Nairobi	Grazing and limited farming. Few human settlements on the valley bottom Normadic grazing. Few human settlements on the valley bottom Grazing. Few human settlements on the valley bottom
Tana	95,430	1,050	600	0-150 150-295 295-509	Heavily meandering river. Pours into Indian ocean cutting a sand dune along the coast line. Heavily meandering river on the flood plain limited by ASAL highlands, leaving ox-bow lakes. Bank erosion/local deposition also serious.	Tana River Taqna River Tana River and Garissa.	Grazing and limited farming. There exists Tana Delta Irrigation Scheme mainly for rice. Some human settlement on the delta. Grazing and limited farming. A few human settlements on natural dykes in the flood plain. Similar to the above though there exists Hola and Bura irrigation projects

				509-650	-do-	Tana River and Garissa.	Nomadic grazing. There exists ADC farm. Few human settlements in the valley bottom.
				650-960	Braiding ti meandering on a wide valley bottom	Tana River, Isiolo, Kitui, Meru, Embu and Machakos	Less human activities except for hydropower generation. Few human settlements in the valley.
				960-1,015	Slightly meandering river, forming v-shape valley on the ASAL highland. There exists Kindaruma, Gitaru, Kamburu and Masinga dams mainly for hydropower generation. Slightly meandering river, forming v-shape valley in the mountain area between mt.Kenya and Nyandarwa	Muranga, Kirinyaga and Nyeri	Subsistence agriculture with small areas. Few human settlements in the valley.
Ewaso Ngiro North	91,428	740	370	0-225	Swampy area in the ASAL area, Called Lorian Swamp, with water only during wet season.	Garissa and Wijir	Nomadic grazing. Few human settlements in the swampy area
				225-350	Meandering river on the ASAL area with water only during wet seaon	Isiolo	Nomadic grazing. Few human settlements in the ASAL area
				350-580	Slightly meandering river on a valley bottom in a hilly area	Isiolo and Samburu	Subsistence agriculture and grazing. A few human settlements in the valley
				580-704	Slightly meandering river, forming a v-shape valley in a mountain area	Laikipia	Subsistence agriculture within small areas. Few human settlements in the valley.

Source:National Water Master Plan, 1992

Main inter basin transfer schemes

Nairobi City water supply schemes

Nairobi lies in the upper part of the Athi Basin. It is supplied from surface and groundwater through a public distribution network, and also with private boreholes.

Box 2.1: Water sources for Nairobi City

Surface water is derived from several rivers within and through inter-basin water transfers from outside the basin. The supply is as follows:

- 360,000 m^3/day from Thika (Ndakaini Dam)*
- 60,000 m^3/day from Sasumua Dam*
- 20,000 m^3/day from Ruiru Dam (*Within Basin*)
- 4500 m^3/day from Kikuyu springs.(*Within Basin*)

Source: Nairobi City Council, Water & Sewerage Department

59.9 Km long and the water is used for domestic, livestock and irrigation water needs. The canal carrying capacity is1.13 m^3/sec. The allowance for irrigation is 0.991 m^3 /s. It has a total supply area of 10,300 ha. Area under irrigation is 808 ha.

About 180,000 people are served from the canal. The canal supplies Matuu Township with 0.04m^3/s. There are many schools, polytechnics and other institutions supplied with water from the canal. Ndalai sub-canal branches 11 Km. away from the main canal intake and has a capacity of 0.05 m^3/ sec supplying 3000 people with domestic and irrigation water.
The canal transfers water from the Tana Basin for use in the Athi Basin.

Table 2.22: Main inter-basin schemes

PROBLEMS	TARGETS	INDICATORS
▪ Implementation of inter-basin transfer schemes without consideration of demand of the donor basin ▪ Inadequate stakeholder consultations prior to implementation of schemes ▪ Uneven distribution of water resources	▪ Basin WRA studies ▪ Comprehensive demand studies to be undertaken	▪ No. of sustainable inter-basin transfer schemes ▪ No. of Basin demand studies done

Table 2.23: Summary Indicator Table

	1992	1996	2000	2003
No. of RGS				
Determined Dam Storages(cubic metres)		124M		303,909,938
No. of Dams developed.		3,000		4,128
Capacity of water moved in Interbasin Transfers (m^3)	420001.13	420001.13	420001.13	420001.13
No. of dams Washed away	No Records	No Records	1	No. Records

Source: Ministry of Water and Irrigation.

Spatial variance of water quality

The country is sub-divided into five drainage basins namely Lake Victoria, Rift valley, Tana river, Athi river and Ewaso Ng'iro drainage basins. The water quality of each drainage basin is summarized in the table 2.24 below:

Table 2.24:Water Quality for the Drainage Basins

Drainage Basin	Surface Water Quality	Groundwater Quality
Lake Victoria	Lake itself has fresh water. Rivers exhibit variable seasonal water quality-water in rivers is turbid, coloured and silt laden in rain seasons. In upper reaches, water is of good quality.	Over 90% of boreholes drilled have good water quality, which is fresh and free from high levels of dissolved salts.
Rift Valley	Only Lake Naivasha has fresh water. The other lakes in the basin have brackish to saline waters. In the upper parts of the rivers, water is of good quality but in lower parts high siltation and agricultural pollutants affect water quality.	Mostly fresh, neutral, soft and free from colour and turbidity. 50% of tested borehole waters have fluoride levels above 1.5ppm.
Athi	In upper reaches, water is of good quality in dry periods but gets very turbid during the rain season. Water quality deteriorates downstream due to pollution from municipal wastes, domestic sewage, industrial effluents and agricultural activities.	Over 50% of boreholes contain hard and saline water. At coastal area, sewage pollution and seawater intrusion affect the water quality. High local variations occur in water quality. Parts of the basin have high fluoride levels, hardness, high iron and manganese contents.
Tana	Generally of good quality. Pollution from municipal sewage, agrochemicals and siltation affects some rivers in this basin. Quality deteriorates gradually down stream.	Generally fresh and free from colour and turbidity. Hardness varies from soft to moderately soft. High fluoride levels in parts of the basin.
Ewaso Nyiro	Rivers have high turbidity due to agricultural activities.	Water often hard with variable salinity levels. Nitrate contamination has been detected and is due to accumulation of livestock waste at watering points

Source: Ministry of Water and Irrigation, Water Quality and Pollution Control Division

Table2.25: Lake water quality:-

Lake Name	Water Quality
Lake Victoria	Fresh
Lake Naivasha	Fresh
Lake Chala	Fresh
Lake Jipe	Fresh
Lake Bogoria	Saline
Lake Nakuru	Saline
Lake Elmementaita	Saline
Lake Baringo	slightly saline.
Lake Turkana	Slightly Saline

Source: Ministry of Water and Irrigation

Figure 2.6 Groundwater Quality Maps

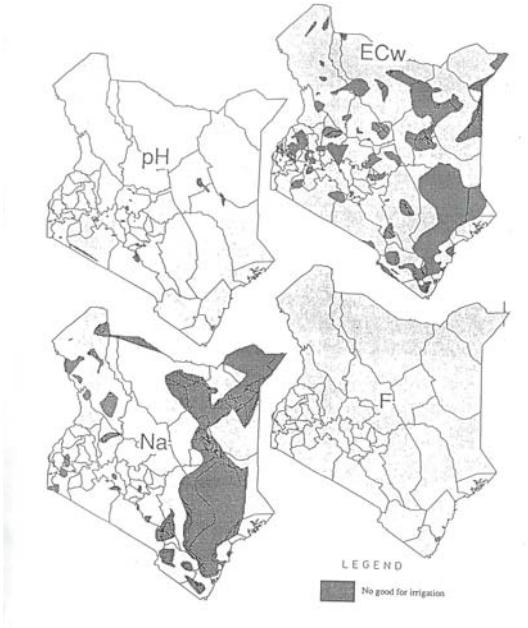

Figure 2.5 Groundwater Quality Maps

Water pollution status

. Major sources of water pollution have been identified as follows:-

- Industrial effluents;
- Domestic/Municipal Wastes- most Local Authorities are ill-managing domestic sewage and refuse, with the consequence of degradation of water resources in their areas of jurisdiction;
- Agro-chemicals and agro-based industries;
- Natural and diffuse sources.

The following are the major polluting industries in Kenya

- Coffee factories
- Tanneries
- Heavy chemical Industries
- Sugar factories
- Textile factories

Water quality and pollution control monitoring stations.

Water quality monitoring stations have been established and distributed among the major rivers, lakes and groundwater in the various

basins. The sampling stations are located at hydrological gauging stations:-

- where practical, upstream of major socio-economic activities and major industrial and domestic effluents discharge points ;and are designed to provide baseline data on natural water quality – "Reference stations"

- Near known point sources of pollution and are specifically for pollution control purposes.

-

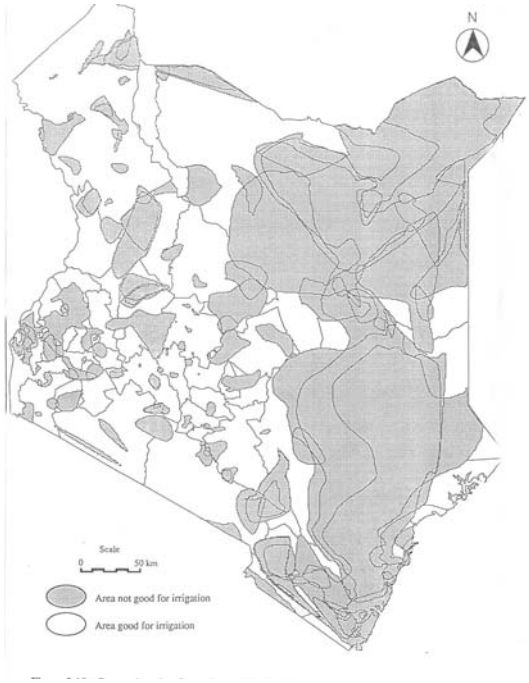

Figure 2.6: Comprehensive Groundwater Quality Map

- Downstream of major agricultural activities, industrial and domestic effluent discharge points – "impact stations"

- At the most downstream points for assessment of the combined load discharged into the lake or ocean and the self-purification capacity of the river – "impact station"

Table 2.27: Pollutant Discharge Load by Sector

Table 2.26: Distribution of Water Quality Sampling stations:

-

Drainage Basin No.	Number
L. Victoria	31
Rift Valley	24
Tana River	24
Athi River	20
Ewaso Ng'iro	6
Country Total	**105**

Source: Ministry of Water and Irrigation, Water Quality & Pollution Control Division

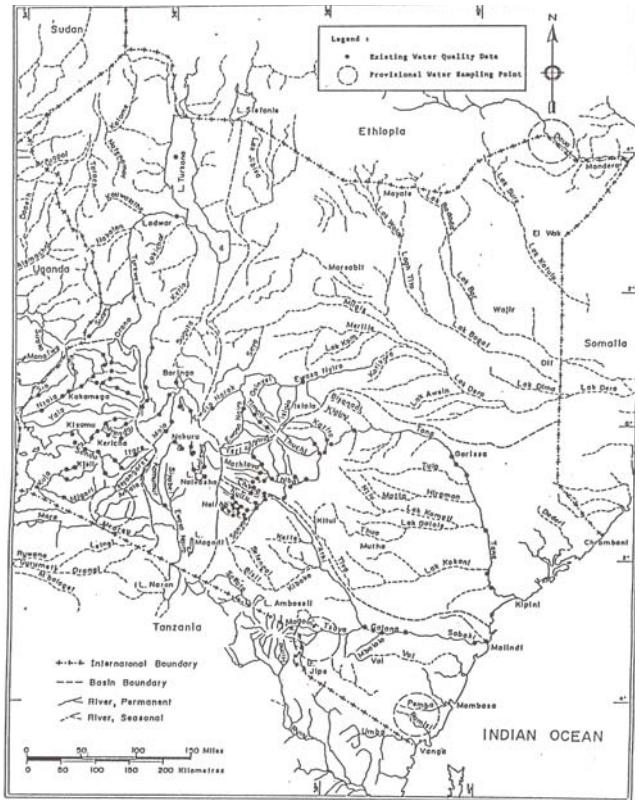

Figure 2.7: Water Quality Monitoring Points

	Pollution Source	Typical BOD Level of Raw Effluent, mg/l	Typical COD Level of Raw Effluent, mg/l
1	Industry		
	- Coffee Pulping	3000 - 9000	3000 - 28000
	- Textile	1500	3300
	- Leather Tanning	1500	
	- Paper and Pulp	1500	
	- Slaughter House	1400	2100
	- Fruit Canning	2000	
	- Milk Processing	1000	1900
2	Domestic Waste	500	
3	Agriculture		
	- Cattle Pen washings	1500	
	- Pig Sty Slurry	15000	
	- Poultry Manure	30000	

Source: Ministry of Water and Irrigation, Water Quality and Pollution Control Division.

General overview of pollutants from human impact

The main pollutants are:-

- Organic residues from municipal sewage, brewery wastes, wet coffee processing, sugar cane milling, pulp and paper milling and creameries
- Toxic wastes from heavy metals, pesticide discharges and tanneries
- Fertilizers from agricultural activities
- Detergents from domestic use
- Micro-organisms from municipal sewage
- Inert suspensions from soil sediments and mine waste

Table 2.28: Issue: spatial variance of water quality

PROBLEMS	TARGETS	INDICATORS
▪ Most surface water resources affected by pollution ▪ No of irregular WQ & pollution control sampling ▪ Limited/WQ data ▪ Poorly equipped WQ Laboratories ▪ Weak enforcement of WQ & Waste water standards ▪ Analysed water quality data control rarely undertaken ▪ Untreated Waste water discharge into water bodies	▪ Regular WQ monitoring and sampling ▪ Establish representative WQ sampling network ▪ Enforcement of WQ standards and waste water standards ▪ Protection of water resources against pollution ▪ Equip WQ laboratories for full chemical analysis ▪ Equip sub-catchment units with portable WQ sampling equipment d ▪ Develop WQ models/capacity for WQ modelling	▪ No of WQ samples taken ▪ No of waste water samples taken ▪ No of additional WQ sampling stations established ▪ No of incidences reported on non-compliance of waste water standards ▪ No of labs that can perform full chemical analysis ▪ No of sub catchment units equipped with portable WQ sampling equipment ▪ No of WQ models developed/No of trained officers on WQ modelling

Source: Ministry of Water and Irrigation.

Table 2.29: Summary Indicator Table

	1992	1996	2000	2003
No. of additional WQ sampling stations established	105	105	105	105
No. of WQ models developed	1	1	1	1
No. of labs that can perform full chemical analysis	6	6	6	6

Source: Ministry of Water and Irrigation

Effect of pollution on water resources.

- Health hazards - Water related diseases increase mortality and morbidity
- Poverty increase
- Cost increase in water treatment and supply
- Eutrophication caused by detergents, fertilizers and sewage
- Habitat modification from soil erosion

Loss of fauna and flora

Droughts and floods (Water Disasters)

Box 2.2: History of Drought in Kenya.

Kenya has a long history of floods and droughts. Both climatological records and oral knowledge show that the droughts with severe occurrence resulting to both human and ecological impact occurred in the following years: 1928, 1933-1934, 1942 – 1944, 1952 – 1955, 1960 and 1965. NWMP-1 Study defined the drought in the early 1970's as the worst for the period from 1945 – 1974.

The anomalies in rainfall have caused widespread famine as drought brings about crop failure. The 1971 –75 and 1984-1985 droughts attracted worldwide attention due to their extent and severity (Source: National Water Master Plan, NWMP).

The latest severe drought experienced between 1998 to 2000 was classified as the third worst ever and affected all sectors of the economy:-

- The energy sector suffered a huge financial loss.
- In the Agricultural Sector, rice production dropped by 40% with productive land lying fallow.
- Agro-Industries lost 30 – 40% of production, and there was a cereal deficit valued at Ksh.2.82 billion.
- Many areas endured livestock losses of 40% of their total stock.
- Five out of six community water supply earth dams and pans in Ewaso Ng'iro South basin dried up. The prevalence of water borne diseases increased.

(Source: Country Strategy on Integrated Water Resources management MW&I).

Table 2.30: Drought

PROBLEMS	TARGETS	INDICATORS
▪ Limited storage capacity of water conservation structures ▪ Siltation of Water storage structures ▪ Weak enforcement of water laws due to limited resources ▪ Water use conflicts in dry periods	▪ Create water storage structures to store water to meet water needs during dry period ▪ Enforcement of water laws governing: Water use in dry periods	▪ Storage capacity of water conservation structures ▪ Number of Water use conflicts during dry periods

Source: Ministry of Water and Irrigation

Table 2.31: Summary Indicator Table

	1992	1996	2000	2003	2005
Storage capacity of water conservation structures(cubic metres)		124M		303,909,938	
Number of Water use conflicts during dry periods	Not Recorded in Number	Same	Same	Same	

Source: Ministry of Water and Irrigation

Flooding

Flood records are sparsely documented in Kenya. Flood events obtained from relevant reports, interview survey and field reconnaissance as well as interpretation of water level records at gauging stations indicate that major floods occurred in the years 1937, 1947, 1951, 1957 – 58, 1961, 1978 and 1998. The exceptionally heavy and widespread rainfall experienced during October and November 1961 resulted in unusually severe floods in many areas.

The 1961 floods inundated the Kano Plains, Yala Swamp and other low-lying areas around Lake Victoria. The inundation area was approximated to be as large as 250 sq.km, excluding permanent swampy areas. Severe damages took place along the Nzoia, Yala and Nyando rivers. Lake water level on the lake Victoria rose by about 1.3m higher since then. *(Source NWMP, 1992)*

The floods also hit the Lower Tana reaches. 500 Km^2 of land near Garissa was inundated by floodwaters. Peak discharge of about 3,000m^3/s at Garissa on 20th to 21st November 1961 was estimated at a probability of once in over 50 years for the upper catchment of Tana River.

The El-Nino induced floods of 1997/1998 caused some US$ 151.4 million in public and private property damage. This figure does not include the number of people who lost family members, savings, property and economic opportunities.

Table 2.32: floods

PROBLEMS	TARGETS	INDICATORS
▪ Degraded catchments ▪ Inadequate flood control structures ▪ No early warning system in place ▪ Lack of insurance cover against flood related disasters ▪ Negative socio-cultural beliefs ▪ Poor maintenance of storm water drainage structures ▪ Human interference with flood control structures	▪ Construct flood control & storage structures. Proper Catchment management ▪ Develop early warning system ▪ Institutional interlink-ages on information exchange ▪ Sensitisation of communication and other relevant institutions in flood prone areas	▪ Capacity of flood control structures ▪ Percentage of area covered with forest ▪ No of early warning systems developed ▪ No. of interlink-age established ▪ No. of sensitisations held

Table 2.33: Summary Indicator Table

	1992	1996	2000	2003	2005
Capacity of flood control structures(M^3)	750	750	750	750	
No of early warning systems developed					
Percentage of area covered with forest				3.3%	2.5%

Source: Ministry of Water and Irrigation

Disaster Management

Historically, Kenya did not view disaster management as an integral part of development planning and water related disasters were responded to in an ad hoc manner when they occurred. It was not until November/December, 1997 when the El-Nino floods hit our region that:-

i) The National Disaster Operation Center (NDOC) was set up in January, 1998. In June, 1999, the GOK, in collaboration with the United Nations Disaster Management Theme Group (UNDMTG), formed the Kenya Action Network for Disaster Management (KANDAM), which was mandated to evolve disaster management strategies tailored to the Kenyan situation.

Currently much effort is being put into the preparation of a Disaster Management Policy Paper. *(Source: Country Strategy on Integrated Water Resources).*

There are several flood protection projects proposed to date. The majority of these projects is concentrated in the Lake Victoria Basin, On rivers such as Nzoia, Yala, Nyando and Kuja. Besides some projects are conceived at Nairobi City and Lower Tana.

Human impacts on water resources
Human impact on the ecology and status of rivers

Catchment degradation resulting from poor land use is amongst serious problems impacting on the water resources in Kenya. Population pressures with weak or no soil and water conservation have precipitated poor land use practices, which have increased soil erosion and are imposing a huge economic burden on the economy.

Examples of poor land uses include:

- Cultivation on steep slopes, river banks and lake shores without proper conservation methods,
- Clear cutting of forests for agriculture in private forests, fuel wood and charcoal
- neglect and destruction of cut off drains, bench terraces and works designed to conserve soil
- Overstocking and overgrazing

Poor land use depletes the vegetation cover and topsoil, makes the topsoil and soil matrix vulnerable to erosion, alters surface runoff and infiltration rates and accelerates soil erosion and hence significantly affects water resources availability and quality.

Due to human impact to the ecology, the effect to water resources is:

- Increased runoff and generation of floods due to loss or reduction of vegetation cover
- Decreased infiltration due to loss of vegetation hence reduced groundwater recharge.
- Reduced low flows in rivers in dry periods
- Lowering of groundwater tables
- Deterioration in water quality due to soil erosion

Impacts of dams, diversions, and transfers

Environmental impact of dams and reservoirs

- Loss of land due to land required for dam site, reservoir, canal and powerhouse
- Temporary loss due to land required for lease for construction of campsite and access roads
- Partial loss of legal right due to way leave agreements along power transmission lines
- Encroachment on river catchments
- Temporary construction of roads and permanent access roads built for the project often have the adverse impact of opening up the river valley to development and other forms of exploitation by loggers and farmers
- Encroachment of national parks and forest reserves and creation of reservoirs inside natural forest reserves especially those of indigenous forest leads to their loss
- Many fish species make annual migration along rivers during the breeding season but dams impede their progress. For example fish in river Tana no longer move freely through the upper and middle reaches of the Tana river. Fish ladder and bypasses need to be provided.
- Rise in water table due to reservoir impoundments
- Increase in salinity due to irrigation activities

General overview of pollutants from human impact

The country strategy on water resources management has formulated a strategy which if implemented will attempt to address water pollution control.

Water pollution has become a serious problem impacting on the limited resources and there is an urgent need to implement the proposed pollution control strategy.

Water pollution has seriously affected surface water resources especially in high

potential areas. Inadequate monitoring of point and non-point sources of pollution and the lack of effective pollution control are compromising the quality of water. This poses potential health hazards and increases water treatment costs among other effects.

Water pollution worsens water scarcity because it limits the use for water and also imposes higher treatment cost for downstream users.

The main pollutants of water in Kenya due to human impact are:

- Organic residues from municipal sewage and brewery wastes
- Inert suspensions from soil sediments and mine wastes
- Toxic wastes from heavy metal and pesticide discharges
- Fertilizers from agriculture and detergents from domestic use
- Micro-organisms such as faecal coliform, E coli, cholera bacilli from municipal sewage, and parasitic worms

Presently, only a small part of major urban centres are connected to central sewerage, the rest depend on septic tanks and pit latrines. Most municipal wastewater treatment plants provide inadequate treatment because they are either overloaded, poorly maintained or are completely broken down.

Partially treated or untreated wastewater is discharged into surface watercourses posing significant health hazards and localized eutrophication.

Pit latrines and septic tanks located in recharge zones pose a significant risk of contaminating water. Water related diseases are increasing.

The major industries discharge into Nairobi, Athi, and Thika rivers in Tana and Athi Basins, while Nzoia and other rivers in the Lake Victoria basin are also receiving increasing variety of industrial contaminants. Tanneries, paper and pulp mills, coffee processing factories, breweries, cane sugar processing factories and various other industries typically do not have properly functioning treatment plants or only achieve minimal treatment. Their effluent invariably contributes significant organic loads, heavy metals and other toxic substances to receiving waters.

Pollution problems in the upper Athi, Thika and Nairobi Rivers due to increased organic loads are common occurrences particularly during low flows. Partially treated effluent discharges from pulp and paper mills also result in frequent fish deaths in Lake Victoria.

Non-point sources of water pollution from agricultural sources are rarely addressed even though the use of fertilizers is high. The Lake Victoria Environmental Management Programme (LVEMP) has started to address this for the Lake.

Severe concerns have been raised with regards to the deteriorating water quality in Lakes Nakuru and Naivasha, in part related to municipal discharges but also as a result of agro-chemical usage.

Table 2.34: Human impact on water resources

PROBLEMS	TARGETS	INDICATORS
▪ Poor land use practices due to lack of awareness on good land use practices ▪ Unplanned settlements ▪ Poor enforcement of existing laws on good land use practices ▪ Deterioration of water quality	▪ Sustainable land use practices ▪ Periodic environmental monitoring of catchments ▪ Increase forest cover with 10% of total land area. ▪ Construct adequate	▪ Number of environmental monitoring reports ▪ Area under forest cover ▪ Number of functional WW treatment plants

▪ Increased water treatment cost ▪ Poor health due to water related diseases ▪ Weak environmental audit	waste water treatment plants ▪ Awareness creation on proper land use practices Periodic environmental audits	▪ No. of environmental audits ▪ No. of sensitisation meetings held

Table 2.35: Summary Indicator Table

	1999	2000	2001	2002	2003	2004
Number of functional WW treatment plants	38	38	38	38	38	38
Number of environmental monitoring reports	1	1	1	1	1	2
Area under forest cover established(Ha)	147,200	147,200	120,000	121,000	122,000	132,300

Source: a) *Aftercare Study, 1998*

b) Economic Surveys 2003, 2004, 2005, Central Bureau of Statistics.

Main problems concerning water resources availability.

There are four main characteristics concerning water resources availability in Kenya that make it important for proper management programmes to be put in place.

- The Country has a limited endowment of just $650m^3$ per capita per year of fresh water. This puts Kenya in a "water scarce" category and means that the country has significantly less water per capita than its neighbors.

- Water availability is highly variable in space and time. Kenya experiences both floods and droughts.

- The major rivers in Kenya all originate from only five specific mountainous regions. Mismanagement of these few water towers has effects throughout Kenya.

- Over half of Kenya's water resources, both ground and surface water are shared with her neighbours. The consequence is that the water resources need to be managed co-operatively within an agreed framework in order to avoid tensions and to exploit the benefits of development for all.

Problems affecting water resources availability

Physical Characteristics
About 80% of the land area is classified as arid to semi arid lands. These lands have limited soil and water resources, and support 25% of the human population and over 50% of livestock in the country. Due to limited water resources in the ASAL regions, water availability is the main limiting factor to the development of these areas.

Limited natural endowment of water:
Kenya is classified as a chronically water scarce country in absolute and relative terms. The natural endowment of renewable fresh water is about 650m3 per capita per year.
Not all of the country's water resources can be exploited. The accessible component is known as the safe yield. The surface water safe yield is estimated to be about 7.4 billion cubic metres per year, while estimated groundwater safe yield is estimated at about 1 billion cubic metres per year. At present, the country withdraws less than the safe yield.

In 1992, the National Water Development Master Plan study estimated the level of withdrawal for surface water as 1.1 billion cubic metres per year whereas groundwater abstraction was estimated at 180 million cubic metres per year. However, these estimates have not been updated to reflect current water withdrawals.

The data shows that in 1992 approximately six times more water could have been safely abstracted from surface water resources and approximately five times more water could have been safely abstracted from groundwater resources. Thus in 1992 only 17% of safe exploitable surface water resources was in use while only 20% of safe exploitable groundwater was in use.

It should be noted that water development potential in the country is not uniform across the country. There are marked regional, annual, and seasonal imbalances.

The country is classified as water scarce but much of the available potential has not been used. This means that the country has not substantially developed even the very limited amount of water that is available, and the low level of development is due to spatial variation in water distribution and low level of investment in water development.

Highly variable climate:
Kenya experiences wide climatic variations both in time and space. Most parts of the country have two rainy seasons. The long rains are typically from March to May while short rains are typically from October to November.

There is considerable spatial variability in rainfall received ranging from 250mm per year in ASAL areas to 2000mm per year in the high mountain areas. About two thirds of the country receives less than 500mm of annual rainfall.

The rainfall received is inversely proportional to the size of the catchment areas, thus the Lake Basin, which is the smallest in the country, receives the highest amount of rainfall whereas the Ewaso Ng'iro Basin, which is the largest, receives the lowest amount of rainfall.

Rainfall is also variable over time, especially in ASAL areas. The country experiences droughts and floods every three to four years. Major floods affecting much of the country were experienced in 1961 and 1997-98. The April 2003 floods were caused by slightly above average rainfall, but flood damage was extensive partly because of heavily degraded catchments together with settlements in the flood plains.
Major drought periods have occurred about every ten years, the 1998-2000 drought was one of the severest in recent times.

Droughts have become endemic in some parts of Kenya. The ASAL areas are the poorest areas of the country and are the areas most affected by drought. The traditional drought coping strategies are becoming ineffective.

Limited water resource areas
Most of Kenya's surface water originates in localized catchments in five mountain areas, namely Mt. Kenya, Aberdares, Mau complex, Mt. Elgon, and Cherangani. These critical sources are commonly referred to as "Kenya's water towers" and they support the major sectors of the economy.

The Mau Forest Complex is the source of Mara and Sondu rivers. The former river supports the Masai Mara Game Reserve and hence is key to the survival of wildlife in Masai Mara Game Reserve and Serengeti National park in Tanzania.

The Sondu Miriu Hydro Power Complex on Sondu river is under construction and is expected to contribute about 60 MW to the national grid. The Njoro river which orginates from the Mau Forest Complex provides water to Lake Nakuru, which is an important wildlife refuge and centre of tourism.
Mt. Kenya provides water supply to Nairobi and is the source of Tana River, which has the seven Forks cascade that generates about 70% of Kenya's domestic electricity. It also supports agricultural development along the Tana Basin.

The increasingly important horticultural and floricultural industries, which generate high export revenue, depend on water from the Aberdare Ranges and Mt. Kenya area.
Groundwater is widely available in Kenya but the annual quantity of renewable groundwater is about 10% of renewable surface water.
Areas that receive low rainfall and runoff such as Ewaso Ng'iro basin are largely dependent on groundwater as a reliable source.
In ASAL areas, any contamination or over - abstraction of groundwater has a very serious consequence for residents who are typically some of Kenya's poorest people. They are highly vulnerable to droughts, so degradation of groundwater in these areas contributes directly to poverty. Groundwater is also an important supplementary source in urban centres such as Nairobi, Mombasa, and Nakuru

Substantial trans-boundary waters
About 54% of Kenya's water resources are shared with other countries. Through the Lake Victoria Basin, Kenya provides about 45% of surface water inflows to Lake Victoria, and hence to the upper Nile. Kenya also shares a large amount of other important surface and groundwater resources with its neighbours - Ethiopia, Sudan, Tanzania and Uganda.

This inter-dependence between Kenya, its neighbours and downstream and upstream Nile countries has considerable implications for the management of the country's water resources. As an example, Lake Victoria Basin is one of the water surplus areas of Kenya but an area which routinely suffers from regular flooding and extreme poverty.
For large-scale use of the water resources in this basin, there has to be trust and confidence built amongst the riparian countries sharing the water resources of this basin. Unilateral action outside a common framework could on the other hand create tensions amongst riparian countries.

Table 2.36: Problems concerning water resources availability

PROBLEMS	TARGETS	INDICATORS
▪ Contamination of water leading to poor water quality ▪ Limited natural endowment ▪ Climate variability ▪ Limited water resource areas ▪ Substantial trans boundary water	▪ Increase availability of water to ASAL areas through interbasin transfer and construction of water storage structures and development of ground water resources ▪ Protection and conservation of main watersheds ▪ Conservation of forests ▪ Storage of flood water ▪ International agreements on shared water resources	▪ No. of interbasin transfer schemes to ASAL ▪ Water storage structure capacity in ASAL areas ▪ Number of successful Boreholes in ASAL areas ▪ No. of Gazetted Water Conservation areas ▪ No. of international agreements on shared water resources

Table 2.37: Summary Indicator Table

	1992	1996	2000	2003
No. of inter-basin transfer schemes to ASAL				
Water storage structure capacity in ASAL areas				$2x10^6M^3$
No. of Gazetted Water Conservation areas				5
Number of successful Boreholes in ASAL				

Source: Ministry of Water and Irrigation

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3

Part III: The Different Roles, Uses and Impacts of Water

Part III: The Different Roles, Uses & Impacts of Water.

Water Reserved For Basic Human Needs & Environmental Concerns (Water Supply, Sanitation & Associated Environmental Needs)

Setting the Scene: Situation & Challenges

Water Supply in Kenya

Currently, access to safe water is estimated at 89% in urban areas and 49% in rural areas the value has not been determined. Sanitation access in urban areas is estimated at 94.8% as compared to 76.6% in rural areas. However, overall coverage has been declining in terms of quality and quantity, reliability and nature of access.

The Ministry of Water and Irrigation (MWI), the National Water Conservation and Pipeline Corporation (NWCPC) and Local Authorities (LA) are the main actors in water services provision. Other actors include River Basin Authorities, Communities, various in
stitutes and NGOs, who operate and maintain their own water supply systems. Local authorities provide sewerage services in municipalities and urban areas. The public institutions are centralized and bureaucratic, their organizational arrangements and culture providing little incentives to maintain facilities. Some actors are mainly concerned with policies, others with implementation, operation and maintenance and others with multiple roles, which has led to conflicts in the sector. The other actors in the sector include MoA, MoH, KVDA, TARDA, LBDA, KWS, and Private Companies.
Records from MWI indicate that currently there are 1549 water supplies under the management of various agencies as shown in table 3.1.

The MWI runs 628 rural water supplies out of which 200 schemes are gazetted for revenue collection, while NWCPC runs 48 supplies, 45 of which are gazetted. Communities combined with self-help groups and NGOs runs 873 schemes and LAs run a total of 8 schemes. More than 9000 boreholes have been registered with Water Apportionment Board (WAB). Approximately 57 million cubic meters is abstracted annually for various uses of which more than 50% is domestic and livestock while the rest is used for irrigated agriculture. Dug wells sustain 12% of the total households in Kenya. In all these schemes there are no demand management and metering systems are very few, causing low collection of water revenue while water quality control is hardly practiced. In general, staffing for operation and maintenance is not adequately provided contributing to intermittent operation of schemes. Record keeping and monitoring is poor while political interference in schemes is rampant

Table 3.1: Number of Water Supply Facilities by Provider and Population Served

Provider/ Supplier	NO.	Pop. Served (millions)
MWI	628	6.1
NWCPC	48	3.7
Communities	356	4.9
NGOs	266	
Self-help	243	
LAs	8	3.9
TOTAL	1549	18.6

*Source: D*raft National Water Services Strategy (2005-2007), Dated May 2005.

Policy, Legislation, Norms & Standards

Water Sector Policy Development
In the past the Government has formulated a series of policies, which have impacted on the water sector. The first positive step was a supply driven intervention policy to redress the colonial era misallocation of water resources. This resulted into setting up of numerous schemes and self-help groups. However, this policy put too much strain on government budget to the point it was not sustainable.

The definitive policy for the water sector was promulgated in April 1999 as Sessional Paper No.1 of 1999. This is the National Water Policy on Water Resources Management and Development. It calls for de-centralization of operational activities from the central

government to other actors, including local authorities, the private sector and increased communities' involvement in order to improve efficiency in service delivery. The new policy tackles issues pertaining to water supply and sanitation facilities development, institutional framework and financing of the sector. To enable sustainable water supply and sanitation services, there is need to apply alternative management options that are participatory through enhanced involvement of others in the provision of these services.

Water Act 2002
In order to operationalize the new policy, a new legal framework had to be put in place.

The Water Act 2002 provides for establishment of 3 levels of institutions for the provision of services. These are:-

- Water Services Regulatory Board (WSRB)
- Water Service Boards (WSB), and
- Water Service Providers (WSP)

The Water Act 2002 sets out these institutions based on the principles of:

- Separation of water resources management from water services provision
- Separation of policy, regulation and implementation functions within the water supply and sanitation sector in order to streamline the roles of the various actors in the sector.
- Devolution of responsibilities for water services provision to WSPs, who shall include the Private Sector, communities and Companies formed by LAs
- Human resource redeployment and development leading to more effective and efficient institutions
- The need to give full autonomy to water service providers to enable them perform without adverse interference or influence
- Improved delivery of services to customers

Strategic Framework for Water Services
The National Water Services Strategy (NWSS) provides a suitable framework to achieve decentralization, injection of efficiency and increase sustainable access to improved water services as legislated in the Water Act 2002. The NWSS is a legal document gazetted in accordance with the Water Act 2002, describing ways of ensuring access to water services, its availability and coverage to every consumer. It shall remain in force until it is amended as provided for in Section 49(2). It is intended that edition of the strategy shall be reviewed after three years of its gazettement, and subsequently every five years.

The Strategy Paper promotes institutional reforms that separate water resource management from water services provision and outlines separation of policy, regulation and implementation functions within the sector, in accordance with the Water Act 2002. A WSRB will regulate the provision of services by registered WSPs through the proposed WSBs. WSBs, apart from exceptional situations will not be required to provide services directly but through contracted WSPs appointed through a competitive process. The WSPs will be required to operate the schemes on cost recovery basis and comply with standards on quality, service levels and performance established by WSRB.

Service Levels

Urban Housing Classes
The water demand for urban setting is classified as per the type of housing.

The Ministry of Lands and Housing has classified housing as high, medium or low class housing and is defined for planning purposes as follows: -

High Class Housing:
Generally low density plots of 0.2 – 0.8 hectares. Houses furnished with internal pipe and hot water, electricity supply, refrigerator, electric cooker, bathrooms, water closet (WC) and internal arrangement for cloth and dish washing.

Medium Class Housing:
Generally low-density development plots of about 0.1 hectares. Houses furnished with at least internal piped cold water, gas or electric refrigerator and electric cooker, bathrooms, WC and internal arrangement for cloth and dish washing. Splash area outside for cloth washing.
Low Class Housing:

Generally high-density development. Houses furnished with very simple piping for cold water or external water points for cloth and dish – washing (splash area). Includes site and service scheme housing.

Rural Areas

The water usage per capita is based on land potential classified due to the amount of rainfall. The classification is as follows: -

High potential area is normally considered to be an area with an annual rainfall more than 1000mm. However, local factors such as very concentrated annual rainfall, adverse topography, soil conditions, special attitudes, tourism, roads irrigation etc. is taken into account.

Medium potential area is normally considered to be an area with annual rainfall of between 500mm and 1000mm. However, local factors may be adjusted as above.

Low potential area is normally considered to be an area with an annual rainfall of less than 500mm. However, local factors may be adjusted as above. In low potential areas, the scheme is invariably small, which serve trade centers, institutions and some people around the center.

Livestock Potential

One livestock unit is defined as high grade stock cattle over 2 years

Conversion of other types of cattle for the purpose of calculating the livestock potential is made using the following tables:-

1 Grade cow= 1 Livestock Unit
3 Indigenous Cows=1 Livestock Unit
15 Sheep or Goat=1 Livestock Unit

Spacing of Primary and Secondary Pipelines

High and Medium Potential Areas

The distance from 90% of the residential houses to the nearest primary and secondary pipeline should normally not exceed 2.5km. However for low potential areas it should not exceed one km.

Urban Areas

The Pipeline should follow roads and streets as shown on the town plan.

Service Type

The distribution between individual connection users (IC) and non individual connection users (NC) i.e. consumers using kiosks or communal water points or share connections for the demand projection of new water supplies is based on the following: -

Table 3.2: Recommended service levels in rural and urban areas

	IC%			NC%		
	Initial	Future	Ultimate	Initial	Future	Ultimate
Urban Areas						
High & Medium class housing	100	100	100	0	0	0
Low class housing	10	30	50	90	70	50
Rural Areas						
High Potential	20	40	80	80	60	20
Medium Potential	10	20	40	90	80	60
Low Potential	5	10	20	95	90	80

*Source: MW&I; D*raft Water Practice Manual, 2005

Water Consumption Rates

The following are the per capita consumption rates, which do not vary during the day and contains about 20% allowances for water losses through leakages and wastage.

Table 3.3: Recommended consumption rates in rural and urban areas

Consumer	Unit	Rural Areas			Urban Areas		
		High Potential	Medium Potential	Low Potential	High class housing	Medium class housing	Low class housing
People with individual connections	L/h/d	60	50	40	250	150	75
People without connections	L/h/d	20	15	10	N/A	N/A	20
Livestock	L/h/d	50					
Boarding schools	L/h/d	50					
Day schools with WC without WC	L/h/d	25 5					
Dispensary	L/h/d	5000					
Administrative offices	L/h/d	25					
Bars	L/h/d	500					
Shops	L/h/d		100				

Source: MW&I Draft Water Practice Manual,2005.

Climbing up the ladder" of Basic Service Levels

Water

It is the improvement of lever of services from Communal Water Point to Individual Connection.

Sanitation

It is the improvement of sanitation service from onsite to Waterborne.

Table 3.4: Summary indicator table on different roles and uses of water

Indicator	1998	1999	2000	2001	2002	2003
Amount spent on water supplies	913.073m	788.605m	932.271m	1.3431b	2.4b	4.4b
Water Storage Structure capacity in water supplies 10% X $1,459x10^3m^3$	$145.x10^3m^3$	$145.x10^3m^3$	$145.x10^3m^3$	$145.x10^3m^3$	$145.x10^3m^3$	$145.x10^3m^3$
% of O&M cost. Recovery for rural water supply	55	55	55	55	55	55
No.of water service companies and WUAS formed and operational	357	357	357	357	357	360
% of unaccounted for water	50	50	50	50	50	50
Water Produced	$1,459x10^3m^3$	$1,459x10^3m^3$	$1,459x10^3m^3$	$1,459x10^3m^3$	$1,459x10^3m^3$	$1,459x10^3m^3$
Actual Population served	9.2m	9,179,714	10,001,734	9,719,858	10,001,734	10,291,784
No. of new connections	27,250	28,040	28,854	29,690	30,551	31,498
No. of employees	12,346	12,141	11,597	10,352	11,376	10,997

*Source:a) A**ftercare Study, 1998(Projections)***
b) Statistical Abstract, 2004

Strategies and Goals

Principles and Justifications

The Water Act 2002 sets out the institutions needed to be put in place so as to improve the overall delivery of the water services based on the principles of

- Separation of water resource management from water services. The purpose is to avoid potential conflicts of interest between the allocation and management of water resources, including setting of water use and reuse standards, and water supply and sanitation operation and maintenance guidelines, and provision of water supply and sanitation services. It is also more efficient to have hydrological surveys, water resources assessment, research and water allocation and standard setting, separated from water supply and sanitation services provisions because these activities require different professional disciplines and experience.
- Separation of policy, regulation and implementation functions within the water supply and sanitation sector in order to streamline the roles of various actors in the sector, including the establishment of a WSRB to monitor the effectiveness of the service providers and take corrective measures as and when necessary.

- Devolution of responsibilities for water services provision to WSPs, who shall include the private sector, communities, and companies formed by LAs
- Human resources redeployment and development leading to more effective and efficient institutions. Redeployment of existing staff to the proposed institutions will be supported by performance based incentive schemes, promotional policies and competitive salaries and benefits, aimed at ensuring the availability and retaining of sufficient numbers of qualified staff in all disciplines required by the sector.
- Provide full autonomy to WSPs to perform without interference or influence.
- Improve delivery of service to the customer

Performance Areas & Indicators

Progress with sustainability indicators

- Economic and financial feasibility
- Institutional capacity
- Participation and ownership
- Operational and Maintenance status

Service provision performance indicators

- Coverage
- Quality
- Reliability

Table 3.5 presents a detailed description of the above elements.

Issues & Constraints

- Over reliance on agriculture
- Poor distribution of resources
- Lack of policy developmemnt

Table 3.5 Reserve Water (Water for Public Purposes) Summary Table

Goal	Target	Indicators	Current Status	Will goal be achieved	Supportive Environment	Monitoring Capacity
1.Sustainability of Water supplies	Economic & Financial feasibility	1. O&M cost recovery for rural water supply 2.Full cost for recovery of urban water supply		Probably	Strong	Fair
	Institutional capacity building by 2007	1. Human resources 2.Financial resources 3.Implementation 3 year plans for the Establishment of the Boards	1.Ongoing establishment of Boards 2.Budget provision for 2004/2005	Likely	Strong	Fair
	Participation and ownership	1.No. of water service companies 2.WUAS formed and operational	1.(9) water companies formed in 2004 2.865 community WUAS established by 2004	Likely	Strong	Poor
	Operational and Maintenance status	1.Service level 2.% of unaccounted for water	1.Declining 2.50%	Likely	Strong	Fair
Service Provision Performance	Coverage 80% by 2010	Actual population served	46% 70%	Probably	Strong	Fair
	Quality	Water Quality Monitoring & Information System	Weak Monitoring System	Likely	Strong	Fair
	Reliability	No. of days without water	Need for survey	Probably	Strong	Fair

Table 3.6: Summary Indicator Table on Different roles and uses of water

of water

	1998	1999	2000	2001	2002	2003	2004
Amount spent on Water Supplies (Kshs)	913.075m	788.605m	932.271m	1.3431B	2.4B	4.4B	
Water storage structure capacity in water supplies (M^3	$145.9X10^3$	$145.9X10^3$		$145.9X10^3$	$145.9X10^3$	$145.9X10^3$	$145.9X10^3$
No. of Gazetted Water supplies.							
% 0f O&M cost recovery for rural water supply.	55	55	55	55	55	55	
% of Full cost for recovery of urban water supply.							
No. of water service companies and WUAS formed and operational..	357	357	357	357	357	357	357
% of unaccounted for water.	50	50	50	50	50	50	
Actual population served	9.2M	9.197M	10.0M	9.72M	10M	10.3M	10.61M
No. of new connections	27,250	28,040	28,857	29,690	30,551	31,437	32,349
No. of employees.	12,346	12,141	11,597	10,353	11,376	10,997	

Sources: Aftercare Study 1998, Statistical Abstract 2003,2004

WATER + NATURAL ENVIRONMENT (Ecosystems)

Setting the Scene: Situation & Challenges

Water is a necessary requirement for living organisms and hence the sustenance of life on

earth. The two essential chemical reactions necessary for life namely; respiration and photosynthesis, take place in an aquatic environment. Ecosystems are sustained through the hydrological cycle.

Kenya is already rated as a water scarce nation . Therefore, efficient management of the water resources is essential for sustained supply of water, which is in turn necessary for sustainable development and alleviation of poverty.

About 80% of Kenya's land mass is classified as arid and semi arid land. In these areas, rainfall is insufficient for the growth of plants, sustenance of the livestock and human populations. Hence these are "fragile ecosystems" dependent on groundwater resources. The rest of the country, though endowed with sufficient rainfall, has been experiencing water scarcity due to changes in rainfall regimes, unsustainable use of water, catchment degradation and general weakness in the management and distribution of this vital resource.

Water resources are also influenced by biotic factors. Examples are like invasive species such as water hyacinth, water lettuce and various types of fish. This brings about ecological imbalance. Furthermore, over use of water resources results in depletion of the ground water resources. This has serious environmental consequences such as lowering the water table, seawater intrusion into coastal aquifers and contamination of groundwater. In addition some areas have experienced loss of water all together when springs and wells dry up.

Pollution from point and non-point sources is a threat to water resources and the ecosystems at large. Pollutants have adverse effects on both flora and fauna, which decreases biomass production and interferes with the health of the ecosystems. This affects the quality of life of the population and indirectly interferes with economic development and results in higher poverty levels.

In general the aquatic ecosystems need intensive management and conservation so that they remain pristine. This in turn provides the necessary water resource for the various developmental activities. In the Kenyan context ecosystems envisaged include lakes, rivers, streams, wetlands, the marine ecosystems as well as the groundwater aquifers. Wetlands in particular are vital for regulation of organic and inorganic matter in water bodies. In this regard, they act as the "Kidneys" of the earth. In addition they also act as recharge centres and water banks to cushion the nation from water scarcity in periods of drought.

The challenge, therefore, is putting in measures in management, planning, legislation and conservation, which allow for sustainable use of the water resources without compromising the quality of the environment. This means ensuring that there is sufficient water for the ecosystem sustenance as well as for developmental purposes.

Policy, Legislation, Norms & Standards

The current environmental policy is geared towards sound environmental management for sustainable development. This is envisaged in the principle of prudent use, which requires that the present day usage should not "compromise the needs of future generations". In the case of water, this is more so because it is the basis of human development. The policy emphasis is on environmental protection in order to ensure sufficient supplies for the present and future generations. The policy envisages the use of the "polluter pays principle", where one is expected to make good any damage made to the environment.

The Environmental Management Coordination Act (EMCA) 1999 was enacted to ensure sound management of the environment. In relation to water resources, Section 42 of the Act deals specifically with the protection of rivers, lakes and wetlands. The act forbids interference with water bodies without the express permission from the National Environmental Management Agency (NEMA) Director General. The permission can be granted subject to the findings of an Environment Impact Assessment (EIA). The act also empowers the Minister of Environment to declare a lakeshore, Wetland, Coastal Zone or riverbank as a protected area and impose such restrictions, as he considers necessary to protect the lakeshore, wetland, coastal zone and riverbank from environmental degradation.

The National Environment Management Authority has already prepared the Environmental Impact Assessment and Audit Regulation 2003. According to the regulations, the EIA should be conducted by a licensed environmental practitioner and submitted to the Authority for consideration.

The standards committee is in the process of preparing various standards including water quality standards. In the meantime the World Health Organization (WHO) standards on water quality are applicable.

Strategies, Goals, Programs & Action Plan

Water quality standards

Water Quality criteria for various water uses have been adopted. Besides, criteria for irrigation waters, livestock watering and other common uses, the most utilised water quality criteria are those for raw water source for public water supplies and treated water. Effluent discharge standards are also adopted on all effluent discharges into streams and other water bodies.

Drinking water quality criteria

In determining the suitability of water for drinking purposes, especially for large community water supplies, reference is made to the World Health Organisation (WHO) guidelines for drinking water quality, and the Kenya Bureau of Standards (KEBS) for drinking water. Tables 3.7 and 3.8 below give the WHO guidelines for aesthetic water quality as well as bacteriological quality respectively.

Effluent discharge guidelines

Effluent discharge guidelines have been formulated and have until 2003 been enforced by the Pollution Control Unit within the Ministry of Water and Irrigation (MWI). The standards are based on the nature and volume of effluent discharge, the dilution capacity of the receiving water body, and the subsequent use of the water downstream of the discharge point. Table 3.6 below gives the generalised effluent discharge guidelines. However, separate discharge limits exist for heavy metals, pesticides and other toxic materials.

Table 3.7: WHO guidelines for aesthetic quality

Parameter	Concentration mg/L
Aluminium	0.2
Chloride	250
Copper	1.0
Hardness as $CaCo_3$	500
Iron	0.3
Manganese	0.1
Sodium	200
Sulphate	400
Fluoride	1.5
Total Dissolved Solids (TDS)	1000
Zinc	5
Colour	15 TCU
Taste and Odour	Not offensive for most consumers
Turbidity	5 NTU
PH	6.5 – 8.5

Table 3.8 WHO guidelines for bacteriological quality

Piped Supplies	Number per 100 ml
Treated water entering	Faecal coliform 0; Coliform organisms 0

Parameter	Maximum Permitted in effluent discharged
BOD_5 (5 days at 20°C)	20 mg/l
Suspended Solids	30 mg/l
Cyanide (as HCN)	0.1 mg/l
Sulphide (as S)	0.1 mg/l
Oil and Grease	NIL
Phenols	0.5 mg/l
Total Toxic metals (alone or in combination)	0.5 mg/l
pH	6.5 – 9.0
Temperature	± 3°C of recipient water body
distribution system	
Untreated water entering distribution system	Faecal Coliform 0; 3 Coliform organisms in everyone or 0 in 2 consecutive samples
Water in distribution system	Faecal coliform 0; 3 Coliform organisms in everyone or 0 in 2 consecutive samples 0 in 95% of yearly samples
Unpiped supplies	Faecal coliform 0; coliform organisms 10
Bottled Drinking water	Faecal coliform-0; Coliform organisms-0
Emergency supplies of drinking water	Water faecal coliform-0; Coliform organisms-0

Species protection plan

The protection of the environment and species is as stipulated in EMCA 1999 part V section 42 (1) from (c) to (d), where it states: No person shall, without prior written approval of the Director-General (of NEMA) given after and environmental impact assessment, in relation to a river, lake or wetland in Kenya, carry out any of the following activities: - (c) Introduce any animal whether alien or indigenous in a lake, river or wetland; (d) Introduce or plant any part of a plant specimen, whether alien or indigenous, dead or alive, in any river, lake or wetland. Section 51(d) states that the Authority shall, in consultation with the relevant Lead Agencies, prescribe measurers adequate to ensure the conservation of biological resources *in situ* and this regard shall issue guidelines for: - (d) special arrangements for the protection of species, ecosystems and habitats threatened with extinction. Sections 52 and 53 of the same act provides for conservation of biological resources *ex-situ* and access to genetic resources of Kenya respectively.

Table 3.9: Generalized effluent discharge guidelines

Environmental economics

Economic theory is about scarcity and choice. If a resource is not scarce, it does not mean that it has no value! And if a resource has a value, it does not necessarily mean it is scarce. The neo-classics of the late 19th to 20th century (Marshall) stated that the value of a good depends on both the input of labour, capital and natural resources (production cost principle) and the demand that is met (marginal utility principle). In this case, it implies that the optimal use of water requires that marginal utility and marginal cost of the water consumed are equal. Neo-classical economic theory applied to the field of natural resources and environment assumes that the environment is regarded as an economic good. Trade –off between environment and other economic goods and services is possible.

The problems in 'water economics' is that the natural resource 'water' has traditionally been regarded as a 'free' instead of a 'scarce' good. The price of water reflects production costs only, not opportunity costs. It should also be noted that externalities of water use are generally high, but difficult to quantify and water generally is not sold and bought at a market, so the market mechanism does not work.

Environmental Impact Assessment (EIA)
Environmental Impact Assessment is a basic tool for the assessment of the environmental impacts in the broadest sense of the word i.e. including political, technical and financial aspects of development proposals (Vis 2001). The National Environment Statute of Uganda (1995) defined EIA as a systematic examination conducted to determine whether or not a project will have any adverse impacts on the environment.

Kenya has since independence pursued policies and strategies aimed at achieving reasonably high levels of development for its rapidly growing population. Over time, the natural resource base has become severely stressed due to unsustainable use of the resources leading to scarcities of vital environmental goods and services in many parts of the country. This has made it imperative to harmonize environmental laws in Kenya under The Environmental management and Co-ordination Act (EMCA 1999) for the purpose of coordinating environmental management.

The National Environment Action Plan (NEAP) of 1994 and the National Policy on Environment emphasize the need for environmental impact assessment (EIA) on development projects. EMCA 1999 clearly makes EIA mandatory for all projects specified in the act.

The act also established the National Environment Management Authority (NEMA) as the institution to coordinate with the Lead Agencies in implementing the act. NEMA

The National Environment Management Authority has prepared a strategic work plan for the year 2003-2005. Adequate attention has been given to the management of the water resources. Indeed a Department of Aquatic Resources Management has been established.

The Department is expected to ensure sound management of water resources. Currently the department is coordinating the New Partnership for African Development's (NEPAD) Marine Resources Management Component. Close collaboration with Lead Agencies and NGOs is envisaged.

The overall objective of the aquatic resources strategy is to ensure sufficient aquatic resources for present and future generations.

Hidden costs and benefits
Improved access to water and sanitation services plays a huge indirect role in local communities in terms of the time savings, which is made available for economic activities. In addition, illness as a result of a water-related disease has a negative bearing on the economy. The time, energy and resources saved by improved water and sanitation can very often be used on productive economic activities.

Many urban poor people buy their water from private vendors, often at a rate well in excess of costs for piped water supply, and whose quality is questionable. This means that a significant proportion of household expenditure is spent on water. Reduced water prices would have a major impact on the economic status of these people and this may lead to economic growth, improved sanitation and reduced poverty.

In addition to paying money, there are other costs to be considered when it comes to water. This includes the resultant loss of production time due to illnesses caused by consuming unclean water, and the cost of seeking medical attention for these illnesses. The time spent collecting water must also be considered in terms of what could have been done or produced if the women did not have to spend three hours or so fetching water.

Tariffs are out of line with costs of providing water and add to the financial difficulties. The tariff levels do not adequately reflect the true economic cost of future water supplies. The poor are rarely connected as providers view them as commercially unattractive. Those connected are seldom metered and/or end-up paying flat monthly rates for water that may serve as many as 20 households (more than 100 people).

Access to safe water supply and sanitation will imply reduced incidence of waterborne diseases, leading to savings in the health budget. Time and energy savings, especially for women and girls, who are responsible for provision of water and sanitation services in most households, will

as well have a positive effect on their health with extra net savings

The economic impact of catchment degradation and deforestation is very significant and will require greater investment in water infrastructure in the near future to reliably meet the country's water needs. Such infrastructure development is expensive and needs to be carefully undertaken, within the context of national development planning, with full awareness of the need to increase the country's ability to survive natural climate variability. Such investments need to be economically and financially viable. The development of infrastructure also needs to be undertaken under internationally accepted safeguard criteria to ensure that it is environmentally sustainable and socially acceptable.

Negative impacts need to be adequately mitigated, including loss of bio-diversity, habitat destruction, social and cultural impacts such as resettlement and the loss of ancestral/archaeological heritage sites. Stakeholder involvement and consultation is therefore critical.

Criteria and guidelines have been developed for sediment surveys, infrastructure design and the operation and maintenance of dams and reservoirs. Rehabilitation of catchment areas is necessary to minimize the impact of reservoir sedimentation and to ensure sustainable use of water resources and associated infrastructure.

Performance Areas & Indicators

The main mission of NEMA is to achieve a clean and healthy environment in order to ensure sustained development and quality of life. In this regard, water resources are of great importance. Main areas of concern include: -

a) Awareness creation
b) Management of pollutants and
c) Monitoring evaluation
d) Water catchment protection
e) Training and capacity building.

The main indictors for water resources management include:

a) Efficient coordinative mechanisms
b) Functional provincial and district committees
c) Effective standards enforcement structure and
d) Well trained manpower with financial and infrastructure capacity to monitor as well as
e) Well-managed water resources.

Issues & Constraints

Freshwater Lakes

A number of lakes exist in Kenya, the most important ones as given in Table 3.10. Nearly all the major lakes are found in the Rift Valley basin. The water quality of the lakes varies from fresh-water lakes (L. Victoria) through brackish (L. Turkana) to saline lakes. (L. Magadi).

Table 3.10: Characteristics of Some Inland Lakes

Lake	Area (Km^2)	Depth (m)
Fresh Water		
Naivasha	115	6.5
Victoria	3785	43
Baringo	130	10
Brackish		
Turkana	6405	120
Saline		
Elementaita	18	1.1
Nakuru	5 – 30	Seasonal
Magadi	100	-
Bogoria	34	10

Wetlands

Wetland products represent a substantial resource within the highly populated, food-scarce Lake Victoria basin. These wetland products are those produced from the natural wetland vegetation/soil/water complex such as fish, papyrus, reeds, clay, livestock grazing, and agricultural products. Traditional uses of wetlands have a long-and integral history as part of the community material culture. Small-scale informal drainage of wetlands for agricultural production has also been ongoing for decades.

Consequently there are increasing and competing demands for wetlands and their products. While certain wetland utilization projects may realize short-term benefits, they may not, in the long-term, be economically or environmentally sustainable. This is well illustrated by the Kisii Valley Bottom Development scheme where a project aimed at the drainage of peat wetlands was abandoned after less than three years as a result of significant peat erosion and loss of soil fertility.

While recognizing the value of natural products from wetlands, there is also substantial potential for agricultural production within wetlands, which is viewed by some as holding part of the solution to food security.

The wetlands of the Lake Victoria Region are of two types:
(a) Those swamps and marshes located in the catchment basin but are far away from the lake and
(b) Those swamps located in the littoral zone of the lake.
The two groups can be further classified into riverine wetlands, inland delta wetlands, and the freshwater swamps.

Like most other wetlands, those in the Lake Victoria Region provide the following, functions among others:

- Ground water recharge and discharge
- Water purification, pollutant removal, and sediment trapping
- Water storage
- Storm protection and windbreak
- Wetland biodiversity and socio-economic values
- Nutrient cycling
- Removal of aquatic pathogens
- Water supply
- Other

Changes in Wetland Use

The Lake Victoria Basin wetlands have been a major part of the history of human society in the region and, in turn, have been affected by human activities. Traditionally, fish were mainly harvested for domestic consumption. Clay was used for pottery while the outer edges of swamps on marshes were used as grazing areas. Papyrus is used for weaving mats, thatching, and for making building ropes. In certain instances papyrus roots are chewed for their sap. Agriculture was practiced in the swamps by exploiting the well-watered and rich soils left after floods had receded. Some wetland trees were used for building, while others were used for making buoys and rafts. The level of exploitation of these resources was, however, very low with no adverse impacts on the wetlands.

In the recent past however, incidents of fire hazards have increased as have the clearing and draining of the wetlands to provide land for settlement and agriculture. The agricultural activities of the Lake Basin are rice irrigation schemes and sugarcane plantations, particularly in the lowlands. Rice irrigation schemes cover over 2,400 hectares of land.

Industrialization and infrastructure continue to exert pressure on land resources and wetlands. In the settled areas of the Lake Basin, there is virtually no large mammal wildlife. Information on the small mammals is very scarce. However, the Ruma National Park in South Nyanza is a haven for a variety of animal species including large mammals such as the rare roan antelope, buffaloes, among others. It has a rich birdlife including the weaver birds and quelea.

Due to the increased human population and the need to intensify income-generating activities, more and more people are engaged in fishing activities both in the wetlands and in the lake. In addition, Lake Victoria and other wetlands have potential for tourism. Tourist facilities such as roads, campgrounds, picnic grounds water sports and lodging facilities may be developed.

Rivers
The main issues related to water resources management include:-

a) Conservation/water use conflicts
b) Resources use conflicts
c) Compliance and Enforcement issues.
d) International/Coordination needs
e) Effective Coordination and Management infrastructure and
f) Public awareness and participation

Management of Kenya's water resources is constrained by the following main problems:-

a) Irregular distribution of water resources in the country
b) Insufficient financial resources
c) Lack of a well established and coordinated information system and public participation
d) Lack of modern and innovative management technologies
e) Capacity to deal with the complex ecosystems inter-linkages and
f) Extreme poverty, which leaves no alternative but to over-exploit the natural resources base.

The various rivers in the country are as shown in figure 3.11

Rivers	Length	Basin Area	Remarks
	Km	Km^2	
Tana	1050	62,160	Last 322 km to sea navigable by launch
Athi- Galana-Sabaki	631	44,029	Last 161 km to sea navigable by canoe
Mara	198	7,770	Half of this river, is in Tanzania
Nzoia	315	12,950	-
Suam Turkwel	390	20,720	145 km perennial
Ewaso Ngiro (North)	740	56,980	290 km perennial
Ewaso Ngiro (South)	213	5,180	97 perennial
Kerio	403	6,475	113 km perennial
Yala	261	2,590	-
Sondu/ Miriu-Kipsonoi	176	5,180	Called Sondu / Miriu by the Luo, Kipsonoi by Kipsigis
Kuja	180	5,180	-
Malewa	108	778	-
Voi	209	5,439	80 km perennial

Table 3.11: Kenyan Rivers

Water + Agriculture (Irrigation)

Background

Agriculture is the mainstay of Kenya's economy. The sector contributes over 50% of the country's export earnings and employs about 80% of the population. The sector accounts for about 26% of the country's Gross Domestic Product (GDP). However, the sector is constrained by among others the erratic nature of the rainfall and the ever increasing population.

Kenya's' Economy

Kenya has since independence relied heavily (directly and indirectly) on the agricultural sector as the base for economic growth, employment creation, ensuring food sufficiency and security and foreign exchange earning (see figure 3.1).

Irrigation has been identified as an important sector that can positively contribute to the growth of the agriculture sector. Irrigation development provides an immediate and guaranteed positive impact on poverty alleviation, employment creation and food security especially to rural population. It contribute 0.3% to the GDP and 18% of the value of all agricultural produce. Drainage development through flood protection and water management accounts for 0.3% of the total area under rain-fed agricultural production.

Irrigation in Kenya has a history spanning about four (4) centuries. This is found along the lower reaches of Tana River and in Elgeyo-Marakwet, West Pokot, and Baringo district. Out of a potential of 540,000 hectares, 105,800 hectares has been developed as shown in Table 3.9.

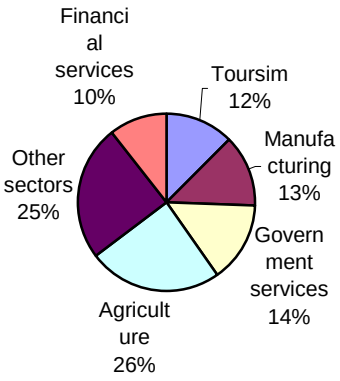


Figure 3.1: Contribution of different sectors to the Kenyan economy by GDP (Economic survey 2000-2001**).**

Many constraints and challenges have hindered the faster development of the existing potential for irrigation. Among these challenges is the massive capital investment required for irrigation infrastructure development.

Basin	Potential (ha)	Developed (ha)
Tana	205,000	68,678
Athi	40,000	10,818
Lake Victoria	200,000	10,827
Kerio Valley	64,000	5,477
Ewaso Ng'iro North	30,000	10,000
Total	**539,000**	**105,800**

Table 3.12: Irrigation Potentials by Basins

Table 3.13: Comparative irrigation development status

Sub-Sector	Developed Area (ha)			Area under production in 2003 (ha)
	1995	1998	2003	
Smallholder Schemes	17,500	34,650	47,000	47,000
National Schemes	11,500	12,000	16,000	10,000
Private Schemes	23,000	40,700	42,800	42,800
TOTAL	**52,000**	**87,350**	**105,800**	**99,800**

Source: MWI Report, National Irrigation Board

Irrigated land as % of total cultivated land

Kenya has a total land area of 58.26 million hectares out of which only 11.65 million hectares (20%) receive medium to high rainfall. Out of these, 11.65 million hectares, only 7 million (60%) hectares is used for agricultural production. Out of these, seven (7) million hectares (60%) of agricultural land, irrigation accounts for about 105,800 hectares (1.5%) as of 2003.Table 3.13 gives a development growth comparison since 1995.

Crops under irrigation

In the irrigated land, different crop types are grown. The types of crops grown in these areas are dictated mainly by the main objectives of the irrigated development. Irrigation accounts for most of the horticultural produce consumed both within the country and also exported. The horticultural crops grown under irrigation encompass vegetables, fruits, cutflowers, ornamentals, edible mushrooms, spices and herbs. Other crops include cereals (such as: maize, sorghum, millets, rice), pulses (such as green grams, beans) and root crops (sweet potatoes). Cash crops such as coffee (in big commercial estates) and cotton are also irrigated.

Crop types and prices

The production technologies for irrigated crop production are very dynamic and in most cases high inputs are required to achieve meaniful outputs. The prices of the different irrigated crops to a large extent are dependent on the target markets and on the ability of the irrigators to synchronize their production cycles with the peak periods for both local and/or export markets. For the right price (more profits) per irrigated crop produce, the irrigator should be conversant with the supply and demand of the produce for the target markets. The irrigator should target production for local markets (where about 95% of the total produce is consumed) during the dry season when the prices are likely to be higher. The prices of the crops are also affected by the quality, especially for produce to the export market (which involves cut flowers, French beans, Asian vegetables, avocados and mangoes). Table 3.14 gives indicative figures of prices for a few crops.

Cultivated land area per crop type

The present scenario is one that has seen preference for horticultural production by most of the irrigation communities. At present, about 65% of the total area under irrigation is under horticultural production. The remaining 35% is under other crops such as cereals, root crops, cash crops and fodder.

Irrigated crops and their water use per mass of produce

Food and agriculture are by far the largest consumers of water. They require one thousand times more than we use to drink and one hundred times more than we use to meet basic personal needs, with up to 70% of the water we take from rivers and groundwater going int irrigation.

Table3.14: Prices of some key irrigated crops (Kshs/kg).

No.	Crop type	Cost (K.Shs./kg)	Remarks
1	French beans	20.00	Prices dictated by the supply and demand forces in the market
2	Tomatoes	26.00	
3	Other vegetables	23.40	
4	Bananas	10.00-15.00	

5	Sweet potatoes	10.00-15.00	
6	Rice	45-75	
7	Maize green	10.00-20.00	
8	Coffee	23.00	Prices dictated by the world prices

Source: MOA reports (2003).

Table 3.15: Irrigated crops and water use

Crop	Water Required (mm)	Remarks
Cabbages	500	Throughout the growing period
Kales	350-500	
Cauliflower	500	
Lettuce	400-600	
Onions	500-700	
Tomatoes		Well distribute water with 3-5 days intervals recommended
Carrots	300-500	Throughout the growing period
Garden peas	400-500	
Cucumber	500-700	
French beans	50 mm/week	
Rice	1Cumec per kg.	

MOA reports 2003

Agricultural water withdraw as % of total renewable water produce

The amounts of water required by the different crops depend on the crop water requirements at the differing stages of growth. Most of this water is normally needed at the flowering and fruit formation stage. Table 3.14 gives some figures for some of the irrigated crops. Irrigation therefore needs 900 Km^3 of water per year for food crops and additional for non-food crops.

The renewable fresh water, nationally, is about 20 billion cubic meters, out of which only 4.7 billion cubic meters is used annually. Out of this total water, irrigation uses approximately 70 % with other uses taking the balance (30%). However, the construction of water storage facilities for the irrigation activities is the lowest as compared to the other uses. Annually, excessive runoff, causing flood damage, is usually followed by droughts in most parts of the country where irrigation potential exists. Harvesting of this flood will increase land under irrigated agriculture.

Policy, Legislation, Norms and Standards

The general development direction in the country is the involvement of the communities, the private sector and other stakeholders in the implementation of the various policies.
The agricultural sector is governed by the Agricultural Act Cap 318 (revised 1980). This statute encompasses provisions for a wide range of Agricultural practices, especially on the development of agricultural land in a sustainable manner. This Act (Cap 318) is augmented by other acts, which address specific agricultural issues. Such acts include:-

- Irrigation Act Cap 347 that provides for large scale centrally irrigation development and management under the National Irrigation Board (NIB). The Act does not recognize the other types of irrigation developments and managements that are currently being implemented by the Ministry of Water and Irrigation.
- The land use policy is still under preparation, and as of now no drafts exists. However, the direction of the policy is to ensure that all lands are properly classified for the specific land uses for maximum benefits.
- The Water Act, 2003 (Cap 372) to provide for the management, conservation, uses and control of water resources and for the acquisition of rights to use. It also provides for the regulation and management of water supply and sewerage services.

The preparation of the national irrigation policy and other related legislations is an exercise that is ongoing currently in the Ministry of Water and Irrigation. The policy direction is for the government to move from implementation of the policy and let communities, private sector and other sector stakeholders to play a bigger role. This policy aims at achieving sustainable development and management of the irrigation and drainage sector by addressing the following objectives:

- To fully develop the irrigation and drainage potential in the country for economic development.
- To effectively regulate, coordinate and manage all activities within the irrigation sector.
- To create an appropriate financing system that will attract investment into the sector.
- To create an enabling environment for effective participation of the farmers' organizations and other stakeholders in the provision of quality and cost-effective support services, and
- To enhance a multi-sectoral approach to irrigation research and development involving government, private, civil society and communities.

It is anticipated that, with the development of this policy, recognition that communities and the private sector offer invaluable potential to attainment of accelerated development within this sector will be achieved.

Strategies, Goals, Programs and Actions

The strategic objective of the irrigation sector is to improve utilization of land through irrigation and strengthening of institutions involved in the implementation.

Among the strategies being adopted in the irrigation sub-sector to contribute to the national goals of achievement of self-sufficiency in food production, employment creation, income generation, and the earning of foreign exchange are:

- Development of the policy and the legal framework on sustainable irrigation and drainage system
- Increasing area under irrigation
- Reclamation of poorly drained and degraded land while being sensitive to ecosystem
- Promotion of appropriate systems that are cost effective and simple enough for the communities can operate, manage and maintain with minimal ease.
- The adoption of the cost-sharing approach with the communities in any development, which can be in kind and/or in cash. This is hoped to lead to better ownership of the developments.
- Adoption of the participatory approach to developments to encourage consensus building through the decision making process.
- Promotion of community participation in the different stages of any development.
- Promotion of integrated development projects and programmes.
- Involvement of all irrigation related stakeholders in all developments.

The key programmes in the sector will focus towards achieving the following:

- Development of the policy and legal framework on sustainable irrigation systems
- Increasing area under irrigation

Performance Areas and Indicators

Irrigation and employment (on- and off-farm)

Development of sustainable irrigation projects has had a remarkable impact on employment generation -both for individuals and at community level. This impact is both in rural areas where 75% of the population resides and in urban areas. The types of this employment are:

- Employment generation in terms of labour requirements (horticultural production under irrigation generates 2 man-years per irrigated ha). This is about four (4) times the labour requirement in rain-fed agriculture. This contributes to settlement of communities.
- Secondary employment through activities such as marketing of irrigated produce, provision of required farming inputs and irrigation equipments.
- Tertiary employment say through provision of other services such a micro credit, training, etc.

Water use efficiency and losses

Water use efficiency is applied as a measure of the performance of an irrigation system. The current irrigation developments have varying efficiencies, mainly due to the losses incurred as water is conveyed through the various systems to the farms. These losses take the form of leakages through canal embankments and pipe joints, overtopping of canal banks, seepage, evaporation and transpiration. Within the irrigation farms, large volumes of water is lost through inefficient utilization as in over irrigation, which results in high salt levels when the excess water is not well drained. In piped systems, use of none standardized sprinklers leads to over extraction. Presently, canal systems have as low efficiencies as (30%) as compared to sprinkler systems (60%) or even drip (80%) systems.

Improving water use efficiency is a slow and difficult process that, to a large extent, depends on the local water scarcity situation and the value the communities' place on the available water. High efficiencies involve proper and effective irrigation systems management and to a large extent systems dependent on farmers. It also depends on policies that encourage water saving by providing incentives and effective enforcement of penalties.

Therefore, as water demands are on the increase, there is need to continuously improve the irrigation efficiency in the country.

Sustainable Irrigation and Drainage Systems

The participatory approach has been applied and found to ensure sustainability in most types of developed projects. In order to ensure community participation, involvement has to be right from the inception stage, identification up to implementation. This acts as a training method for the communities as they prepare to undertake the O&M activities.

The most appropriate types of systems are recommended. Gravity systems where possible are constructed as they have low O&M costs. These are the main systems to be found in many parts of the country.

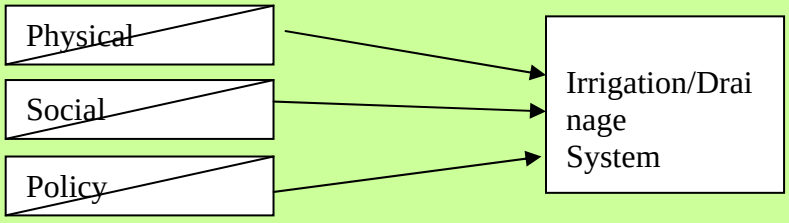
Management of irrigated areas (including O & M) has been delegated to water user associations (W.U.A) with the exception of large scale systems under NIB that manages the main canal and the water intake structures of the public irrigation schemes. WUA's have been formalized and officially recognized by the provision of statutes and bye-laws in the new Water Act 2002.

The development of projects has been coupled with the marketing of the produce to enable for the generation of maximum revenue, needed for the Operation and Maintenance activities.

Therefore, sustainability of systems can be attained through the following strategies:

- Increased beneficiary participation
- Quality and appropriate technical designs.
- Promotion of strong leadership in community organizations (WUAs) – especially for O&M.
- Proper crop choices for better financial returns
- Consideration of the gender issues (Dominant gender group in the proposed developments)
- Regular evaluation/monitoring
- During the design process consider physical and socio-economic issues

Figure 3.2 Simplistic view of factors that affect the performance of Irrigation or drainage systems



Water Quality in Irrigation Agriculture

Irrigation water quality refers to its suitability and impacts for agricultural use. Maximum economical returns are expected with good quality water whereas poor quality water brings with it soil and cropping problems that call for special management practices.

It has been found that water considered unsuitable for domestic use may under certain conditions be considered usable and is better than having no water. Within limits, waste water may be used for irrigation. .Water quality in irrigation is classified into physical and chemical quality.

Physical Water Quality

This refers mainly to suspended material. The effect of sediment in the irrigation water is influenced by the nature of the material and the soil conditions of the irrigated fields. Where fine sediments are deposited on sandy soils, agricultural value of the soil increases. Deposition of very fine particles may on the other hand result in sealing off the soil, thereby reducing its permeability. Sedimentation in waterways i.e. reservoirs, channels pipelines and weirs has caused serious problems, resulting in high maintenance costs and even failure of irrigation systems.

Water containing sand and silt is especially a problem in localized irrigation because it causes the plugging of the distributors. It has also caused serious wear on pumps and equipment especially in sprinkler and drip irrigation.

The remedial measures applied include sand and silt traps, filters, screens and strainers.

Chemical Constituents

Irrigation water chemical quality is commonly assessed in terms of soluble salt content, percentage (%) of sodium, boron, and chloride and bicarbonate contents. The Kenya Agricultural Research Institute offers the service of soil analysis for chemical composition at a moderate charge.

Salinity hazard has been found to occur when the salts from applied irrigation water accumulate in the crop root zone. This is mainly to over application of the water. This is also caused by shallow water tables due to upward movement of water with dissolved salts. Crop yields have declined with increase in salinity. Very low salinity water (EC less than 2mmhos/cm) has resulted in dispersive soils that result in sealing of pores thereby inhibiting infiltration.

Total Concentration of Soluble Salts

Salinity hazard has been found to occur when the salts from applied irrigation water accumulate in the crop root zone. This is mainly as a result of over-application of the water. This is also caused by shallow water tables due to upward movement of water with dissolved salts.

Yields have declined with increase in salinity.

Water quality impacts from agricultural use

The quality of surface and underground waters is under constant threat of pollution from the various wastes and chemicals in agricultural use. In terms of quantity, over 70% of the water available is being used for agriculture. In terms of quality, agricultural activities are the main contributor to nitrate and ammonia pollution. Agricultural activities also lead to:-

- Land degradation (catchment deteriorization, cultivation of wet lands, competition between urbanization and agriculture) has a negative impact on the amounts and quality of water available.
- Increase in salinity due to poor drainage and water management practices in irrigation. Designs should address these concerns.
- Over obstruction of ground water.
- Reduction in genetic diversity in crop and livestock species due to habitat degradation which may have a negative impact on fisheries industry.
- Water borne diseases such as malaria, *schistosomiasis* and amoebic dysentery are common in irrigated areas. Collaboration with the health workers during planning and design may alleviate some of these issues

The Role of Irrigation in Alleviating Poverty and improving Food Security

Kenya relies more on rain-fed agriculture than on irrigated agriculture. With an irrigable potential of 540,000 ha its exploitation can have a big positive impact on availability of food (reduce food insecurity) and also on alleviating poverty (increased income and creation of employment). Irrigation provides

83% of the total land mass is classified as ASAL. These lands support a population of

about 25% of the country's population. The population in the ASALs is on the increase due to irrigation development here which will lead to increased agricultural productivity. In the high and medium potential lands (17% of the total land Mass), development of irrigation will lead to diversification into new crops and intensification of production per unit area. This will eventually translate into more employment and higher incomes. Irrigated crops contribute significantly to foreign exchange earning. The horticulture and floriculture industry, which is a heavy consumer of irrigation water, has been on the increase and at present is among the top contributors to the country GDP. For instance, more than 40% of the onions consumed in the country originate from irrigation schemes (Loitoktok, Taveta, Pekerra).

Irrigation has been used as a way of settling communities and providing opportunities to individuals and communities to boost food production, both in quality and diversity so as to satisfy individual needs and to generate income from the surplus.

Irrigation has a land augmenting effect For irrigation to have an impact on food security, it has to be integrated with the relevant complementary measures such as credit, marketing, extension, land tenure issues among others.

Thus, irrigation provides a powerful management tool against the vagaries of rainfall and makes it economically attractive to grow high-yielding seed varieties, and increased yields per area of cultivated land.

Issues and Constraints

Improving Water use efficiency and productivity in Agriculture

Water, being a scarce resource in terms of spatial distribution, requires effective and efficient use particularly with regard to irrigation, which consumes a high percentage of available water (70%).

Existing traditional irrigation methods, which have low efficiency, need to be improved. Irrigation water where possible needs to be conveyed through lined canals and pressurized pipes. Sprinkler and drip irrigations systems minimize on the total losses. For example, in surface irrigation with unlined canals and with no storage, the same amount of water can irrigate three times as much land area under sprinkler irrigation and five times as much under drip irrigation. New schemes developed will therefore be tailored towards water saving as much as possible.

At farm level, appropriate crops for the available water regimes will be encouraged. Capacity building on issues dealing with irrigation water management will be provided to the irrigating communities. Abstraction of water where possible will be encouraged in groups instead of on individual basis to save on water. Communities will also be encouraged to participate in irrigation water resources management.

Modernization and Empowerment

Irrigation modernization is the process of changing irrigation systems from supply-oriented to service-oriented and involves institutional, organizational, and technological changes. It aims at transforming traditional irrigation schemes.

In 1966 the National Irrigation Board (NIB) was established, through Cap 347 of the Laws of Kenya, and took over the running of centrally-managed irrigation schemes that had been developed by the Government to settle communities. The performance of these schemes to date is low due to the complex management style where the communities' farms as tenant and are do not participate in decision-making.

In 1977 the Small Scale Irrigation Unit (SSIU) was created in the Ministry of Agriculture to coordinate development of small-scale schemes. The unit was upgraded and renamed the Irrigation and Drainage Department (IDD) in 2002, in the Ministry of Water and Irrigation with the main aim of promoting farmer managed irrigation and drainage schemes. The schemes developed by this department utilize the participatory approaches and communities are involved at all stages of project development to prepare them for the O&M phase which is their core responsibility. These schemes have to be sustainable.

Therefore the reforming process will focus on the following:

- Rehabilitation of the traditional schemes to be more sparing in water use.
- Transfer of the operation and management activities in large schemes to the users and or water undertakers.
- Promotion and development of community based smallholder schemes that are fully managed by the Irrigation Water Users Associations (IWUAs).
- Building managerial of capacities among the users of the irrigation schemes.
- Implementation of cost-effective and appropriate systems that are responding to the identified needs of the benefiting communities.
- Development of integrated systems that address all the relevant services providers (Marketing, credit, agronomic extension, and farm inputs among other issues).
- Charging for irrigation water to improve on efficiency.

As outlined above, modern methods, if combined with sale of water by volume means less wastage and makes distribution as per demand achievable.

The simpler the methods, the less expensive but less efficient the irrigation projects are and also the smaller the net national income from these. On the other hand, when irrigation projects are well designed and executed by efficient means, production level rises translating into the communities moving up the economic ladder, increases in the amount of their private investment, their standard of living rises as does the level of the children's education and habitats.

Equity in roles of men and women in irrigation

Gender concerns have real impacts (negative & positive) in irrigation projects. Women are the major players in poverty alleviation, food production and in ensuring and dispensing nutrition at the household level. They also do lots of work in the field. They are the ones who mostly cultivate the family plots and usually market the produce. It is therefore, imperative that the women be involved in the project. They should be kept informed and be given a chance to air their views.

The women may not actively participate in public meetings; however, extension staff may gather views from them informally during routine visits of the scheme as women are mostly found working in the plots.

Participation of women in the scheme committee is recommended. A woman may be chosen as an irrigation group leader. Generally a leader of women's groups is a member of the steering committee.

Box 3.1: Irrigation Water Quality

To use the wastewater for irrigation activities the following parameters are to be considered:

Physical:

- Total dissolved solids
- Electrical conductivity
- Temperature
- Colour/Turbidity
- Hardness
- Sediments

Chemical:

- Acidity/basicity
- Type and concentration of anions and cations
- Calcium
- Magnesium
- Sodium
- Bicarbonate
- Chloride
- Sulphate
- Sodium adoption ratio
- Boron
- Trace metals
- Heavy metals
- Nitrate-nitrogen
- Phosphate phosphorous
- Potassium

Use of waste water for Irrigation

In areas where water is becoming increasingly scarce, irrigation development can be done by use of wastewater (water of marginal quality). Properly planned use of wastewater alleviates surface water pollution problems and conserves valuable water resources. It also takes advantage

of the nutrients contained in sewage to grow crops.
Principal health hazards associated with the constituents of wastewater are contamination of crops or groundwater. Pathogenic organisms give great health concerns in agricultural use of wastewaters especially where the crops grown are consumed in raw form.

Important water quality parameters in agriculture include a number of specific properties of water that are relevant in relation to the yield and quality of crops, maintenance of soil productivity and protection of the environment.

The extent of treatment of a wastewater determines the selection of the crops that can be grown.

In Kenya, there is minimal utilization of wastewater. The little irrigation activities that occurs are illegal whereby sewage systems are interfered with to irrigate crops near the urban and peri-urban areas where the sewage systems run. Commonly irrigated crops are arrowroots, sugarcane, spinach and kales for local consumption. This irrigation is practised mainly by the slum dwellers for income generation.

The total wastewater irrigated area is negligible. Any potential that may exist has not therefore been fully exploited and requires further address.

Future investment in irrigation

Future investments in the irrigation sector are towards the development of appropriate irrigation infrastructure. The unit cost of irrigation development in Kenya ranges from K.Shs 150,000.00 to K.Shs: 300,000.00 per hectare depending on the kind of irrigation infrastructure constructed. This figure does not include the cost of water storage structures (dams).
A total of 50,000 hectares is proposed to be developed by 2015 as part of the contribution towards the attainment of the MDG on eradication of extreme poverty and hunger. The MDG targets to reduce by half the number of people who live within an income of one dollar a day and reducing by half the proportion of people who suffer from extreme poverty. Another major investment will be on the construction of irrigation water storage structures and on capacity building within the communities to be able to operate and manage the irrigation systems.

The estimated cost does not include the contribution of the communities which takes the form of land improvement and on-farm irrigation.

The other area to invest in is in the development of the national policy and the relevant legislative framework to guide in the development of sustainable irrigation systems by the various stakeholders.

This will be accomplished at an estimated cost of about K.Shs 15 billion.

WATER + INDUSTRY

Situation and challenges

Distribution of manufacturing establishments

There are about 2,527 industries in Kenya, 1,206 (47.8%) of which are located in Nairobi. In descending order, the following districts are enumerated as industrialized:-

a) 258 industries in Mombasa,
b) 164 or 6.5% in Nakuru,
c) 126 or 4.0% in Kiambu and
d) 96 or 3.85% in Kisumu

Major industries by type are:-

1. food, beverage, and tobacco, accounting for 678 or 26.8% or the total;
2. wood, wooden products and paper related, 442 or 17.5% and
3. Textile industry, 398 or 15.7%.

These three types account for 60% of the total industrial establishments.

Present production and value added by manufacturing industry

Manufacturing, communication, transport and storage of produced goods earn the largest income to the economy at about 22% each (Table 3.16)

Table 3.16: National Accounts

CAPITAL FORMATION						
Industrial Breakdown, 1998 - 2002						
(a) At Current Prices						
	1998	1999	2000	2001	2002*	2003**
Non Monetary Economy						
Ownership of Dwellings	3,146.88	3,178.26	3,159.20	3,222.38	3,343.6	3,577.7
Monetary Economy						
Enterprises and Non - Profit Insititutions						
Agriculture	8,025.54	7,731.85	8,304.32	8,523.92	9,147.2	9,787.7
Forestry	113.1	20.1	35	43.64	46.4	39..5
Fishing						
Mining and Quarrying	972.06	1,082.46	1,087.20	1,093.64	1,268.2	2,050.4
Manufacturing	25,118.06	23,868.98	23,977.64	25,439.18	26,652.4	28,581.8
Building and Construction	8,129.58	8,447.60	10,634.98	10,811.99	11,134.0	12,962.5
Electricity and Water	8,526.60	8,358.14	9,031.06	8,640.43	8,627.8	9,069.5
Trade Restaurants and Hotels	3,657.18	3,755.58	3,504.96	4,302.15	4,815.1	5,9956
Transport, Storage and Communications	25,264.80	25,619.98	24,383.44	25,595.12	25,630.7	26,790.5
Finance, Insurance, Real Estate and Business Services	4,889.96	5,114.46	5,212.44	6,197.99	6,321.1	7,371.1
Ownership of Dwellings	2,395.30	2,374.12	2,394.70	1,808.94	2,384.9	2,562.7
Other Services	4,526.84	4,769.54	5,284.36	5,984.63	5,160.0	5,782.7
Total	**91,619.02**	**91,142.81**	**93.850.10**	**98,441.63**	**101,187.8**	**110,993.5**
Producers of Government Service						
Public Administration	7,093.38	6,518.80	6,078.80	7,236.17	6,596.1	7,564.9
Defence	-	-	-	-	-	-
Education	2,066.52	1,956.60	2,054.78	2,170.84	2,296.0	2,637.2
Health	2,654.72	2,769.22	2,937.46	3,111.00	3,264.1	3,338.7
Agricultural Services	2,880.04	2,531.64	2,617.20	2,769.49	2,757.6	3,059.5
Other Services	4,418.18	4,863.86	5,670.98	6,217.25	4,868.0	5,395.5
Total	**19,112.84**	**18,640.12**	**19,359.22**	**21,414.75**	**19,781.8**	**21,995.8**
Traditional Economy	3,146.88	3,178.26	3,159.20	3,222.38	3,343.6	3,577.7
Monetary Economy	110,731.86	109,782.93	113,209.32	119,856.38	120,969.6	132,989.2
Total All Sectors	**113,878.74**	**112,961.19**	**116,368.52**	**123,078.76**	**124,313.2**	**136,566.9**
Percentage Rate of Growth						
Traditional Economy	2.05	1.00	-0.60	2.00	3.8	7.0
Monetary Economy	3.68	-0.87	3.12	5.87	0.9	9.9
Total	**3.63**	**-0.82**	**3.02**	**5.87**	**1.0**	**9.9**
Source: Central Bureau of Statistics						

* Revised

** Provisional

Trend of Industrialization

In the 1960's, the pattern of industry in the country bore the characteristics of the colonized economy inherited from the pre-independence era. Major industries were developed in Nairobi, Mombasa and other big town's since 1970. However, the growth of new industries in Nairobi and Mombasa has been deteriorating with time. In the smaller towns and rural areas, there are few large industries, though small enterprises become more common. In the 1980's the older established towns like Kisumu, Thika, Nakuru, Kericho and Eldoret.

The present distribution of industries is caused by the following influences:-

a) Historical background, geological, and ecological conditions including those of raw materials.
b) Personnel interaction with government policy makers, capital, managerial and industrial skills;
c) Infrastructural facilities such as transportation, energy, water and communication;
d) Industrial linkages with supporting industry such as insurance, commerce services and spare parts suppliers.

Policy, Legislation, norms and standards

There has not been a coherent official policy on industrial locations except in the EPZ development programmes although attempts at industrial decentralization have been made at various stages in the development process. Moreover, in the Sessional Paper No.1 of 1986 the Government addresses to promote to develop into more industrialized societies as cones increase, although there are 10 concrete plans available regarding regional development and relocation of manufacturing industries.

In view of the above the present trend of industrialization is expected to continue in the future.

Strategies, Goals, Program and Actions

The total value added of the manufacturing sector in 2000 and 2010 is projected to be K.Shs. 38 billion and K.Shs. 62 billion at 1988 constant prices respectively. Among the districts, Nairobi attains the highest value added of K.Shs. 18 billion in 2000 and Kshs.29 billion in 2010. The top five districts regarding valued added attainment are Nairobi, Mombasa, Nakuru, Kiambu and Kisumu which account for K.Shs. 44 billion in 2010 or 71% of the National Total.

Performance Areas and Indicators

Water Demand

Table 3.17 shows the water requirements of manufacturing industry by District to the year 2010. In 2010, water demand in Nairobi is estimated to be 282,00m3/day, accounting for 57% of the National total industrial water requirements. Secondly, Mombasa accounts for 67,000m3/day or 14%. Manufacturing establishments in Nakuru, Machakos and Kisumu districts will also consume a substantial amount of water.

Table 3.17: Industrial Water demand by District: 1989 - 2010

Code	District	1989	1990	1995	2000	2005	2010
110	Nairobi	120,813	128,300	167,417	218,953	249,690	281,668
210	Kiambu	8,843	9,405	12,382	16,362	18,893	21,649
220	Kirinyaga	426	457	624	857	1,039	1,258
230	Murang'a	629	673	915	1,257	1,519	1,833
240	Nyandarua	361	386	524	720	866	1,045
250	Nyeri	2,361	2,521	3,380	4,570	5,417	6,407
310	Kilifi	3,493	3,705	4,794	6,206	6,989	7,762
320	Kwale	160	172	232	317	380	459
330	Lamu	319	341	463	632	759	910
340	Mombasa	28,982	30,768	40,072	52,286	59,458	66,834
350	Taita Taveta	1,052	1,122	1,505	2,033	2,408	2,845

360	Tana River	88	94	129	178	217	264
410	Embu	455	488	659	900	1,078	1,290
420	Isiolo	160	172	233	318	382	458
430	Kitui	176	188	258	356	433	527
440	Machakos	2,880	3,072	4,107	5,525	6,515	7,659
450	Marsabit	480	513	695	950	1,141	1,368
460	Meru	1,530	1,637	2,216	3,024	3,627	4,346
510	Garissa	122	131	181	251	307	376
520	Mandera	160	171	231	316	379	455
530	Wajir	0	0	0	0	0	0
610	Kisii	1,446	1,547	2,093	2,855	3,422	4,100
620	Kisumu	5,516	5,880	7,824	10,472	12,278	14,329
630	Siaya	1,059	1,134	1,533	2,091	2,504	2,998
640	South Nyanza	1,997	2,114	2,862	3,910	4,690	5,625
710	Kajiado	65	69	90	117	132	148
720	Kericho	2,378	2,541	3,437	4,685	5,606	6,702
730	Laikipia	1,143	1,223	1,662	2,278	2,744	3,303
740	Nakuru	9,341	9,922	12,969	16,996	19,429	21,989
750	Narok	212	228	308	422	506	606
760	Trans Nzoia	1,046	1,119	1,519	2,080	2,502	3,009
770	Uasin Gishu	3,313	3,530	4,689	6,267	7,333	8,541
810	Baringo	116	125	169	232	278	336
820	Elgeyo Marakwet	58	62	82	114	136	166
830	Nandi	799	855	1,157	1,581	1,899	2,278
840	Samburu	225	241	322	434	513	606
850	Turkana	319	342	463	632	758	910
860	West Pokot	53	57	77	105	126	152
910	Bungoma	1,282	1,370	1,832	2,468	2,916	3,440
920	Busia	231	247	337	465	564	685
930	Kakamega	1,651	1,767	2,388	3,258	3,899	4,669
0	Unidentified	160	171	231	316	379	455
Total		**205,880**	**218,860**	**287,061**	**377,789**	**434,111**	**494,454**

Industrial Discharges

The major agricultural based rural factories are such as coffee pulping and fermenting factories which have increased from just over 500 in 1965 to over 2000 to date. There are also six major and two minor sugar milling factories. Seven sisal fibre processing factories, one pulp and paper mill, two major slaughter houses, eleven tanneries, twelve textile mills and fruit canneries.

The urban based industries include tanneries, textile mills, breweries creameries, paper recycling mills, chemical processing factories, slaughter houses, soft drink plants and various other types of small industries which discharge their effluent into the public sewers.

Wet processing of Coffee

Kenya has about 1500 coffee factories which are situated next to rivers or streams. This is the single major source of industrial effluent discharged into surface water bodies. Effluent from this industry is particularly acidic and constitutes a very strong organic load, with a BOD ranging form 5000 to 9000 mg/l and pH of 4 to 5. This is difficult to treat and at the same time, is discharged into small streams in a period of 10 to 12 weeks per year only. In that short period, the receiving streams experience shock organic loads of a population equivalent to pollution by domestic discharge of about 3 million people.

Sugar cane milling factories
These consume large quantities of water. The resultant discharge has a high organic load with a BOD range of 3000 to 5000mg/l; total dissolved solids of 600mg/l and suspended solids 1300mg/l. The by-product molasses produced if not utilized or reprocessed, is very polluting. The cane effluent is similarly difficult to degrade and due to the large volumes, the quality of the final effluent is invariably sub-standard in relation to disposal standards. In spite of the large dilution, the effluent exerts significant polluting effects on the receiving streams.

Pulp and Paper Mill
This is a critical source of pollution in western Kenya. The mill consumes large volumes of water and the resultant effluent is highly coloured and has high COD and BOD values. In spite of elaborate treatment facilities, the discharged effluent has a strong colour and odour to the receiving water body.

Tanneries and Creameries
Mainly based in urban areas, tanneries in particular, produce toxic chemicals such as chromium, cadmium and sulphates in addition to organic pollutants. The Total Organic Solids (TOS) is 10,000mg/l and BOD_5 of 2300mg/l.

Creameries discharge very strong organic effluent. In most cases these industries have pre-treatment plants which nevertheless produce effluent that does not meet discharge criteria directly into natural water bodies. Typical characteristics of dairy wastes are: BOD_5 – 1800mg/l, TDS-4500mg/l and suspended solids of 600mg/l.

Textile Mills
Effluent form these mills contains dyes and other refractive compounds which are difficult to remove or degrade through conventional treatment methods. When the effluent is discharged into public sewer for combined treatment with domestic sewerage it invariably interferes with the performance of the sewerage systems, and the efficiency of the treatment works is compromised.

Breweries
Breweries produce large quantities of very strong organic effluent. The major brewery, which is located in Nairobi, discharges very strong organic effluent into the NWSC sewer system without any treatment.

Others
These range form slaughter houses, electro plating industries, garages and other informal sector sources of pollutants. Wasters from these industries are discharged into water courses, rivers, and lakes either with minimum or no treatment through different methods applicable to each industry. Even with effluent treatment, the quality of the final effluent discharged is generally below the discharge standards prescribed for each individual industry by WHO criteria that are currently in force.

The total volume of all the effluent discharged is estimated to be in the order of 130 million cubic metres per year, including municipal and industrial effluent in addition to mixed waste water

The general trend as inferenced from the above assessment is that water in major rivers and lakes has a certain measure of contamination.

- Over reliance on agriculture
- Poor distribution of industries
- Lack of minerals
- Lack of policy for construction of industries.
- Poor prices of agricultural produce
- Ecological zones of the country.
- Emerging economic blocks
- Tax regime
- Lack of enough infrastructures.

Table 3.18 below shows an overview of water quality changes in rivers and lakes since 1965

Parameter	Desired Level	Actual level in				Projected level
		1965	1974	1984	1989	2020
Colour	Colourless	Colourless	Colourless	Slightly Coloured	Coloured	Highly coloured
Turbidity	Clear	Clear	Slightly Turbid	Turbid	Turbid	Highly turbid
Sediment loads	Nil	Nil	Nil	Moderate	Moderate increase	Very high increase
Level of contamination	No pathogens	Low contamination	No pathogens	Low contamination	Gross contamination	Gross contamination
Biological Oxygen Demand	Less than 5mg/l	5-20	Little contamination	20-40	40-60	66+

Table 3.18: Overview of water quality changes in rivers and lakes since 1965

WATER AND TOURISM

Setting the Scene:

Tourism Resources

a) Natural Resources

Abundant and characteristic natural resources in Kenya are located in the mountains and highlands, arid and semi-arid land, and coastal areas. (See Figure 3.1). Natural resources with potential for tourism in those areas are geographic features and scenery, attractive and interesting flora, and a well diversified fauna. Twenty two national parks, 23 national reserves, 1 national Marine park and 5 National marine reserves have been gazetted as protected areas in which tourism is a major economic activity. The flora, fauna and ecological systems in the National Parks, National sanctuaries and National Marine parks are conserved and managed by KWS.

Natural Resources for tourism development can be categorized into the following three groups:

I. Geographic features,
II. General and
III. Specific land forms which present attractive scenery and places which create an opportunity for sports and recreational activity for tourists.

The flora, general vegetation features, is roughly categorized into 8 regions. Bushland and shrub land on arid, semi arid and desert land represent the majority of the vegetation cover. On the other hand, afro-alpine forest, *guineo-cungotean* rain forest, coastal forest, mangrove and marine life are rare and interesting vegetation and resources attracting tourism to Kenya.

Wildlife (fauna) resources are widely spread. Mammals are the most attractive and interesting to tourists, especially carnivore and herbivore species. Large herds of other medium- and small-sized mammals are an attractive to tourists. Others like birds, insects and endangered species are important tourism resources.

Geographic Features as Tourism Resources

General and specific geographic features are major tourism resources. They present attractive scenery and interesting scenic spots for sight

seeing. Opportunities for sports and recreational activities for tourists are sought as well.

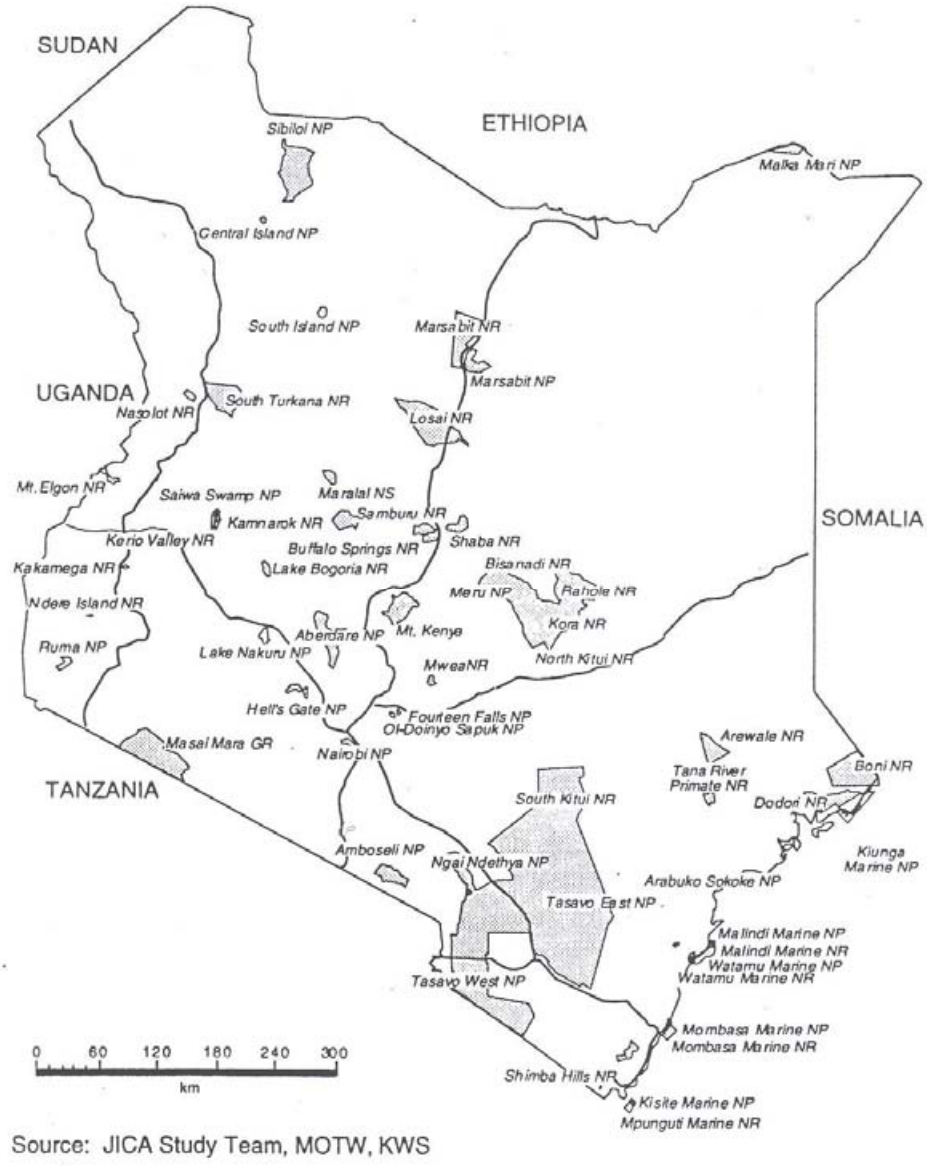
Examples of attractive natural scenery in Kenya:-

- The Rift Valley
- Mount Kenya, Mt. Kilimanjaro and Mt. Elgon, and
- The contrasting view of white coral sandy beaches/green coastal forests/blue skies and the sea.
- Rock towers
- small craters and crater lakes
- Caves, island geysers
- glaciers and other land forms
- Opportunities for sports and recreational activities for tourist are based on geographic features. For example, Mt. Kenya offers opportunities for mountain climbing, rock climbing and trekking. The Indian Ocean provides attractive opportunities for fishing and marine sports.
- The coastal area and coral reefs provides opportunities for rafting and river safaris.

Policy, Legislation, Norms and Standards

Tourism Policies and Targets]

(a) Kenya's general tourism development strategy over the past 30 years has been to gradually and considerably increase the number of tourists visiting, with a strong focus on both the mass tourism market segment and the coastal area(sun and beach holiday). However though, increasing the absolute number of tourists has remained a core element since the 1969 National Development Plan. Since the 6th National Development Plan (1989 to 1993), concerted development efforts have shifted towards spread in the spatial diversification of tourist destinations and reducing the negative impacts of tourism on the environments



Source: JICA Study Team, MOTW, KWS

Figure 3.1: Locations of National Parks Reserves and other Natural Resources

.Table 3.19: Kenya Tourism Development plans since 1969

	Sessional Paper No. 8 of 1969	Development Plan 1979-1983	Development Plan 1984-1988	Development Plan 1989-1993	Development Plan 1994-'96
Target number of tourists	20% increase per year	50 8,000 foreign visitors in 1983 5.5 million bed nights.	6.2 million bed nights in 1988	1,183,000 foreign tourists in 1993. 7.1 million bed nights in 1993	907,000 foreign tourists in 1996 7.5 million bed nights in 1996.
Target market	• Mass tourism • local tourists • conference tourism – long term and • retirement tourists	increase tourists from:- • well-established Markets (North America, US • Growing markets (Germany, France, Italy, Holland) • New market (Austria, Japan, Middle East Spain)	• Increase tourist traffic during low seasons from existing tourist generating countries • promotions in North America markets • local tourist market	• retirement tourists • less encouragement of "package tours" • domestic tourism	• Eco-tourism up-market tourism
Target tourism destinations to be utilized	• Coast wildlife areas especially Southern parts of Kenya(Mt. Kenya Aberdare, Lake Nakuru) • man-made consumptive utilization entertainment	• Coast, Maasai mara, Amboseli, Samburu, Buffalo springs • consumptive utilisation of wildlife • Environmental conservation	• No description	• No description	• Spatial diversification of tourist destinations
environment	• Land use for tourism development	• Consumptive utilization of wildlife • maximum utilization of natural resources		• Damages to the parks and reserves • Minimise negative impacts of tourism to environment	• Environmental consciousness has created a new and growing tourist market" • Utilisation of environmental and cultural resource by local community's participation.

** The study on National Tourism master plan in the Republic of Kenya volume 4 page 74(year)*

Performance Areas and Indicators

Table 3.20: Growth rate in arrivals

Parameter	Compound Growth Rate	
	1979 to 1993	1982 to 1995
Total Arrivals	4.91	4.92
Total Tourist Arrivals	6.65	6.12
Average Length of Stay	-2.05	-1.93
US & Receipts	6.2	3.97
Average US & Receipt per	-0.19	-2.09
Real total K£ Revenues	9.85	7
Expenditure per day	5.73	3.67

**Source:- National Tourism Master Plan 1995*

Table 3.21: Tourist arrival and departures

Year	Arrivals	Departure
1997	1,000,557	924,732
1998	894,285	868,116
1999	964,323	765,431
2000	1,036,537	995,227
2001	993,638	990,814
2002	1,001,250	1,013,438

Table 3.22: Hotel Bed occupancy as % from 1995 - 2002

Year	Occupancy
1993	58%
1994	43.1%
1995	43.7%
1996	44.6%
1997	51.6%
1998	35.3%
1999	33.9%
2000	39.3%
2001	40.3%
2002	42%

Table 3.23: visitors to Parks and Game Reserves 1993 - 2002

Year	No
1993	1,511,923
1994	1,528,952
1995	1,493,100
1996	1,530,145
1997	1,403,004
1998	1,073,250
1999	1,530,438
2000	1,644,917
2001	1,650,310
2002	1,771,335

Table 3.24: visitors to parks and Game Reserves, 2001-2002

Year	No
2001	1,650,310
2002	1,771,335

Table 3.25: visitors to museums, Snake Parks and other sites 1995-2002

Year	No
1995	842500
1996	758800
1997	588100
1998	500030
1999	579825
2000	593069
2001	683781
2002	580070

Table 3.26: Game Lodge occupancy 2000-2002

Year	%
2000	24.4
2001	20.6
2002	19.9

Source: - Statistical abstract 2003

Table 3.27: Tourism Performance Data 1982-1993

Parameter	Unit	1982	1993
GDP	K Million	3077.7	4337.6
Trade, Rest Average	K Million	306.7	479.6
Share GDP	Percent	9.97	11.06
Growth Rate GDP	Percent	NA	NA
Growth Rate Tourism	Percent	NA	NA

NA- Non applicable
Source: - National Tourism Master Plan 1995.

- Total tourist arrivals in the country have grown by a Compound Annual Growth rate of 6.42% over the period 1982 to 1993 or 6.58% over the reference period 1979 to 1993.
- The average length of stay in the country has declined by a compound annual growth rate of –1.93% over the period 1992 to 1993.
- Notwithstanding the above trends, total revenues measured in K£ as well as average K£ expenditures per day measured in constant 1982 prices have grown by an Annual compound growth rate of 7.00% and 3.67% over the period 1982 to 1993 respectively.

Issues & Constraints

- Competition
- Poor Tourism infrastructure
- Lack of capital to improve infrastructure.
- Population pressure on land.
- Advisory notices
- Security

WATER + ENERGY

Setting the Scene: Situation and Challenges

Kenya is largely dependent on three sources of energy, which are primarily used for drying purposes, to lubricate the wheels of socio-economic growth and development. These are petroleum, electricity and wood fuel. Here, electricity refers to hydro- and thermal but not solar energy. The overall consumption for these fuels including coal and coke was 9.8 million tonnes of oil equivalent (TOE) in 1996. This level of consumption was 5.2% higher that in 1995. Table 3.29 shows the trend of energy consumption between 1997 and 2004. Both fuel wood and charcoal accounted for 66% of the total consumption in 1996. The corresponding consumption percentages for petroleum, hydro and geothermal electricity were 24% and 9%, respectively, while that of coal and coke was 1%.

Policy, Legislation, Norms and Standards

The broad energy sector objectives are to:

- Guarantee security supply of both electricity and petroleum fuels to the domestic economy consistent with growth in demand;
- Enhance energy supply and delivery capacity to all sectors of the economy including domestic households at a pace consistent with growing through technically efficient but cost effective systems;
- Create and enabling environment for private sector participation in the supply of energy including electricity;
- Institutionalize and internalize Environmental Impact Assessment and awareness of energy development and consumption and develop an internal capacity for impact assessment and mitigation of negative effects; and,
- Promote energy conservation through use of technically efficient but cost effective supply and end-use technologies.

Petroleum Demand and Supply Situation

The demand for petroleum fuels increased from 1.93 million tonnes in 1990 to 2.27 million tonnes in 1997. This represents an annual compounded growth rate of 2.3%. Annual rates of growth in demand for petroleum fuels have

been consistent with GDP growth rates. In years when the GDP growth has declined, there has also been a declining trend in the energy demand. For example, from Table 2.30 it is apparent that the 4.6% real GDP growth rate in 1996 corresponded with an 8.1% growth in demand for petroleum fuels. The decline in energy demand of -2.7% in 1997 can be attributed to the estimated -2.9% GDP growth to in the same year. The wide spread dumping of petroleum fuels intended for export markets in the hinterland could have accounted for the decline in the officially recorded consumption figures for 1997 as this consumption goes unrecorded.

Projected Demand for Petroleum Products (Energy): 1996 to 2010

The demand for petroleum fuels is projected to increase from 2.27 million tonnes in 1997 to 4.44 million tonnes in 2010 and to 7.66 million tonnes in the year 2020. The assumptions made in these projections are that:-

- Annual GDP growth will be 5% in real terms,
- annual population growth 3%, and
- Increase in petroleum domestic prices 8% per annum.

Petroleum Supply and Distribution Infrastructure

As of March 1998, there were 724 service and filling stations retailing petroleum fuels in addition to providing a host of other services to consumers in Kenya. The stations are distributed throughout the country with most located in major urban centers. Their ownership is either by limited private companies and/or individuals. Many of these companies though have limited distribution facilities located in different parts of the county.

In 1996, the oil companies sold 282 million kilolitres (cubic metres). The Shell-BP consortium had the largest market share at 26%, followed by Caltex and Total with 19% and 15% market shares, respectively. Kenol and Kobil had the smallest market shares at 4% and 9%, respectively. In addition to these companies, there are also 26 other companies licensed by the Ministry of Energy to trade in petroleum fuels in Kenya, of which ten (10) have been active in oil trading on a small-scale.

All the petroleum consumed locally is imported from mainly the Persian Gulf both in form of crude oil and refined products. Small quantities are occasionally imported from South Africa and the Mediterranean region.

Imported crude oil and refined petroleum products are received at the Kipevu and Shimanzi oil jetties in Mombasa. The Kipevu oil jetty handles both crude oil and refined products, whereas the Shimanzi jetty receives only refined products. The Kipevu oil jetty handles ships carrying up to 85,000 tonnes of crude oil and is also capable of handling shiploads of more that 30,000 tonnes of refined products. Shimanzi jetty has been handling imported cargos of refined products of up to 1000 metric tonnes. This handling capacity is projected as more than adequate to meet domestic demand in the foreseeable future.

To ensure that demand does not outstrip both supply and storage capacity, periodic reviews are undertaken by the Government. In addition, private companies undertake independent reviews and where commercial situations warrant development of company specific storage facilities, appropriate investments are made. In this respect, 380 tonnes of Liquefied Petroleum Gas (LPG) storage has been constructed at Mombasa by two oil marketing companies to supplement their respective supply facilities.

The Kenya Petroleum Refineries Limited (KPRL) owns storage for 179,000 kilolitres for petroleum products. In addition, the company has storage for 254, 000 kilolitres of petroleum crude oil. KPRL is currently rehabilitating its 47,000 kilolitre tankage for handling residual oil for export. This is expected to be operational by the year 2000. The Government and KPCL both own 486,000 kilolitres of storage for both refined products and crude oil. This is nearly half of the total storage capacity of 978,000 kilolitres. The oil marketing companies have a total combined storage capacity of 313,000 kilolitres for all products. This is 32% of the total storage

Electricity Demand Situation

Electricity consumption in Kenya increased from 2.16 billion kilowatt-hours in 1986 to 2.85 billion kilowatt-hours in 1991, and then to 3.53 billion kilowatt-hours in 1996. This is equivalent to an average annual growth rate of 5%. In comparison, the GDP growth in the same period averaged 3.4%.
The country has continued to experience donor aid embargo since 1991 which hampered generation capacity. These generation capacity constraints have from time to time necessitated power rationing, with the attendant loss in production of goods and services. Overall, the real demand has outstripped consumption.

Table 3.30 shows electricity sales from 1986 to 1996. Electricity consumption by commercial and industrial services grew from 1.40 billion kilowatt-hours in 1986 to 1.74 billion kilowatt-hours in 1991, and then to 2.5 billion kilowatt-hours in 1996. This, on average, depicts a 4.4% annual growth rate. Of the total electricity sales in 1996, industrial and commercial sectors accounted for 61%, off peak consumption 3% and domestic consumption 32%. The remainder, 4% was accounted for by the Rural Electrification Programme (REP) consumers.

In 1986, the corresponding consumption by major consumer categories was; 29% domestic consumption, 65% commercial and industrial, 5% off-peak and REP consumers 1%. Sales to consumers under REP have continued to register a 28% annual growth, rising from 24.5 million kilo-watt hours in 1986 to 83.2 million in 1991, and then by 13% growth annually thereafter to reach 156.1 million kilowatt-hours in 1996. The high growth in REP sales is reflective of the high demand for electricity in rural Kenya.

Electricity Generation Situation by Source

To meet the growing demand for electricity, generation has been undertaken from a combination of sources. In 1978, generation was 466.1 megawatts (MW) of installed capacity. Excluding the traditional import of 30 MV from Uganda, a breakdown of this generation capacity was as follows:-

- Hydro, 306.5 MW (66%),
- Oil thermal, 98 MW (21%)
- gas turbines (GTs) and
- Diesel, 61.6 MW *13%)

The power generation mix has continued to change with new generation capacity additions and with retirement of some old thermal generators at Kipevu, Mombasa.
In 1986, the installed domestic capacity was 541.7 MW. Of these;

- Hydro accounted for 64% (348.5 MW);
- Oil thermal 18% (98 MW).
- GTs and diesel 9% and
- Geothermal power 8%.

By December 1997 the installed capacity was at 861.1 MW with:-

- Hydro: 598.5 MW (70% of the total),
- Oil thermal 75.5 mw, (9%),
- GTs and diesel 141.7 MW (16%) and
- Geothermal 45 mw (5%).
- Independent Power Producers (IPPs) accounted for 87.5 MW of the 141.7 MW GTs and diesel installed generation capacity.

Table 3.31 shows the installed capacity by plant type from 1986 to 1997. In the table, out of the total installed capacity of 861.1 MV, the effective generation capacity stood at 820.2 MW. The effective capacity for some power plants is less that the installed capacity due to factors like plant technology, age, and for some hydro power plants, inadequate flow of water into hydro turbines.

There is a bilateral agreement for importation of 30 MW of hydro power from Uganda. However, only a fraction of this (about 10MV) is currently available during off-peak hours. Therefore this is considered as a non-firms source. The Ruiru plant was retired after December 1997.

The available effective capacity occasionally drops as generating units are taken out for scheduled maintenance or when there is a breakdown of such machines. For instance, the effective capacity as of April 1998 was 724.7 MV as compared to 820.2 MW in December 1997. This is due to:-

i) The retirement of the Ruiru plant
ii) Taking out one unit at Gitaru, and
iii) Taking out some thermal generating units at Kipevu for scheduled maintenance.

In contrast, power demand in April 1998 was 755 MW and this was expected to rise to 773

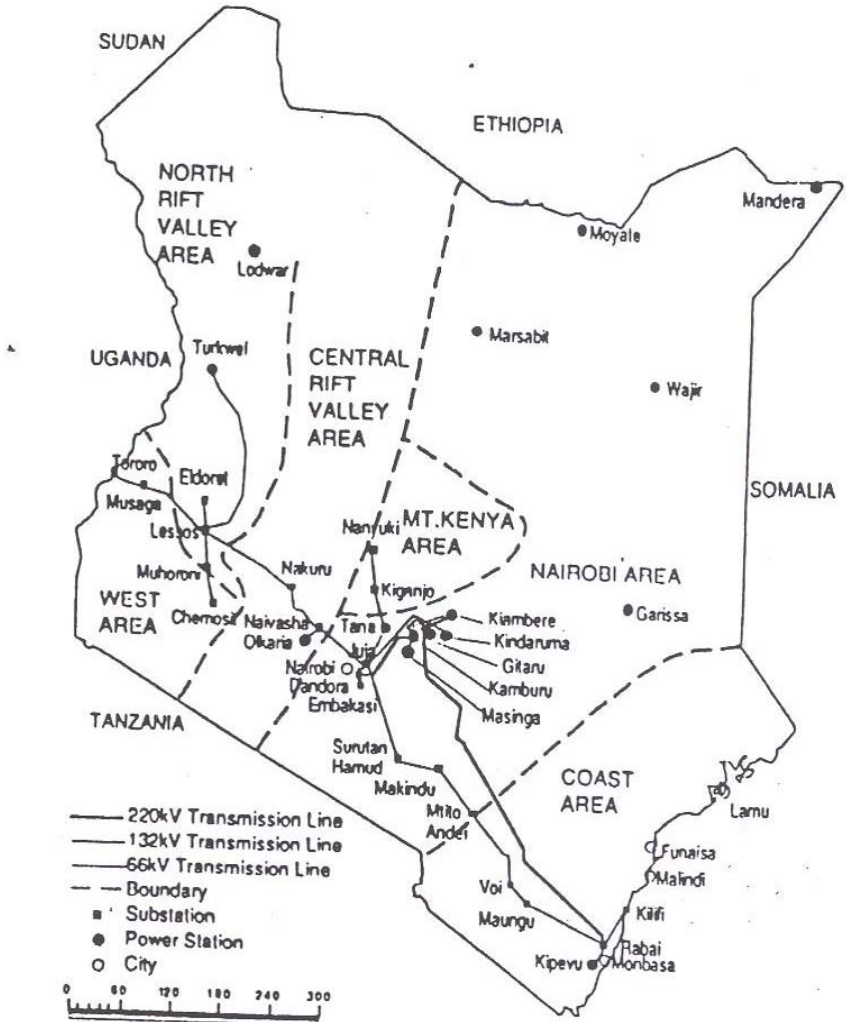


Figure 3.2 National Grid

MW by end of June of same year, and further to 800 MW in November 1998. This supply-demand situation clearly shows that the Kenyan power system experiences a critical generating capacity constraint. To correct this imbalance, 110MW of medium speed diesel generating capacity was to be constructed by the private sector on a fast track basis.

Generation of Electricity including import from Uganda rose from 3.39 billion kilowatt-hours in 1991/92 financial year to 3.7 billion kilowatt-hours in 1993/94 and to 4.3 billion kilowatt-hours in 1996/97.

Due to capacity and energy constraints of the Uganda power system, imports from Uganda have continued to decline annually from a 273 million kilowatt-hours peak in 1992/93. The previous year's quantity was 240 million kilowatt hours. Electricity imported decreased to 184 million kilowatt-hours in 1991/95 and further to 144 million kilowatt-hours in 1996/97. This situation is not expected to improve in the short term.

Strategies, Goals, Program and Action

An econometric study carried out by the Kenya Power and Lighting Company (KPLC) had shown projected consumption of electricity to grow form 3.6 billion kilowatt-hours in 1996/97 to 4.3 billion kilowatt-hours in 1999/2000 and to 6.5 billion in 2006/7. This is projected to rise further to 11.8 billion in 2016/17. The attendant capacity requirement was projected to grow from a peak of 718.1 MW in 1996/97 to 864.8 MW in 1999/2000 and further to 1,303.9 MW in 2006/7. Power peak is projected to rise further to 2,382.7 MW in 2016/7. These demand projections have been derived using monetary GDP and electricity tariffs as the key independent variables, with the overall GDP growth assumed at 5.1% per annum in real

terms and consumer tariffs fixed at 75% of the long run marginal cost at constant 1982 prices.

Box 3.2:Water and energy resources

Kenya's total energy demand is 3 million tonnes of oil equivalent, 72% imported and 28% supplied from domestic sources. Energy demand is increasing at a rate of 5% per annum. Hydropower contributes 75%, geothermal 8.5%, gas and oil generation, 19.3%.

In 1999 Kenya had 872.60 MW of installed capacity for electric generation. The same year, 140 million kilowatt-hours (Kwh) were imported from Uganda. Extreme weather, severe droughts and excessive rainfall limit the capacity of hydro-electric plants. Drought reduces the levels of water while excess rainfall reduces the volume of the dams through siltation. Hydro generation declined in the year 2002 as a result of prolonged drought and heavy siltation of dams due to the El Nino .floods of 1998. This situation led to power rationing and increased thermal generation from private producers. Imports from Uganda increased.

Kenya is heavily dependent on fossils fuels such as coal and petroleum products whose burning yields gas emissions including carbon dioxide, hydrocarbons and sulphur dioxide. In addition they generate other solid and li waster that result in air, water and soil pollution that impact negatively on environment and natural resources.

In 1997 reforms were initiated in the power sector. The reforms led to the creation of the Elecricity Regulatory B (ERB) to formulate policies and regulate the power sector. Kenya Generating Company (KenGen) supplies 90% power and KPLC transmits and distributes it.

Strategy

Intensify catchment and riparian management with a view to mitigate recurrence of siltation in hydropower plants.

Environmental pollution

Agricultural activities, industrial processes and provision of various services are major consumers of natural resou Extraction of mineral resources and addition of agrochemical inputs such as chemical stress, the self purifica capacity of echo systems because they lead to increased levels of emissions and pollutants into air, water and land. result is high level of water borne diseases and transmission of pathogenss thus increasing diarrhoea, diseases, upper respiratory tract infections. Accumulation of detectable chemical residues in agro-products is both a he hazard and a threat to the market where products are exported.

Source: NEMA website

Table 3.28: Performance Areas & Indicators.

Problem	Targets	Indicators
Inadequate Power Systems	Expansion of the Power system	No. of Power Plants constructed annually
Lack of Finances	Liberalization of the electricity generation segment to broaden the investment through private sector participation in the generation of electricity	Investments being injected in power sector No. of Institutions and private sector in power sector
Posting of losses by KPL	Set Electricity Tariffs and review of such Tariffs even when there are no applications for Tariff increases.	Profits posted by Kenya Power Company
Excess Staff	• Downsizing of KPL personnel • Establishments to free up resources expanded in labour by raising the customer to staff ratio from 31 to 49. • Savings accruing from this measure to be used to enhance the operations and maintenance budget to improve customer services. • Contracting out of non core and sole core activities to customers such as Janitorial and cleaning services.	No. of casuals/Contractors working with KPL
Reduce Rural – Urban migration	Intensify efforts to mobilize soft and grant funding to accelerate the pace of Rural Electrification consistent with the Government's Policy on Industrial dispersion throughout the country and on development of economic infrastructure to support industrial and commercial activities in rural areas.	Investments in Rural Electrification program.
Foreign exchage loss	Provision of incentives to investors for exploration and exploitation of hydrocarbon resources locally.	No. of exploration on oil being undertaken
Inadequate oil/fuel infrastructure	Enhancing the sub-sector liberation through provision of adequate infrastructure for importation of all refined petroleum fuels including LPG	Investments in infrastructure concerned with oil transport etc.

Table 3.29: Energy consumption by Primary Source: 1997-2004 (in '000'TOE)								
Primary Source Type	1997	1998	1999	2000	2001	2002	2003	2004
Fuel-wood	5391	5558	5731	5908	6091	6280	6475	6676
Charcoal	1355	1397	1440	1485	1531	1578	1627	1678
Coal & Coke			71.5	66.1	66.1	98.6	92.4	108.0
Petroleum Oil			2311.6	2448.1	2385.2	230.9	2129.3	2374.5
Hydro & Geothermal Electricity			930.2	1160.4	1142.2	1142.2	1142.2	1198.1
Total			10,484.2	11067.6	11,215.5	11,404.7	11,465.9	12,034.6
Percentage Annual Growth Rate			5.56	1.3	1.7	0.5	5	10
PER CAPITA Consumption (Excluding Wood-fuel in KOE			90.8	89.4	86.2	87.0	80.7	86.6
PER CAPITA Consumption (including Wood-fuel in KOE								

Source: Economy Survey 2004-2005 CBS.

Table 3.30: Electricity Sales in Megawatt-Hours (Mwh) between 1986 and 1996					
Year	Domestic Consumers	Commercial & Industrial Consumers	Off-Peak	Rural Electrification Programme	Total Consumption
1986	622553	1402184	111436	24493	2160665
1987	667266	1514134	110730	30858	2322988
1988	718044	1531150	109072	41887	2400153
1989	758762	1617239	116952	57507	2550460
1990	860490	1720513	121916	69965	2772884
1991	914730	1737533	116160	83216	2851639
1992	920238	1822612	103082	103768	2949700
1993	965403	1856653	112742	116911	3051709
1994	1020505	1908124	121575	135630	3185834
1995	1060409	2013993	110746	138544	3323693
1996	1126735	2152834	95259	156092	3531420
1999	1266.7	218608	84.9	152	3685.2
2000	1074.4	2061.8	59.8	124.7	3320.7
2001	1139.3	2167.5	54	65	129
2002	1269.3	2277.9	605	134.2	3742
2003	1290	2305	59	153.2	3807.2
2004	1423.8	2587	66.8	156.5	4234.1

Source: Economic Survey 2004 &2005, CBS

Table3.31: System Installed and Effective Capacity in MW by Plant Type as of December

Power Station	Installed Capacity	Effective Capacity
Hydro* Masinga	40	40
Kamburu	91.5	84
Gitaru	145	145
Kindaruma	44	44
Kiambere	144	144
Turkwell	106	106
Tana	14.4	12.4
Wanjii	7.4	7.4
Small Hydros	6.2	5.4
Sub-Total	598.2	588.2
Thermal (Oil) Kipevu Stream	75.5	50
Gas Turbines and Diesel including Wind Turbine Kipevu	30	30
Nairobi South	13.5	10
Ruiru	1.5	1
Ngong Wind	0.4	0.4
Isolated Diesel	9.2	8.1
Sub-Total	54.6	49.5
Independent Power Producers Iberafrica, Nairobi South Diesel	44.5	44.5
Westmont, Mombasa Barge Mounted Gas Turbine	43	43
Sub-Total	87.5	87.5
Geothermal	45	45
Grand Total	860.8	82.2

Table 3.32: Electricity Transmission Projects Selected for Implementation on the Basis of Least-cost Criteria to meet the Current unserved and projected demand over the nest five years

Project Name	**Length**	**estimated Cost in US$**	**Timing**	**Implementation Agency**				
Kipevu-Rabai (132kv)	17	5.2	1999/2000	KPLC				
Kiambere-Nairobi (220	160	22.6	1999/2000	KPLC				
Kilifi-Malindi	60	5.7	2001/02	KPLC				
Olkaria 1- Nairobi North	76	28.2	2001/02	KPLC				
Nairobi North - Dandora	33	15.9	2001/02	KPLC				
Olkaria 1-Olkaria II	4			KPLC				

SONDU Miriu-Kisumu (132kv	50	4.8	2002/03	KPLC				
Masinga-Nanyuki	140	13.3	2002/03	KPLC				
TOTAL COST	**511**	**95.7**						

Table 3.33: Electricity Projects selected for Implementation on the Basis of least cost criteria to meet the current unserved and projected demand over the next five years

	Project Name	**size in MW**	**Estimated Cost in USS(Million)**	**Timing**	**implementation Agency**	
	Kipevu Gas Turbine (Refurbished)	30	9.8	1998/99	KPLC	
	Kipevu I (Medium Speed Diesel)	75	79	1999/2000	KPC	
	Kipevu II (Medium Speed Diesel)	75	82	1999/2000	IPP	
	Gitaru Unit 3 (Hydro-power)	72.5	17.8	1999/2000	KPC	
	Fast Track Units (2) (Medium Speed Diesel)	110	90.7	1999/2000	IPPs	
	Olkaria II	64	178	2001/02	KPC	
	Olkaria II	64	208	2001/02	IPP	

Water and Forestry

Forests are among the Kenya's important natural resources as they supply goods and services for socio economic and cultural development. The gazetted forestland is estimated to be 1.7 million hectares. This is just about 2.5 % per cent of the country's land area. Recent estimates, based on remote sensing, indicate that Kenya has a critical 1.7 per cent of closed canopy forest cover (UNEP, 2001). The gazetted forests constitute 0.12 million hectares of plantation forest, 1.21 million hectares of indigenous forest, and 0.5 million hectares of protective bush and grassland. A total of 36.7 million hectares of other forest associations exist under other legal frame works that include National Parks, Ranches, Trustlands and forests private ownership. (Source: Forest Department)

Economic Importance

Despite the low closed canopy forest cover, the nation's forests are important natural assets for their economic, environmental, social and cultural values. They provide utility products such as timber, transmission poles, fuel wood, pulpwood, and a wide variety of non wood products.

Kenya's forests support country's main water catchments which include Mt. Kenya, the Aberdares, Mau Forest Complex, Mt. Elgon and the Cherengani hills. These

catcments are sources of the major rivers in the country, which provide water for hydroelectric power generation, irrigation and for both domestic and industrial use. Close to three quarters of Kenya's electricity is derived from hydropower therefore forest conservation is very important for the sustainable supply of electricity in the country. Forests are also important in conservation of biological diversity, carbon dioxide sequestration and are a major habitat for wildlife.

The relationship between our river system and forest is clearly demonstrated by the Figure and 2 below.

Forestry, Water and Soil

Cyclic relationship exists between soil and water resources and forests. Soil is the foundation of trees and most other plant life of the forest as it provides the medium in which plants grow. It also supplies essential nutrients for plant survival. Water is an essential plant nutrient and regulates plant physiological processes.

Stable forests' ecosystems in turn protect, stabilize and build soils. They in addition capture water as precipitation, store water in the forest soils and release the water to streams, rivers and lakes in controlled regimes that reduce floods, erosion and sedimentation. They act as a source of well distributed clean water to other forms of life and human society. Therefore soil and water resources are both inputs for stable forest ecosystems and outputs of the same forest ecosystems.

In Kenya this is reflected in confinement of forests in the five main water catchments and their service as the source of our river systems. The river systems in our country are Tana basin system, Athi basin river system, Ewaso Ngiro North basin river system, Rift Valley basin river system, and Lake Victoria basin river system. These have clear relationship with the five water catchments in that all the rivers that drain in these basins in one way or another emanate from the water catchments.

Soil and water conservation play a crucial role in providing strong linkages with agriculture and tourism, which are the mainstay of Kenya's economy. The agricultural sector contributes 30 per cent of the GDP and provides the main livelihood for about 80 per cent of the population.

In addition many forests in Kenya are traditionally important for cultural ceremonies and serve as sacred sites to local communities, and specific tree species have cultural values.

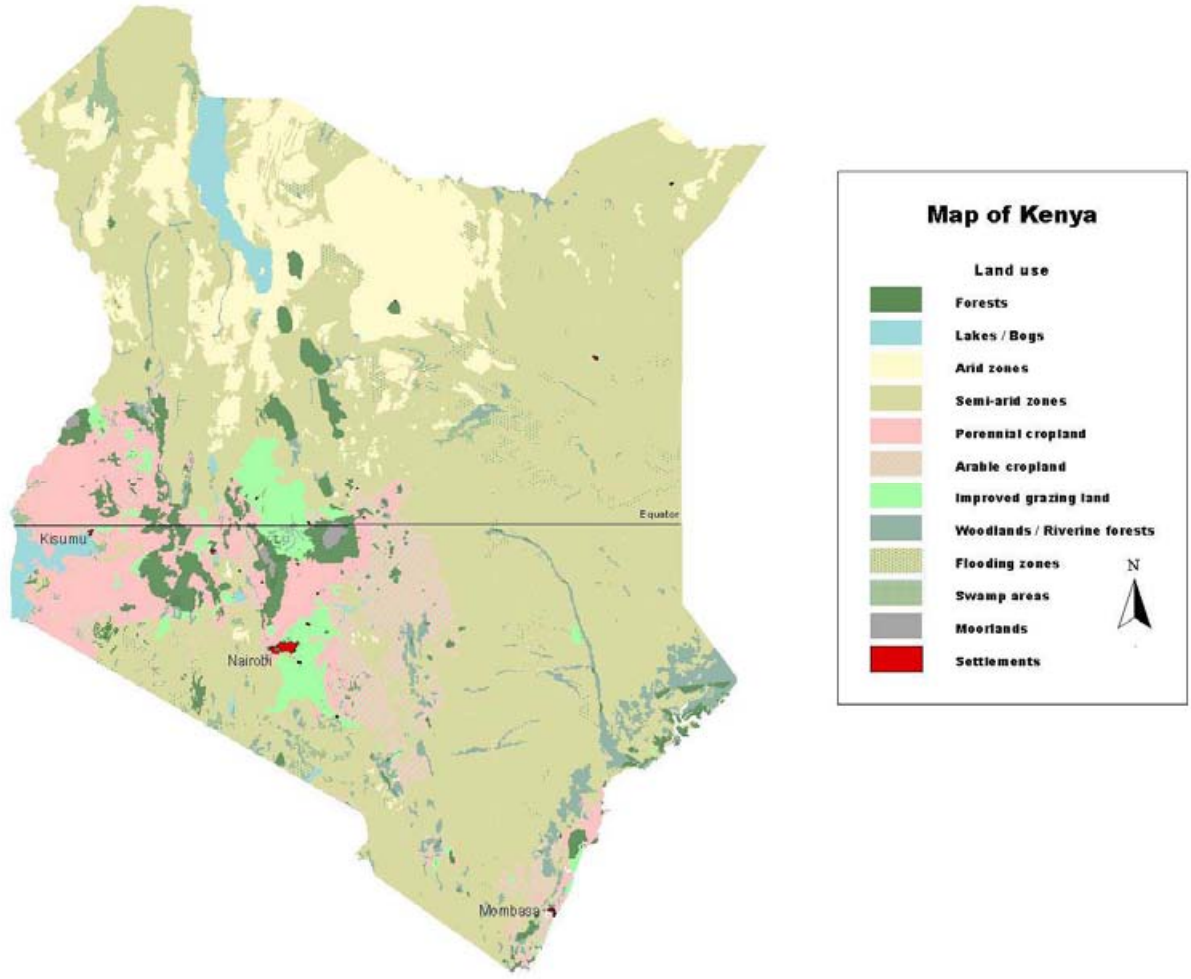


Figure3.3: Forest Distribution in Kenya

Forest and Employment

Forest development is currently viewed as an inter-sectoral issue which is a component of integrated national efforts aimed at raising living standard, creating employment and increasing outputs to provide goods for domestic use and export. This calls for planning taking into account the relationship between the sector and the rest of the economy.

In 1994 the sector had directly employed more than 23,000 people who have currently reduced to be 10,000 people due to staff rationalization and right sizing programme being implanted by the Government. In addition to this the sector had employed more than 30,000 in timber industry which has also decreased due to ban on timber harvesting in the country. Through the inter-relationship with other sectors of the economy forest sector has contributed to employment in the energy, Agricultural, water, tourism and education sectors.

Situation Analysis

Forests as Water Catchment

The 1.2 million hectares of closed canopy in Kenya serve as water catchment for the Kenyan rivers. Of this the area that fall within the main water catchment is as shown in table 3.34 below:

Table 3.34: Forests by Acreage in Kenya

Forest Reseve	Area Hectares
Mt. Kenya	199,558
Aberdares	103,315
Mau Complex	400,000
Cherangani	128,000
Mt. Elgon	73,089
Total	903,962

Source (Forest Department)

This is 75% of our total forest in the country which is about 2.5% of Kenya's Total land area.

In addition to the above main water catchments other numerous smaller forests exist that serve as water catchment for the streams and rivers that emanate from them.

Problems and Issues on Forest Conservation

The main problem facing forest management and conservation in Kenya is population pressure which has led into competition for land. As a result the country has in the recent past witnessed substantial loss of forest cover both within the Gazetted forests, Trustlands, as well as within the private lands. Majority of this loss is as a result of change in land use especially the conversion of forestland for purposes of agriculture and settlement. This in turn has resulted in destruction of water catchment areas especially within the five major water catcments in the country in the country. The population pressure on forests in Kenya is demonstrated on Population Map Figure 3 .4 below.

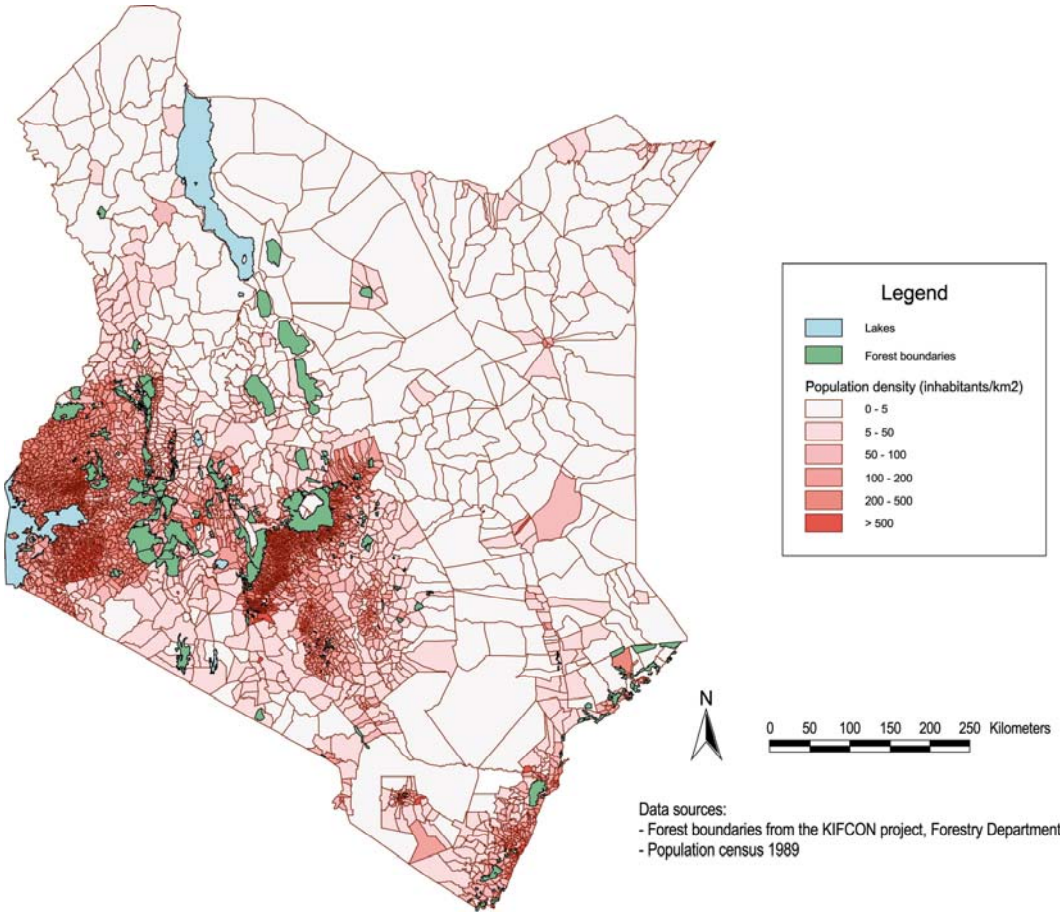


Figure 3.4: Population Distribution

Other problems that face forest management in Kenya include forest fires, squatters, timber poaching, wildlife damage, and overgrazing. These affect the overall quality of the forests' function as water catchment.

Challenges

The following are the key challanges that have been identified as facing suststainable forest management and conservation in Kenya today. The Challenges are categorized into three types depending on the type of forest affected.

Gazetted forests

Forest Excisions: This has been identified as the key contributor to the declining forest cover in the country and the main origin of forest destruction and subsequent environmental degradation. Examples of these include the excision of 67,000 hectares in 2001 in parts of Mau escarpment, Marmanent, South Nandi, and Mt Kenya forest reserves among others. Most of these areas have not been degazetted, hence they are legally still forest land.

Human encroachments into gazetted forests for settlement and agriculture
This is a problem as a result forest neighbouring communities extending their farmlands into forest land. Example of this is the case of Cherangani hills especially Markwet District.

Squatters: This is as a result of people moving and esiding within gazetted forest land. This a common problem in most forest especially where communities were not moved after the forest reserves were gazetted.

Others: Other challenges include Illegal logging, Animal (Wildlife) damage, Resource constraints and Weak forest policy and legislation

Challenges within trust lands forests

Challenges trustland forests include Land use change from forest to settlements, especially within vital catchment areas e.g. the Masai Mau, unsustainable tree harvesting, lack of adequate protection measures in local authorities' forests, weak Policy and Legislation especially the current Trust Land Act CAP 288 has weak provision for natural resource management

Challenges within private forests

The challenges that face privately owned forests are competition for forest land with agricultural activities, increasing demand for forestry products leading to over harvesting, lack of incentives to maintain private land under forest cover, weak policy and legislative provisions for sustainable forest management, and lack of enforcement of the Agricultural Act requirement for conservation of riverine vegetation/forests.

Policies, Legislation, Norms and Standards

Forest management is influenced by various policies and legislation that set standards and norms.

Policies

Sessional Paper No. 1 of 1968 a Forest Policy for Kenya

The objective of the Policy was to lay down the basic principles to guide the development and control of forestry in Kenya for the greatest common good of all. The principles were described under ten main heads which included reservation of land for forest purposes, protection of forest estate, management of the forest estate, industry, finance, employment, local authority forests, private forests and other forests not under state ownership, public amenity and research and education. The driving force was to restate the White Paper No. 85 of 1957 which was the full Forest Policy statement for Kenya stated during colonial time. The main points of sound forest development did not change but there was need for Independent Nation to clearly state its aims in this vital field of development.

Kenya Forest Development Policy Sessional Paper No.9 of May 2005
The objectives of the new Kenya Forestry Development Policy are sessional Paper No. 9 of May 2005.

1. Contribute to poverty reduction, employment creation and improvement of livelihoods through sustainable use, conservation and management of forests and trees.
2. Contribute to sustainable land use through soil, water and biodiversity conservation and tree planting through the sustainable management of forests and trees.
3. Promote the participation of the private sector, communities and other stakeholders in forest management to conserve water catchment areas, create employment, reduce poverty and ensure sustainability of forest sector.

4. Promote farm forestry to produce timber, woodfuel and other forest products.
5. Promote dryland forestry to produce wood fuel and to supply wood and non-wood products.
6. Promote forest extension to enable farmers and other stakeholders to benefit from forest management approaches and technologies.
7. Promote forest research, training and education to ensure a vibrant forest sector.

The above policy objectives affect conservation of water catchment in one way or another.

Challenges Faced by the Forest Policy

One of the most significant challenges affecting Kenyan forests is the rapid and accelerating population increase. Between 1968 and 2005, the population of Kenya has more than doubled from 11 to 30 million at a growth rate of around 3.4%. Demand for Woodfuel, construction wood and environmental needs have inevitably increased. Forest reserves can no longer provide sufficient wood products and services on sustainable basis. This calls for promotion of forest conservation methods that recognise the role of the other stakeholders. This is addressed in the new Forest Policy.

There has been an increase in excision of forestland especially in high potential areas as a result of population increase since 1968. Conversion of forest land to agriculture in high potential areas, some of which is extremely important for water, soil and biodiversity conservation, calls for intensification and deliberate natural resources conservation and management practices.

The expansion of cultivated land into both high and low potential areas has led to loss of natural vegetation outside gazetted forest areas. If per capita cultivated area of 0.4 ha in 1990 prevails over time, farmed area will theoretically increase from 3 to 6 million ha by the year 2010. More forest products, mainly Woodfuel that accounts for about 90% of all wood requirements, will have to come from farms. There will also be more need for regular water flow for people, livestock and agricultural development. This calls for effective forest conservation to ensure water catchment protection.

Problems of land degradation in form of soil erosion and desertification especially in marginal areas due to influx of population from high potential areas in search of agricultural land to feed the expanding population need to be addressed. In these areas, the main thrust in natural resources conservation and management is by conserving the existing vegetation by protecting individual useful trees or preserving fodder for animals in protected plots. It is possible to grow trees in these areas but one has to bear in mind the issue of both land and tree tenure.

Economic Management for Renewed Growth: Sessional Paper No.1 of 1986

At present, this is the most important policy document, in that it lays down the broad strategy and specific measures which must be followed by all the national development plans from 1986 to 2000 in order to achieve the target GDP growth of 5.6%. The paper viewed agriculture as the key sector for economic growth, and emphasized seven commodities namely coffee, tea, maize, wheat, milk and horticultural products.

Timber Industry (structure and production)

The total area under indigenous forest is 1.03 million hectares. The total area set aside for plantation development is about 170,000 ha, of this area only 120,000 ha is under growing stock. The rest is either in preparation for planting or is un-planted bush after timber harvesting.

In addition to this there is un-quantified manmade forest in private farmlands. This has been registered due to the fact that, despite the decline in forest area and the stock in our forests a positive trend in the amount of biomass increase, has been registered since 1970s. Increased tree planting and conservation undertaken by individual farmers in their farms.

Harvesting of timber in the country is now under ban in gazetted forest plantations. The main tree species grown include *Cupressus lustanica, Pinus patula, Pinus radiata* and *Eucalyptus spp*. The first three species are the main timber species; while the last provide timber, fuel wood, and poles. All the species are used for pulp production in the pulpwood area. The ban has resulted in over-exploitation of trees on farms due to high demand for timber

Some supply of hardwoods is done from our indigenous forests from a illegal

exploitation as indigenous forest exploitation was banned in 1986. This should not be underestimated because they meet some demand in the timber market. The demand for the hard wood is high and hence the high cost of the product. In addition to serving in construction industry, the hardwoods are very important for furniture industry.

Legislation

Forestry legislation is fairly comprehensive but it is spread over various Acts which are administered without coordination by various public bodies. The outline of the relevant acts is given below:

- Forest Act, Cap. 385 of 1962 (revised 1982 and 1992
- Timber Act, Cap. 386 of 19972
- Wildlife Conservation and Management Act Cap. 376 of 1976
- Fisheries Act, Cap. 378 of 1989
- Agricultural Act, Cap. 318 of 1986
- Registered Land Act, Cap. 300 of 1985 (revised 1989)
- The Environmental Management and Co-ordination Act No.8 of 1999.

Goals

The goal of forest management is manage trees and forests for sustainable of goods and services for socio-economic development. To achieve this, Forest Department has designed four major forest programmes that include:

- Catchment and natural forest conservation programme;
- Dry land forest development programme;
- Forest extension services programme and
- Plantation development prograqmme.

Strategies

Forest management will require to employ the following strategies to ensure the sustainable supply of goods and services:

- Government to expedite resolution of pending excisions and finalization of pending related litigations.
- Government to consider lifting the current ban on timber harvesting.
- Expedite enactment of the Draft Forest Policy and Forest Bill 2005.
- Squatters within forest areas to be evicted and the degraded areas rehabilitated.
- More reinforcement in terms of:
  - Security personnel (Forest guards);
  - Logistics (vehicles, motorcycles, communication equipment);
  - Establishment of Forest Guard outposts to enhance policing.
- Concerned agencies to step up strict law enforcement within the protected areas.
- Building of linkages and partnerships with relevant lead Government agencies, private sector, forest adjacent communities and all other stakeholders in forest conservation and management.
- Establishment of a Forest Conservation Fund as recommended in Draft Forest Bill 2005.
- Government to hasten the development of a Land Use Policy to address subdivision of Trust and Communal lands.
- Adequately fund and equip the forest department or proposed Forest Service to effectively execute its mandate in forest conservation and management.
- Promote use of alternative energy and create incentives for adoption of modern and appropriate processing and conversion technologies to minimize wastage

Performance Indicators

The following indicators will be used to measure success in the implementation of the programmes:

- Area of natural forest rehabilitated.
- Area of plantations replanted.
- Improvement in river stream flow.
- Area of excised critical catchment land that reverts to gazetted forest.
- Established forest conservation trust fund.
- New forest Act.

Issues and Constraints

The issues and constraints classified into three categories as given below:

Gazetted Forests

1. Unclear legal status of the proposed excision areas (Government is yet to make a decision on the matter). This phenomenon is leading to indecisiveness by forest managers on management issues for these areas
2. Current ban on timber harvesting is creating lucrative black market for timber hence acting as an incentive for illegal logging
3. Inadequate surveillance due to labour shortage and other logistical facilities including vehicles, communication equipment, etc
4. Lack of proper policy guidance on squatter relocation and settlement
5. Inadequate policy and legislative provisions to support suststainable forest management
6. Conflict of interests in the conservation and management of forest reserves among the various stakeholders e.g.

    - Individuals advocating for excisions of forest areas for settlement as opposed to conservation
    - NGOs/Institutions advocating total conservation with total disregard to utilization
    - Rural communities and forest dwellers such as the *Dorobos* claiming ownership and rights to forest reserves for basic livelihoods

Trust Lands

- Lack of legal backing for MENR&W to influence and control subdivision of Trust lands where forest cover exists.
- Lack of a consultative process during subdivision and land use change
- Lack of a National land use policy which would designate and reserve certain areas for specific environmental management objectives

Community and Private Forests

- Inadequate legislative frame work to influence and control subdivision of community forests
- Inadequate capacity to sustain ably manage and conserve these forests
- Lack of a National land use policy that would designate and reserve certain areas for specific environmental management objectives.

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4

Part IV: Integrated Aspects of Water

Part IV: Integrated aspects of Water

Water and Social Aspects

Water and Gender

Gender mainstreaming is the appropriate active involvement of women and men in decision-making. Gender balance requires that women's views, interests and needs shape the development agenda as much as men's. The development agenda recognizes that men and women have different opinions about development issues of which water is one. More often that not, the relationships between them are unbalanced. Effective development means recognizing these facts. For example women and the poor in general are rarely given opportunities to benefit from development and governance. It is therefore necessary to effectively use human resources and institutional reform to allocate burdens, profits and responsibilities logically and equally between men and women. (Water voice project report 2003)

Role of women in domestic water use

Women are responsible for ensuring that their families have water for daily living. As a result, when water is scarce, it is the women who suffer because of their role as domestic water providers, caregivers and household managers.

Access to potable water is becoming increasingly difficult due to changing national policies, increased water scarcity due to pollution, degradation of water resources and changes to methods of water supply. Domestic water use in the country especially in rural households has been adversely affected as women and girls spend lots of time walking long distances or queuing to fetch water for use at home. Many times the water is not affordable affecting the domestic water use.

This has adversely affected the girl child education and the woman's ability to engage in other income generating activities, cultural and political involvement, rest and recreation.

Box 4.1: Women and Water in Isiolo District

Most of the women in Isiolo District spend their day fetching water. They wake up very early in the morning, do their morning duties and set out to fetch water. By the time they get to the water points and back in the house it is noon. They prepare lunch and again set out to fetch more water as the water earlier fetched was not enough to meet requirements as they could not carry large containers. By the time they get to the house again, its already dusk and they have to do their evening chores and the day ends. The same routine is repeated each and every day.

Sanitation cannot be detached from water issues. Provision of water and sanitation services has remained one of the greatest challenges for the government. In the Nairobi slums, one toilet is shared among 300 people thereby denying the slum communities access to decent sanitation and hygiene. Improving sanitation and hygiene practices requires skills in participatory approaches that build on women's and men's own perceptions of the benefits. Sanitation programmes offer natural entry point for gender approaches. Coping with sanitation inadequacies adds enormously to women's domestic burdens as well as robbing them and their children of health and dignity.

Water privatization

Failure to effectively manage water resources by many local authorities and central government departments has led towards

privatization of water services. Privatisation is one aspect of the world's water crisis that has deeply negative impacts on the livelihoods of women as its scarcity. Water privatization perpetuates gender inequalities that women and girls are responsible for and are the main suppliers of water to their families and households. Over many years women have disproportionately experienced the burdens of privatisation policies and or lack of government control of enormous price hikes and deteriorating water quality especially in those areas that fully depend on the water vendors.

Inequitable Distribution of Water

Naturally water resources are distributed unevenly in space and time. While some areas have abundant supplies of water, in other areas, especially those classified as arid or semi arid, water resources are unevenly distributed yearly and also from one local area to another. Available water in Kenya is distributed as shown in figure 4.1

Competing Demands for Water

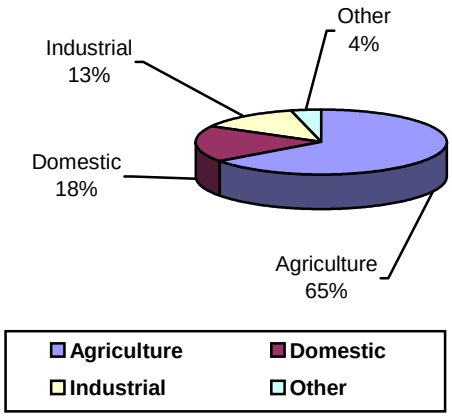


Figure 4.1: Water Distribution

Inequitable supply of water has clear gender dimensions especially in the rural areas where due to depletion of water resources; women are forced to walk long distances in search of water, leaving no time for other household chores including economic activities.

Increase in water prizes and inadequate access to water greatly increases women's burden thereby exacerbating gender inequity. Human rights advocates recognize water as a critical component of gender equality and women's empowerment as well.

Box 4.2: Disparity in Water access in Urban areas

The poor are paying much higher for water than the rich. Slum dwellers in Nairobi do not have water connections from the municipality. They depend on private water vendors for their day-to-day water needs. This is also true to so many other urban dwellers in all parts of Kenya. With no regulated prices for water, the poor are being charged as much as ten times more for water whose quality is not assured, compared to what the residents with piped water are paying

In November 2002, the authoritative UN committee on Economic, social and cultural rights adopted General Comment 15 on the right to water. The general comment clearly recognizes water as a basic human right as it is fundamental to life and health. The right to drinking water is recognized in a number of international conventions and treaties. These include but not limited to the Convention on the rights of the child (1989), the Convention on the Elimination of All Forms of Discrimination against Women (1979) and the two Geneva Conventions relating to the humanitarian laws during war.

In ensuring that this right is realized, special attention must be paid to those individuals and groups who traditionally have faced difficulties in exercising the right, including women, children, minority groups, indigenous peoples and other such marginalized groups.

Water Governance

Access to social services differs mainly due to socio-cultural factors and lack of a comprehensive policy for redressing gender inequalities, and ensuring equal opportunities for both men and women. In education programmes, enrolment rates and adult literacy are both lower for women than men

except for Central and Nyanza provinces where the situation is vice versa. At university level, female enrolment is less than 35% of total enrolment.

There lacks gender equality in water development decision-making processes. Most water institutions have very low women representation at the planning and decision-making levels. In stakeholder associations, the percentage of women is even lower because seldom do women participate in these kinds of organizations.

Inclusion of women in government organs that formulates policies and regulations related to the water sector, the environment, agriculture and related areas, is one step that will help in highlighting the specific gender issues, defining the impacts on women and building a support structure that will enable women to participate in and benefit from water for nature initiatives. Whilst the involvement of women in water committees is encouraged in a few policies, the precise role or the qualification of women who should be involved is rarely specified. (*Gender and Water Alliance (2003).*

Effective water governance requires changes in attitude and behaviour among individuals, institutions, professionals, decision makers etc. Public or stakeholders participation is an important tool in implementing such changes as it facilitates more informed decisions and eases conflict resolution. *(Water Voice report 2003*) It guarantees that voices of relatively powerless groups such as women and indigenous people are heard. Participation offers people the opportunity to meet their responsibilities and claim their rights.

Gender considerations are just beginning to infiltrate most of the government institutions and the process is still encountering obstacles and oversight. With lack of gender visibility in the national institutional framework, water resources management may become constrained Affirmative action should be employed to ensure that women get real opportunities in management of water resources.

Health and safety

Women are more vulnerable to environmental hazards than men because of their particular social and economic roles. (DFID *et al*. 2002) When women's access to water is deficient, a number of negative health and social impacts result.

Firstly, low quality and contaminated ground water not certified for domestic consumption is used, thus threatening family health and well-being (*WEDO 2003*). This is a particularly frightening alternative given that 80% of all illnesses are water-related.

Secondly, these illnesses drain limited household budgets as available funds are diverted for medical expenses or for purchase of water at high costs.

Multi-sectoral water use benefits households, communities and national economies in three different ways.

- Firstly, it leads to better family hygiene and health, and so to lower private and public health costs.
- Secondly, it enables women to produce food for home consumption, with beneficial effects for nutrition, family health and child development.
- Thirdly, productive uses of water by women and to some degree by men saves on domestic expenditure and creates additional income which is used for the family welfare. (*Gender and water Alliance*.)

Table 4.1 Key Problems on Integrated Aspects of Water

Problem	Target	Indicators	Recommendations
Satisfy the water demand across the competing sectors.	Improve the management of water resources and extend water coverage	The intensity of regulatory and monitoring roles of water undertakers.	Water development, use and management should be based on a participatory approach, involving users, planners, implementers and policy makers at all levels. To realise the action plan formulated in the

Problem	Target	Indicators	Recommendations
Inadequate financing of water conservation and protection	Increase water coverage in the country by June 2006 (I*nvestment Plan 2004)*	Level of participation by other stakeholders Stabilised water flows Increase in forest cover in water catchments	national water policy 1999. Mainstream local water undertakers in the decision making processes Water user charge: establishment of Catchments protection levy (for every kilowatt hour consumed, every cubic metre used, every tourist entry into a water related scenery) Ensure that water utilities plough back a percentage of their proceeds into water conservation Implementation of User pays and polluter pays principle
Attaching a social, economic, cultural and environmental value to water.	Develop Guidelines on water valuing	Guidelines in place. Collaborative mechanisms set up at the regional levels.	The government subscribed to the World Water Forum in the Hague whose resolutions required this aspect to have taken place by 2000. Effective and realistic integration and coordination amongst the relevant sectors, for example for virtual water Agriculture and Water ministries. Other critical sectors are environment, finance, energy, livestock, tourism etc. Enhance interaction towards enhancing water resources management, development and use.
Lack of information strategy to capture economic contribution by water, Lack of strategies to collect and disseminate information	Develop a strategy to integrate water in the ERS and PRSP	Number of jobs created by the water and water related activities Information on water demand and water supplied	Integrate water in the ERS, PRSP and in the Ministry's information strategy. Capacity building on efficient use of water Investing in research
Lack of implementation of gender perspectives	Translate the policy provisions into actions	A third of women of in water entities Affirmative action proposes 50/50	Apply the recommendations in the action plan in the national water policy 1999. Integrate the needs of the poor, women men and vulnerable groups
Inadequate	50% access by	No. of people with	Develop tariff guidelines that take into

Problem	Target	Indicators	Recommendations
access to domestic water services Lack of integration of HIV Aids in gender and poverty	those without water by 2015 Assess and outline the impacts of HIV in the water sector	access to water and sanitation	consideration the socio-economic aspects of Kenyans Safe, sufficient, affordable and within reach eg Water facilities should be located at 200m in high potential and 5km in low potential. Quality should conform to WHO & KBS standards Assess the socio economic professionally loss Time women spend caring for the sick and the added burden Education of children
Inadequate technologies options for water and sanitation		No. of persons trained Inventory of water and sanitation technologies Budgetary allocations for technological development	Investment in research in water and sanitation technologies eg water harvesting, child friendly designs

Table 4.2 Summary Indicator Table on integrated aspects of water

	1992	1996	2000	2003
The intensity of regulatory and monitoring roles of water undertakers	55%	55%	55%	55%
Level of participation by other stakeholders	30%	30%	30%	40%
Increase in forest cover in water catchments	2%	0%	10%	20%
No. of people with access to water and sanitation	8.2m	8.7m	9.4m	10.3m
Number of jobs created by the water and water related activities				
No. of water services companies and WUAs formed and operational	256	300	357	360
Inventory of water and sanitation technology	80%	75%	70%	65%

Due to walking for long distances in search of water, women and children are often exposed to danger of physical violence, abuse and attacks by wild animals.

Economic contribution

Women make more than 50% of the Kenya's population. They constitute about half of national human resources and they are naturally endowed with potential, ranging from intellectual, the physical and the spiritual which when properly used, make them a potential force of the productive manpower. Water and sanitation projects work better with groups of women because in many cultures women are the primary water providers at domestic levels. Many projects organize groups of women in the

community and new technologies for improving water supplies and sanitation are introduced. Women can raise funds to build water and sanitation projects.

Special focus should be placed on women to implement and manage water systems. Women should be involved in the conception, planning, and implementation stages as well as in evaluations related to domestic water supply and sanitation projects. Gender specific budgets should be provided to enhance women's involvement in the water systems. The water service providers will undertake gender specific initiatives with water related income generating activities.

Gender Enrolment in water related training

Women should also be encouraged and given equal opportunities as men in water related training institutions to enhance their skills and knowledge in water issues. Literacy ratio for females to males increased from 81% in 1989 to 90.5% 2000. (MDGs 2003) However specific examples of women training in water-related fields and institutions, the figures are quite low.

In a Case study of Kenya Water Institute (KEWI) for the past 5 years, enrolment for Higher Diploma and Certificate courses in water, the data obtained is as tabulated in Table 4.3 below.

Table 4.3: Case Study on enrolment at KEWI

Year	Women	Men	Percentage
2000	29	64	31%
2001	16	51	24%
2002	27	86	24%
2003	37	103	26%
2004	4	28	13%
Total	***113***	***332***	***25%***

Issues to be addressed

- Participation of women in decision making and involvement in water committees.
- Focus on women to implement and manage water systems.
- Women specific budget and women initiatives.
- Valuing and compensating contribution from women.
- Training in technical and basic management and water resource management skills must include women. (a targeted effort to encourage women enrolment in water related courses)
- Gender elements in training curriculum e.g. Inbuilt gender aspects in participatory Learning and Action and Participatory Rapid Appraisal.
- Recruitment of staff at all levels must include women.
- Privatisation of water which poses negative impact on the livelihoods of women.

Table 4.4 Indicators

Goal	***Target***	***Indicator***
Decision Making	Involving women in planning and decision making in water resource management. The water resources users should ensure that at least 50% of management committee members are women	Proportionality in the number of men and women involved in decision making
Capacity Building • Institutions training • Skills at community Level	Proportion of women and men enrolled in water training institutions. Training in technical and basic management in water resources must include women	Proportionality of the number of men and women training in water institutions The number of women

Goal	*Target*	*Indicator*
	Ensuring that skills in water resource management are imparted to women at community levels	involved in community level education on water issues. Proportion of men and women included in technological transfer
Decentralization	Water managed responsibilities should be equally shared between men and women	The number of women included in staff recruitment in the water sector is more or equal to that of men
Government Support	The government should recognize the initiatives done by women towards water resource management	A specific budget allocation towards women's initiatives by the government
Distance and the number of people to a water points	To bring water closer to the people.	Proportion of time spent by especially women and children in domestic water use
Valuing of women's contribution to water development	Developing incentives to encourage and promote women's role in water development	The percentage of national economic contribution by women
Water disasters	To help women cope with water disasters such as floods and come up with mitigation measures against such calamities	Gender responsiveness to mitigation and in handling disasters

Definition of Indicators

Indicator 1

Definition: Proportionality in the number of men and women involved in decision-making

Purpose: To assess integration of men and women, their views in water development and decision-making processes.

Relevance to sustainable water resource management: Women relate to water differently from men and each ones views must be brought on board for effective decisions making.

Indicator 2

Proportionality of the number of men and women training in water institutions

Purpose:

Assessment of capacity development of women and men in water development

Relevance:

To enhance women's capacity to effectively participate in decision-making processes at all levels.

Increase the number of women with expertise in water resources management at all levels.

Indicator 3

The number of rural water schemes being managed by women.

Purpose: To ensure both women and men are recruited in the existing opportunities in water sector, and that one group is not only involved in offering free services while others are been paid for their contribution

Relevance

To recognize the contributions from both men and women.

Indicator 4

A specific budget allocation towards women's initiatives by the government

Purpose

To provide incentives to women for their active involvement in water resources management.

Relevance: Increase the number of women initiated water related projects at the local level.

Indicator 5
Proportion of time spent by especially women and children in domestic water use
Purpose: To assess portability, water points
Relevance: Increase potable water within an accepted distance. Increased amount of time left for women and children for other activities and school respectively.

Indicator 6
The percentage of national economic contribution by women
Purpose: assess the value of women's activities in water development
Relevance: Translate their efforts into economic terms

Indicator 7
Gender responsiveness to mitigation and in handling disasters
Purpose: to assess development of coping mechanism for adaptation
Relevance: If there are adequate measures local initiatives to mitigate water related disaster,

Water + children

Children often spend long hours collecting water. Others die annually from water related diseases.

It has been recognised that children are the best agents of behavioural change. A lesson learnt in infancy is permanently stamped on memory. Children who learn the importance of washing hands in school will impart the behaviour on the family and peers. In recognition of these, the government has continued to support the school Participatory Hygiene and Sanitation Transformation (PHAST) Programme.

Children should also be freed of the burden of fetching water so as to spend adequate time in school and on learning. In addition, Improved water provision in schools translates in to improved enrolment and retainment in schools especially for girls in ASAL areas.

Situation of Water and environmental Sanitation in Schools

Access to safe drinking water and environmental sanitation is universally recognised as a human right, which has special significance to school-going children. These rights are guaranteed by the Convention on the Rights of the Child (CRC) and in the African Charter on the Rights and Welfare of the Children (ACRWC) which considers the provision of adequate sanitation a basic right for survival, development and protection of the child.

Table4.5: Source of Water for primary schools as reported in self administered questionnaire in 2003

	Piped	River	Borehole	Spring	None	Total Safe	Total Unsafe
Nyanza	9%	36%	29%	17%	9%	38%	53%
Rift Valley	19%	35%	25%	15%	5%	44%	51%
Nairobi	88%	5%	5%	1%	2%	92%	5%
Central	42%	36%	7%	9%	6%	49%	45%
Coast	36%	21%	31%	5%	7%	67%	26%
Western	11%	16%	39%	28%	6%	50%	44%
North Eastern	8%	16%	53%	4%	18%	61%	21%
Eastern	21%	43%	21%	10%	4%	42%	53%
Source: Ministry of Education Science and Technology. 2003.							

Water in Schools:
Access to water in schools mirrors the situation in the country. 56 % of the primary schools countrywide have access to safe water. Table 4.5 shows the state of water provision in primary schools by province.

Other issues arising from recent field assessments (carried out in 2003), as well as the WFP's School Feeding Programme, include:

- Long distances to water in the arid and semi arid areas with some water points being more than 10 km from school. Both children and teachers are affected by the situation.
- Some water points are unreliable and prone to drying up. In the arid areas this becomes a crisis in the drought seasons and schools are forced to closedown.
- In urban areas, schools are often unable to pay for water, usually piped, and the children have to source the water from elsewhere.
- Monitoring reports by WFP show that during the drought periods, some schools especially those in the arid districts are unable to prepare school lunches due to lack of water.

Other related concerns are:

- The water systems in many schools are broken down particularly bore holes fitted with hand-pumps in many places.
- West Pokot District. The story is the same with leaking storage tanks, rusted iron-roof catchments, etc.
- Water conservation measures are generally not practised in most schools as evidenced by bare school compounds. Other schools do not have appropriate roofs to collect rainwater.
- In some schools, pupils ferry drinking water to school, as well as water for washing classrooms and toilets. This water is of doubtful quality.
- Stress among some pupils has been observed because of travelling long distances in search of water and this has direct implications on school attendance and performance. [MWI]

Basic sanitation in Kenya
Basic sanitation is based on the fair share approach which considers the poor majority, competing uses, environment, neighbours, women and children.

Figure 4.4 below compares the average number of pupils per latrine by province as per three ranks. Fair refers to the average of the class of schools which have a ratio of less than 40 pupils per latrine, bad are the average in the class of schools that have between 40 -100 and dangerous are the average of the class of school that have beyond 100 pupils per latrine.

Box 4.3: Environmental Issues in Schools

- Environmental Action Learning / Eco School Strategy

A strategy for enhancing safe water and sanitation – by the Kenya Organization for Environmental Education (KOEE)) to solve water and sanitation problems in schools.

This plan is meant to:

- Promote school and community based policies in safe water and sanitation.
- Promote a healthy, safe and secure school environment.
- Equip learners with skills to enable them to address water, sanitation and health related problems.

The *Plan* comprises of (among other things):

- Health-related school policies;
- Provision of safe water and sanitation;
- Skills-based health education; *and*
- Participatory methods of managing water resources (by all stakeholders).

The *solutions* offered by EAL include:

- Developing awareness on water and sanitation;
- Developing knowledge and skills necessary to analyse and understand why people view and use water in particular ways;
- Refocusing on combating specific menace such as typhoid, diarrhoea and dysentery.

EAL *strategies* revolve around:

- The promotion of school-community partnerships in EAL micro-planning and micro-projects which serve as learning aids as well as income generating innovations; *and*
- Developing national/local/culturally –oriented curricula (by using/utilising local resources) to solve environmental problems, and to provide basic knowledge/skills for optimising learning environments in order to mobilise resources and to meet the needs of the learners.

The *benefits/outputs* of the Eco-School are:

- Cleaner and aesthetic environment;
- School-community co-operation in addressing water and sanitation issues;
- Learner empowerment to actively resolve local water and sanitation related problems;
- Financial savings (hospital bills, water bills, etc.);
- Improved quality of life; *and*
- Increased water and sanitation awareness.

Source: *Report of the water and environmental sanitation in schools workshop held at the Stanley hotel, Nairobi on 19th – 20th August, 2003*
November 17, 2003

WATER AND SOCIAL DIGNITY

Water is Life and Sanitation is Dignity

Access to water supply and sanitation is a fundamental need and a basic human right. It is vital to satisfy basic right to life with dignity that includes health to all people. The health and economic benefits of water supply and sanitation to households and individuals that is of special importance to the poor are the time saved, convenience and dignity that improved water supply and sanitation present. Most of those without access are the poorest and least powerful. Access for the poor is a key factor in improving health, economic productivity and above all self-esteem and it is therefore an essential component of any effort to poverty alleviation.

Poor water supply and sanitation have high toll on health, cause resource conflicts and /or violence and indeed degrade human self worth. Improving water and sanitation brings valuable benefits to both social and economic development. Social well being encompasses more than simply material satisfaction, it takes account of less tangible aspects of people's lives such as the quality of neighbourhoods, work and leisure, the environment and the ability to fully participate in society. Sufficient potable water and adequate sanitation contribute to social dignity by improving on both the natural and human environments in terms of ensuring cleanliness, reduced morbidity and increased human capital which adds up to enhancing social status in the community.

Table4.6 National Diseases Pattern related to Water and Sanitation

Disease	National Morbidity (%)
Malaria	32.6
Respiratory System	24.6
Diarrhoea & Intestinal worms	17.0

Source:Ministry of Health

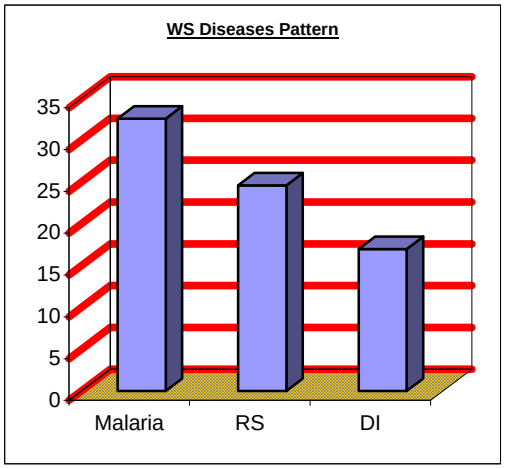


Figure 4.3: Water and sanitation Disease Pattern

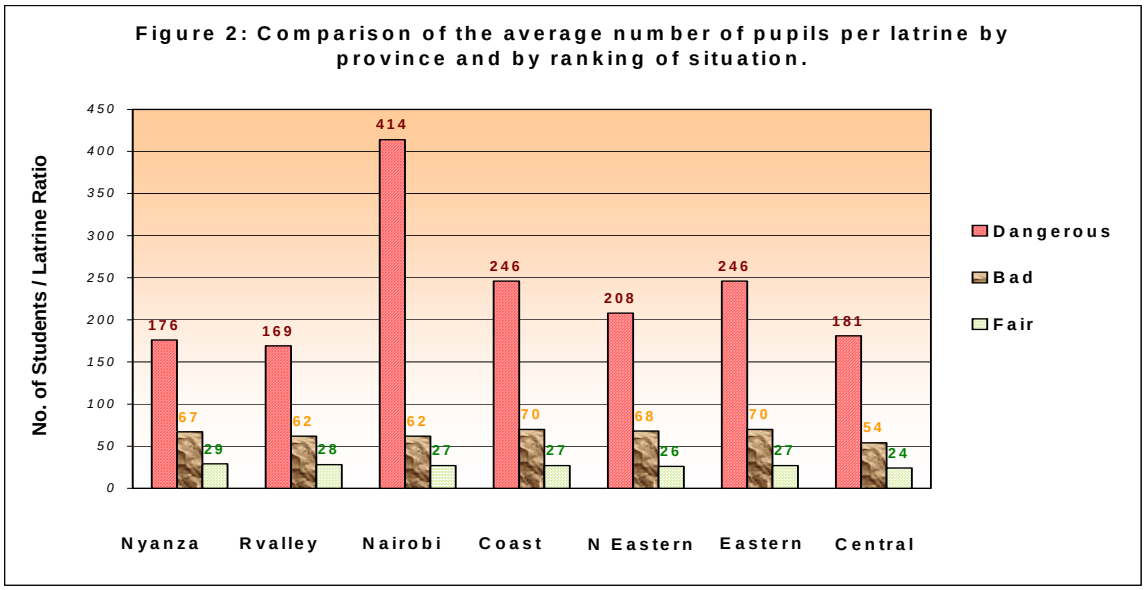


Figure 4.4 Average number of pupils per latrine by province

Key
RS – Respiratory Diseases
DI – Diarrhoea & Intestinal worms

The Kenya morbidity disease pattern indicates that over 60% of diseases are waterborne or sanitation related. Improving hygiene, water supply and sanitation, readily controls diarrhoea and the simple act of washing hands with soap and water can reduce sanitation related deaths by up to 35%

Table 4.6 Percentage Distribution of Households by Main water Sources by province

Region/ Province	Pond/Dam	Lake/River	Spring	Well/Borehole	Piped
Kenya	4.9	28.3	11.7	20.9	30.0
Kenya Urban	1.4	5.5	1.9	10.8	74.7
Kenya Rural	6.1	36.0	15.1	24.4	14.9
Nairobi	1.2	0.6	0.4	2.0	91.0
Central	2.9	37.9	3.1	21.4	30.1
Coast	10.7	11.3	2.1	17.3	52.4
Eastern	4.6	31.4	9.1	25.1	27.0
North Eastern	13.6	14.1	0.7	56.8	7.1
Nyanza	6.8	39.9	24.0	16.9	8.5
Rift Valley	5.6	35.5	7.8	23.2	23.4
Western	1.3	21.4	38.1	28.0	9.8

Source: National Census 1999

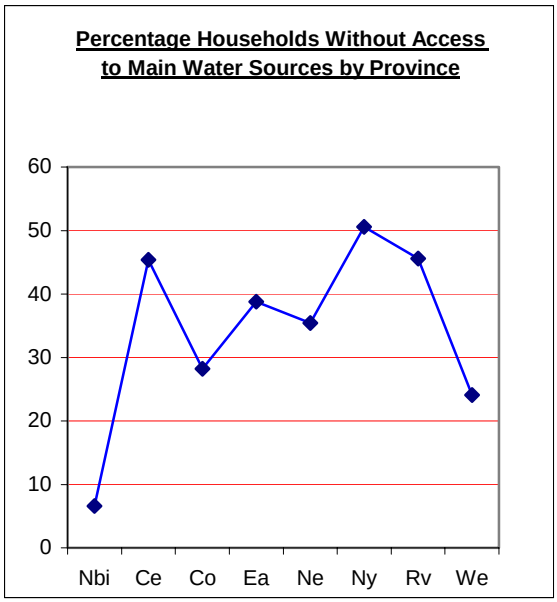


Figure 4.5: Water accessibility by province

Regional analysis shows that households in Nairobi, Central, Eastern, Western and Coast provinces have better access to clean water. Over 50% of the households in these regions use piped supply, boreholes and wells as water sources. Nyanza and Rift valley provinces were below the national level.

At the district level, there were significant disparities even within the same province. Except Maragua, all districts in Central province had good access to potable water. Similarly, Malindi, Kilifi, Mombasa and Lamu districts in Coast; Embu and Meru districts in Eastern; Kisumu in Nyanza Province; Kajiado, Nakuru and Uasin Gishu districts in Rift Valley Provinces recorded high levels. Generally, most of these districts with better access to clean water can be said to be urbanized than those with poor access.

Water Use

Water use is an important element in pursuit of personal well being. When people get used to spending a certain amount of water to satisfy needs, in the absence of a sustained supply from the source they will seek to source for the water from elsewhere to meet the deficit

Table 4.7 Water use per capita per day

Name of City	Water use per capita per day (liters)
Nairobi	38.4285
Mombasa	52.4507
Kakamega	33.0194

Source:Willingness to Pay Study Report WB

As table 4.7 stipulates, Mombasa had the highest per capita water use of 52.45 litres among the three urban centres. But this figure is still low in international standards. In Nairobi's informal settlements, a family of six lives on 60 litres of water per day
(Maji na Ufanisi 2003).

Both availability of water and social class of households have direct impact on per capita water demand.

Table 4.8: Household daily expenditure

Name of City	Household Daily Expenditure on Water (Kshs.)
Nairobi	**51.8551**
Mombasa	**33.1099**
Kakamega	**21.2987**

Source: Willingness to Pay Study Report WB

Total household expenditure on water are higher in Nairobi where households spent one and half times more than households in Mombasa and two times more than households in Kakamega as shown in table 4.8. In the urban informal settlements the cost of water ranges from K.Shs. 2.00 – 20.00 per 20-litres. Distance to water points range from 5m to over 3km. Due to inhibiting costs, water is used sparingly forcing sanitations to low standards like wearing of dirty clothes and eating of unwashed foods (*Maji na Ufanisi 2003)*

In Marsabit District the per capita water consumption is 1.5 litres. (PISP/MNU end of programme report)

Kenya is classified as a chronically water scarce country with a limited natural endowment of fresh water of only 647 cubic meters per capita

Under conditions of insufficient water supply, hands, bodies and the domestic environment cannot be maintained clean and hygienic. Skin and eye infections (including trachoma) are easily spread, as are faecal-oral diseases. Conflicts that sometimes degenerate into violence erupt. In 2001 over 100 people were reported to have died from disputes over access to water in Tana River District
Access to sufficient water supplies therefore adds value to the well-being of the community and society in general.

Nomadic communities, with the exception of the young, elderly and home-based care givers, wash and water livestock at the water points. Otherwise, they will go for days without washing clothes or even bathing. Basic sanitation like regular washing of hands are not practiced except by using spits or livestock urine like camels and cows. Substitutes like milk and livestock blood are taken to cope with thirst. Water scarcity is such that tea is prepared for minimal number of cups. Milk, if and when available, is used instead. Meat is often roasted rather that boiled.
The young ones of animals which may not move to far away water points are kept in dome-shaped thatched, kraal shelter from severe weather (PISP 2001)

Sanitation and Social Dignity
Adequate sanitation facilities prevent faecal contamination of water and so curb transmission of faecal-oral diseases at source. Inadequate sanitation leads to coping mechanisms like sharing of dirty, defecation in the open and indiscriminate dumping of household wastes. Such dumpsites pollute the environment through bad odour and are breeding grounds for vermin namely; rodents, fleas, flies and mosquitoes Sanitation practices that remove human waste from the immediate vicinity of one community only to contaminate the water supply and environment of neighbours are unsustainable. Major behavioural changes are needed to overcome this.

Table 4.9: % Distribution of Households by Type of Human Waste Disposal by Province

Region/Province	Main Sewer	Pit Latrine	Septic Tank/ Cess Pool	Bush	Other
Kenya	7.7	72.1	2.8	16.4	1.0
Kenya Urban	27.4	60.5	8.4	2.1	1.6
Kenya Rural	1.0	76.1	0.9	21.3	0.7
Nairobi	48.2	42.1	6.7	1.1	2.0
Central	4.3	91.6	3.2	0.4	0.4
Coast	3.6	56.7	8.6	29.6	1.5
Eastern	2.2	80.4	1.3	15.4	0.7
North Eastern	1.2	17.6	0.6	77.2	3.4
Nyanza	2.4	77.0	0.9	18.5	1.3
Rift Valley	4.2	66.0	2.0	27.2	0.6
Western	1.6	92.3	0.7	4.9	0.5

Source: Census 1999

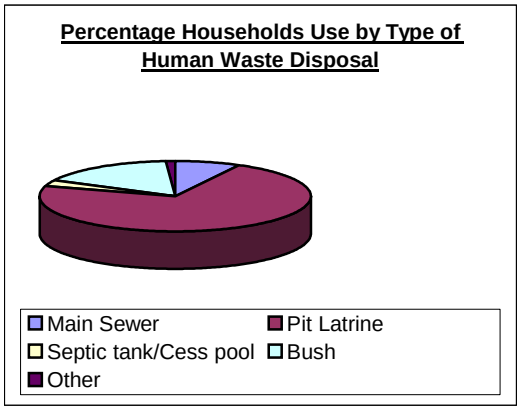


Figure 4.6:Household use by type of human waste disposal

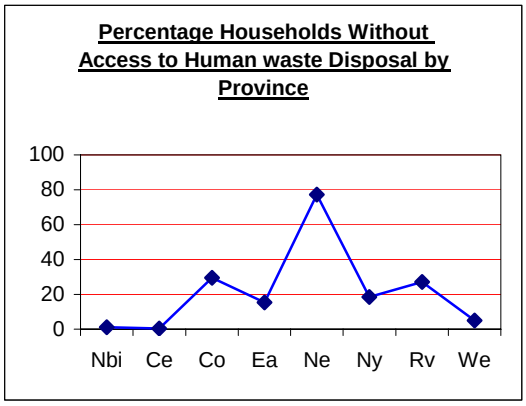


Figure 4.7: Households without access to human waste disposal by province

BOX 4.4: State of Sanitation by Provinces

Provincial analysis showed that Nairobi, Central and Western provinces had the highest access (above 80%) to decent sanitary facilities while North Eastern province had the least access (77.2% of households had no toilet facilities). Nyanza 18.5%, Coast 29.6%, and Rift Valley 27.2% had no poor access to sanitary facilities. Despite high levels of access in Nairobi Province, sanitary conditions in slum areas are in poor state due to overcrowding. Districts with the worst access to sanitation included Kwale, Kilifi, Tana-River, Marsabit, Garissa, Mandera, Wajir, Suba, Baringo Samburu, Narok, Trans Mara, Turkana, West Pokot, and Migori all of which have over 40% of households without access to decent sanitary facilities. Table 4.9, Figure 4.5 &4.6

The results further indicate that pit latrine was the dominant type of human waste disposal by majority of households in most towns with a population of 10,000 or more. Main sewer facilities are still not fully developed in most towns due to high capital outlay required. Nairobi, Thika, Nanyuki, Mavoko and

Nyahururu recorded better (44% households) access to main sewer while Msambweni, Lokichogio, Wajir, Narok and Maralal had over 30% of households without access to decent sanitary facilities that is used bush. Majority of households in most regions more particularly in the rural areas are exposed to poor sanitary conditions. In the informal settlements on average 200 people share a single pit latrine *(Ref: Baseline Study Report for Kibera and Kangemi by Maji na Ufanisi 2003*)

Primary Schools Sanitation (Ref: Study by MOEST-2003)

Water, sanitation and hygiene situation in Kenyan Schools is worrying. According to the rating used by the Ministry of Education Science and Technology (MOEST), the situation is fair when less that 40 children share one latrine. The situation is rated bad where 40 to 100 children share a latrine, and dangerous if over 100 pupils share one latrine. A study by MOEST shows that a majority of public primary schools are in the "dangerous" category.

Nation-wide, there was an average of 55 schoolchildren per toilet in 1999. The situation was worst in semi-arid North Eastern Province where an average of 95 children shared one toilet. However, the survey shows that in 2003 the situation had become considerably worse with an average of 64 schoolchildren sharing one toilet. Some schools in rural districts such as Kwale, Turkana, Wajir and Mandera have no latrine at all, and the nearby bushes are used as toilets. Even where latrines exist and the coverage is fairly good, their condition varies from fair to very poor. In nearly all schools, hygiene education and practices are given low profile.

National Water and Sanitation Trends

Table 4.10 National Water Trends
Use of Safe Drinking Water

Year	Percentage Population (%)
1989	48.1
1994	43.3
1997	49.7
2000	57.1

Source: Multiple Indicator Cluster Survey Report, 2000

Table 4.11: Sanitary means of Excreta Disposal

Year	Percentage Population (%)
1992	84.1
1994	80.4
1997	83.3
2000	81.1

Source: Multiple indicators Cluster Survey Report, 2000

Whereas access to safe drinking water improved from 48.1% in 1989 to 57.1%, access to proper sanitation deteriorated from 84.1 in 1992 to 81.1% in 2000 as recorded in table 4.10 and table 4.11.

Table 4.12: facilities provided per population

Provider/supplier	Number of Facilities (No.)	Population Served (Millions)
Ministry of Water Resources Development	628	6.1
National Water Conservation and Pipeline Corporation	48	3.7
Community	356	4.9
Non Governmental Organizations	266	
Self-Help Schemes	243	
Local Authorities	8	3.9
Total	1549	18.6

Source: Zero draft investment plan paper 2003

Water, Sanitation and Governance

The above data indicate that the Ministry of Water and Irrigation doubled up as a facilitator and an implementer in a field where there are other actors. In this case the Ministry was bogged down with immense responsibilities and against the backdrop of scarce resources and capacity, the efficiency of the water services would not be guaranteed. Moreover, this scenario denies ownership and responsibility of the general public to water schemes. In light of this, opening up the water sector for more participation by the civil society and private sector would inject more human and financial resources that would catalyse the realization of the water sector objectives and/or targets.

Role of Water and Sanitation in Kenya

Kenya identifies safe water and adequate sanitation as one of the pillars that can improve the quality of lives of its people and especially the poor communities. Poor water supplies and inadequate sanitation impede economic and social development and strains government resources when water- and sanitation-related diseases break out. It is increasingly accepted that social infrastructure is needed to complement physical inputs to ensure greater efficiency and sustainability for water and sanitation. The overall goal of the Government is to ensure that households have access to affordable and safe drinking water within reasonable distance.

The 1999 population census showed that a significant Kenyan population depends on lake, river, ponds and dam water sources all of which are regarded as unsafe. Hence, many people are exposed to serious health problems. Development of water supplies has not matched the country's rural and urban population growth. Between 1989 and 1999, the number of households with access to piped water dropped from 31.9% to 30.0%. This is partly explained by the diminished performance of some of the existing water schemes. This necessitates a change in water policy approach to that of participatory management. Expansion of human activity, particularly agricultural activities in water catchment areas has contributed to the decline in forest cover and in some parts of the country has affected availability of water. There is need for concerted efforts by all players to conserve water catchment areas to sustain the current water sources.

The Road Map for Actors in the Water Sector is to Build Strategic Partnerships

Most Kenyans, the poor especially, are poorly represented at all levels of political life and decision-making, leading to widespread neglect of their priorities Meeting the needs of the poor should be the principal focus of planning for water and sanitation services. The act of balancing hardware and software components of supply and sanitation provision i.e. establishing effective institutional management arrangements, aims at realizing active participation of water users in the design of interventions, to ensure they reflect the needs and priorities of the intended beneficiaries. Proper operation and maintenance of water supply and sanitation schemes is best achieved when there is ownership of the facilities. Access to both water and sanitation provides social welfare to the society that is critical to enjoying acceptable material standards of life and to participation in social and political issues.

Conclusion/Recommendation

The social impacts due to human use of fresh water coupled with adequate sanitation are important for the quality of human life, living standards and social development. Shortage of water can cause tensions at domestic, national and even international levels. The cost of water shortage, flooding and/or pollution usually hurts more vulnerable groups in society. Diseases associated with lack of safe water and poor sanitation are a major cause of poverty and death in Kenya especially in women and children. When cases of flooding occur, social disruption as a result of relocation, resettlement, loss of property and life, devastation of social cohesion and dignity are experienced.

Affluent people can afford to take action to avoid the immediate impacts of environmental damage and pay the price for high-quality water services. Low-income communities, however, have fewer options open to them either to pay for services or to adapt their lifestyles to conserve water and protect the environment.

facilities brings a multiplicity of benefits in terms of more time, improved health and better opportunities for production and leisure. In addition, confidence in opinions towards shaping of water and sanitation programmes. The benefits are especially important for rural women who are often extremely poor and work long hours. Besides improved access to water and sanitation promotes and strengthens partnerships amongst the private, public and community sectors.

Considering the benefits accruing provision of safe and sufficient water coupled with adequate sanitation, the concern for the actors is why certain communities do not have access to these. For example, within rural areas why the difficulties in collecting water, particularly for the elderly, disabled and women, while in urban areas, why informal settlements and squatters do not have access to public water and sanitation services. The right of water suggests that any person or group denied the right to adequate water should have access to legal remedies and compensation.

Water and Sanitation Targets

Water Supply Target
To provide clean and potable water at a source less that one kilometre in high potential areas and less than five kilometres in low potential areas by the year 2015.

Significance
Water is essential for life, health and human dignity. In extreme situations, when sufficient water is not available to meet basic needs, supplying a survival level of safe drinking water is of critical importance. In most cases, the main health problems are caused by poor hygiene due to insufficient and sometimes consumption of contaminated water.

Indicators:
- Proportion of households with access to improved water supply
- All people have safe and equitable access to sufficient and affordable quantity of water for drinking, cooking and personal and domestic hygiene.
- Public water points are sufficiently close to households to enable use of the minimum water

Definitions
- Average water use for drinking, cooking and personal hygiene in any household is at least 15 litres per day.
- Water sources and systems are maintained such that appropriate quality and quantities of water are available consistently or on a regular basis.
- Household expenditure on water should not take undue proportion of the total household income, that is, utmost 10%
- Improved water supply means water drawn from either piped and/or protected water sources.

Appropriate Sanitation

Target
Universal access to sanitary provision of excreta disposal by the year 2015.

The status of environmental sanitation in the country had been declining as shown in data of early 2000's. The coverage of adequate sanitation had dropped from 49% to 45%. Only 40% of the rural population had access to basic sanitation, mainly pit latrines. In urban areas, only 29% have access to conventional sewerage system. 80% of the hospital attendance is as a result of preventable water-, sanitation- and hygiene-related diseases. Improving sanitation is not just about building improved facilities but also proper use and maintenance. Users need to use hygienic behaviour to achieve improved health.

Solid waste management is a major problem in the urban centres particularly in the informal settlements among the urban poor where there is overcrowding and infrastructure for garbage collection and safe waste disposal non-existent.

Challenges

- Inadequate levels of funding and investment in sanitation
- Cultural barriers and taboos
- Appropriate technology for difficult soil conditions
- Development of appropriate financing mechanism

Goals

By the year 2015, in conjunction to attaining the millennium development Goals, the following should be achieved:-

- Households need to be educated and made aware of the importance and need for improved environmental sanitation and hygienic practices for improved health.
- Every household to have access to a hygienic, affordable and sustainable facility.
- All households and the surroundings to be clear and free from solid waste, unpleasant odours and to have adequate drainage.
- The national incidence of preventable excreta-related disease will be halted.

Significance

Safe disposal of human excreta creates the first barrier to excreta related diseases, helping to reduce transmission through direct and indirect routes. The provision of appropriate facilities for defecation is essential for people's dignity, safety, health and well-being.

Indicator:

- Proportion of households with adequate access to toilet facilities
- People have adequate numbers of toilets, sufficiently close to their dwellings, to allow them rapid, safe and acceptable access at all times of day and night.

Definition

- A maximum of 20 people use each public toilet facility
- A maximum of two households share a private toilet facility
- Shared or public toilets are cleaned and maintained in such a way that all intended users use them
- Separate toilets for women and men are available in public places (markets, distribution centres, health centres etc)
- Toilets are no more that 50 meters from dwellings
- Toilets are used in the most hygienic way and children's faeces are disposed of immediately and hygienically.

Water and Sanitation Governance

Target

Promote decentralization and strengthen local ownership of water and sanitation schemes

Significance

The crucial role contributed by water and sanitation to socio-economic, cultural and political development of the society, calls upon decision making processes that are within sustainable framework and take into account the socio-economic and cultural aspects of the target groups. Besides, responsibilities and ownership of water and sanitation schemes should be practiced at the lowest possible level of the society- the source of water and sanitation issues. This approach if nurtured within the principles of effectiveness, equity, participation, accountability and security would ensure that people derive maximum benefits from water and sanitations schemes.

Indicator: Decentralized ownership of water and sanitation schemes

Definitions

- Effectiveness: The local water and sanitation entity has a sufficient budget to meet its operational and development needs. It has control over the collection of a significant portion of its budget with relatively less external funding.
- Equity: Water and sanitation services should be delivered to all residents in order to make their lives safe and productive. Women and men have equal access to decision-making. The number of households without access to potable water and adequate sanitation should be as low as possible.
- Participation: All residents should be involved in decisions regarding water and sanitation issues
- Accountability: An accountable water and sanitation entity can operate relatively independently and confidently through an

open process in all operations and projects and obtain the confidence of its users in return.

- Security: The local water and sanitation entity should ensure in collaboration with other key actors that the users have a safe and healthy life and environment through appropriate policies or by-laws on the utilities**.**

Gaps

- Lack of a comprehensive information strategy to capture information on water and sanitation related conflicts or violence (insecurity incidental to water and sanitation)
- Lack of a sanitation policy that could provide an enabling environment for improvement of sanitation
- Lack of data on the water quality status

Other Indicators

- Formal citizen involvement in major planning decisions
- Civic Water and Sanitation Associations per 10,000 people
- Percentage of women representatives in local water authorities
- Cleanliness index
- Social acceptance of water and sanitation facilities
- Water and sanitation literacy level
- Percentage budgetary allocations to water

Water + Poverty Eradication

Combating poverty and facilitating economic recovery is a dominant theme in development policy in Kenya. The poverty reduction plan is in line with the Millennium Development Goals, notably to reduce the proportion of people living in poverty by half by 2015. The National Water Policy has encompassed poverty alleviation as a primary goal. The government recognizes that growth, pro-poor and equity goals can be achieved simultaneously and sees the mainstreaming of the National Water Resources Management Policy and the Water Act 2002 as an important step for reduction of poverty.

According to the Poverty Reduction Strategy Paper (PRSP), the poor tend to be clustered into certain categories such as female-headed households, landless, subsistence farmers, people with disabilities, households headed by people without formal education, pastoralists in ASAL areas, unskilled and semi-skilled casual labourers, urban slum dwellers, unemployed youths, AIDS orphans and street children. They are the people who have difficulty of access to clean and safe water.

Access to water for human consumption, agricultural and livestock use is a major problem in rural areas. In ASAL areas, people have to trek long distances to water their cattle and women have to go even further in search of water for domestic use. Risk of diseases associated with consuming contaminated water is present. Livelihoods of many rural communities depend on access to water for their livestock. Two thirds of the rural poor do not have access to safe drinking water. Rural women who mainly depend on land and natural resources become more vulnerable to poverty due to environmental degradation. Water resources get depleted, fuel wood exhausted and more time has to spend to fetch these from far distances. Women are considered to be more vulnerable to poverty than men.

The contribution of rural water supply and sanitation and more effective water resources management to alleviation of poverty is well documented. The specific measures that the Government will contribute to in water resources management to increase the impact on poverty reduction are:

- Identify and amend by-laws, regulations and practices that impede access to water by the poor communities and other marginalized groups.
- Develop technical standards and Water Resources Management techniques to allow innovative approaches and create incentives to improve equitable access to water;
- Ensure that business plans of the WRMA explicitly cater for the poor and promote that the implementation of WRM measurers

at catchment and sub-catchment level addresses the needs of the poor;
- Ensure that the permit systems and the new water use fees and other pricing policies cater for needs of the poor through affordable tariffs for basic needs;
- Focus on making water available for economic needs of poor households;
- Strengthen the management capacity of community groups and small-scale providers;
- Involve communities more effectively in determining appropriate arrangements for WRM and access to water.

Affordability of water services

The Government through the Ministry of Water and Irrigation has the responsibility of ensuring that all Kenyans have access to safe drinking water within a reasonable walking distance and cost and in achieving the set goals of the Millennium Development Goals (MDGs).

Water from sources such as springs, rivers and ponds is free, but if one was to buy water from a kiosk or water vendor the prices range between Kshs10 and Kshs20 for 20 litres depending on location and time of the year. When there are charges involved, this can and does affect people's ability to consume water

Other costs to be considered when it comes to water include the resultant loss of production that results from illnesses caused by consuming unclean water, and the cost of seeking medical attention for these illnesses. The time spent collecting water must also be considered in terms of what could have been done or produced if the women did not have to spend three hours fetching water

Large numbers of urban households are not connected to public sewer systems. They dispose the sewage through cesspools, septic tanks or directly into nearby streams. This may contaminate the shallow groundwater from which some utilities draw water supply. The rural households dispose their waste through pit latrines and in bushes.

For communities that mainly access water from natural sources such as rivers, streams, ponds, and springs, there is little initiative for maintenance and protection of the water supply. For communities that have piped water supplies, responsibility for maintaining the supply rests with those who sell the water, as they have a business to run.

The Government has put in place mechanisms for supporting provision of the "basic water supply and basic sewerage". It is anticipated that a 10% subsidy of the Ministry budget will be required to meet the costs of this basic services to those who cannot afford it at all.

WATER + HEALTH ASPECTS

Water-related Diseases

The most common health problems associated with water resources in Kenya include:

- Malaria
- Typhoid fever
- Cholera
- Diarrhoea and dysentery
- Bilharzia
- Worms
- Eye infections and
- skin diseases

Water is the prime mover of the economy and it should be supplied in the right quantities and qualities so as to ensure sustainability of the economy. This simply means use of clean and safe water, since contaminated water can be a source of diseases.

The diseases that are associated with water can broadly be classified into the following three categories:

Water based – Bilharzia, malaria and schistosomiasis. These diseases can be eradicated through proper sanitation, environmental modification including drainage channels, clearing of bushes and proper waste disposal.

Water borne – Typhoid fever, cholera, diarrhoea and dysentery. Others are infectious hepatitis and poliomyelitis. These diseases can be minimized through application of safe water, ensuring food safety and application of proper hygiene and sanitation.

Water washed – Eye infections and skin diseases. These diseases can be eradicated by ensuring availability of safe water and hygiene.

For provision of clean and safe water, effective treatment practices need to be put in place in order to ensure a healthy nation, reduced disease burden and to realize substantial cost savings which would otherwise be used for other economic activities.

Malaria Control

Malaria is a serious public health problem in Kenya, contributing to the worsening survival chances of children. It is the biggest killer of young children in Kenya resulting in an estimated 26,000 deaths in under-fives every year (72/day). An estimated 3.5 million children under the age of five are at the risk of developing severe malaria and its possible complications of severe anaemia and cerebral complications. Both of these have severe consequences for long-term child survival and educational and social development even if they do not result in the immediate death of the child. National assessments show that approximately 20 million people in Kenya are regularly exposed to the bite of the female Anopheles mosquito and are therefore at the risk of being infected with *P.falaparum,* which is known to cause the most serious form malaria..

Pregnant women are particularly prone to severe and complicated malaria due to their reduced immunity levels. Malaria in pregnancy is a major cause of anaemia in pregnancy and therefore exposing exposes Kenyan women to a higher risk of maternal mortality. In addition to its undesirable direct result on the health of women, malaria infection during pregnancy has serious consequences for the unborn infant, leading to low birth weight (<2,500g), one of the most important factors in determining the future survival and development of the child. Up to 5% of neonatal deaths and 30% of prevalence of low birth weight reportedly result from maternal malaria in highly endemic regions (Child Health Research Project 1999). Infection with HIV/AIDS aggravates the severity of malaria. Pregnant women who are HIV positive are particularly vulnerable.

As well as its direct effects on health in the country, increasing attention is being drawn to the economic effects of malaria. Malaria illness leads to a reduction in household income through lost working days, whilst at the same time increasing household expenditure on treatment and prevention measures.

An estimated 170 million working days are lost each year as a result of the disease and almost every household is afflicted by the human suffering and financial hardship caused by malaria illness. The economy in general and the health sector in particular are heavily burdened by the cost of drugs and treatment. Cumulatively, malaria represents a massive barrier to socio-economic development and poverty alleviation.

In addition to areas in which malaria is endemic and therefore regularly and intensively transmitted, epidemic(unstable) malaria has been increasing in frequency and severity among densely populated and economically important areas of Kenya's Western highlands, since the 1980"s; approximately 8.5 million Kenyans are at risk of epidemic malaria Recently it has been noted that malaria cases are appearing in areas, otherwise declared as free. Kenya's ecology therefore provides both the ideal conditions for the malaria-carrying mosquito, especially in the coastal and lake regions as well as climatic conditions, which

are conducive to epidemic intensity in the highlands and semi-arid parts of the country. Both endemic and epidemic responses are therefore required for effective control.

Causality Analysis

The direct cause of malaria is through the bite of infected female Anopheles mosquito and the resulting introduction of the plasmodium parasite, the infectious agent into the human body. *Anopheles gambie* is an extremely efficient transmitter of the disease and has earned the epithet of "the malaria machine" because it has a strong preference for humans. Most species feed at dust and during early night hours. There are four types of infectious agents, causing four variations of human malaria namely *plasmodium faliparum, Plasmodium malariea, plasmodium vivax and plasmodium ovale.* The most serious is the falciparum malaria, which is found many parts of Africa, including Kenya and presents in various forms including fever, chills, headaches, vomiting and diarrhoea and in severe cases, especially in children with convulsions, confusion and coma. Underlying causes include lack of access to preventive measures such as bednets, poor nutritional status, poor access to health services and poor living environment. Many malaria deaths occur because prompt, effective and affordable treatment is not readily available. The basic causes include poverty, ignorance about disease causality and prevention and the declining economic conditions, which have made it increasingly difficult to the government to ensure basic social services, such as health, education, housing, water and sanitation.

Increasing drug resistance to first line drugs, substandard drugs, inadequate case management and poor surveillance further compounds the control of malaria in Kenya. Chloroquine is no longer effective in the management of over 60% of clinical episodes across the country and was abandoned in 1997 as the recommended first-line drug. Pyrimethamine sulphadoxine or pyrimetahmine sulphalene (SP), the current recommended first-line drug has already begun to show evidence of reduced sensitivity in several parts of the country, resulting in growing concern it may be ineffective within a few years. Presently, there are no affordable alternatives to manage the disease. In this regard, regional efforts to monitor drug resistance demonstrate a new spirit of collaboration between scientists and control staff across international borders.

Population growth and mobility, poverty, drug resistance and depleted health systems create a wide and increasing malaria risks across Kenya, including epidemic infections that endangers entire population groups. Poor nutritional status, especially of children and pregnant women, inadequate health care services, weak caring practices and low access to basic social services and lack of resources increase the risk and severity of malaria.

Government's commitment to ensure the health of 30.8 million Kenyans is enunciated in the Health policy Framework Paper of 1994 which expresses the overall goal of promoting and improving the health of status of all Kenyans through the deliberate restructuring of health sector to make health services more effective, accessible and affordable. The National Health Sector Strategic Plan for 1999-2004, whose objectives are to enhance equity, quality, accessibility and affordability of health care through better targeting of resources to the poor underscores this commitment by aiming to prevent and mitigate the effect of diseases, especially on the 16 million Kenyans earning less than $1.00 per day and living in abject poverty. Malaria, Tuberculosis and HIV/AIDS , are three diseases targeted for priority action n Kenya. According to the Ministry of Health "Malaria is so invidious, its consequences so debilitating and its scale so great, that no national plan or aspiration, social or economic, can be divorced from it" (National Malaria Control Strategy, An Introduction 2001).

Immediate Causes	Underlying causes	Basic causes	Human Rights Denied
Bites from an infected mosquito • Infection with malaria parasites • Poor nutritional status exacerbates malaria illness • Pregnancy reduces mothers immune status	Inadequate food security leading to protein energy malnutrition. Inadequate health care services Under utilization of existing health care services. No access to preventive measures e.g. ITNs, IPT Weak care giving practices in the home (inadequate diagnosis of illness, inadequate home based treatment, child not p rotected from mosquito bites) Poor living environment	• Lack of resources • Lack of capacity (motivation, authority, access to and control of resources, communication, decision making and learning) • Lack of knowledge • Inadequate participation in decision making process due to gender discrimination, age discrimination. • Weak organizational of society • Weak prioritization	• Right to life, survival and development • Right to information • Right to highest attainable standard of health • Right to an adequate standard of living for physical, mental, spiritual, moral and social development • Right to participation.

Health Sector Reforms are part of the wider economic reforms being implemented by the Kenyan Government in all sectors to stimulate economic growth and reduce poverty and unemployment.

In addition to policy guidelines, there are Public Health laws enacted to promote safe environment, which is free from mosquito breeding and therefore likely to reduce the risk of exposure to mosquito bites. The National Essential Drug policy details the government-approved drugs for the management of specific diseases and there are drug regulatory and drug quality control mechanisms to monitor the quality of drugs in the market.

The National Malaria Strategic Plan that aims specifically at addressing the problem of malaria in Kenya was developed in collaboration with partners in April, 2001, as a follow up to the April, 2000 meeting in Abuja, Nigeria when African Heads of states resolved to reduce the scourge of malaria in the continent in accordance with the Roll Back Malaria objectives. The Roll Back Malaria objectives. The Roll Back malaria initiative was established in May 1998 by WHO, UNICEF, UNDP and the World Bank to facilitate country actions to significantly reduce the burden of malaria. In Kenya, the main goal is to reduce the level of malaria illness and death in Kenya by 30% by the year 2006 and to sustain that improved level of control to 2010. The key operational strategies are to guarantee effective, affordable and accessible case management, provide malaria preventive measures and treatment to pregnant women, ensure the use of insecticide treatment nets (ITNs) by at- risk communities and improve epidemic preparedness and control. It is implemented by the Government of Kenya in collaboration with country level partners including the WHO, UNICEF, DFID, JAPIEGO and NGOs. The coordinating mechanism is the Inter-Coordinating Committee (ICC) for Malaria control, whose membership is made up of all the partners supporting the control efforts

SCHISTOSOMIASIS:

Its Ecology and Control

This parasitic infection, also known as bilharzias, is a debilitating disease which is rarely fatal. It especially afflicts people between the ages of 10 to 20 due to their greater contact with infected water bodies.

Diesfeld and Hecklan (1978) estimated that one million people in Kenya are infected with schistosomiasis and Highton and Chaudry (1974) and Chaudry (1975) report that all major irrigation schemes in Kenya have been colonized by potential intermediate snail hosts.

Two genera of snails are involved each having slightly different habitat requirements and transmitting two different forms of the disease:-

Bulinus (mainly *B. Africanus*) prefers still or slowly moving perennial streams and is found also in small pools, water holes and permanent dams below 1800 metres altitude; it is responsible for transmitting urinary bilharzias (*Schistosoma haematobium*) and eggs are passed out with urine. Bulinas is able to aestivate for long periods in the muddy bodies. The snail is widely distributed throughout Kenya though the parasite is confined to the coastal plain, the central part of the country and around lake Victoria.

*Biomphalaria (*mainly *B. pfeifferi)* is the second genus and can live in faster moving water and is common in irrigation channels and dams where it is able to avoid desiccation by aestivating for several months while buried in bottom sediments of pools or dams. This genus transmits *Schistosoma mansoni* which infects the intestine and eggs are excreted with the faeces. Both snails are parasites and are widely distributed in Kenya except along the coast where water temperatures are low. It is uncommon to find both species of snail cohabiting the same area of water.

The basic life-cycle of the schistosome worm is summarized in Figure 4.8. This figure indicates that the cycle of infection can be broken at one or more of four susceptible stages in the cycle and these represent potential control points, namely:

Reducing the output of eggs by patients using chemotherapy,
Reducing contact between people and infected water bodies,
Reducing the number of eggs entering water bodies (via a combination of points I and ii and improved sanitation,
Control or elimination of snail intermediate hosts.

These four main approaches to control schistosomiasis are considered further in the following paragraphs; the principal methods for control are summarized in the Table 4.13 below.

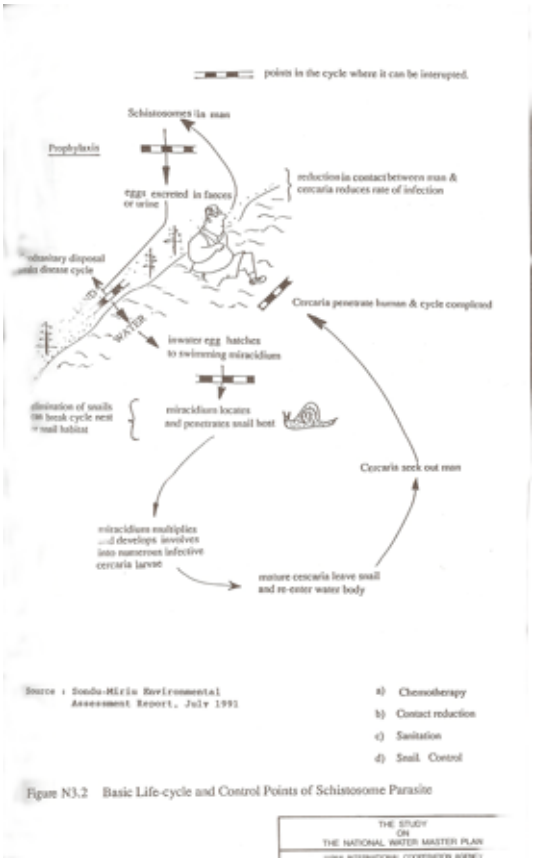


Figure N3.2 Basic Life-cycle and Control Points of Schistosome Parasite

THE STUDY ON THE NATIONAL WATER MASTER PLAN

Figure 4.8:Basic Life cycle and control points of Schistosome Parasite

Table 4.13: Summary of methods for Control of Schistosomiasis

CONTROL OF BILHARZIA	Social Management (interrupt 1,3,4) (see Figure 4.7)	chemoteraphy reduction in contact with infected waters prevention of excretion in public water sources
	Management of snail habitats (interrupt 2) (see Figure N3.a)	molluscicide application drainage and filling of all non-vital water bodies water level fluctuation in irrigation schemes and reservoirs design channels to create inhospitable habitat for bilharzias snails biological control

Social Management

Chemotherapy: Praziquantel (Biltricide) is the drug of choice against all forms of schistosome and has negligible side effects. Two others Oxamniquine (Vansil) and Metriphonate are effective only against *S. mansoni* and *S haematobium* respectively and also have some adverse side effects in some patients. Although the use of these drugs reduces the numbers of excreted eggs available to infect local water supplies this approach is not a practical long term solution especially for those who because of their circumstances will be continually reinfected such as paddy workers, fishermen and children.

Reduced Contact: Reducing the amount of time spent in infected waters can greatly reduce the worm load carried by man. Contact occurs through domestic and recreational uses of water and also during defaecation which promotes the disease. To facilitate a reduction in contact alternative sources of water and proper latrine sanitation are needed; these would simultaneously reduce contact and also the numbers of eggs entering water supplies.

Sanitation: Theoretically the most effective means of eliminating bilharzias is to prevent the eggs in human waste from entering water supplies. This requires major changes in the social behavior of the waterside dwellers and the provision of alternative sites for waste disposal. In practice this has not proven effective. To encourage better sanitary habits, proper excreta disposal facilities need to be provided which are more convenient to use than the natural environment. Even so, provision of such facilities does not ensure utilization.

The effectiveness of eradicating schistosomiasis by decreasing the numbers of eggs contaminating water supplies is lessened because of the enormous multiplication of the parasite infective stage within the snail; thus a single egg can ultimately give rise to a huge number of miracidia and many people can thereby become infected as a result of this single egg entering the water supply.

Management of Snail Habitats

Application of Molluscicides: There are several types of molluscicides available that work effectively but are costly and often have adverse side effects on non-target organisms including fish, water birds and man.

Drainage and In-filling of Snail Habitats: The removal of unnecessary pools of water in ponds and ditches containing emergent and submerged aquatic weeds will discourage the build-up of large snail populations; unintended adverse impacts on the environment are however unavoidable.

Water Level Fluctuations: The stranding of snails in the drawdown zone of reservoirs can reduce population density to some extent but the ability of many snails to burrow into the muddy sediments helps

them to avoid desiccation and death often for many months.

Water Management: Intermittent application of water rather than ponded paddy systems greatly reduce the abundance of vector snails. In the Philippines where rice was formerly grown in paddies, the number of snails reduced from 200 to less than 1 per square metre as a result of conversion to intermittent irrigation. Rice yields were reported to have increased by over 50% at the same time. This technique would also reduce other water associated diseases including malaria.

Channel Design: Where water is conveyed in smooth lined channels, snails can be discouraged and dislodged by water velocities exceeding 0.8 m/s in the absence of rooted vegetation.

Biological control: The introduction of snail predators (other snail species and some fish) into irrigation schemes in various parts of the world has been tried with limited success.

In conclusion, it must be stressed that a combination of chemotherapy of egg excretors, mollusciciding and engineering measures coupled with changes in social habits are required to effectively reduce the incidence of bilharzias and that some of these measures must be maintained for long periods if the disease is to be kept at a reduced level.

Evaluation of Disease Risk:

To assess the risk posed to the health and welfare of the public by the implementation of an irrigation scheme it is necessary to compare the existing pre-project risk (the without-project scenario) with that expected to exist with-project. This is not an easy assessment to make and the results of such analyses are only semi-quantitative. One attempt at this kind of evaluation has been carried out in Kenya and the results are presented in Table 4.14 below.

Table 4.14: Net Increase in Health Risks Resulting from Irrigation/Drainage

Basin	Malaria	*Schistosomiasis*	
		Haematobium	*Mansoni*
Yala	0	2	1
Kano Plains	0	2	1
Baringo	1	0	1
Kerio Valley	1	1	1
Upper Tana and Upper Athi	1	1	2
Lower Tana and Upper Delta	0	1	0
Lower Athi	0	2	1
Taita Taveta	0	0	0

Legend: none=0 low=1
Medium=2 High=3

Source: Study on Options and Investment Priorities in Irrigation Development: Kenya, 1987.

These data must be interpreted carefully; the emphasis is on risk increase and not risk per se. Thus in the Kano Plain or Yala area the risk of malaria is naturally very high, in which case the implementation of an irrigation project is unlikely to Increase the actual risk involved. In contrast, in these same areas the project would increase the risk of infection by *Schistosoma haematobium* moderately and slightly for *S. mansoni*.

It must also be realized that although the risk of disease may not be increased by project development this does not necessarily mean that a larger number of people will not be affected since, if the project attracts people into the area (and especially if they are not immune to the local diseases) then more will be put at risk and become infected. At the Hola irrigation scheme, for example, the population density in the area increase 100 fold, yet the incidence of Malaria remained the same ie. Holoendemic.

The term risk used here implies a combination of both chances and severity of infection. For a non-immune person one bite from malaria falciparum carrying mosquito may prove lethal; while infection by a single schistosome causes only mild discomfort and only repeated infections (as experienced by paddy workers) canlead to chronic debilitating illness and permanent disability. Thus in the case of malaria chance of infection is most important, while for bilharzias both chance of infection and severity are important.

In addition to the comments on risk made above it should be noted that the degree of risk inherent in irrigation development depends on several factors related to project design and management, briefly the method of water application very much determines the risk hazard as follows:

Greater risk hazard
Paddy and permanently flooded furrows,
Intermediate *hazard*
Temporary flooded systems,
Least hazard
Sprinkler and dip irrigation systems.

Cropping intensity also playas significant role in irrigation risk development; the malaria risk at Mwea for example, where one rice crop per year is grown, is considerably lower than in Kano Plains, where two crops are grown.

It is also emphasized that environmental impact assessment, particularly on health, is quite important on irrigation schemes. It is worthy of carrying out post assessment survey for the existing schemes to disclose the situations actually prevailing in the irrigation area.

Water and HIV/Aids

The first AIDS case in Kenya was detected in 1984. Initially, the government thought that this was a health problem and the people who developed such symptoms used to be taken to hospitals for treatment. Unfortunately all those people never got cured. Consequently, the government went deeper to study the disease and it was discovered that AIDS is the final condition that is precipitated by the human immunodeficiency virus. This is a virus that destroys the immune system in a human body over a long period of time during which a person displays no signs of sickness and the virus can only be detected through blood tests. With time, the immune system is totally compromised, and the body becomes vulnerable to all types of opportunistic infections like typhoid, cholera, dysentery, pneumonia, malaria etc.

Transmission Modes
The HIV virus is most commonly spread through

- Sex (90%),
- Mother to Child Transmission (5%) and
- Blood and blood products (5%).

Sex being the order of the day, coupled with the long incubation period of the virus explains the reason for the fast spread. The government then realized that the virus could not be spread by the people it was hospitalising but by those other people who continue practicing irresponsible sex in the urban and rural set-ups. This fact revealed that HIV/AIDS is not a medical but a socio problem and that its fight therefore required a well coordinated multi-sectoral approach. The HIV/AIDS had and still continues to affect people from the household to community and finally to national levels and it as affected all the sectors of development.

HIV/Aids Mortality and Morbidity Rates
The spread of HIV continued unabatedly due to poverty, deep-rooted socio cultural factors and lack of a legal framework. The government tried to respond to it although the virus was spreading like a bush fire resulting in increased infection and death rates over the years. In June, 2000, the first data on HIV/AIDS in Kenya was released as follows:

- 1.5 million people had died of HIV/AIDS.
- 1.1 million children had been orphaned.
- 500 were dying daily of the HIV/AIDS disease.
- About 2.0 million Kenyans are already HIV positive. This was a prevalence of 14%

Further analysis showed that the people who were dying were children below 5 years and

from 15 to 49 years. The under fives are children who contract the virus through mother to child transmission (MTCT), while 15 - 24 years represents the youth (**the window of opportunity)**. 24 to 49 years represents the economically active age bracket. Decimation of the last two age brackets will result in a doomed country.

Table 4.15: HIV/AIDS prevalence trends from 1990 to 2002

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
%	5.1	6.3	7.4	8.5	9.5	10.4	11.2	11.9	12.5	13.0	13.4	13.0	10.2

The Infant Mortality Rate during the year 2003 was 60 babies out of every 1000 live births.

Cure for HIV/Aids

AIDS has no cure and there are no chances of discovering one in the foreseeable future. In the absence of any cure for the virus, the only weapon left at people's disposal is prevention of the infection through sexual behavioural change. However, this is compounded by myths and misconceptions that surround the disease.

Declaration of HIV/Aids a National Disaster

The data that was released in the year 2000 had been collected over the years when the fight against AIDS was still going on. A number of AIDS forums had been held countrywide and the climax of these forums was the Mombasa Workshop when immediately after the release of this data, the government declared AIDS a national disaster reckoning that no family in Kenya remained untouched by the effects of HIV/AIDS and that the pandemic had reduced Kenyans to mere beggars.

Institutional Set-Up

Against this background, the government through Legal Notice No. 170 of November, 1999, established the National AIDS Control Council (NACC) which was mandated among other things to coordinate the multi-sectoral approach in the fight against AIDS and to manage the resources. This was a Herculean task for a single body to effectively execute. Consequently, AIDS Control Units were established in all the government ministries and their main mandate was to mainstream HIV/AIDS into the core functions of the ministries.

National HIV/Aids Strategic Plan (NASP) 2000-2005

In the fight against HIV/AIDS, NACC prepared the Five Year NASP to guide its operations up to the year 2005 and beyond. The success of this fight will be based on three pillars namely the Public Sector, the Private Sector and the Civil Society comprising of NGOs, Church Organizations and Community Based Organizations.

The principal objectives of the Strategic Plan are:

- Reduction of the HIV prevalence in Kenya by 20-30% among the people aged 15-24 years by 2005.
- Increasing access to care and support to people infected and affected by HIV/AIDS in Kenya.
- Strengthening capacity and co-ordination to respond to HIV/AIDS epidemic at all levels.

Key priority areas of the Strategic Plan

The Strategic Plan identified the following Five (5) Key Priority Areas to be addressed in the fight against HIV/AIDS.

- Prevention and advocacy
- Treatment, care and support of the infected and the affected people
- Management and coordination
- Mitigation of the social and economic impacts
- Research, monitoring and evaluation

The next NASP (2006 – 2010) is already under preparation and it will be released next year. The required resources are very huge and the fight against HIV/AIDS will not be won without a war chest of a size far beyond what is available so far.

Negative Socio Economic Impacts

This paper only addresses some of the negative economic impacts HIV/AIDS inflicts on the water sector. A quick survey carried out in the year 2001 revealed that the Ministry (which ministry) was losing about 120 officers annually. This in itself resulted in deterioration of service delivery and ultimately poor health. Another ripple effect is environmental degradation with diminishing water resources. This is mainly so because the survival of the people who would conserve the environment is already threatened by HIV/AIDS. With dwindling water resources, there cannot be sustainable agricultural and industrial development and the end result are increased poverty levels countrywide. Poverty is one of the factors that facilitate the spread of HIV/AIDS together with other myths and misconceptions that surround the disease. All these have to be addressed head on if the fight against HIV/AIDS has to achieve any success

Box 4.5: GOVERNMENT INTERVENTIONS

- Detection of first AIDS case in Kenya - 1984
- Establishment of the First Medium Term Plan - 1986
- Establishment of Second Medium Term Plan - 1992
- Sessional Paper on AIDS in Kenya - 1997
- Declaration of AIDS as a National Disaster - 1999
- Number of daily deaths as at 1999 - 500
- Establishment of NACC - 2000
- Launching of the Strategic Plan - 2000
- Establishment of the AIDS Control Units - 2001
- Serious advocacy and establishment of VCT Centers - 2001
- Subsidy on ARVs - 2003
- Release of current prevalence data - 2003
- Current HIV/AIDS prevalence - 10.2%
- Number of daily deaths - 350

Water and Aids

AIDS is a condition of compromised immune system when the body becomes prone to opportunistic infections (OI) that are mainly transmitted through air, insect or water. These diseases can be drastically reduced through clean environment and use of clean and potable water devoid of pathogenic organisms as these will aggravate the already bad status of AIDS. This can be achieved through conventional water treatment methods or boiling the water in the rural areas. However, the latter is being hampered by lack fuel due to the wanton destruction of forests countrywide, a phenomenon that has also reduced the water resources in the country. It is for this reason that the Ministry of Environment, Natural Resources and Wildlife has come out with a policy of increasing the percentage of forest cover from the present 1.7% to the internationally recommended cover of 20%. This again calls for protection of people from contracting the HIV virus. AIDS sufferers are also to pay up their water bills resulting in deterioration of the water schemes.

Present HIV/Aids Data

The Campaign against AIDS was vigorously mounted from the year 2001 after the establishment of AIDS Control Unit. This unit has crusaded the fight against HIV/AIDS. These efforts have born fruits as revealed by the following data: -

- HIV/AIDS prevalence has dropped to 10.2%
- The daily deaths have reduced to 350 people.

However, steady state in the numbers of deaths and orphaned children has been reached due to reduced fresh infections and emerging use of anti-retroviral (ARV) drugs which are now available in the market at affordable rates.

Behavioural Change and VCT

The success of the fight against HIV/AIDS cannot be measured against vaccines but against sexual behavioural change. HIV is a sex problem. This is the awareness that has been sustained. Records indicate that there is a noticeable level of behavioural change as evidenced by open talk and visits to the Voluntary Counselling and Testing Centres (VCT). Behavioural Change can only be achieved through a process of personal and socio transformation. There is some hope that the fight will be won

Safer Sex

Sex is a human need and a source of life. Ideally, people cannot totally abstain from sex. The awareness to be spread is for the practice of the ABCs of safer sex. This involves:

A - Total abstinence from sex altogether

B - being faithful to one uninfected sex partner

C - Proper condom use

If the above measures will be practised, then the fight against HIV/AIDS will be won.

TARGETS

The targets are:

- Reduction of the HIV prevalence in Kenya by 20-30% among the people aged 15-24 years by 2005.
- Increasing access to care and support to people infected and affected by HIV/AIDS in Kenya.
- Strengthening capacity and co-ordination to respond to HIV/AIDS epidemic at all levels.
- To eradicate malaria countrywide
- To minimize TB cases
- To eliminate water borne diseases i.e. typhoid, cholera, dysentery and diarrhoea
- Reduction if IMR by 66% between 1990 and 2015
- Reduction if Maternal Mortality Rate by the same % 1990 and 2015
- Control and stop the spread of HIV by the year 2015.

INDICATORS

The indicators are both measurable and non measurable

- No. of established VCT Centres
- No. of people seeking VCT services
- No. of people who have gone public on their HIV status
- Reduction of cases of absenteeism in the offices
- Reduction of cases of contributions towards death cases
- Reduction of Infant Mortality Rates
- Reduction if Maternal Mortality Rates
- Open talk of HIV/AIDS as a policy
- Free air time to talk about HIV/AIDS in all vernaculars
- Mass and Electronic media involvement if the fight against HIV/AIDS
- Erection of bill boards with AIDS messages
- Drop in early marriages in the communities
- Increased uptake of Anti Retroviral
- Increased use of condoms
- Good political will from the government
- Establishment of many Community Based Health Care Centres
- Reduction of the national HIV/AIDS prevalence to 10.2%
- Reduction of daily death rates - 350 people per day
- Introduction of Insecticide Treated Nets (ITN) by the Population Services International
- Existence of the Malaria Control Strategy
- Existence of the TB Control Strategy
- Existence of the Diarrhoeal Control Strategy covering typhoid and cholera
- Existence of the integrated management of childhood illnesses.
- Existence of a reproductive health program that addresses maternal mortality.

Above all, the MOH is preparing an Environmental Sanitation and hygiene Policy that addresses most of the above indicators.

Table 4.16: Summary Indicator Table on integrated aspects of water

	1992	1996	1998	2003
No. of established VCT Centres				
No. of people seeking VCT services				
No. of people who have gone public on their HIV status				
Number of jobs created by the water and water related activities				
No. of people with access to water and sanitation			12,572,000	
No. of water service companies and WUAS formed and operational..			357	360

Source: Ministry of Water and Irrigation

Water + Sanitation

Most of the water-borne diseases mentioned can be contracted by drinking poor quality water or coming into direct contact with contaminated water. In case of malaria, where mosquitoes are the transmitting agent the disease is usually prevalent where the environment enhances breeding.

In Kenya, over the years, the status of sanitation has declined. According to a joint Ministry of Health/Ministry of Water and Irrigation rapid assessment 1983, the national coverage stood at 49%. However the 1990 GOK/UNICEF situation analysis report revealed that the coverage level of households with access to adequate sanitation was 45%.

The coverage in the rural areas as estimated in 1990 had dropped to 40% in 1996. The situation worsened in the urban informal settlements where coverage level dropped from 45% to 42% between 1990 and 1996. The prevalence of sanitation-related diseases such as diarrhoea, typhoid and intestinal worm infections are on the increase.

Eradication of Malaria mosquito

- Conducting malaria prevention campaigns and emphasizing on the need for to use treated mosquito nets.
- Draining wet lands for malaria control
- Conducting cholera programs
- Improving water supply and sanitation practices

Creating social awareness.

Sanitation

The community PHAST subproject was re-crafter within the Sanitation Project by the Mid Term Review, 2001, process. The term emphasizes the focus of the UNICEF sanitation programme on the process of Hygiene and Sanitation behavioral change. It also emphasizes that the community is on the driving wheel to these changes and therefore while the activities may revolve around sanitation the scope may be wider and cover the totality of community interaction with the physical environment.

Causality analysis

Manifestations.
The disease prevalence by province in 1999 is shown below:

Figure 4.8: Five top Causes of Outpatient Morbidity by Province, 1999

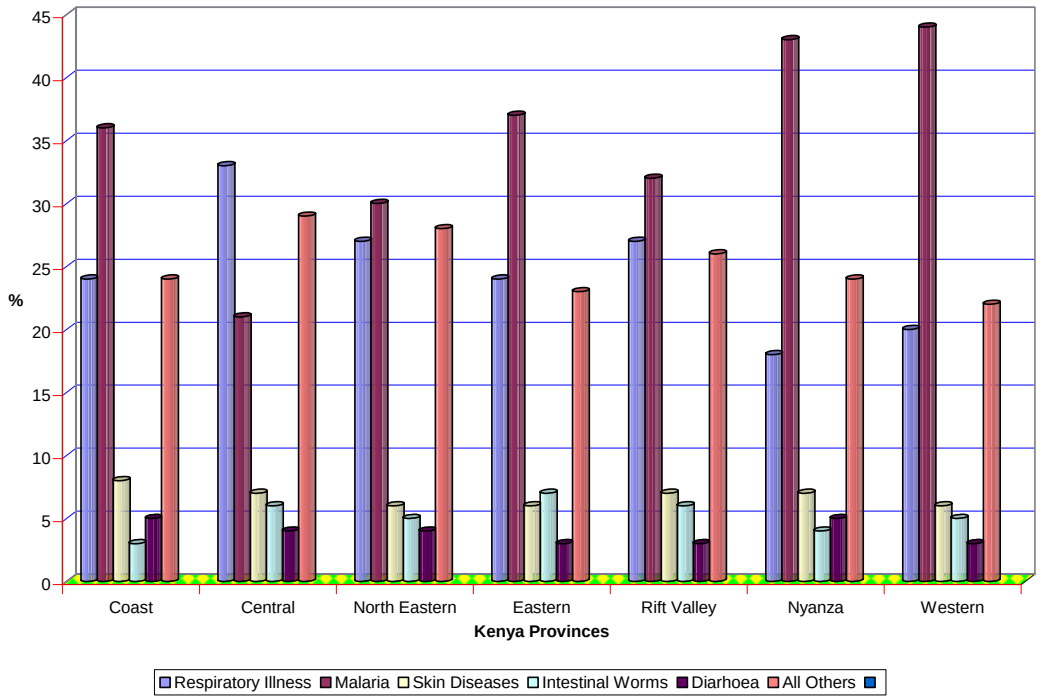


Figure 4.9 Causes of morbidity

Malaria is the most prevalent disease while Respiratory illness is next in most provinces. While the relative percentage of diarrheas disease is low, Kenya is subjected to WES related disease outbreaks, especially cholera, this is discussed in detail below. The others in the graph include diseases like Typhoid fever. Major diarrhea diseases include Cholera.

Meanwhile gastroenteritis are the leading cause of hospitalization for infants as shown below:

Table 4.17: The 5 Leading Causes of Hospitalization Among Infants (< 1 yr), 1999

Disease	Percentage of Total
Diarrhoea and gastroenteritis	13.6
Malaria	13.3
Anaemia (all)	10.7
Pneumonia (all)	9.8
Volume Depletion (Dehydration)	7.4

Table 4.18: Leading Causes of Death Among Infants (< 1 yr) 1999

	Percentage of Total
Pneumonia (all)	20.2
Malaria	13.1
Disorders related to short gestation & LBWt	7.6
Di8arrhea and gastroenteritis	7.5
Anaemia (all)	7.4
Bacteria Sepsis Of Newborn	6.4

Table 4.19: Leading causes of hospitalization for children

Disease	Percentage of Total
Malaria	21.3
Pneumonia (all)	18.7
Anaemia (all)	10.2
Diarrhoea and gastroenteritis	7.0
Burns and corrosions and Low birth	2.5

Table 4.20: Out Patient Morbidity In 1999 By Province Absolute Numbers

Province DISEASE	**Nairobi**	**Central**	**Coast**	**Eastern**	**North Eastern**	**Nyanza**	**Rift Valley**	**Western**	**Total**
Malaria	54,066	603,620	609,637	1,036,905	45,974	869,606	877,117	412,599	4,509,524
Diseases of RS	79,389	876,209	370,969	611,721	35,078	317,622	665,087	156,801	3,112,876
Skin Diseases	19,833	222,533	136,231	181,073	6,720	142,200	188,480	62,270	959,340
Diarrhoea	24,129	106,844	86,818	107,073	7,678	109,558	152,709	48,312	643,151
Intestinal Worms	7,388	187,061	57,095	193,014	4,597	70,780	78,637	25,701	624,273
Anaemia	4,951	7,028	29,956	12,196	3,384	18,631	8,532	8,496	93,174
Urinary TI	16,659	58,589	42,739	53,403	9,235	54,478	54,131	22,811	312,045
Pneumonia	18,971	57,259	23,292	73,203	5,282	51,868	59,707	34,174	323,756
Eye Infections	23,079	69,021	21,373	50,023	3,557	35,930	62,233	14,047	279,263
Ear Infections	27,481	29,163	18,852	32,244	3,503	26,178	31,044	10,602	179,067

From the above statistics malaria is the most serious a public health problem, with a caseload of 4.5 million in 1999 or about 16% of Kenyan population. It kills 26,000 children in Kenya every year[29]. As can be seen from figure 4.8 it is well spread but is especially serious along the Coast and Lake Victoria basin. Seasonal outbreaks of highland malaria have been experienced in the highlands of the Rift Valley province. For instance in July, 2002 there was a malaria outbreak in the Western parts of Kenya that claimed about 325 lives. There were estimated 200,000-reported cases of infected people in 11 districts in this outbreak and the estimated number of persons at risk was 5.7 million. The economic cost of malaria is very high. 20 million Kenyans are regularly affected by malaria, with most treating the disease at home. An estimated 170 million working days are lost each year as a result of the disease.

The diseases of the respiratory system which include Acute respiratory infection (ARI) and pneumonia affected about 11% of the population in 1999, while diarrhea, intestinal worms and skin diseases affected 8% of the population. These diseases dis-proportionally affect children and in 1998 the affected 43% of children between 6 and 23 months of age (KDHS 1998) and Respiratory illness are the leading cause of infant mortality as per Table 4.18 Children are more likely than adults to die from diarrhoea because they become dehydrated more quickly. About one in every 200 children who contract diarrhoea will die from it.

Cholera has been endemic in Kenya, especially in the Lake and Coastal regions. There have been major outbreaks since mid – 1997 as one the impacts of the El Nino rains of 1997/1998. The cumulative total number of cases reported was 17,200 in 1997 and 22,432 in 1998 with 555 and 1,237 deaths respectively. An outbreak of cholera occurred in Nyanza, Eastern, Rift Valley and Nairobi Provinces, which strted on 27 December, 1998. As of 19 January, 1999 a total of 1025 cases with 25 deaths is estimated to have occurred. The latest outbreak was in Kwale and Mombasa in August,2002. Details are given in the Test box 4.5 below:

Text box 4.5: Cholera outbreaks along the coastline of Kenya Manifestation

Cholera epidemics are not a recent phenomenon along the coastline of Kenya. For instance in 1868, there was a major cholera outbreak in this area that lasted through 1869. This epidemic incidence had arrived overland along the major trade routes[31] and then quickly spreading to Mombasa and then soutwards into the various islands and along, the coast line of what now Kwale district. These outbreaks still continue into the 21st Century, despite significant advances in knowledge of the causative agents, *vibroyo cholera* bacteria, and prevention methods. In fact there have been an average of 3 outbreaks per year since 1998 in different towns.

The epicenters of these outbreaks have keen identified by the medical authorities as Vanga and Lunga-Lunga which are major trade routes in Kwale. In 2002 Shimoni, Wasini Island joined this list. In the year 2002 the first outbreak occurred in March 2002 in Vanga. In August, 2002 sporadic outbreaks is still occurring the latest being in Lunga-Lunga. While the health authorities, supported mainly be Red Cross and UNICEF have been on top of things in terms on containing disease outbreaks involvement of the population is low. The threat of a major outbreak looms.

Causality analysis

80% of the population living along the coastline of Kwale depend on usage sources of water For example at Shimoni and its environs the population is dependat on over 80 uncovered wells while Vanga mainly depends on 13 uncovered wells. In Lunga-Lunga, a significant proportion of the population depends on the river Umba. A significant number of the wells are dangerously sited in the proximity of pit latrines and are inadequately protected from contamination both in the hydro-geological and structural sense. In particular the ground water bearing, formation is coral stone, which has a high hydraulic conductivity. Therefore the underground flow of contaminated water from a latrine to a well is relatively easy. Solid waste particles; leaves, plastic paper and pieces of wood, were observed floating in most of the public wells.

Nairobi Province is served by 358 health facilities of which public facilities constitute 42% and private/NGO 58%. Table 4.19 shows the leading causes of outpatient attendance and a comparison of the same conditions ranked nationally.

Not practicing exclusive breastfeeding when mothers breastfeed exclusively during at least the first six months, there is a dramatic decrease in episodes and, to a lesser extent, respiratory infections. Even small amounts of water-based drinks decrease breastmilk intake and weight gain, and increase the risk of diarrhoea. Continuing to breast feed up to two years of age, in addition to giving complementary foods, maintains good nutritional status and helps prevent diarrhoea.

Poor sanitation and hygiene practices especially, poor methods of excreta management, inadequate cleanliness in food preparation and handling and not washing hands before eating or after using the toilet.

Consumption of unsafe water especially its use in diluting milk used in preparing food supplements.

Other sanitation related diseases are intestinal worms and skin diseases. Risk factors in worm infection is ingestion of contaminated food or water and walking bare feet on contaminated soils, while the main risk factors in skin diseases are poor person hygiene.

The risk factors in malaria are:

Climatic conditions that is conducive to the proliferation of mosquito. These conditions are especially found in the Coast and Lakes regions. Other areas that are seasonally at risk are the Highlands and the semi-arid areas of the Northern and North Eastern regions of Kenya.

High incidence of contract between the vector (mosquito) and Human beings

Basic Causes.

Community knowledge and misconceptions on the causes malaria infections in the endemic areas, these include exposure to cold, being rained on, eating mangoes etc. There is obviously significant room for improvement in education. For cholera and other diarrhea diseases the sited causes range from Lake Spirits, *nyawawa*, to letter and flies dying in food amongst others.

Urban Sanitation

In most town of Kenya there is poor management of solid and liquid wastes. In fact the most visible solid waster is the plastic bags that litter most of the landscapes in these towns. Unsightly Waster mounds in town estates and in various parts of the central business districts are common features. The Nairobi City Council is only able to collect about 10% of the more than 474,500 metric tons of solid waste generated in Nairobi per year[33]. The rest in dispose by private means, natural decomposition, and individual arrangement such as burning.

The issues in Environmental Sanitation are lack of municipal coverage for garbage disposal, disposal of liquid wastes, drainage, sanitation facilities and disposal of solid wastes. 56% of the residents in the informal settlements have no access to adequate sanitation facilities. Whatever toilets are provided is inadequate and unsanitary. Toilets are the open pit type, which are often filled up and overflow during the rainy season. The 'flying' toilets, which are wrap in paper and thrown in drains and streams, are often the method of faecal disposal in households. Open pit latrines are the common toilets as there is no piped sewerage system in the informal settlements. Drainage and sewerage system is combined in open canals that lead to pools of stagnating water logged by garbage denying the children clean and safe place to play. These open earth canals drain into the surrounding rivers namely, Gitathuru and Nairobi rivers in Korogocho as well as Nairobi Dam in Kibera.

Due to the heavy congestion of dwellings landlords often do not provide ample space for bathrooms as this is sometimes viewed as a waste of space. The unavailability of bathrooms also forces the people to bath outside, or inside their dwelling or not take a bath at all. Often the rivers become the dumping grounds for garbage and other wastes. Proper garbage disposal is needed as most settlements are littered with garbage contaminated with human waste that poses great health hazard to dwellers in these communities. Children often lack a sanitary environment to play and are exposed to disease and chemical poisoning when they play in garbage dumps, and contaminated streams and ponds.

Analysis of the conditions outlined in table 4.20 is a reflection of the environmental sanitation and housing conditions that the majority of Nairobi's population is subjected. The crowded poorly constructed shanties that serve as a dwelling for the majority of those in informal settlements predisposes the residents to respiratory diseases especially pneumonia. The same conditions are also predisposing factors to accidents especially burns.

Rural Sanitation

Rural sanitation is even more worrying More than 90% of the WES diseases outbreak occur in the rural areas, and sanitation coverage is very low comparable to the Urban slums, at less that 45%

Government Policy.

The Public Health Cap. 242 is the principal law that impacts on public health. This acts empowers the Ministry of Health to regulate activities concerning human wastes disposal and prescribes standards and procedures to be followed failure of which punitive and corrective measures are taken. Others include the Food, drugs and Chemical substances acts cap 254. The Mosquito control act, the local government act Cap. 256. the Chief Act Cap 128 the water act cap 272 factories Inspectorate act cap 514 and various Local Authority by Laws. At the above acts provide the legal basis for intervention in sanitation issues as well as the framework to facilitate the operation of various stakeholders. The new Water Act has several stipulations on the prevention of industrial pollution with the application of "polluter pays" principal. The problem with

these acts and has have been enforcement, which the new policy seeks to address.
The Government through the current Health Policy framework has decided to adopt policy directions that shift emphasis from curative health to preventive health care. The level of environmental sanitation and hygiene standards are seen as key to preventive health. To ensure the environmental hygiene and sanitation policy has been proposed.

During the years 2001-2002 several workshops have been co-financed by the Government, World Bank and UNICEF to formulate the policy. So far thematic groups have reported back to the plenary. Consultation of communities and other stakeholders is planned.

Institutional arrangements

Ministry of Health: Division of Environmental Health.
The Division of Environmental Health within the Ministry of Health is charged with promotion and enforcement of Sanitation and Hygiene standards ion Kenya. The The division is well established from National to sub-location levels.

Capacity Cap analysis

Inadequate funding
Preventive health only attracts 20% of the MOH funding and most of this goes into personnel salaries and emoluments.

Sanitation Policy
The sanitation policy is still in the process of formulation and requires continued support, and especially community and women involvement until completion and enactment.

Urban Solid and Liquid Waste Management
Most of the Urban Areas Authorities are unable to cope with the urban wastes and the worst affected are the peri urban informal settlements where 60% of the urban population resides.

Participation of Community
Past projects have shown remarkable improvement of solid and liquid waste management when communities and especially women are mobilized, trained and do contribute time and resources in sanitation. However this have been pilot projects and there is need to take these projects to scale.

Malaria, Respiratory Illness

There is need for targeting malaria, respiratory illness in children as well as in the 2003 work plan as they are together the principal causes of mortality and morbidity in children in Kenya.

WATER+ FOOD SECURITY

Securing Food for Growing Population

In November 1996, Heads of State and Government and high officials gathered in Rome for the World Food Summit convened by FAO and pledged political will and commitment to the continuing effort to eradicate hunger in all countries. They resolved to half the number of chronically undernourished people in the world by 2015. To achieve that goal and feed the ever-increasing population, agricultural production must be rapidly increased and intensified while protecting the natural resources and avoiding pollution. National governments and the international community will need to reverse the decline in support to agriculture (US $ 10 billion in 1982 to US $ 7.2 billion in 1992). This would require efficient use of the water resources, including use of irrigation, in addition to other requisite agricultural inputs.

National level
Kenya is defined as a Low-income Food-Deficit Country (LIFDC) with chronically undernourished people. The country does not grow enough food to meet all her needs and has insufficient foreign exchange to fill the gap by imports. However, the Government development objectives for agriculture has been captured in various policy documents and the Government is currently implementing strategies to achieve the objectives for sustainable agriculture, which include food self-

sufficiency and food security in addition to employment creation, income generation, foreign exchange generation (earnings), rural-urban balance, economic growth, poverty alleviation and generation of raw materials for domestic industry and agricultural exports. The Strategy for Revitalization of Agriculture, in harmony with the Economic Recovery Strategy for Wealth and Employment creation, suggests measures to be implemented to address issues of food insecurity in the country.

Policies on beneficiary participation and cost sharing in the agricultural sector such as artificial insemination (A.I) services and dipping and clinical services were also introduced in 1992. The parastatals reform programme was introduced in 1993 with the aim to restructure the perennially loss-making parastatals and to rationalize the public sector to allow for more private sector involvement in agricultural marketing. For example, the National Cereals and Produce Board (NCPB) was commercialised in 1993 so that it could compete with other grain merchants in the grain market.

Coupled with the above, agriculture and livestock extension policy guidelines were formulated in 1999 to revamp extension services offered to the farmer and to evolve a demand driven extension service. Reforms on legal framework to accommodate various changes, addressing constraints in the agricultural sector through a well planned and a well coordinated sector-wide programme principally to stimulate private sector involvement in agriculture through increased investment in development of rural access roads, water resources, marketing facilities and outlets, electricity and other forms of farm energy, credit facilities and research and extension have been on-going though slowly. Other efforts include

- The National Policy Framework Paper (1997) on poverty alleviation and food security,
- Sessional Paper No. 1 of 1999 on the National Water Policy and Water Resources Management and Development,
- The study on The National Water Master Plan (1992) and
- The Sessional Paper No. 3 of 1999 on National Poverty Eradication (1999-2015).

The right to food

During the World Food Summit, Kenya, among other countries made commitment on the right to food and would therefore ensure that each and every Kenyan has a right and access to nutritious, adequate and safe food.

Food security and its indicators

The definition of food security has changed to include a concept of entitlement that demands that the poor and hungry have access to food at all times for a normal healthy active life in addition to food availability. Adequacy, safety nutritional content and societal acceptance of the food commodity also constitute the key ingredients of food security for a given population.

Achieving food security has remained elusive for the country for a number of years, especially in the ASALs. Recent welfare monitoring surveys reveal that the food poor, that is, those who cannot meet the minimum of 2,250 kilocalories per day currently stands at 15 million, up from 7.3 million in 1973. 3 million of these are in constant need of relief. The number of malnourished children is also increasing. Food insecurity has been worsened by rising poverty levels among the population. For example, the welfare monitoring survey of 1997 indicated that the poverty level rose from 47% in 1994 to 53% in 1997 in the rural areas and from 29% to 49% in urban areas over the same period. Recent statistics put poverty levels at 56% by the year 2000.

Other factors contribute to food insecurity in the country. The national food policy emphasizes more on food production and ignores the important parameters of food quality and access. The result is a situation where there could be abundance of food but limited access by many households. High post-harvest losses as result of pests and diseases, inadequate early warning systems, over-reliance on a few staple crops such as maize, beans, wheat and rice, poor marketing infrastructure, environmental degradation and increasing incidences of HIV/AIDS among many farming households equally contribute to food insecurity in the country.

The main sources of food supply

Local agricultural production has always shouldered the burden of food security for the

country. Food for majority rural and few urban households come from own-production. The trend of decreasing per capita food production in the country poses unique challenge because of the rising population, poverty, inherent biological and soil fertility, social (HIV/AIDs), adequate credit, adequate foreign exchange reserves, and infrastructural limitations among others.

The urban population relies more on the food markets (local and international), which account for about 54% of their food needs. Food aid (about 5%), mainly by international relief agencies and gifts (about 1%) comprise other sources of food supply in the country.

The Role of Irrigation in poverty alleviation and food security

The impact of water on intensification of agriculture for increased food security has been to render the productivity gains unstable and prone to risks. This is because Kenya relies more on rain-fed production with very little irrigation. There is potentially high payoff from developing the county's capacity for irrigation especially as there is more cultivable land available. It should be noted that Kenya has a high to medium potential land of only 16% (9.4 million ha) of the total land area out of which only 2.8 million ha is devoted to arable (rain-fed) agriculture. The ASALs, which comprise about 80% of the total land area has about 9 million ha that can support agriculture with appropriate irrigation technologies.

The irrigation and drainage potential for the country is estimated at 540,000 ha and 600,000 ha respectively but only about 109,350 ha has been put under irrigation. Water is also complementary to the varieties of fertilizers used and is needed to take full advantage of fertilizer-seed technology as prescribed under the green revolution. Evidently there is potential for increased irrigation to enable the country achieve food security.

The special role of groundwater

Kenya receives an annual average rainfall of 570 mm/year (310 billion m^3/year) with a rangie of from less than 300 mm/year in the drier ASALs to more than 2000 mm/year in the wetter highland areas. Only a small amount of this water infiltrates into the soil and recharges the groundwater. It represents a considerable resource of generally good water, which could be exploited for gainful activities. The groundwater is stored in different rock types whose characteristics largely determine the water quality and the feasibility to abstract the water. For example, the groundwater quality in Western, Central, Nyanza, and Nairobi Provinces is generally suitable for both domestic and irrigation use. However, groundwater salinity increases in the North-eastern Provinces due to evaporite deposits and in the Coast Province due to seawater intrusion thus rendering such water unsuitable for irrigation use. High fluoride contents are a particular concern in the Rift Valley, Nairobi and North-eastern Provinces.

The groundwater is normally exploited in form of shallow wells and deep boreholes. By the year 2000, the total number of boreholes was estimated at 13,000. Groundwater abstraction based on annual utilization rate using 9,400 boreholes was estimated at 137 million cubic meters in 1990. Contrary to the case of boreholes, there are hardly any records on abstraction rates and sanitary status of the shallow dug wells.

Groundwater is generally considered as an expensive source of water for irrigation principally because of high drilling costs compared to the low abstraction yields (6-9 cubic meters per hour) and the high operation cost needed to pump water from high depths below the ground surface. For example, drilling a 200-meter borehole producing 8 m^3/hr costs about K.Shs. 2,000,000. This high cost is an obstacle to groundwater exploitation in the rural areas for domestic, livestock and irrigation water use. In the arid and semi-arid areas, use of groundwater for irrigation is sometimes compromised by unsuitable water qualities like high levels of salinity.

Main Food Types and their Water Use

The majority in the country relies almost entirely on growing a small range of crops,

mainly cereals (maize, sorghum, rice, and millet), pulses (beans, peas and grams) and root crops (sweet and Irish potatoes, cassava, yams and arrow-roots) or on pastoralism as in the ASALs. The majority depends on a narrow livelihood base that renders it vulnerable to external shocks of food shortage. Without irrigation or access to food markets, farmers find it hard to change to other crops and where individual farmers' education level is low; they have few opportunities to access other forms of employment. Women are even more disadvantaged: Men can migrate either into cities or be employed as labourers in large farms while women remain on the family farm.

Cereals and oil crops

The main cereal crops are comprised mainly of maize, wheat, rice, sorghum and millets. However, *maize* is the principal cereal staple in Kenya and has always been treated as a strategic political crop in the country. A majority of households are net buyers of maize, ranging from roughly 30% of the households in the primary maize belt areas to over 80% in low potential areas and in areas where priority is given to high value crops. Lack of maize means lack of food to many households. For people who live at or below the poverty line, maize accounts for nearly 30% of food expenditure.

Maize is the most frequently produced and marketed crop, grown by 90% of households and sold by more than 30% of households in the main growing areas. Smallholders account for about 75% of total production in Kenya, but it is estimated that 75% of all marketed maize comes from large farms. Support to smallholder farmers from the 1960s to 1980s was mainly through input subsidies, cheap credit, subsidized transport costs, and use of state-controlled marketing agencies, which implemented the price controls. Subsequent liberalization in the early 1990s included the removal of price controls on grains, deregulation of maize meal prices and an end to subsidies.

However, such reforms have been blamed for the decline in grain production in Kenya in the face of inadequate participation by the private sector. Concerns have been raised over how to contain food price instability and source adequate supplies to meet domestic demand during local production shortfalls.

Wheat production has been declining in the recent due to low producer incentives and liberalization of the market like for maize.

Rice:

Local production of rice is low and does not meet domestic demand. Poor management of local irrigation schemes where paddy rice is produced from the early 1990s led to such decline. Deficits have been met by imports mainly from Pakistan, India and Thailand.

Oil crops

Oil crops development in Kenya has been poor. Under the auspices of Oil Crop Development Company, Unga Group of Companies and the Ministry of Agriculture, efforts to promote the growing of oil crops which has a very great potential as a source of income and food security for the rural farmers has not borne much fruit. Demand shortfalls are met by imports of mainly palm oil from Malaysia and soybean oil from USA and Brazil and other countries. However, efforts to promote the growing of such crops, including oil palm, sunflower, groundnuts, sesame, cashew nuts and coconuts, is still being pursued by the Ministry of Agriculture and the private sector.

Table 4.21: Water use by main crops

Crop	Estimated current are ('000 ha)	Crop water requirement (mm)	Days to maturity	Crop water requirement (billion m^3)	Est. suitable area ('000 ha)	Total Crop water requirement (billion m^3)
Maize	1,400	400-750	75	10.5	5,000	37.5
Wheat	190	300-450	110	0.9	1,400	6.3
Rice	20	500-950	180	0.2	1,300	12.4
Sorghum	250	300-650	50-75	1.6	7,200	4.7

Potatoes	110	350-625	105	0.7	1,600	10.0
Beans	650	230-450	70	2.9	3,900	1.8
Coffee	150	800-1,200	-	1.8	800	9.6
Tea	70	1,400-1,800	-	1.3	600	10.8
Cotton	70	550-950	170	0.7	2,200	20.9
Sugarcane	180	100-1,500	540	2.7	600	9.0
Pyrethrum	20	1,200-1,600		0.3	1,400	22.4
Sisal	20	550-800		0.2	3,700	29.6
Total	3,130	-	-	23.8	29,700	175

Adopted from Water and Food Security 2004

From table 4.20 estimated crop cover is 3 million ha and the estimated seasonal crop water requirement is approximately 24 billion cubic meters. The total estimated land suitable for cropping is about 30 million ha. The total estimated crop water requirement is 175 billion cubic meters.

Livestock and food security

The livestock sector accounts for about 10-15% of the Gross Domestic product and over 30-45% of the agricultural GDP. The sector also employs over 50% of the agricultural labour force. Based on the above statistics, the role the livestock sector plays in poverty reduction, employment creation and income generation and therefore food security cannot be over-emphasized.

Pastoralists keep about 70% of the national livestock herd estimated at about 8.9 million beef cattle, 9.6 million goats, 8.3 million sheep, and 0.8 million camels. Under normal circumstances, these are the main sources of their livelihood as sources of meat, milk and money when stocks are sold. The red meat comprising of beef, mutton, goat and camel meat, for example, accounts for 80% of all meat consumed locally and about 67% of this meat is produced in the arid and semi-arid areas. Of the estimated total beef consumed in Kenya, about 50% originates from pastoral areas. Indigenous breeds from the high potential areas and the cow and male culls from dairy herds contribute the rest of the red meat and male culls from the dairy herds. The rest 20% of all the meat consumed in the country is contributed by poultry and emerging livestock such as ostriches.

The dairy sub-sector as grown tremendously over the years and about 600,000 households derives their livelihoods from small-scale dairy farming. The total national dairy herd stands at approximately 3.3 million heads of cattle. Together with the about 8 million indigenous breeds, the combined total milk produced is 2.8 billion litres per annum. I addition to milk being food in itself, the income derived from the sales can be used to buy other foodstuffs for the family.

Emerging livestock activities such as bee keeping, ostrich rearing, rabbitry and crocodile rearing also contribute significantly as sources of income, employment and food security.

Fisheries and aquaculture contribution to food security

Even though fisheries constitute only a small percent of the GDP, it is an important source of livelihood for many Kenyans. Those engaged in fishing have an avenue of employment and earn income from the activity. The fisheries sector also supplies raw materials for other economic activities, notably manufacturing and agriculture. Spoilt fish and by-products of fish processing are increasingly finding use in the manufacture of animal feeds, important inputs in poultry, dairy and beef production.

The potential of the fisheries sub-sector is estimated at 660,000 metric tons per annum but current exploitation is only a meagre 25% of this potential. Marine fishing potential alone is estimated at 260,000 MT per annum but current production is only 6,000 MT while aquaculture potential is estimated at 50,000 MT per annum but stood at 1,103 MT by the year 2000. The

total value of fish landed was 7.6 billion in the year 2000.

It is estimated that about 90% of fish harvesting is done in Kenya is done by small-scale fishermen who operate in the inland lakes, along rivers and streams, and in shallow waters off the Indian Ocean.

Aquaculture is also practised in many parts of the country. Tilapia and trout are reared mainly in inland fresh water dams while marine aquaculture farms along the Indian Ocean mainly rear prawns, shrimps and oysters.

The contribution of animal rearing to food security

The contribution of animal rearing to food security cannot be over-emphasized as indicated above. Animals are not only important as sources of meat (beef, mutton, pork, chicken e.t.c.), honey, and milk, they are also sources of valuable income when sold as live animals, as by-products of processing as in hides and skins and as bones for bone-meal in animal food industry. Households use the income from such sources to buy the necessary food staffs from the local markets.

Food Trade and its role in food security

Food Markets and access to basic food

Food markets, on which both the cash and food crop producers depend for the household consumption needs, are found in the main urban centres and the local markets in the countryside. There exists a range of different marketing channels and physical markets where smallholder's food produce and imported food staffs are sold:

- ◊ Local markets where smallholders sell marketable food crops and livestock products mainly through small traders and local processors, for domestic consumption in the rural neighbourhoods;
- ◊ Urban markets countrywide and rural markets in food deficit areas where food crops and livestock products from smallholders in surplus areas are taken through a system of traders and wholesalers, to be sold to urban consumers or local processors or through retailers in rural deficit areas where a certain product is lacking;
- ◊ Crops and livestock products that are delivered to medium and large scale processors and are transformed into processed, usually packaged food stuffs, which are then sold locally or countrywide for domestic consumption or for exports outside;
- ◊ Specialized commodity foods that are sold through brokers and local factories into well organized marketing channels destined for predetermined markets that are often abroad either as fresh products or as pre-processed products, e.g. fruits and vegetables sold to local tourist hotels and exports.

Access to basic food requires efficient markets. For example, the relative success of food market liberalization in Kenya has led to relatively efficient food markets with consumers throughout the country and in deficit areas benefiting from the proliferation and lower milling margins of posho mills; strengthened private grain trade; greater availability of maize grain and cross-border trade in response to domestic surplus or deficit. Price instability under liberalization has been modest. It can be noted that the majority of rural food producers are commercialised to some degree. To build on this existing situation cash crop commercialisation can also serve as an engine for smallholder income and productivity growth. This will require that the inputs markets and output marketing channels function well.

Food Imports and external dependency

Cereals, including maize, sorghum, millets, wheat and rice are the main food crops in Kenya. Maize is normally considered the main staple food. Kenya is normally self-sufficient in maize production during good years but tend to face deficit at times of low rainfall and drought. Production shortfalls in maize are met by imports, mainly by the major grain millers. For example, Kenyan millers imported a total of 75,000 metric tons of maize from South Africa and other southern African countries like Malawi, Zambia and Zimbabwe during 2003 to meet local production shortfall. The country has imported more than 300,000 metric tons of maize during five out of the past ten years, with a peak of 1.1 million metric tons in 1997.

In case of serious production shortfalls which result in acute drought-induced food shortages as happened in between 1999 and 2003, imports by international relief agencies such the UN

World Food Programme (WFP) compliments the government efforts by importing relief food. During 2003, WFP bought 60,000 metric tons of maize and nearly 30,000 metric tons of maize meal from the East Africa region.

The differential between international and Kenyan maize prices has been large during the 1990s and the poverty impact of higher maize prices is substantial because of the large share of maize in the food expenditure of the poor. During 1996-1998, for example, wholesale price of maize meal in Nairobi were between 10-100% higher compared to other capital cities in the region. Producer prices in the major maize growing areas in Kenya are normally between 40-50% higher than in countries such as Ethiopia, South Africa and Zambia. For example, for the period August 2002 until July 2003, the monthly wholesale maize prices three main markets in Kenya averaged 21% higher than those in three main markets in Uganda and 50% higher than three main markets in Tanzania.

Access to Food Storage

Post harvest losses have been estimated to account for 30-40% of loss of produce among the farming community. Access to storage is a critical limiting factor in controlling such losses, especially where food crops are concerned. Farm level storage depends on traditional methods such as cribs, smoking grains, use of jute/sisal or manila bags and use of pots. These methods are amenable to pest infestations and loss of quantity and quality to vary degrees.

Access to modern storage methods depends on farmers' abilities in terms of income, which would determine the kind of storage structures they can put up and access to main private/government players who own modern facilities such as grain silos. For example, the National Cereals and Produce Board (NCPB), a state corporation, which now operates as a commercial entity in the liberalized grain, markets but with an added function of market stabilization and holding of national strategic food reserve as an elaborate network of handling, storage and preservation facilities. Its principle trade is the purchase and sale of food crops, in particular maize, wheat and beans. Maize is bought mainly from assemblers and large-scale farmers and sold to large-scale millers. During 1999 and 2000, the NCPB bought some 2.4 million bags of maize. During 2003, it bought 5 million bags of maize.

Other major players with modern storage facilities include major millers, and grain handlers/importers. Some of these facilities are located in Nakuru and Mombasa.

Table 4.22 Indicators Table

Goals title							
Year	1990	1991	1992	1993	….	2002	2003
Indicator 1							
Indicator 2							

WATER + SETTLEMENTS

Water and Cities

Issues Identified

Conflict management and resolution: Athi River and Ultresh
Institutional arrangements; (Water Act and Public Health Act, Agriculture Act, Physical Planning Act Cap 286, Environmental Management and Coordination Act no.8 of 1999) and related sector policies
Water and Investment: water and sanitation infrastructure
Water and Policy

Indicators

Urban: population size and density, level of infrastructure development, number of urban centres classified

Competing Water Needs in Urban Environment: Category and proportion (percentage, amount, cost) for industrial, residential (domestic), commercial, public purpose, Education Institution, Recreational facilities

Challenges of water and cities: Water supply (source, capacity, distribution (network, coverage), unplanned settlement (way leaves),

Quality management (pollution levels of water sources

Urbanization and Migration: rate, slum development (number of people and area occupied), existence of related infrastructure (coverage and persons and area served)

Catering for the growing Informal Settlement in urban areas

Proportion of people that have access to water supply (improved and adequate): Individual standpipe, hand dug wells, piped, borehole, communal points and the people served. Affordability (less 5% of the income), sufficiency (20 litres per capita per day). Distance and time (with reach less 1 hour, 200 metres)

Urban development and Water Management: Augmentation and Expansion: (graphs, time series of water supply and population and identify gap), Efficiency (investment trends)

Water Demand Management: Water conservation (regulate water supply: time series and season, seasonal variation of supply, peak and normal, off –peak demand), spatial variation demand maps.

Water loss management: percentage water loss, unaccounted for water (40%), minimize the percentage (time frame)

Water service levels to the urban poor: frequency and reliability (rationing time frame: once day, once a week), catering for the growing population in urban areas, pricing policy (25 Khs per cubic metre, 1000 cubic metre per week, one cubic metre is 50 jerricans), percentage income used in getting water

Urban water and sanitation benefits and costs: Improved health, time for work and leisure, education, shortened distance to services, available for other uses, reduced cost, adequate water in quantity and quality, cost of supply per capita, less pollution to the environment, income savings, efficient management.

Cities ecological footprints: Urban impacts on ecosystems: water supply and source, pollution

to environment, human settlements, wetland encroachment (acreage), waste generated (levels of both liquid and solid), land use change: rate of change from natural to built environment

Urbanization is a recent phenomenon in Kenya's development. The numbers of towns defined as population centres inhabited by 2000 people or more are considered urban. However, the development of such towns during the last a two or three decade has been rapid and follows general urbanization trends in other developing countries.

Urbanization and Migration

The proportion of population living in urban areas is still low compared to those living in the rural areas in Kenya but has been increasing from; 8% in 1969; 15% in 1978; 18% in 1989, and 19% in 1999. However, the urban growth rate has been falling from 5.2% in 1979-1989 to 3.2% in 1989-1999. The decline in urban growth rates between the two period show that the pace at which people are moving from rural to urban areas have declined.

Table 4.23: shows the population distribution of urban centres between 1962 and 1999. There have been many administrative and civic boundary changes with a population of 20,000-99,999 were the majority representing 41.8% of the total. The urban centres followed this with a population of 10,000-19,999 were the least in the local authority.

Table 4.24 illustrates the growth of main urban centres in the Republic of Kenya. Most of the urban centres have quadrupled their population since 1969, there is high rapid urbanisation among secondary towns. This increase definitely exerts a lot of pressure the water

resources, due to high demand of portable water in these urban centres. Kangundo town drastically grew by 11585% as highest growth, Mombasa town was 74% as the lowest growth and most town have grown by more than 300% .

Implications of these to water resources include the demand for land for urban expansion as stated that most of these developments have been more informal. Over 60% of the urban population live in the informal areas, increased subdivision and overcrowding in these areas. Pressures on water catchments, wetland area and ground water recharge areas especially within peri-urban neighbourhood are envisaged. Land use planning must therefore focus to protect and conserve these environmentally sensitive areas against urbanization process.

Table 4.23: Distribution of urban centres by population size, 1962-1999

Size of Urban Centre	1962	1969	1979	1989	1999
100,000	2 (5.9)	2 (4.3)	3 (3.3)	6 (4.3)	19 (9.5)
20,000-99,999	2 (5.9)	2 (4.3)	13 (14.3)	21 (15.1)	84 (41.8)
10,000-19,999	3 (8.8)	7 (14.9)	11 (12.1)	19 (13.7)	17 (8.5)
5,000-9,999	11 (32.4)	11 (32.4)	22 (24.2)	32 (23.0)	30 (14.9)
2,000-4,999	25 (53.2)	25 (53.2)	42 (46.2)	61 (43.9)	51 (25.4)
TOTAL	34 (100)	47 (100)	91 (100)	139 (100)	200 (100)

Source: Republic of Kenya, Central Bureau of Statistics (2000), The Popular Report and Housing Census: The Popular Report, Ministry of National Development.

Table 4.24: Growth of some urban centres, 1969- 1999

Urban Centre	1969	1979	1989	1999	1969-1999% Increase
Nairobi	509,286	822,775	1,324,570	2,143,254	321
Mombasa	383,452	341,148	461,753	665,018	74
Kisumu	32,431	152,643	192,733	322,734	895
Nakuru	47,151	92,851	163,927	231,262	390
Eldoret	18,196	50,503	111,882	197,449	2187
Thika	18,387	41,324	57,603	106,707	480
Machakos	6,312	84,320	116,293	143,274	2170
Kitale	11,573		56,218	86,282	1184
Meru	4,475	72,049	94,947	126,427	2725
Kericho	10,144		48,511	93,213	819
Kisii	6,080	29,661	44,149	65,235	973
Malindi	10,757		34,047	118,428	1000
Karatina	2,436		5,554	126,337	5086
Nyeri	10,004	35,753	91,258	101,238	912
Naivasha	6,920		34,519	158,678	2193
Kakamega	6,244	32,025	58,862	74,115	1087
Kitui	3,071		9,305	106,873	3380
Bungoma	4,401		26,805	73,048	1560
Kangundo	1,540		10,880	179,952	11585

Region	Piped water in compound	Public outdoor/borehole	Protected well	Unprotected well/rain water	River/lake/ pond	Vendor/ Truck
Central	16.1	6.9	4.1	15.9	55.5	0.7
Coast rural	4.2	31.3	9.2	15.4	34.4	0.0
Eastern rural	7.5	16.5	6.6	22.4	43.4	0.1
Nyanza rural	2.2	8.9	18.3	26.8	43.4	0.5
R.Valley rural	5.0	10.8	11.8	16.6	53.6	0.2
Western rural	5.6	10.0	42.9	31.6	9.9	0.0
Total rural	6.0	12.2	16.2	22.4	41.4	0.4
Total urban	34.7	42.5	3.3	2.0	2.0	11.3
Nairobi	35.6	42.2	0.0	0.0	0.0	14.4
Mombasa	17.4	71.0	1.8	0.0	0.0	8.4
Kisumu	18.2	54.8	5.2	0.0	2.8	19.0
Nakuru	41.5	54.8	0.0	0.0	0.0	0.8
Other urban	41.9	27.4	9.9	7.0	6.3	7.4
National	11.5	18	13.7	18.5	33.8	2.5

Migration is the movement of people across a specified boundary between defined administrative boundaries within a country, thus referred to as internal migration. The factors that influence people to migrate include seeking for education, employment, infrastructure, land, and recreational facilities. Major migration patterns in Kenya have followed four broad patterns: One migration in resettlement districts of Laikipia, Trans Nzoia, Uashin Gishu areas; Two cash crop districts of Murang, Kiambu, Nyeri mainly central province and Nandi and Kericho in Rift Valley; Third migration in marginal districts influenced by pastoral lifestyle in Mandare, Wajir, Turkana Districts; Lastly, districts in national borders of Busia, West Pokot, Kajiado and Narok. However, the districts in Nyanza, Western and Eastern provinces have registered net losses. The metropolitan districts of Nairobi, Mombasa, Kisumu and Nakuru have experienced net gain of population mainly due to search for employment opportunities and better living standards.

Catering for Growing Informal Settlement and the Urban Poor

Republic of Kenya's 29 million populations is 65% rural and 35% urban. While over 60% of the urban population live in unplanned (informal) slum settlements with inadequate environmental infrastructure. The water sector has had little investment to meet the burgeoning population. Most of facilities are 0ver 20 years old and obsolete. With lack of maintenance and no new investment, the water demand are not being met. These urban centres are therefore focusing on alternative means such as Kiosks, vendors and/or natural sources (Table 4.25). In addition most of the urban poor have no access to conventional wastewater (sanitation), about 85% of low-income households use pit latrines (Table 4.26).

Inadequate environmental sanitation, which is critical in environmental health, is a major challenge in managing diseases such as diarrhea and malaria and epidermics such as cholera and typhoid.

In efficient management of water facilities have led to mushrooming of informal providers, who charge more than the official prices. The urban poor not only contend with high prices but also unsafe drinking water, inadequate sanitation and spend more of their income on portable water. Lastly, although investments in urban utilities have been substantial the poor have received little in terms of planning, investment and access to safe water and adequate sanitation.

	Dry Season				Wet Season			
	Poor		Non-poor		Poor		Non-poor	
	Safe	Unsafe	Safe	Unsafe	Safe	Unsafe	Safe	Unsafe
Central rural	27.1	72.9	39.5	60.5	28.2	71.8	38.2	61.8
Coast rural	44.1	55.3	56.5	43.5	38.8	61.2	55.9	44.1
Eastern rural	30.6	69.4	40.6	59.4	24.2	75.8	31.8	68.2
Nyanza rural	29.3	70.7	33.6	66.4	23.9	76.1	29.3	70.7
R. Valley Rural	27.6	72.4	41.4	58.6	25.6	74.4	38.7	61.3
Western rural	58.4	41.6	63.9	36.1	56.7	43.3	56.7	43.1
Total rural	34.4	65.6	42.9	57.1	30.8	69.2	39.1	60.9
Total urban	80.6	19.4	90.2	9.8	80.7	19.3	91.9	8.1
Nairobi	77.7	22.3	100.0	0.0	77.7	22.3	100.0	0.0
Mombasa	90.2	9.8	80.5	19.5	89.5	10.5	83.9	16.1
Kisumu	78.2	21.8	64.5	35.5	78.6	21.4	72.8	27.2
Nakuru	96.3	3.7	95.2	4.8	90.7	9.3	92.6	7.4
Other urban	79.3	20.7	83.1	16.9	81.1	18.9	86.5	13.5
Nation	43.3	56.7	53.0	47.0	40.4	59.6	50.3	49.7

Source: Republic of Kenya (2000)

Urban Development and Water Management

Improving urban water and sanitation provision, as part of integrated water resource management is central to many of the emerging approaches envisaged to overcome urban related water crisis.

Demand side management (DSM) is a major aspect of Integrated Water Resource Management (IWRM). DSM approaches include conservation-oriented approach, public health approach, and economic approach. Public health strategy focuses on water and health to reduce water related diseases. Economic approach aims at efficiency through price incentives. Lastly, community approach advocates for the role of community groups in water and sanitation improvements. The DSM is a critical attempt to the supply-fix approach characterizing many urban centres.

However, most urban centres have only emphasized conservation approaches neglecting other demand side issues, including the need for sanitary improvement, especially in poor urban settlements. However, in Kenya the water planners perspective to include the various options provide future challenges. These include, the declining untapped sources, increased frequency of drought, competing water between urban and agriculture, environmental concerns and lastly the unforeseen funds and political good will for investments.

Cities "Ecological Footprints"

Cities ecological footprints refer to the cities as part and parcel of the natural ecosystem. The sustainability of the ecosystem requires the balance between human settlement development and the natural ecosystem, which is a symbiotic relationship. Urban expansions in terms of demand for resources, namely land, water, sink for wastes and by product do compromise this symbiotic relationship. Urban expansion reduces the land under natural ecosystem. Secondly, urbanization processes, which include production, distribution of goods and services, acting as sinks for wastes generated both liquid and solid wastes, basically modify and alter the natural ecosystems dynamics. These are also well exemplified in wetland encroachment, hence loss of its function of water pollution filter. Growth of cities in terms of population, functions and activities proportionately increase demand for water. The increased water demand, in urban centres such as Nairobi, Kisumu, Mombasa, require respective management authorities to import the water with subsequent massive abstraction of from neighbouring ecosystem. Nairobi and Mombasa get their water over 150 Kilometre away from Abardare and Mzima springs respectively.

Land Policy, Planning, Management and Development Responses

Land is the most important resource in sustainable human settlement development and is utilized by both rural and urban residents under varying tenure systems. The Government has mobilized all stakeholders to participate in key initiatives aimed at rationalizing policy on land utilization and management. These measures include the Constitution of Kenya Review Process, and the National Land Policy Formulation Process. Secondly preparation of Regional and Local Physical Development plans creates an avenue for implementation of water projects, while at the same time protect and conserve the water resources. Third other complementary initiatives that specifically target land information and tenure issues in slum and informal settlements have also been commenced. These are Kenya Slum Upgrading Programme and the Land Information for Improved Security of Tenure in Slums and Informal Settlement project.

Preparation of land use and related urban investment plans and the formulation of sectoral policies and programme provide urban local authorities with a framework for meeting the Millenium Development Goals. This attained through the planning and delivery of urban services such as housing, roads, water, sanitation, education, transport

and environmental management. The enactment of the Physical planning Act (Cap,286) in 1996 and the adoption of Local Authority Service Delivery Action Plans (LASDAP) by local authorities ha improved participatory planning and budgeting in urban areas as well as rural areas. The LASDAP process facilitates the mainstreaming of key urban and rural stakeholders in the planning and prioritization of local authority projects that are pro-poor.

The Government has also adopted the Sessional Paper No.3 on the National Housing Policy for Kenya, which, together with the National Housing Development Programme (2003-2007) will guide the delivery of 150,000 housing units annually by all stakeholders. In addition, the Kenya Slum Upgrading Programme is providing a framework for systematically upgrading slums and informal settlement in urban areas in order to improve the living environment and the livelihoods of the urban poor.

Rural Settlements

Macro economy

Agriculture is the mainstay of Kenya's economy. The sector, which is mostly rural based, contributes over 50% of the country's export earnings and employs about 80% of the population. The sector accounts for about 26% of the country's Gross Domestic Product (GDP).

Population

Kenya with a population of 30.4 million (1999 census projections) faces enormous challenge of providing water and sewerage services to the increasing population. Most of the population lives in rural areas (approximately 70%), while about 30% live in urban areas out of which more than halve live in informal settlements. Access to safe water is estimated at 70% in urban areas and only 49% in rural areas.

Rural and livestock water supply

It is apparent that the situation of rural water supply is worse than the urban water supply. Most of the rural domestic water supply is directly from the water sources such as rivers, lakes, unprotected springs, pools and ponds, shallow hand dug wells and wetlands and sand beds and may therefore be untreated hence not safe and potable. In the case of small scale rural water supply (SSWRWS), mainly water points with some pipe works are supply sources to the pubic and livestock. Large-scale rural water supply (LSRWS) may have pipe reticulation consisting of trunk, secondary and tertiary mains for distribution and transmission. Individual connections are a major type of service connection. At the periphery supply areas, schemes may have water points to serve the surrounding rural population.

According to the Aftercare Study (1998) on the National Water Master Plan (1992), the following concepts were proposed for constructing new SSRWS.

- Water sources for domestic use may be spring, groundwater (shallow well, boreholes) or riverbed from a hygienic viewpoint.
- Supply basically from water points with minor piping works to supply water to major institutions such as schools and hospitals.
- Disinfection is a minimum requirement for all schemes to meet the Ministry's water quality guidelines.
- Installation of a master meter to increase cost recovery, and the application of universal metering, especially at large consumers as minimum requirement.
- Gravity supplies to reduce recurrent costs and pumping being limited to areas where it is essential.
- Community based organization and management in line with the decentralization policy set up by the Government.

In planning and locating water sources in the rural areas, the following issues related to project management were to be considered for successful operation.

- Tribal issues: conflicts between tribes are common in Kenya. Selection of the location shall be decided after a series of dialogues with the people concerned.
- Religion: Due to religion, vandalism of the constructed facilities is also common. The people concerned will select members of a water user committee through election.
- Cultural issues: Nomads dependent on livestock move seasonally from place to place. Provision of water points may cause social-cultural problems among people.
- Assessment of public needs for water: People's needs for water assessed carefully. Where water supply is planned to be constructed by other undertaker's water point construction is not recommended.
- Formation of water user committee; to ensure sustainability of the water supply scheme, a water user committee responsible for operation and management of the scheme will be organized within the community concerned.
- Public involvement and participation: To increase opportunities of the public involvement to the schemes, it is more preferable too ask the community to provide work forces during construction.
- Investment costs to be borne by beneficiaries: beneficiaries shall meet the investment costs
- Women's involvement i9n the stage of design, construction and operation: Women play an important role in handling water in their daily lives and should therefore be involved in all stages of the scheme development.
- Hygiene and health education: It is of vital importance to instruct people on the need for safe and potable water, sanitation, water borne diseases related to pubic hygiene and health through seminar, meetings, movies, etc.
- Tarrif: the water user committee will set up tarrif levied on all customers. The revenue collected are to cover recurrent costs required for normal operation and maintenance.

Shortages are severe during dry seasons especially in ASALs. This together with service coverage coverage, health conditions, contribution to tourism, people's willingness to pay for water, and cost effectiveness of the planned schemes are some of the issues to be considered for ranking the projects.

According to the 1998 study, based on the criteria of service ratio, time spent by households who don't have safe water sources, health conditions, contribution to tourism, willingness and affordability of customers and cost effectiveness of projects, out of 50 districts, only 5 districts were found to have sufficicient on-going rural water supply(RWS) projects. The rest were not sufficient to meet the estimated water demand even by completion of ongoing projects.

Annex I has tables on projections of potential domestic and industrial water demand in 2010. From the tables, the total rural population is projected at about 27.6 million. The total rural water demand is projected at 932,631 cubic metres per day(residence) and 229,140 cubic meters per day(non-residence) making a total demand of 1,161,771 cubic metres per day.

The areas have wide varieties in their land potentials, population densities, etc. Therefore uniform approach to the rural water supply development may not be applicable. Besides the sources mentioned in the foregoing, other potential water sources, such as roof catchment, small dams, subsurface dams and rock catchment can also be considered.

WATER +THE ECONOMY

Economic Development

The importance of water for economic development cannot be over-emphasized. The major economic role of water lies in its core contribution both in agriculture and power generation.
Agriculture is the mainstay of Kenyan rural communities whose population is 70% of the national population. Availability of water ensures food production for household nutrition and for sale at local markets. In addition, the availability of irrigation water enables more crops to be grown per year, and the economics involved in the selling of produce. Irrigation allows year-round farming, which increases employment opportunities with consequent direct economic benefits to a local community

The country's population increase, currently estimated at 2.6% annually, is exerting considerable pressure on available resources, especially water and land. By 2015, the average size of holdings in the high and medium potential area is expected to have declined from the present two hectares to one hectare, due to this pressure, migration of people from high and medium potential agricultural lands to the low potential arid and semi arid-arid lands is on the increase thereby exacerbating the already fragile ecosystem.

Since 70% of the county's poor live in rural areas, this pressure continues to make them sink deeper into poverty as returns from the shrinking holdings diminish while the arid and semi-arid areas to which they migrate also cannot support them economically. Some of these areas can be brought into productive use through irrigation development for food and foliage production to support the increasing population. Irrigation development provides an immediate and guaranteed positive impact on poverty alleviation, employment creation and food security especially to the rural population.

Sustainability of irrigation development has been an issue of concern arising from diverse problems. In the national irrigation schemes, farmers are not well prepared and at times unwilling to take over responsibilities consequential to liberalization of crop marketing. In the smallholder schemes, the major challenge is on improvement of productivity of the land and water resources. A cross cutting challenge in the national and smallholder schemes include financing and carrying out operation and maintenance of irrigation and drainage infrastructure. In the private sector, the challenge is mainly on cost reduction through improved water management and attaining required standards for their produce. The national average irrigation efficiency stands at 45%, which is a major constrain in water resources management.

The Government has recognized that, there is the need to accelerate development of the ASAL areas for faster economic growth. A major input to development of these areas is availing water for livestock, domestic and irrigation development. Thus the Government's target of integrating ASALs in the overall development strategy primarily implies putting in place mechanisms that would harness the limited water resources in these areas as a basis for pursuing development endeavours in other sectors. It is instructive to note that in the irrigation sub-sector out of the estimated potential of 540,000 hectares, most of which is in the ASAL areas, only 87,350 ha. have been developed. The groundwater potential is also still underdeveloped with only about 30% having been exploited.

The Government has also placed high priority to irrigation development as a means of increasing agricultural production to reduce poverty and improve the standard of living of

the rural population especially those in the arid and semi-arid lands (ASALs) through formulation of appropriate policy guidelines and investing additional resources.

Inadequate water resources management is imposing a huge cost on the nation's economy. Droughts and floods impose a huge cost of the people and the economy. The cost of water resources degradation relates to

- Insecure water supplies due to over allocation of water
- Public health problems due to pollution
- Increased cost of water treatment from pollution and siltation
- Water supply infrastructure damage from siltation
- Damage to coastal and marine resources from siltation and
- Cost of aquatic weed control

To meet the costs of water resources management, the NWS strategy outlines the necessity to mobilize local resources and to complement them with aid from development partners. An appropriate levy and fee structure will be developed that ensures cost recovery to enable sustainable management of water resources. Financial management systems will be rationalized to increase efficiency, transparency and accountability. Ultimately it is planned that the WRMA will achieve financial autonomy. This should help attract foreign capital and technical investment into the sector.

Water + Economic Production

Kenya's socio-economic development goals are highly dependent on availability of good quality and quantity water. It is important for food production, hydropower generation (65-70% of electricity), manufacturing, fisheries and livestock, tourism as well as basic human health and well-being. Sustainable utilization, development and management of water resources therefore fundamentally underpin the achievement of long-term socio and economic goals.
Water plays a central role in food production, public health, industrial & power production, and recreation and poverty reduction. With the increasing growth in national population and the subsequent socio-economic pursuits such as urbanisation, industrial production, tourism and agricultural activities demand for water continues to rise. Over 80 per cent of Kenya is arid and semi-arid and hence, available fresh water resources are unevenly distributed in space and time. Current estimates indicate that only about 68 per cent and 49 per cent of the country's urban and rural populations respectively have access to safe drinking water.

Through widespread public participation Kenya has undertaken water sector reforms on policy, legislation and institutional arrangements. These reforms are intended to bring about decentralization of decision-making and to promote stakeholder participation in the management of the national water resources

At the regional level, Kenya is committed to the East African Community and other regional initiatives that have a bearing on Trans-boundary water resources use, conservation and development. Kenya participates along with other riparian states in the management of Lake Victoria basin resources, in the IGAD sub-regional water programme and in the River Nile basin resource management

Most existing water supply and sewerage collection treatment and disposal systems were constructed 20-40 years ago. With inadequate maintenance, non-replacement of obsolete equipment and failure to establish new assets coupled with declining allocations from the exchequer these existing water and sewerage facilities have been deteriorating rapidly, and currently fail to meet water demand in terms of both quantity and quality, of the ever increasing population. This is result in extremely high levels of unaccounted-for water reaching as high as 40%-70% on the average. This means that of

every 100 cm of water produced only 30 cm may be delivered to the beneficiaries. Losses include both technical losses due to leaks and inefficiencies in the physical system of pipes, pumps, treatment plans, valves and meters as well as social losses. Social losses include theft of water, "informal" unauthorised and unpaid for connections as well as other mechanisms for obtaining water without paying for it.

For the country to effectively attain the projected growth in agricultural productivity to attain food security and accelerate rural development new production measures that utilize the scarce water resources more effectively must be employed and disaster management measures be established to mitigate against the adverse effects of climate variability. The country will shift the effort of increasing productivity to focus more on the management of the scarce water resources as the basis for production.

Water + Jobs

Key providers of water services are the Director of Water under the Ministry of Water and Irrigation (MWI), the National Water Conservation and Pipeline Corporation (NWCPC), some Local Authorities, and Self-help schemes. Other actors include local communities, various institutions, and NGOs who operate and maintain their own water supply systems. Overall coverage and access has been, declining in terms of quality and quantity, reliability due to the aging of existing infrastructure.

Currently, Records indicate that, there are over 2600 water supplies under the management of various agencies. MW&I runs over 600 rural water supplies out of which 200 schemes are gazetted for revenue collection, while NWCPC runs over 48 water supplies, 45 of which are gazetted. Communities combined with self-help groups and NGOs run more than 2000 schemes and LAs run a total of 8 schemes. More than 9,000 boreholes have been registered with the defunct Water Apportionment Board (WAB).

Water + Economic Growth

Water is life. But it is a scarce and vulnerable resource whose use and development underpins the social and economic fabric of the Kenyan society. The Government of Kenya is committed to improving the management and protection of water resources to ensure that water is available for equitable allocation for all the demands in the country including water for domestic and public use, industry, agriculture, energy, livestock, wildlife, tourism and the many other uses. To achieve this, the Government has begun a process of reforming the water sector. The reforms include the development of an autonomous institutional framework that will be solely responsible for the management of our scarce water resources in such a way that we can be assured of sustained development. The reforms are based on the globally accepted principles of decentralization participation and sustainability of the water resources.

The National Water Master Plan indicates that water demand for essential uses (domestic, industrial, irrigation, livestock, wildlife and hydropower) will increase significantly from by the year 2010. This will take up an estimated 15% of available resources. Only 12.6% of gross run-off in river can be obtained without regulation works in rivers such as dams and reservoirs.

Currently water demands in all sectors are not being met. Until recently the emphasis has been on the provision of water supplies and water resources management has been neglected. The levels of storage for urban and rural requirements are very low with poor operation and maintenance and assets are being increasingly depleted due to

siltation as a result of catchment degradation. Shortage of resources and lack of control of water use is resulting in conflicts between users. In order to meet the present and the future demands for water and to promote the country's development, systematic Integrated Water Resources Management needs to be employed

Urban and rural water utilities, irrigation supply and hydropower generation companies are facing a range of management problems including huge inefficiencies in the systems due to large unaccounted for water, leakage, outdated technologies, poor design, illegal connections and theft. Individual allocation decisions are not made within a sustainable framework that takes account of climate, flow, variability, regional economic planning and environmental protection. The long and ineffective process for issuing permits has led to increased lawlessness in water abstraction. In areas of heavy water use such as the Ewaso Ng'iro North catchment, it is accepted that "illegal" abstractions amount to some 90% of the total abstractions.

It is crucial that utilization and allocation of water be determined in each catchment and sub-catchment, together with the water requirements for maintaining required resources protection, on an equitable basis to meet economic and social requirements.

In order to meet the present and future demands for water and to promote the county's development, systematic, efficient and sustainable management of water resources, cutting across all sectors and regions, will be the underlying principle of removing availability of water as a constraint to sustainable development.

Economic and social development objectives will be met through sustainable management of water resources including their proper allocation, development and protection and through increased efficiency of water use.

Water + Prosperity

Kenya's economy is largely rural and heavily dependent on its natural resources base. Water plays a central role in the nation's economy. It is a resource for urban and rural consumption, for energy generation and for agricultural development (Irrigation and Livestock watering).

The water requirements for domestic purpose includes provision of water for household and sanitary purposes, watering and dipping of stock, for public purposes to municipalities, townships, villages, communities and small industries and for all reasonable demands for public undertakings but not involving the use of water for generation of power or major irrigation and industrial use.

The present level of formal supply coverage is 70% for an urban population of 7.5 million and 46% of a rural population of 23.7 million. Many urban and rural centres that are supplied with piped water have unaccounted for losses of up to 50% of the supply. A combination of inadequate water resources management, especially in conservation, and poor management of supply functions has led to water shortages in most utilities. During periods of drought most urban and rural water supply becomes irregular with resulting negative impacts on the economy.

The Water Supply and Sanitation Strategy, which has already been prepared, provides the details of how services are to be provided, on the assumption that adequate water will be available from the country's water resources.

WATER + FINANCIAL ASPECTS

Asset Values

The Ministry is assessing the conditions of the existing water supply projects and infrastructure and will source funds for the rehabilitation of the essential infrastructure (water supply and sewerage infrastructure). The participation of the private sector in the development of the water systems and infrastructure will be sought.

Most existing water supply and sewerage treatment systems were constructed 20-40 years ago. Most of it has outlived its economic design life and is in urgent need of replacement or rehabilitation and augmentation. With inadequate maintenance, non-replacement of obsolete equipment and failure to establish new assets coupled with declining allocations from the exchequer these existing water and sewerage facilities have been deteriorating rapidly, and currently fail to meet water demand in terms of both quantity and quality, of the ever increasing population.

This results in extremely high levels of unaccounted-for water reaching as high as 40%-70% on the average. This means that, of every 100 cm of water produced only 30 cm may be delivered to the beneficiaries. Losses include both technical losses due to leaks and inefficiencies in the physical system of pipes, pumps, treatment plants, valves and meters as well as social losses. Social losses include theft of water, “informal” unauthorised and unpaid for connections as well as other mechanisms for obtaining water without paying for it. The dilapidated system, with huge unaccounted for water is coupled with an extremely low level of coverage for water supply and especially for sewage services.

Investments

During the implementation of the Economic Recovery Strategy (ERS) more than Kshs13 billion will be required to improve access to clean and reliable water supply, improve water retention capacity and protect life and property in the rural areas. Over K.Shs 10 billion will be required to mitigate the vagaries of weather by storing water during the rainy seasons for use during the dry spell especially in the Arid and Semi Arid lands. This is in recognition of the fact that in the 44 arid and semi arid districts, the distances the population has to walk in search of water for both domestic and livestock is large.

Rehabilitation of the rural water supplies during the plan period will be intensified. Majority of the rural water supplies were constructed long time ago. Their design capacity has already been overstretched due to the population increase. Lack of investment in the water supplies has also take a toll on the provision of safe and reliable water to the rural communities.

Rehabilitation of water control dykes in Nyando and Nzoia rivers is being undertaken to protect lives and livelihood for the surrounding communities.

During the plan period K.Shs 5.5 billion will be required to rehabilitate 35 urban water supplies, develop 4 sewerage schemes and institutionalize the reforms as outlined in the water Act 2002.

To provide water as an ingredient to both social and economic tool in the development of urban areas, a total of Kshs3.2 billion will be used. Major water supply for big town and small water supplies for small towns and urban centres will be developed. All the institutions envisaged in the Water Act 2002 will be in place by the end of the plan period. Already 10 out of the 11 institutions earmarked for creation in the Act have been establish and are operational.

Table 4.27: Increase the Rural Water coverage from the 2002 baseline of 50% rural households with safe and reliable water to 60% by 2007.*Cost in Million K.Shs*

Programme/Activity	Unit Cost	Total ERS Cost	Actual MTEF spending 2002/03 – 2003/04	Required spending 2004/05 – 2006/07
Rehabilitate 85 rural water supply schemes per annum	5.562	2,364.21	521.21	1,843.00
Rehabilitation of 150 small dams per annum to increase water pounding by 2.5 million cubic meters	13.9	10,431.00	375.35	10,055.65
Rehabilitation of water control dykes in Nzoia and Nyando rivers	492.5	985.00	194.57	790.43

Table 4.28: Increase Urban Water coverage from 73% in 2003 to 83% in 2007 and establish water management system as provided for in the water act 2002 *Cost in Million* ***Kshs***

Programme/Activity	Unit Cost	Total ERS Cost	Actual MTEF spending 2002/03 – 2003-04	Required spending 2004/05 – 2006/07
Rehabilitate 35 urban water supply schemes per annum	18.4	3,220.00	566.57	2,653.43
4 sanitation schemes completed per annum	110.3	2,205.91	705.91	1,500.00
Operationalize the 11 institutions envisaged in the water Act	N/A	171.86	6.86	165.00

The ERS was completed before the country had carried out a comprehensive costing of the interventions required to meet the MDGs. However, since then Kenya has been assisted by the United Nations (UN) system to develop a generic list of interventions that will lead to the achievement of the MDGs and identify both the costing of these interventions as well as the financing options available to the country. The MDGs needs assessment and costing studies are provisionally completed and preliminary estimates indicate that achieving the MDGs will cost US$ 44.5 billion spread over 10 years (2005-2015). Given the large magnitude of the resources requirement, achieving the MDGs will thus require both prioritisation of domestic resources as well as increased development partner support.

It is envisaged that an 80% nationwide coverage of safe water supply and 96% coverage of improved sanitation by 2015 will meet the target population.

It has been estimated that the country needs K.Shs 65.33 billion (US$ 816, 648, 937) by 2015 to meet the MDG for provision of water and sanitation services. This estimate has been generated from the MDG Model with the generic interventions adopted for the country. The average annual investment from 2005 to 2015 will be about K.Shs 6.534 billion per annum

Capacity Building

There are a large number of issues to be addressed within the full scope of integrated water resources management. It is necessary to establish the required functions and then review existing skills and experiences to perform the required functions. After undertaking such an analysis, it will be possible to determine the gaps that exist and to design a capacity building programme to

"fill the gaps". In addition, a long-term programme of upgrading and developing skills and experience of all levels of personnel within the Department and the Authority will need to be developed and implemented. The human resources development programme will encompass the broad process of review and support of career development in order to meet the requirements of professionals, technicians and all staff in order to attract and keep top staff in the service of the country.

As women play an important role in provision, management and safeguarding of water, particular attention will be placed on adequately incorporating and representing them in water resource management. The issue will be addressed from two perspectives; facilitating the participation and involvement of both sexes in water resource management; and their access to water.

The organizational restructuring in public sector water management will create an opportunity for a cultural shift in public administration that will free up the undoubtedly high quality human resources within government to rise to peak performance. The IWRMS will provide the basis for establishing a strong, lean and and operationally effective WRMA which will make efficient use of modern technologies.

The water sector requires a diverse range of skills and technical expertise in relation to capacity building and on-the-job training programs. This will lay emphasis on:-

- Assessment and utilization of the existing manpower potential
- Supporting the development of new skills
- Identification and projection of sectoral manpower requirements.

Environmental Management

Environmental Impact Assessment (EIA) is envisaged as a major tool for the management of the environment in general and water resources in particular. This is a requirement for all projects. All new industrial projects must adhere to the EIA guidelines before implementation. Existing industries will be subjected to environmental accounting and auditing, so that firms, which cause environmental degradation, can be subjected to deterrent punishment.

The environment is the source of water and must be protected both in terms of quantity, quality and essential natural functions. Water should be conserved to ensure that critical environmental functions are sustained and that enough is available for other competing demands such as domestic, agriculture, industry, tourism, hydropower etc.

It is therefore critically important that, in the planning and management of resources, water sources of and their natural functions be safeguarded, in terms of both quality and quantity. Critical environmental assets need protection including riverine biotic species, plants, animals, insects, catchments, wetlands, and deltas.

Cost of Water Production & pricing

It is now three (3) years since the current water tariff came into effect in September 1999. The tariff structure has therefore been static for the last three years while during the same period economic trends have been changing for the worse to the extent that if this tariff is not reviewed now, the operation and maintenance of most water supplies in the country risk total collapse and may proof extremely costly to revive.

As may be observed from Table 4.29 below, the unit cost of water production in diesel dependent water schemes was Kshs.32.30 in 1999 and Kshs. 41.50 in 2001, which is an increase of 28%.

4.29: Cost of Water Production and Cost Recovery per cubic metre

DESCRIPTION	1997 (Kshs)	1998 (Kshs)	1999 (Kshs)	2001 (Kshs)	2002 Proposed Tariff (Kshs)	% Change(1999-2002)
Average Production Costs per m^3						
Gravity Schemes	7.5	8.3	9.1	11.5		26.4
Electric Powered Schemes	15.3	16.8	18.2	23.7		30.2
Diesel Powered Schemes	26.8	28.8	32.3	41.5		28.5
Average total direct cost including water chemicals	16.3	18	20	26.8		34
Add 60% Indirect Cost	26.08	28.8	32	42.88		34
Average tariff charges in urban schemes per m^3						
Consumption up to $10m^3$/ month	16	16	16	20	30	50
Consumption up to $20m^3$/ month	17	17	17	25	35	40
Consumption up to $50m^3$/ month	20.6	20.6	20.6	30	45	50
Average tariff charges in rural schemes per m^3						
Consumption up to $10m^3$/ month	15	15	15	20	25	25
Consumption up to $20m^3$/ month	15	15	15	25	30	20
Consumption up to $50m^3$/ month	16.8	16.8	16.8	30	40	33

- On electricity dependent water schemes, the unit cost of water production in 1999 was Kshs. 18.20 and Kshs. 23.70 in 2001, which is an increase of 30%.
- On water treatment chemicals and related inputs, the unit cost has increased from Kshs.
-
- 20.00 in 1999 to Kshs. 26.80, which is an increase of 34%.
- On average the cost of producing 1 m^3 of water is Kshs. 42.00 and rises to Kshs. 50/ m^3 when 20% return on investment is included.

Cost efficiency and cost management

Pre-Reform Water Sector Economics and Financing

Prior to the present reforms, little use was made of economic incentives in the water sector in Kenya. In respect of water resource management, very few charges were made. Abstractors had to pay fees for permits, but the amounts were nominal, and there were no volumetric-based abstraction or usage fees for bulk water. Polluters faced penalties but the amounts involved also tended to be small, with the real value of penalties being continually eroded by inflation.

In respect of service delivery, the amounts of revenue generated from user charges were extremely low. It was not so much that the applicable tariffs were so low, but that many customers who should have been paying more were on the minimum fixed monthly fee due to an absence of meters, and because billing and collection systems were grossly inefficient. With low cost recovery in the formal part of the water sector, the main source of financing for publicly supplied water was central government allocations (a significant part of which came from donors), with communities, NGOs and the private sector making complementary contributions.

Skewed incentives, inadequate financing, a highly centralized institutional structure and other pre-reform deficiencies have given rise to the water sector performing well below what is required of it in terms of its social and economic role in national development. The

reforms are being put in place to counter a range of inter-related problems

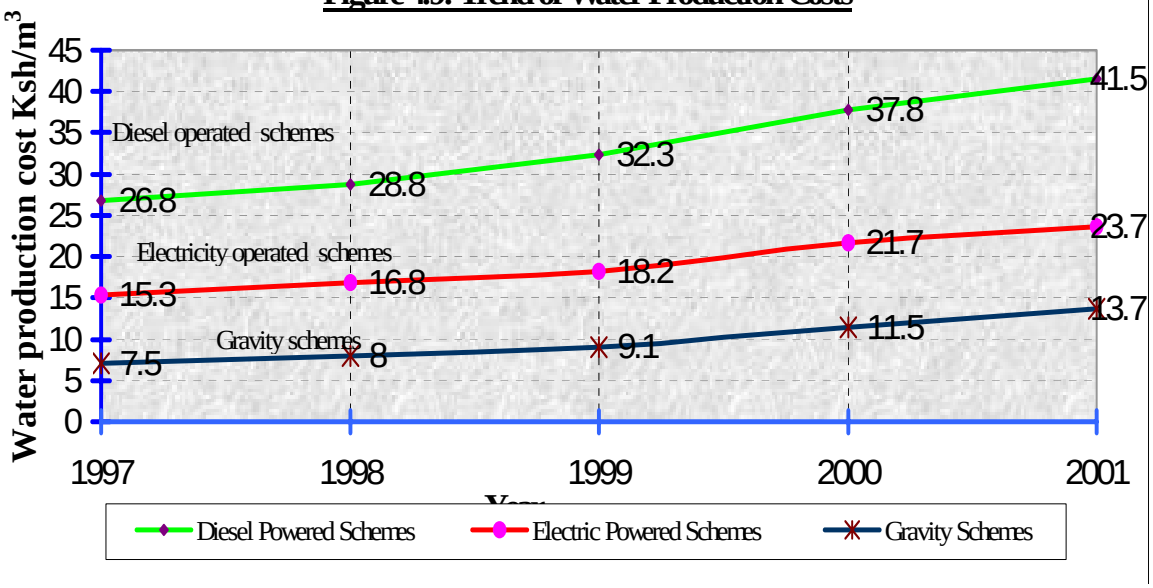
Pricing

The Water pricing is one of the major instruments to be used to achieve overall water sector objectives, and resolve some of the inevitable trade-offs that exist between them. The main objectives of water pricing are to:

- Facilitate economically viable development and use of water resources;
- Restore environmental sustainability;
- Contribute to providing adequate water (in terms of quality and quantity) to meet reasonable demand;
- Promote equitable access to water;
- Ensure efficient utilization of water;
- Achieve as high a level of cost recovery as is compatible with the other objectives;
- Be readily implement able and socially acceptable (requiring that tariff structures be simple and transparent).

The water pricing objectives also entail trade-offs. For example, setting a high abstraction charge would raise resources for activities such as catchment protection, but could prejudice water intensive economic activities, such as irrigation, which produce income, jobs and foreign currency earnings for Kenya.

Figure 4.9: Trend of Water Production Costs



For domestic customers of urban water utilities, to promote equity and water use efficiency economic theory would advocate a relatively complex tariff structure (such as the rising block structure, starting from a 'lifeline' level). As already mentioned in Section 1.4, the application of such a tariff structure requires that all consumers have meters, that the water meters are accurate and reliable and that there is an efficient billing and revenue collection system in place. In practice, where these requirements are going to take many years to attain, it would be in the interests of both consumers and the water utility to have a simpler structure, despite this involving compromises on equity and water use efficiency.

Water tariffs per water use and volume

Table 4.30: Tariff structure for water supply in Kenya (KShs)

	Prior to 1999	Since 1999
* Where no meter is installed a monthly charge of	100	200
* Where a meter is installed the monthly charges will be calculated as follows: where the amount of water sold		
1. Does not exceed 10m 3 (minimum charge)	120	200
2. Is more than 10m3 but does not exceed 20(formerly 30) m3 the charge per m3 in excess of 10m3	(18)	25
3. Is more than 20(formerly30) m3 but does not exceed 50m3(formerly 60) m3 the charge per m3 in excess of 20m3(formerly 30m3	(23)	30
4. Is more than 50(formerly60) m3 but does not exceed 100m3the charge per m3 in excess of 50 (formerly60) m3	(35)	45
5. Is more than 100m3 but does not exceed 300m3the charge per m3 in excess of 100m3	45	75
6. Is more than 300m3 the charge per m3 in excess of 300m3	45	100
* Where water is sold through a meter at a kiosk or for the bulk sales to an undertaker for resale the charge per m3	10	15
* Where water is sold by retail at a kiosk per unit of 20 liters or part thereof the charge per unit	1	2

Table 4.31: Proposed Service Charges for Water Supplied:

1. **FEES FOR SERVICES**
The charges in this category are consumer driven and should therefore pay for direct cost and part of the overheads.

		Existing Kshs	**Proposed Kshs**	**Recommended Kshs**
(a)	For special reading of a meter	200.00	300.00	300.00
(b)	For disconnecting of the supply at the request of a consumer	200.00	300.00	300.00
(c)	For turning on the supply otherwise than in respect of a first connection	200.00	300.00	300.00
(d)	For turning on supply after disconnection for non-payment	500.00	500.00	550.00
(e)	For testing a meter at the request of the consumer where it is not found to register incorrectly to any degree exceeding 5 per cent	The actual cost subject to a minimum charge of 500.00	The actual cost subject to a minimum charge of 500.00	**The actual cost subject to a minimum charge of 500.00**

(f)	For use of water tankers per trip	-	3,000.00	The actual capacity of the water tanker at the rate of 300.00 per cubic metre subject to a minimum charge of 2,000.00

2. **METER RENT FIXED CHARGES**

The proposed charges will ensure the consumer pay a meter rent to make provision for the cost of replacement of the meter based on full cost recovery over the useful period of eight years. For existing unmetered connection, when metered (not on consumer's request) the consumer should only pay the monthly rental charges. When the consumer request to be metered on an existing connection, the customer should pay the full cost of the meter and installation. However where a consumer provides his own metre no rental will be applied. The proposed charges based on the market prices of meters are: -

		Existing Kshs	**Proposed Kshs**	**Recommended Kshs**
(a)	All Meters of nominal size up to 15mm	50.00	50.00	55.00
(b)	All Meters of nominal size up 20mm	50.00	50.00	55.00
(c)	All Meters of nominal size p to 25mm	250.00	250.00	260.00
(d)	All Meter of nominal size up to 38mm	250.00	250.00	270.00
(e)	All Meters of nominal size up to 50mm	250.00	250.00	280.00
(f)	All Meters of nominal size up to 63mm	450.00	450.00	460.00
(g)	All Meters of nominal size up to 75mm	450.00	450.00	470.00
(h)	All Meters of nominal size up to 100mm	800.00	800.00	880.00
(i)	All Meters of nominal size up to 150mm	800.00	800.00	1000.00
(j)	All Meters of nominal size larger than 150	1,500.00	1,500.00	2000.00
(ii)	Water Kiosk annual registration fee..	-	1,000.00	500.00

3	**DEPOSITS CHARGES** A consumer is required to pay as a security, which may be used to meet the outstanding bill should he default on payment. It is also used to settle outstanding debt when a consumer is terminating his account. The current deposit level is too low to meet the cost of the bill. In fact the current deposits have increased the rate of defaulting because consumers even find it easier to request for a new connection instead of settling the accumulated bill. In order to improve on this situation, it is proposed that existing consumers asked to increase their deposits, by paying the extra fees on installments When a consumer is disconnected for non-payment, he will be required to pay the new deposit in full before reconnection. The following deposit charges are proposed: -

	Category of Consumer			
		Existing Kshs	**Proposed Kshs**	**Recommended Kshs**
(a)	Domestic consumer	1,000.00	1,500.00	1,500.00
(b)	Water Kiosks, where anticipated monthly water consumption is: - (i) Less than 50 cubic meters (ii) Between 50 to 100 cubic meters (iii) Between 100 to 150 cubic meters (iv) More than 150 cubic meters	 1,000.00 2,000.00 2,500.00 3,000.00		
	Water Kiosks	-	3,000.00	2,500.00
(c)	Retail shops, workshops and offices more than 10 cubic meters	3,000.00		
	Retail shop, workshop and offices	-	3,000.00	3,000.00
(d)	Bar, restaurant and lodgings more than 15 cubic metres	5,000.00		
	Bar, restaurant and lodgings	-	5,000.00	5,500.00
(e)	Hotels class “A” and “B” less than 150 cubic metres	10,000.00		
	Hotels class “A” and “B”		15,000.00	15,000.00
(f)	Hotels class “C” and “D” more than 150 cubic metres	15,000.00		
	Hotels class “C” and “D”		20,000.00	20,000.00
(g)	Hospitals more than 150 cubic metres.	20,000.00		

	Hospitals	-	20,000.00	25,000.00
(h)	Minor construction site (temporary connection) less than 200 cubic metre.	10,000.00		
(i)	Large Construction sites (temporary connection) more than 200 cubic metres	50,000.00		
	Construction sites	-	30,000.00	30,000.00
(j)	Light Industries less than 200 cubic metres	10,000.00		
	Light Industries	-	10,000.00	15,000.00
(k)	Medium Industries 200 to 300 cubic metres	15,000.00		
(l)	Heavy industries more than 300 cubic metres	20,000.00		
	Heavy Industries.	-	30,000.00	30,000.00

(m)	Health centers /dispensaries less than 150 cubic metres	5,000.00		
	Health centers /dispensaries	-	5,000.00	5,500.00
(n)	Schools/colleges/other Institutions more than 200 cubic meters	10,000.00		
(o)	Schools less than 200 cubic meters	5,000.00		
	School/colleges/other institutions....	-	10,000.00	10,000.00

4	**PENALTIES**			
(a)	Illegal Reconnection is Kshs 1,000.00			
(b)	Damage to meters is Kshs. 1,000.00 plus the cost of new meter.			
(c)	Tampering with meter seals is Kshs 2,000.00			
(d)	Illegal connection - (such as by-pass, direct connection etc.)	Kshs 3,000 plus the estimated cost of water used		
((e)	Where a consumer is disconnected for non payment he will be required, in addition to settling the outstanding amount, to top up to the new deposit before reconnection.			
(g)	All bills should be paid within fourteen days from the date of issue failure of which the water supply should be disconnected without any further notice to the consumer.			

5	TARIFFS FOR URBAN AND RURAL WATER SUPPLIES In order to meet the cost of operation and maintenance for both urban and rural water supplies, the proposed charges are as indicated below: -					
		PART A - TARIFFS (URBAN)				
				Current Kshs	**Proposed Kshs**	**Recommended Kshs**
1.		Where no Meter is installed a monthly charge of		200.00	300.00	350.00
2.		Where a meter is installed the charges will be as follows: -				
	(i)	Where the amount of water sold through the meter in any one month does not exceed 10 cubic metres (minimum charge)		200.00	-	300.00
		Where the amount of water sold through the meter in any one month does not exceed 5 cubic metres (minimum charge)		-	10.00	-
		Where the amount of water sold through the meter in any one month is more than 5 cubic metres but does not exceed 20 cubic metres, the charge per cubic metre in excess of 5 cubic metres		-	25.00	-
	(ii)	Where the amount of water sold through the meter in any one month is more than 10 cubic metres but not exceed 20 cubic metres, charge per cubic meter in excess of 10 cubic metres		25.00	-	35.00
	(iii)	Where the amount of water sold through the meter in any one month is more than 20 cubic metres but does not exceed 50 cubic metres, the charge per cubic meter in excess of 20 cubic meters		30.00	50.00	45.00
	(iv)	Where the amount of water sold through the meter in any one month is more than 50 cubic metres but does not exceed 100 cubic metres, the charge per cubic metre in excess of 50 cubic metres		45.00	75.00	75.00
	(v)	Where the amount of water sold through the meter in any one month is more than 100 cubic metres but does not exceed 300 cubic metres, the charge per cubic metre in excess of 100 cubic metres		75.00	100.00	125.00

	(vi)	Where the amount of water sold through the meter in any one month exceeds 300 cubic meters, charge per cubic meter in excess of 300 cubic meters		100.00	125.00	150.00
3.		Where water is sold through a meter at a kiosk, the charge per cubic meter		15.00	42.00	25.00
4.		Where water is sold by retail at a kiosk per unit of 20 litres of part thereof, charge per unit		2.00	3.00	2.50
5.		For the bulk sales to an undertaker for resale, charge per cubic metre		15.00	2.00	18.00

		BOARDING SCHOOLS (URBAN)				
				Current Kshs	Proposed Kshs	Recommended Kshs
1.		A school with a permissible water demand not exceeding 600 cubic metres per month, the charge per cubic metre		20.00	-	30.00
2.		A school with a permissible water demand not exceeding 1200 cubic meter per month, the charge per cubic meter		25.00	-	35.00

3.		Any other learning institution with a permissible water demand of 1200 per month, charge per cubic metre.		25.00	-	40.00
4.		The charge per cubic metre of water consumed in excess of permissible water demand		45.00	-	50.00
		Any other public or community based learning institutions, the charge per cubic meter		-	42.00	40.00

		PART B - TARIFFS (RURAL)				
				Current Kshs	**Proposed Kshs**	**Recommended Kshs**
1.		Where no Meter is installed a monthly charge of		200.00	250.00	300.00
2.		Where a meter is installed the charges will be as follows: -				

	(i)	Where the amount of water sold through the meter in any one month does not exceed 10 cubic metres (minimum charge)		200.00	-	250.00
		Where the amount of water sold through the meter in any one month does not exceed 5 cubic metres (minimum charge)		-	5.00	-
		Where the amount of water sold through the meter in any one month is more than 5 cubic metre but does not exceed 20 cubic metres, the charge per cubic metre in excess of 5 cubic metres		-	15.00	-
	(ii)	Where the amount of water sold through the meter in any one month is more than 10 cubic metres but not exceed 20 cubic metres, charge per cubic meter in excess of 10 cubic metres		25.00	-	30.00
	(iii)	Where the amount of water sold through the meter in any one month is more than 20 cubic metres but does not exceed 50 cubic metres, the charge per cubic meter in excess of 20 cubic meters		30.00	45.00	40.00
	(iv)	Where the amount of water sold through the meter in any one month exceed 50 cubic metres but does not exceed 100 cubic metres, the charge per cubic meter in excess of 50 cubic metres		45.00	60.00	50.00
	(v)	Where the amount of water sold through the meter in any one month is more than 100 cubic metres but does not exceed 300 cubic metres, the charge per cubic metre in excess of 100 cubic metres		75.00	75.00	125.00
	(vi)	Where the amount of water sold through the meter in any one month exceeds 300 cubic metres, charge per cubic meter in excess of 300 cubic metres		100.00	110.00	150.00
3.		Where water is sold through a meter at a kiosk, the charge per cubic metre		15.00	32.00	20.00
4.		Where water is sold by retail at a kiosk per unit of 20 litres of part thereof, charge per unit		2.00	2.00	2.00
5.		For the bulk sales to an undertaker for resale, charge per cubic metre		15.00	42.00	18.00

		BOARDING SCHOOLS (RURAL)				
				Current Kshs	Proposed Kshs	Recommended Kshs
1.		A school with permissible water demands not exceeding 600 cubic metres per month, the charge per cubic metre		20.00	-	25.00
2.		A school with a permissible water demand not exceeding 1200 cubic meter per month, the charge per cubic metre		25.00	-	30.00
3.		Any other learning institution with a permissible water demand of 1200 per month, charge per cubic metre		25.00	-	35.00
4.		The charge per cubic metre of water consumed in excess of permissible water demand		45.00	-	40.00
		For water sold to public or community based schools and any other public or community based learning institutions, the charge per cubic metre		-	32.00	35

Uncollected Revenue (cost recovery)

Although it has widely been pronounced in many public fora and Ministerial tours/visits on the dire need for consumers to pay for the water consumed, the response has so far not been encouraging as amounts of uncollected revenue continue to soar due to defaulting. Among the leading defaulters are Government Departments and institutions from which it has been very difficult to obtain this revenue water. What this has translated to over the years is progressive increase in maintenance costs, which should be contained, by corresponding increase on the tariffs in order to continue providing an acceptable level of service. This is coupled with the Ministry's desire to raise revenue to undertake complete rehabilitation of schemes that are currently in a poor state of maintenance.

2.6 Water Demand Management

Water demand management [WDM] may be defined as the development and implementation of strategies aimed at influencing water demand in order to achieve water consumption levels that are consistent with the equitable, efficient and sustainable use of the finite water resource. Pricing water in economic opportunity cost terms (as just discussed) is perhaps the most important WDM instrument, but there are many other approaches to WDM

The most obvious water demand management measures are those that encourage water *consumers* to use water more sparingly. In Kenya, where in the domestic sector consumption levels are already extremely low, WDM on the face of it would seem to have no place. A different view of the current reality, however, is that now is precisely the time to ensure that the habits of using water sparingly become entrenched, so as to avoid Kenyans using water profligately once it comes into full supply. In addition, utilities might consider sponsoring the adoption of water efficient technologies as these can lead to substantial savings over the long term.

Table 4.32 below gives a more complete list of WDM measures at the level of water utilities and their customers (agricultural, industrial and commercial as well as domestic). Many of these measures involve only modest costs for the utility (education, consciousness-raising etc), but there are some which involve major investments, such as the reuse of treated sewerage by choosing biological nutrient reduction [BNR] technology.

Short-term benefits of WDM

By reducing the volume of water that has to be delivered, WDM in the short-run brings financial savings to the water supply utility through reductions in treatment and pumping costs. However, if the utility has a cost structure that is dominated by fixed costs, reducing demand may mean a disproportionate decrease in revenues, making the utility less viable when WDM becomes effective. There may be strong *economic* reasons to introduce WDM, but if the implication is to undermine *financial* viability, the utility may not in practice be in favour of WDM.

Social and macro-economic factors may play an important part in whether a utility supports and promotes consumer-oriented WDM strategies. For example, WDM that reduced water consumption would have the implication of reducing demand for treatment chemicals, which are often in short supply. For a given stock of chemicals, the lower volume of water to be supplied reduces the risk of under-treating the water and thereby avoiding disease outbreaks.

Long-term benefits of WDM

In the context of rapid urban population growth rates, much larger benefits will accrue in Kenya from WDM making it possible to delay having to invest in major new water supply projects, which are typically several times as expensive as existing sources. Investing in WDM potentially provides a much cheaper source of water than investing in a new source of supply.

This requires some explanation; there is often misunderstanding about the benefits of delaying infrastructure projects, in view of the fact that the *financial* or accounting costs of projects are bound to rise if they are delayed. So when engineers are challenged about building dams before they are needed, one of the factors they point to is lower investment cost. However, such cost savings are in ***nominal*** terms. In other words, the investment cost goes up purely because of inflation. In ***real*** or ***inflation-adjusted*** terms, the cost in today's money of a project, which is delayed into the future, could well be lower because of improvements in engineering processes or factors such as lower duties on imported equipment.

It is these *economic costs*, which are relevant to analysing the benefits and timing of alternative investment strategies. From an economic perspective, the substantive point is that the main benefit of delaying a major water supply augmentation project is that the resources which would have had to go into the project can be used for a more urgent need in the water sector or for a productive investment (as opposed to an infrastructural one without immediate use). The alternative use will generate benefits somewhere else in the economy.

Table 4.32: Summary of WDM Technological Options

Utility level	1	Reuse of treated sewerage (e.g. BNR technology)
	2	UAW network strategies (leak detection & elimination, pressure management, water auditing etc)
	3	Reduction of illegal connections
	4	Ability to stipulate & enforce prohibitions (eg hosepipe bans)
	5	Tariff structure for equity & efficiency (+ metering, billing & collection)
	6	Data acquisition & management
	7	Infrastructure replacement (O&M)
	8	Performance monitoring
	9	Training & capacity building
	10	Research & development
Consumer level	11	In-house retrofitting (dual flush toilets, low flow showers etc)
	12	Rainwater harvesting
	13	Supplementary point sources (wells, boreholes)
	14	Water re-use (grey water for gardens etc)
	15	Water re-cycling by consumer
	16	Water-wise gardening
	17	General school education

Donor Support

Kenya has a long record of co-operation with development partners in the water sector including SIDA, DANIDA, World Bank, KFW/GTZ, AFD, UNICEF, JICA, DFID, ADB, FINNIDA, and EU among others. Table 4.20 below presents information on financial cooperation of main bilateral and multilateral agencies by sub-sector (Urban, rural, and WRM). They are grouped for the periods 1990-2000, and 2000- beyond.

Currently, IDA and AFD are interested in work on commercialising of water utilities serving main urban centres (Nairobi and Mombasa). The German cooperation (KFW) is focusing on commercialising of water utilities in medium-sized urban centres. Japan is interested in supporting smaller urban centres and rural areas. Denmark, Finland and Belgium aim to cooperate on rural water supply. The African Development Bank (ADB) is financing projects in urban areas.

Table 4.33. Major Donors to the water sector in Kenya 2000-2005 (US$ millions)

	ABD	AFD	AUSTRIA	BELGIUM	DANIDA	FINNIDA	IDA	ITALY	JICA	KfW/GTZ	MMU	NWCPC	SFD	TOTAL
1990-2000														
Rural	-	-	-	3.7	-	-	-	50.5	-	-	-	-	-	54.2
Urban	25.6	-	11.4	-	-	-	115.(	-	-	7.7	-	-	10.7	171.1
WRM	-	-	-	-	-	-	-	-	-	25.9	-	0.7	-	26.6
Total	25.6	0.0	11.4	3.7	0.0	0.0	115.(	50.5	0.0	33.6	0.0	0.7	10.7	251.8
2000- Beyond														
Rural	-	-	-	4.7	2.9	5.4	-	-	10.7	-	2.6	-	-	26.1
Urban	5.4	35.2	-	-	-	-	160	-	13	34	1.2	0.3	-	249
WRM	-	-	-	-	-	-	-	-	-	-	0.4	-	-	0.4
Total	5.4	35.2	0.0	4.7	2.9	5.4	160.(	0.0	23.7	34	4.2	0.3	0.0	275.6

(Source:- World Bank, MDGs for water and sanitation, Country Assessment- Kenya, 2004)

WATER + TECHNOLOGY ASPECTS

Appropriate Technologies

Introduction of appropriate technologies adaptable to the local needs, one easy to use and to maintain is encouraged. Some technologies introduced are not suitable for the country. Some drain financial resources, particularly on spare parts that are not locally available or are too expensive to run on petroleum fuel, stretching community management capacity. There is need to identify and assess the technologies that are adaptable, affordable environmental friendly and cheap to maintain. Other technologies need to be improved, protected and patented.

Some of the appropriate technologies available in the country are:

Water Abstraction Technologies

Infiltration Galleries

These are used in dry river beds where perforated pipes are buried several meters below ground and water is allowed to flow to collector wells which are slightly below the pipes. Water is then pumped from the collector wells to storage tanks. The size of the perforations should not allow silt to flow to the well. However, some filters can be incorporated around the pipes.This form of water abstraction can serve up to 20,000 people in the rural areas depending on geometry and recharge of the sub-surface flow.

Sub-surface dams and sand dams

These are constructed across the sandy river-beds of seasonal river where in some cases the confining wall does not rise above the surface

in order to allow sand to run over during floods. A deep well is then drilled or dug inside and upstream of the confining wall. Water is then pumped to the storage tanks where it flows by gravity.

Wells and Boreholes

Shallow hand-dug wells are the cheapest form of water abstraction in ASAL areas. They are mainly dug along the dry river- beds and sub-surface soils in medium and high potential areas. The methods of water abstraction depend on the community or individuals resources capacity.

Bored deep wells or boreholes are dug using expensive drilling rigs whose cost is beyond the material resources of the rural communities. Technical and financial Assistance is normally needed.

Dams and Pans
Dams are constructed across streams and rivers for large towns and rural water supplies. In some cases, they are used for hydropower generation.
On the hand, pans are shallow, open and pan-shaped water storage structures found in arid and semi-arid areas. Mainly they are used for livestock and can BE constructed using dam construction machinery or local labor.

Gravity Mains
These are used in high potential areas where water intakes are constructed near the river sources. The water is then allowed to flow by gravity to the point of use. Depending on water quality and turbidity, Treatment plants may be accompanying. They serve major cities and towns. However, other gravity mains need pumping, using electrical energy. This consumes 40% of the running cost.

Desalination
These use reverse osmosis to remove salt from water. It is an expensive process used in large tourist hotels along the coast. Nevertheless, it is a technically viable measure where no other sources of water are available.

Rock Catchment
These are constructed in dry rocky areas where massive and expansive rocks are found. Retaining walls and collection channels are constructed to keep water on the surface of the rock. A tank may then be constructed below the channel for long-term storage. This technology is suitable for arid and semi-arid areas where no other sources of water are available.

Water Pumping Technologies

Wind Pumps
These are used to pump water from wells and shallow boreholes in flat windy areas. In spite of the fact that the output by this form of pumping is normally low though the technology is suitable to the local situations as it is easier to maintain.

Solar Pumps
These have the greatest potential in arid and semi-arid areas. They have minimal maintenance and can thus improve the living conditions of the vulnerable groups. They have the potential threat of vandalism of solar panels.

Diesel Powered Pumps
These are used to pump water from boreholes where there is no electric power supply. Power is supplied by generators of various capacities and models. They are expensive to run because of fast moving spare parts and transportation of diesel to the remote areas of the country. The pumps and the generators are not standardized for cost-effectiveness.

Electrical Powered Pumps
These are used for large water supplies where electricity is available. They are expensive to run, sometime going as high as 40% of the maintenance cost. Cross-subsidy is therefore required to reduce the cost of unit production of every liter of water. These makes water too expensive, especially to the urban poor.

Water Disinfection and Treatment Technologies

Water Purification
Aluminium Sulphate, commonly referred to as *alum*, is the one mostly used to remove impurities from turbid water for medium to large water supplies. The method requires skilled personnel in order to measure the right quantities. The technology is not accessible to the rural areas because of high transportation costs and the economies of scale.

Chlorination
This is the most commonly used form of water disinfection for both large and small water supplies even to the household level. However,

it is not accessible in the remote areas of the country.

Solar Disinfection
This is a simple technology that can be used in the remotest parts of the country. It involves painting the lower part of a conducting container black and exposing the water in it in the sun for a minimum period of six hours. Water is then fit for consumption, as major and harmful pathogens are dead by the end of the six hours.

Traditional Herbs and Shrubs
Some societies have been purifying water using herbs and shrubs. Some of these plants are more effective than conventional technologies. Studies are on-going to identify and improve on these plant species for use by the rural areas in order to reduce the cost of water treatment

Technological Lessons Learned

Resources in terms of financial support are required to improve some of the appropriate technologies that suit the local needs. in particular, capacity building of personnel needs to be undertaken. Valuable information from the old generation on traditional methods is invaluable. Lessons learnt in relation to technologies are as shown in Table 4.30 below.
Comprehensive studies on the various technologies, equipment and their performance needs to be undertaken.
Maintenance systems are plagued with management problems thus weakening sustainability especially where there has been little or no community mobilization and participation. For instance it is estimated that the Nairobi City loses more than 40% of its water to wastage. This is one of the reasons why water coverage in Kenya has remained low despite the modest investments in the water sector. This also has implications of privatization of water and subsequent cost of water production

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Table 4.34: Selected Water Technologies Available in the Country and their Complexities

Types of sources and technologies in use in Kenya				
Type	Description	Relative technical complexity	Remarks/Gaps	UNICEF Contribution
1	**Deep ground Water:** Borehole installed with generators and electric submersible pumps in boreholes, often with fairly elaborate pipe networks and water kiosks.	High: Engine, alternator: Electric pump: pipeline maintenance, fairly complex. Require maintenance.	High capital cost which depends on depth of ground water level as well as complexity of the reticulation system. Requires mobilization of heavy drilling equipment. Ideal for large populations livestock densities.	Borehole drilling. Studies on equipment and maintenance. Advocacy for standardization of equipment.
2	**Shallow ground water source:** Hand pump systems, based on shallow wells or boreholes point of use systems.	Low: Women can be trained on hand pump maintenance; spare parts available locally if standardized to India Mark II and Afridev.	Medium capital cost. Also depends on ground water level. Water supply can be constructed by skilled artisans using hand labour, hand auger drilling or small motorized drilling equipment.	Development and implementation of strategies to develop maintenance support systems through clustering and networks of women groups.
3	**Rivers and Dams**. Small to large water treatment works with small to large pipe networked systems.	High: Require specialized personnel to carry out treatment works.	High siltation of the Kenyan rivers increases cost of treatment. Vulnerability to Flooding events that destroys water treatment plants located along the river.	Rehabilitation of small urban water supply after El Nino with low cost but strategic interventions. E.g. In moyale, Garissa, Marsabit, Garsen Townships.
4	**Roof catchments**	Low	Not adequately used in	Plans to start

			Kenya. Awareness, design and cost of tanks are noted limitations.	partnership to pilot low cost tanks.
5	**Rock catchments**	Low	Medium cost depending on amount of earth movement and other civil works. Can be constructed by community with skilled supervision.	Partnership started to build rock catchments.
6	**Lake** Small to large water treatment works with small to large pipe networked systems.	High Requires specialized personnel to carry out treatment works.	Water quality of concern.	Set up alternative water sources along the Lake Victoria Basin. Need for project scaling up.
7	**Artificial pans: point of use systems**.	Low/Medium (Off-take and catchment maintenance)	Cost is high to low medium depending on volume of earth moved. Maintenance a big issue.	Partnership started on use of animal power for de-silting of pans.

Innovative Technologies

There are several innovative technologies that have been developed in the country. Others have been improved on to suit the local needs. Some examples are the following:

Foot Pump:
This is designed like a hydram, only that instead of using water pressure; the foot pressure is applied to pump water from small streams, dams or wells. It is fairly simple, cheap to purchase and maintain, fit for rural areas where small-scale irrigation is widely practiced

Bicycle Pump:
This was innovated in our laboratory and though it is not yet complete, tests had indicated that it can pump water from a 70 meters deep well. Pumping uses the bicycle principle and is fairly efficient. It was to use the locally available materials.

Horizontal Roughing and Slow Sand Filters:
This uses the principle of natural filtration process in rivers and groundwater aquifers. The filtration material is arranged in a series starting with gravel that removes large particulate matter like leaves and the other materials follow with decreasing grain size until you end up with fine sand. This is referred to as *horizontal roughing filter*. It is used for moderately large water supplies. For household water supplies, these materials are arranged in reverse in a container, starting with fine sand and ending up with gravel. This is *slow sand filter* as water stays for sometime before it is filtered.

Advances in technology and methodology

Aresearch division was setup in the Ministry of Water and Irrigation in 1986. The division has been elevated to a branch. In conjuction with IAEA and the University of Nairobi's Institute of Nuclear Science, it has conducted a research on the recharge of Merti aquifer in North Eastern Province of Kenya.Research is also proposed on new and indigenous water treatment methods for example using the local Muringa tree. The bransch has now been merged with the Kenya Water Institute and is expected to initiate and spearhead research in new and appropriate teachnology. This will include hydrometry, water treatment, reticulation, storage and metering among others in conjuction with national universities and other research institutions

THE DIFFERENT VALUES OF WATER
The concept of virtual water

In discussing water scarcity there is a bias towards surface water. We can however transport water easily in its "Virtual" form. In fact, this is what water-scarce countries are already doing.

A kilogram of grain under favorable climatic conditions, rain-fed, corresponds with about 1-2 m^3 or 1000-2000 kg of water. In other words, by importing grain, instead of growing it, implies the importation of water in a very condensed, "Virtual" form.

The table 4.31 below shows some data on the virtual water content of some food products.

Table 4.35: Virtual water content of food product.

Food Product	Virtual Water Content (m^3/Kg)
Potatoes	0.5
Wheat	0.9
Sorghum	1.1
Maize	1.4
Rice	1.9
Soya	2.0
Sugar	2.7
Milk	1.0
Eggs	3.7
Chicken	3.5
Butter	22
Beef	20-100

It has become more and more common to question the ambition of many countries to

strive for food self-sufficiency. Especially for water scarce countries it is often agreed that it would be wiser to import the food from countries with ample water resources. In this way, water would indirectly be imported, as so huge volumes of water are hidden behind each unit of food import (some 1000-3000m^3 of water per ton food grain). This virtual water approach looks very attractive from a purely theoretical perspective, especially from an economical one, as it argues that the countries with the best comparative advantage to provide food (i.e. having a lot of water to do so) should concentrate on that and export it to water deficit countries.

Definitions and Perspectives.

Countries are increasingly recognizing that water is not only a social and environmental good but an economic good as well, one that must be managed in terms of both quantity and quality. The task of valuing water among competing uses is complex in most countries. Most do not or cannot rely on the automatic reaction of market forces to determine prices; water has generally not been allocated by market forces alone because of its common good characteristics and externalities that distinguish it from other commodities.

For benefit/cost analysis, one of the key variables that must be measured is the value of water or the benefits from using water since it is both an input into production and a good directly consumed. Estimating the value of water is not easy because its value varies with quality, use, location, and time. During dry periods of the year or during drought years, water values will be much higher than in other periods. Moreover, certain seasons or times of the year may6 also be important (high water values) because of critical water demands for crop growth, heating, cooling, industrial production, or, shipping.

Agenda 21, Chapter 18 states that " *protection of the quality and supply of freshwater resources: application of integrated approaches to the development, management and use of water resources"* According to this declaration, freshwater resources are essential component of the Earth's hydrosphere and an indispensable part of all terrestrial ecosystems. The freshwater environment is characterized by the hydrological cycle, including floods and droughts, which in some regions have become more extreme and dramatic in their consequences. Global climate change and atmospheric pollution could also have an impact on freshwater resources and their availability and, through sea-level rise,

threaten low-lying coastal areas and small islands ecosystems.

Agenda 21 emphasizes the approach of integrated water resources management. This is because, it is clear that water is needed in all aspects of life and therefore, the general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water –related diseases. Innovative technologies including the improvement of indigenous technologies are needed to fully utilize limited water resources and to safeguard those resources against pollution.

The three factors of production ,natural resources (water, land etc), labour and capital

People neglect the value of water (Natural resource) because:

(a) Can obtain it freely
(b) Not 'scarce'
(c) Has no price
(d) It is a common property
(e) Not traded on a market
(f) The value can not be expressed in terms of money e.g Kenya shillings.

Water has value, and value is:-
(a) The cost of getting it e.g pumping, treating, transporting etc.
(b) The benefit it gives us.

The option values of water are:

1. Option value= willingness and pay for the preservation of the resource in order to ensure its future availability and the option for future use.
2. Request value = willingness to pay to preserve the environment for the benefit of our children.
3. Vicarious value=willingness to pay to preserve the environment for the benefit of others e.g. because we like them (whales, Dolphins, fish etc.)

The intrinsic value of water is merely due to its existence; for example if there were no humans, would water still have intrinsic value? The answer is yes and no because humans express the intrinsic value of something on behalf of species and habitats and the value is a human construct.

The value of water can be seen in line with:

(a) The value of rainwater for rain-fed agriculture
(b) The value of river water for hydropower generation
(c) The value of water for wetlands

The value of river water in case of flooding. Economic efficiency is an important development objective in most countries. Everything else equal, countries would like to produce the desired goods and services with the minimum amount of resources. In fact, it is the ability to produce more with fewer (or same amount of) resources that helps create economic development and gives a country a comparative advantage in producing certain goods and services. For water, this means that economic incentives are needed to encourage efficient allocation of the resource to those uses that provide the greatest socio-economic benefits for society.

It should be noted that economic development can only be sustained if a country's renewable resources (including its population) are protected and maintained. Aside from any inherent worth of natural ecosystems, protecting them can ensure the availability of resource in the future and can avoid serious consequences of neglect in the present. Such neglect in the management of water resources has resulted in depleted water resources, contaminated supplies, and public health hazards, aside from significant economic costs of lost benefits from adequate water resources. The water needed to protect ecosystems should be considered a use a long with the use of water for human consumption, agriculture, energy, and industry. The "Derived" values of water include: **domestic water uses** (drinking water, which is a direct benefit to the people - primary value), **agricultural water uses** for irrigation water which benefits farmers through increased production and indirectly benefits people-derived value and **industrial water uses** such as hydropower generation and cooling which benefits the people and industrialists directly

Values associated with Water Uses.

Total Economic Value of water

Value of water comprises both direct use of the water, such as the consumption of water, irrigation and industrial water uses, and indirect use of the environment, like sustaining life and maintaining a dynamic equilibrium in natural processes. Furthermore, option value is distinguished as a use value. Option value is defined as the value to humans to preserve an water resources as a potential benefit for themselves in the future. It arises from retaining an option to a good or service for which future demand or supply is uncertain: if people are uncertain about their future preferences or the future availability of the good, people might be willing to pay a price to keep the option for future use open .

The *non-use value* of water refers to the non-instrumental value, not associated with use. This includes existence value; a recognition of the value of the very existence of water. It is based on a sympathy with or concern for the welfare of non-human beings – a desire that ecosystems or species should have a right to exist. Bequest value is both a use and a non-use value. It is related to option value, but it is the willingness to pay for the preservation of water for the benefit of one's descendants. This benefit incorporates both use and non-

use of the environment. People and the environment are thus highly dependent on water for a large variety of functions. There are many different uses of water and its functions. These functions can be split out into Production functions, regulation functions, carrier functions and transfer functions. The uses include: households, industries, agriculture, fisheries, ecosystems, hydropower, navigation, recreation, tourism and many others. It is therefore clear from the list of uses that water users consist of consumptive and non-consumptive (often in-stream) users. Besides on quantity, the users depend largely on the quality of the resource. With regard to the consumptive use an important concept is that of 'virtual' water, where products are expressed in the amount of water required for its production, this concept is both useful as a measure for efficiency and for the discussion on food security.

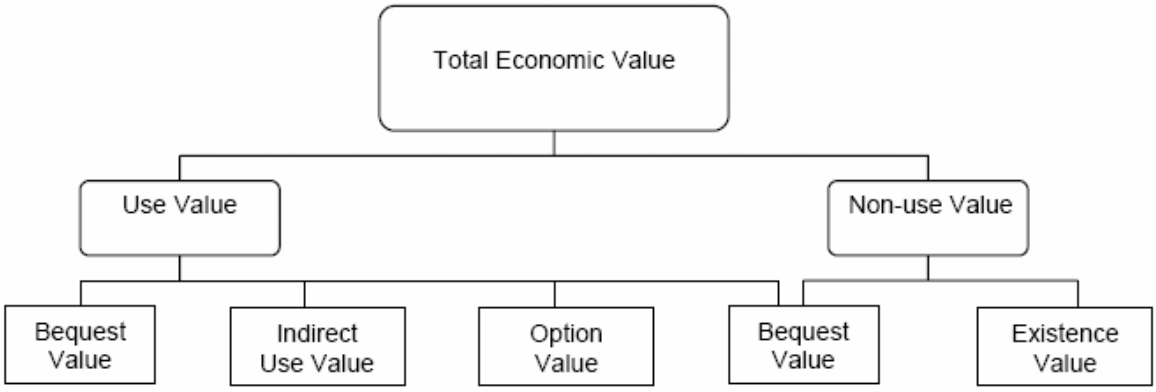

Figure 4.10: Values associated with water.

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5

Part V: Management, Stewardship and Governance

Part V: Management, Stewardship and Governance

Governance

Toward a Water-Secure Kenya:

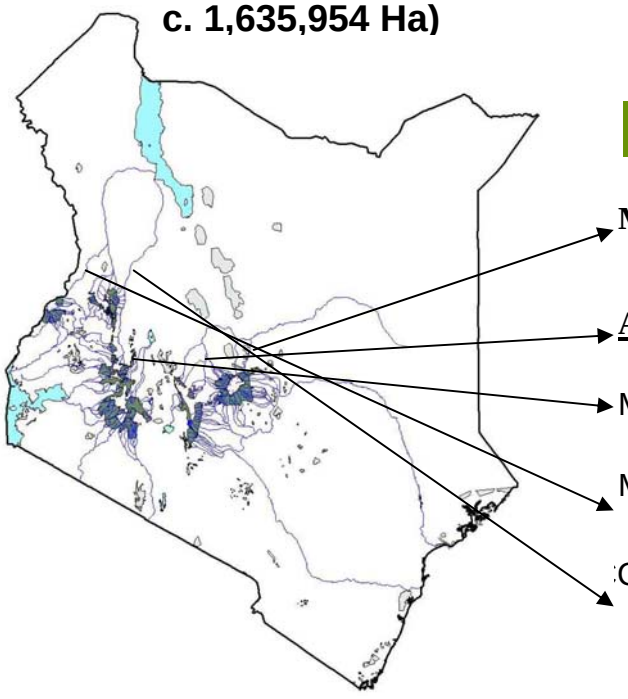
Box 5.1: Water situation in Kenya

Poor governance of water resources including poor financing and tariff policies, large unaccounted-for losses, inefficient technologies, lack of demand management, ineffective management of water sheds, inadequate pollution control, deteriorating hydro-meteorological services, and neglected demands for stream flow requirements impose a major additional constraint on an already stressed resources base threatening its long term sustainability.

Fresh water has become increasingly scarce with population increase. This has become a limiting factor to sustainable development. Little appreciation and understanding of the role water in an economy has contributed to poor funding for water resources management and development. As a result, institutions responsible for implementing water resources management have weakened.

Shrinkage of the forest cover in the five major water towers of the country namely; Aberdare's, Cherangani Hills, Mt. Kenya, Mau Complex and Mt. Elgon has led to the rapid scarcity of water resources. The water towers are as shown in Figure 5.1.

Major "water towers" of Kenya(Total acreage c. 1,635,954 Ha)



FORESTS	Ha	%
Mt. Kenya	199,558	12.1
Aberdares	103,315	6.3
Mau complex	400,000	24.5
Mt. Elgon	73,089	4.5
Cherangani	128,000	14.1
Total	**960,312**	**55.3**

of all Forest Reserves

Figure 5.1: Five major water towers

Following three consecutive years of major floods and drought in Kenya i.e. 1997-2000, economic growth declined while population growth below the poverty line increased. The poor and marginal communities, both rural and urban are particularly vulnerable to floods and droughts due to their limited options and consequent habitation in marginal and vulnerable areas such as degraded water sheds, floodplains, shortages of water supply from biased water allocations, poor water quality due to uncontrolled water pollution, catchment degradation and to the consequent effects of eutrophication and invasive weeds.
Often poor governance most adversely impacts the rural poor such as the farmers, pastoralists and fishermen. They bear the brunt of floods and droughts as well as decisions to allocate water for commercial purposes, and so have to use poor quality water.
This requires urgent fair and transparent allocation of the water resources, community involvement in water resources decisions at local and catchment levels, adequate funding for enforcement of allocation decisions and the control of pollution, the storage of sufficient water to tide people over during droughts, the improvement of water catchments to control floods, and control of discharges to control pollution.

Water utilization in Kenya
The average national water abstraction volume in 1998 was estimated at 10^9 m^3 / year as tabulated in Figure 5.1 below. That was 5.4% of the potential resources volume, which reflects a low level of water development.

Table 5.1: Average Annual Water Availability and Abstraction by Basin

No.	Main National Drainage Basins	Volume (BCM/YR*)	% Water Abstracted
1	Lake Victoria Basin	11.7	2.2
2	Rift Valley inland Basin	2.8	1.7
3	Athi River Basin	1.2	11.6
4	Tana River Basin	3.7	15.9
5	Ewaso Ng'iro North Basin	0.4	12.4
6	Groundwater	0.6	9.1
	National Total Water	20.4	5.4

**BCM/YR – million cubic meters per year.*

Kenya is facing a complex water resources crisis because of three legacies.

Natural Legacy:
Kenya has limited per capita freshwater resources endowment as well as high hydrological variability, both temporal and spatial. The country receives less than $750m^3$ per person per year as renewable supply of freshwater, making it among water-scarce countries the world over. Annual rainfall is highly variable, droughts are endemic and floods occur frequently. Much of the rain falls in less than 20% of the land in the Central Highlands and the Lake region. Nearly 80% of the land is arid and semi-arid.

Management Legacy:
From the recent past, Kenya has been characterized by, on one hand, rapidly growing demand for water for most sectoral uses and, on the other hand, diminution of natural storage capacity (wetlands, catchments and aquifer recharge areas) and a lack of development of artificial storage capacity (dams and reservoirs) to meet the demand. The country's water resources have been mismanaged through unsustainable water and land use policies, laws and institutions, and weak water allocation practices, growing pollution, and increasing

degradation of rivers, lakes wetlands and aquifers and their catchments.

Colonial Legacy:
National boundaries were drawn without regard for geographic or social realities or traditional expertise in water management. Consequently, Kenya shares over half its water resources such as rivers, lakes and aquifers with neighboring nations. This offers an opportunity for joint action and cooperation, and at the same time, greatly complicates the management of these water resources. It has implications for regional security and development, particularly as the nation faces increasing pressure to develop and manage its water resources.

The solution to these problems lies in having a sound improved organization structure for water resources management that will allow planning and management of water resources on drainage and catchments basins, which conforms to natural dictates.

Institutional Arrangements 2004:

Organizations involved in water resources management are varied. They have experienced weak institutional setup among other factors like inadequate funding. Re-evaluation of different organizations' role in the water sector and reassignment for respective actors has since been necessitated. The policy calls for the government to assume a regulatory role and provide an enabling environment for other actors by reforming various institutions involved in the water sector. The Government will hence withdraw from direct provision of water services.
The water act 2002 in return provides for the establishment of a Water Services Regulatory Board as an autonomous institution to regulate the provision of water services. The regulatory board has been established and has started e licensing some of the seven Water Services Boards. Private sector involvement and community participation will be encouraged for water supplies and sanitation development. The Government will collaborate with other relevant training institutions to build institutional capacity for the entire water sector.

Targets:
- The GoK to redefine its role in the water sector. It will withdraw from direct provision of water services.
- The GoK to maintain a regulatory role & provide an enabling environment for other actors to operate in.
- The organizational structures at the MWI as well as other institutions and actors to review their roles.
- Institutional reforms to be implemented encouraging integration and procedural changes in the water sector.
- Community management of water services to be encouraged.
- Local institutions to be strengthened in sustaining water and sanitation programmes.
- An institutional capacity policy for the entire water sector to be encouraged. This will in coordination with other institutions in the water sector.

Institutional Regulations:

The Government has commenced a process of water sector reforms that addresses water resources management. These include the adoption of the National Policy of Water Resources Management and Development in 1999 to address both Water Resources Management (WRM) and Water Supply and Service WSS delivery issues. Its objective is to preserve, conserve, and protect available water resources and allocate it in a sustainable and economic way. The enactment of water act 2002 is an extension of the integrated water resources management concept in the 1999 water policy. It provides an improved legislative framework for more effective management, conservation, use and control of water resources and for the acquisitions and regulation of rights to use water and provide for the regulation and management of water supply and sewerage services.

The Water Act 2002 has bestowed to the Water Resources Management Authority (WRMA)

the responsibility of managing water resources. The authority is established as provided for in this Act. The governing board comprises of the Chairman and ten members who represent different stakeholders. The governing board has been inaugurated, and has held a number of meetings to chart the way forward.

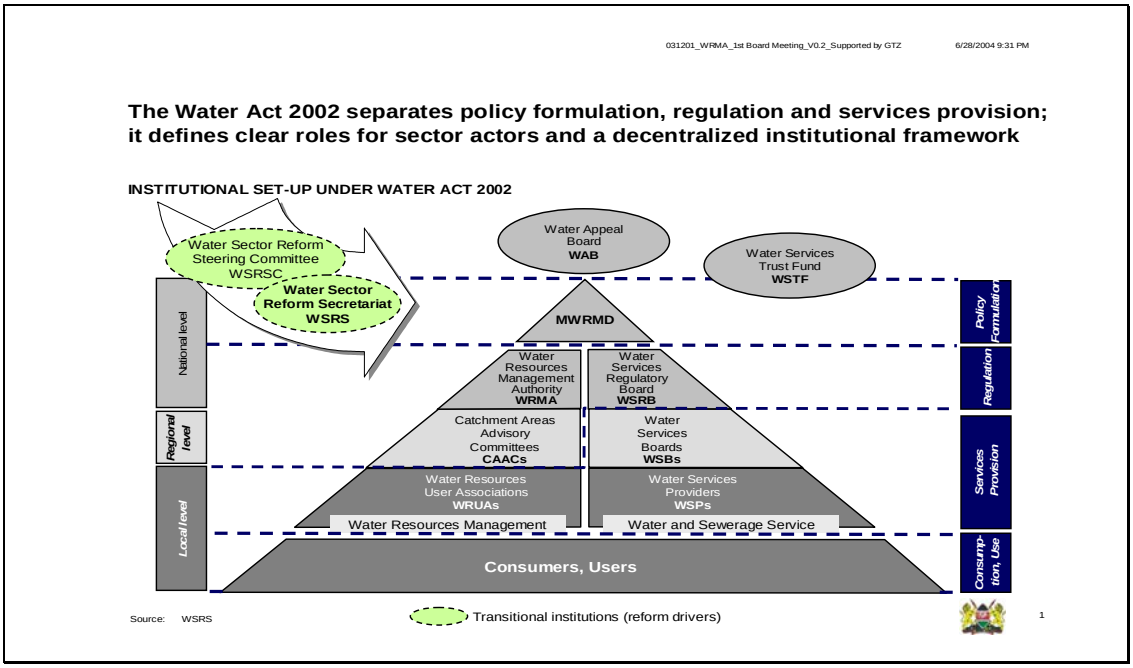


Figure 5.2: Institutional Set-Up (Transitional Set-Up) as Per 2002 Water Act.

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Clear roles and responsibilities defined to sector actors will result in improved water sector performance

EXPECTED OUTCOMES UNDER WATER ACT 2002

Policy Formulation	• Improved coordination in Water Sector under one Ministry • Clear policy accountability • Focused attention to water resources management
Regulation	• Clear regulatory framework • Coordination of the management of water resources • Performance monitoring and evaluation • Improved performance of water-undertakers
Service Provision	• Improved management , conservation, and protection of water resources (Quality and Quantity) • Rational allocation of water resources • Ability to attract and retain skilled manpower • Efficient provision of services leading to self sustainability • Improved service delivery • Increased coverage • Ability to attract investments • Improved infrastructure

Source: WSRS

2

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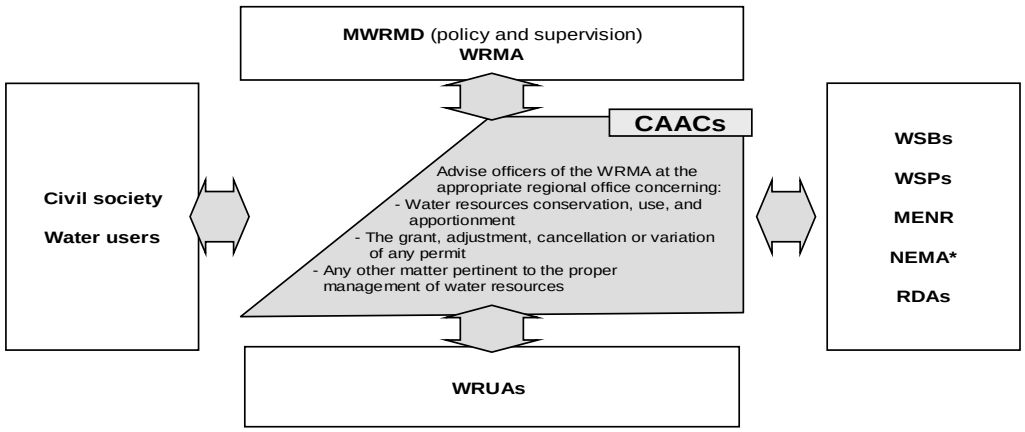
Catchment Area Advisory Committees (CAACs) shall advice the WRMA on conservation, use, and allocation of water resources in their catchment

KEY RESPONSIBILITIES AND INTERACTION: CAACs



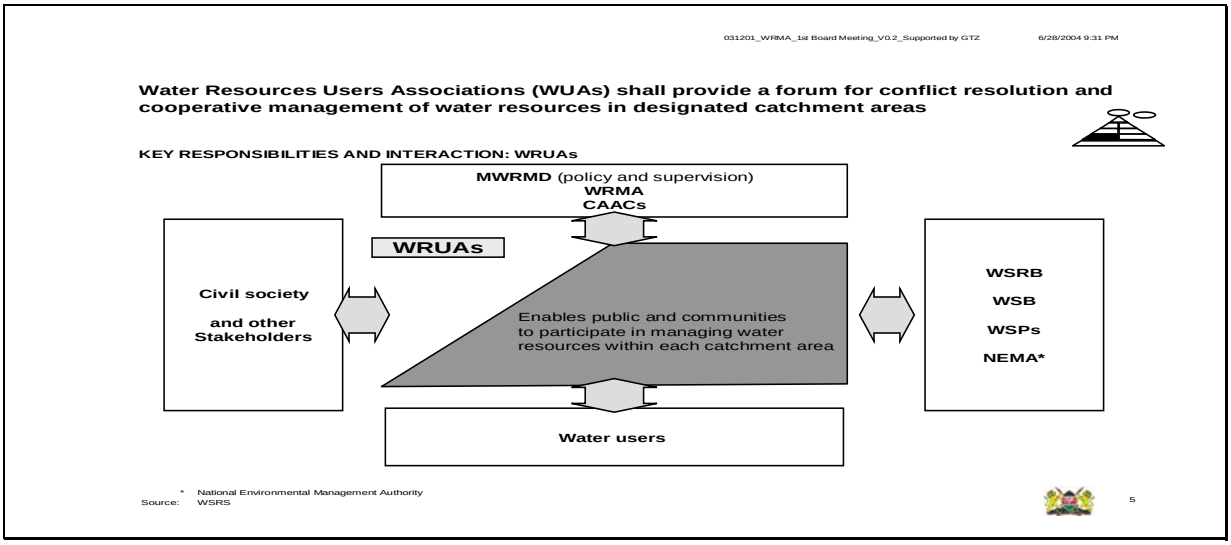
* National Environmental Management Authority

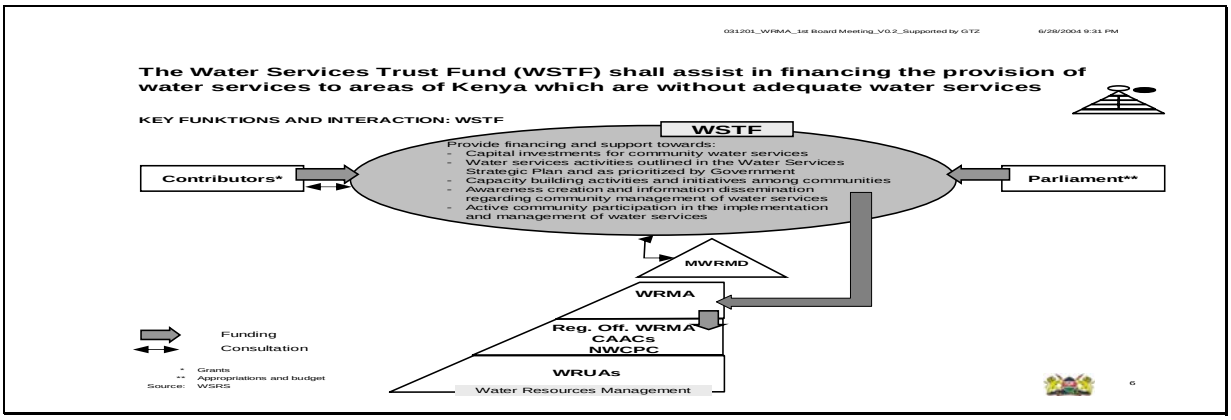
Source: WSRS

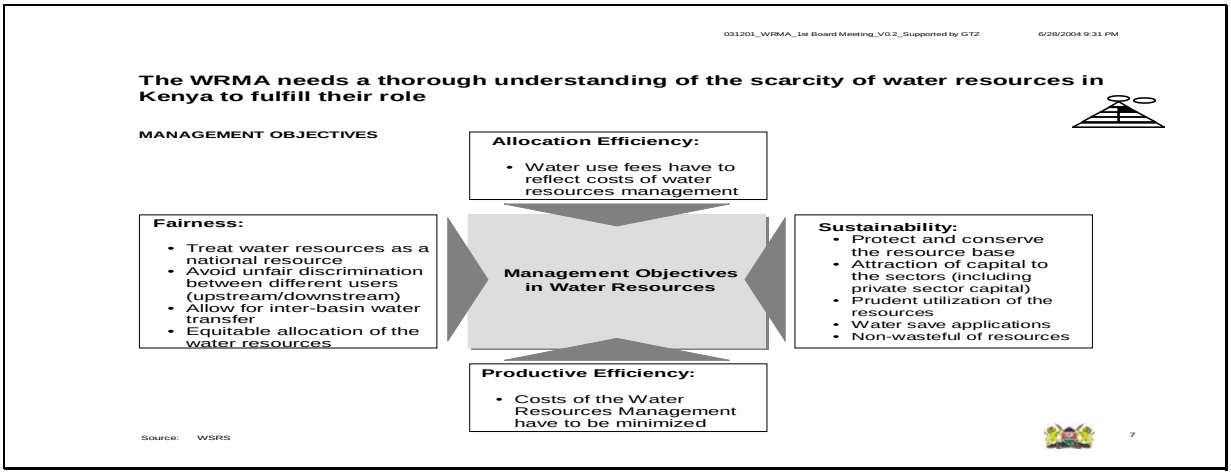
4

Table 5.2: Target and indicators on governance.

TARGET	INDICATOR
Develop an institutional capacity building policy for the water sector	
Re-organize key institutions in the water sector in line with the new roles.	
To encourage local institutions to put in place water and sanitation programmes	
Community management of water services to be encouraged	
The organizational structures at the Ministry of water as well other institutions and actors will have their roles reviewed	
To maintain a regulatory role and provide an enabling environment for other actors to operate in.	







Information Management

Priority will be given to Water Resources Assessment and monitoring and data obtained will be compiled, analyzed, stored and disseminated at a cost to the users for effective management. Determination of water sources, dependability and monitoring of human activity impact on water will be done. Hydrogeological surveys shall be carried out to determine ground water potential followed with monitoring of ground water levels. A good flow of information on water resources will be encouraged for continuous and reliable data flow and hence production of accurate reports.

A continuous assessment of water resources will be encouraged for reliable collection of data. The Ministry of Water and Irrigation aims at establishing a comprehensive water resources databases at all management levels. This will contain updated data and will be self-sustainable and easily accessible.

The Ministry of Water and Irrigation is in the process of establishing a website on which information on water will be shared. Other information can be obtained from stakeholders, development partners, local authorities, and NGO's. Dissemination of information will also be through mass electronic and print media.

Table 5.3: Targets and indicators on information management.

TARGETS	INDICATORS
Establish a comprehensive and self-sustaining water resources database at all management levels.	
Establish and maintain the ministry's website.	
Put in place water resources assessment and monitoring systems. Making relevant information easily accessible.	

Integrated Water Resources Management

Water Resources Management

Integrated Water Resources Management promotes coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner and not compromise the sustainability of vital ecosystems".

Figure 5.3 shows a conceptual framework linking water resources management and sectoral uses of water. It also indicates the fundamental concept that productive sectors-such as agriculture, power generation, manufacturing and tourism as well as domestic water supplies are highly dependent on a timely and reliable supply of good quality water.

Due to the topographical land formation of the Great Rift Valley, Kenya is in five drainage Basins namely;

1.the Lake Victoria
2. The Rift Valley,
3. The Athi
4. The Tana and
5. The Ewaso Nyiro North. Drainage basins.

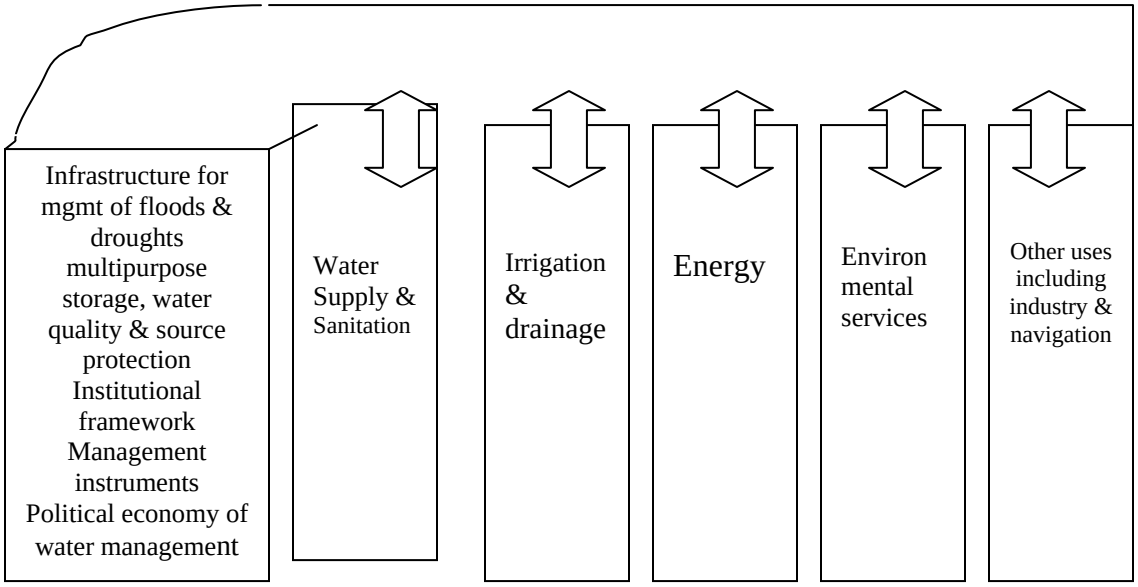


Figure 5.3: Water Resource Management Organogram

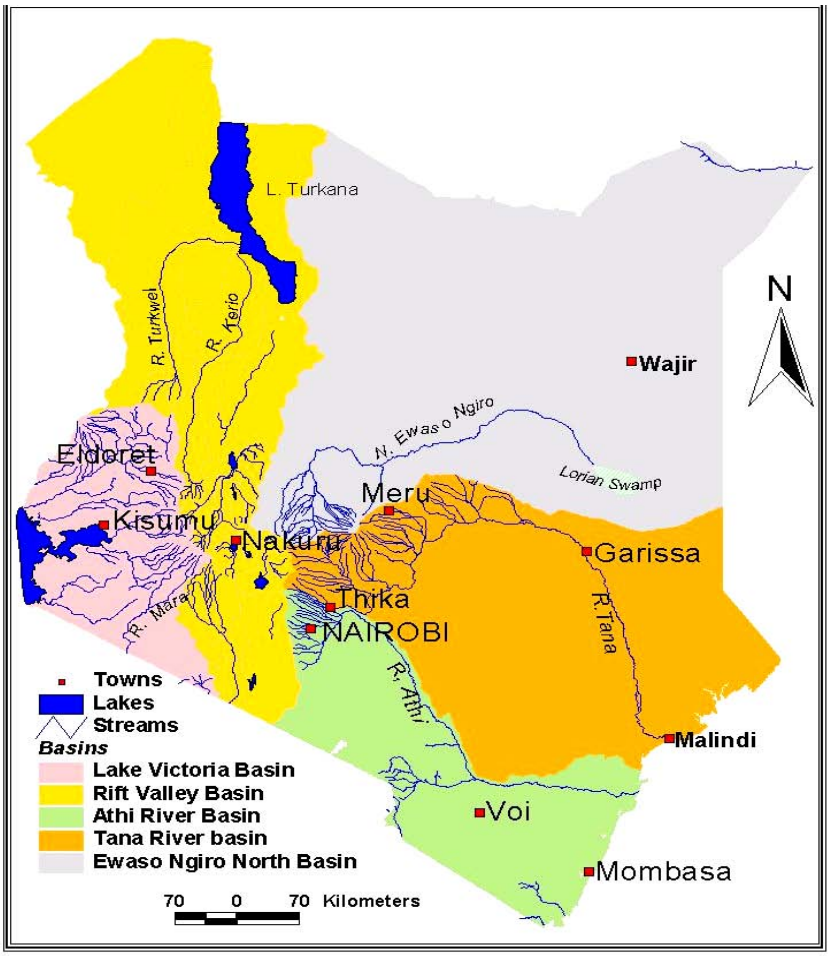


Figure 5.4: Drainage System of Kenya.

Water Quality Management

Box 5.2; Development of water pollution legislation in Kenya.

Kenya has not had serious history of water pollution. Water pollution awareness emerged in 1949 when a concern about the treatment and disposal of waste waters from the wet processing of coffee was raised in the local journals. There was, however, no legislation to control of the water pollution until 1952 when water act (cap 372) was published. Despite the legislation, awareness was minimal as a result of ignorance aggravated perhaps by illiteracy and colonialism. During this period, the majority of the population lived in the rural areas and there were few industries, so that the quantities of waste effluent from industries and urban centres were also minimal. After attaining independence in 1963, however, the upsurge in development and urbanization resulted in new sources of pollution exacerbated by gradually increasing population.

Before 1973, there was no central institution responsible for pollution control and enforcement in Kenya. Following the publication of 1973 Government commission report prepared by WHO, entitled "sectoral study on community and rural water supply, sewerage, and pollution control" a pollution control section was

established in the water department of the then Ministry of agriculture.

Today's level of population distribution, affluence, awareness, and various demands for water, means water pollution control is considered critical in water management resources. 80% of population lives in rural areas and most of them obtain water for domestic purposes directly from rivers, lakes, dams, streams, and impoundments. They use it directly without treatment.

Currently, water quality monitoring is being encouraged to check on pollution control. The water Act 2002 has provided deterrent penalties for water pollution in line with the polluters pays principle which is set at a maximum KShs.100, 000.00 for the first offence and KShs. 100,000.00 plus a jail term of twelve months to the operator of a polluting enterprise. The legislation of pollutant discharge is scattered across a wide range of statutes. Most directly relevant are Public Health Act, Agriculture Act, Water Act, The chief's Authority Act, The local Government Act, and The Fisheries Act.

Table 5.5: Indicators for water quality management

TARGETS	INDICATORS
Formulate standards and guidelines for disposal of undesirable elements in water.	
Introduce legislation on banning/regulating disposal of undesirable elements into water bodies with appropriate fines/tariffs.	
Strengthening the national water quality-monitoring programme.	
Levying effluent discharges into water systems based on the quality of the effluent.	
Ensure implementation of related activities of classifying water bodies according to quality.	
Create awareness on the effects of pollution.	
Carry out studies on extent and effects of pollution.	
Establish laboratory linkages and accreditation mechanisms for the analytical laboratories.	

Water Services Operation, Regulation and Sanitation

Poor performance and failure of water supply schemes have happened owing to poor operation and maintenance of the schemes as well as poor inception of projects without adequate prior planning.

Full involvements of the consumers of the water will be encouraged through their participation and they will be prepared for eventual taking over of the schemes. The government will encourage self-sustaining projects by encouraging the beneficiaries to take full control of the water projects at all levels including running and maintenance of the projects.

The government will facilitate the taking over management of the various community projects by training personnel from the community in running and maintenance of these projects and gradually pulling out in the running of these projects

.

Table 5.6: Targets and indicators

Targets	Indicators
Full participation of beneficiaries in development and operation of water supplies (encourage cost sharing).	Number of projects for handed-over to beneficiaries and stakeholders.
Encourage self sustaining water projects in terms of financial soundness and management.	Number of water users associations formed.
	Initiate an intensive capacity building at the district/community/local levels and within the private sector for eventual take-over of all currently government
Improvement of urban and rural water supply	
Improvement of livestock development	
Secure the water quality standards	
Involve NGO,s and communities in water resources management and development	
Improvement of sanitary facilities in rural and urban areas	

Disaster Management (Mitigating Risk and Coping with Uncertainty)

Disasters are unexpected, unplanned for and unpredictable occurrences, which cause damage to both human and the natural environment. Often, they cause immense negative impacts on the environment.

The human and environmental impacts of disasters are so immense to be ignored. Some of the most frequent disasters that have occurred in the recent past include floods, land/mud slides, drought, famine, fires and disease outbreak. These create severe stress on the people and the economy and on already overtaxed water resources.

Initially, disaster management was not viewed as an integral part of development planning. As a result, water related disasters were responded to in an *ad hoc* manner whenever they occurred. The other elements of disaster management i.e. prevention, mitigation, preparedness, recovery and rehabilitation were either ignored

There are various government institutions charged with the responsibilities to take precautionary and remedial measures with regard to drought and floods. These institutions notwithstanding, disasters continue to cause havoc. Other intervention measures include the drought contingency plan of 1992 and the National Disaster Management Programme of 1994. A National (Disaster) Operation Center (NOC) has been established in the Office of the President for the coordination and management of disasters. The provisions of EMCA (1999) add value to flood and drought management.

Box 5.3: A history of Drought and Famine experienced in Kenya since 1800

The recorded droughts since the last century include severe droughts followed by famine, starvation and even deaths which occurred in 1800, 1835, 1865, 1883, 1889/90, 1894/95, 1896, 1900, 1921, 1925, 1943/44, 1947-50, 1952-55, 1960/61, 1964/65, 1972, 1973/74, 1974-76, 1980/81, 1983, 1984, 1987, 1992/93, 1994, and 1999/2000. The duration between droughts continues to shorten, while droughts persist longer. Thus, the drought phenomenon has become difficult to predict with accuracy. Following the above pattern, the next severe drought is predicted to occur between 2009 and 2015.

The 1998-2000 droughts was classified as the third worst ever and affected all sectors of the economy. The energy sector suffered a huge financial loss. In the agriculture sector, rice production dropped by 40%, productive land lay fallow, and the cost of implementing mitigation measures as well as financial losses due to unproductive staff time and machinery was immense. Agro-industries lost 30%-40% of production, and there was a cereal deficit valued at KShs. 2.82 billion. Many areas endured livestock losses of 40% of their total stock and value of livestock dropped by 80%. Many industries in the coastal region relocated to Nairobi, resulting in a large regional job and revenue losses. Major tourist facilities incurred high costs due to installation of dissemination plants to obtain secure supplies. The preference of water borne diseases increased. 5/ community water supply, earth dams and pans in the Ewaso ngi'ro south basin dried up.
The Elnino induced floods of 1997-1998 caused some US$ 151.4 m. in public and private property damage. This figure does not include the number of people who lost family members, savings, property and economic opportunities. In June 1999, the GoK in collaboration with the United Nations Disaster Management theme group (UNDMTG), formed the Kenya action network for disaster management (KANDM).

Table 5.7: Targets and indicators for disaster management

TARGETS	INDICATORS
Formulate policies on settlement in disaster prone areas.	
Improve catchment conservation and protection.	
Develop infrastructure design parameters and regulations.	
Develop flood control infrastructures.	
Increase public awareness on dangers of settling on disaster prone areas.	
Put in place appropriate land use management practices.	
Put in place an advisory services system for disaster prone areas.	
Develop long-term strategies for planning and construction of infrastructures to increase the per capita storage of water to ensure food security.	
Develop food and water supply contingency plans to include local authorities, NGO's international organizations	

Environmental Management

Any human development around water resources is bound to have a negative effect on the environment in one way or another during construction and operation.

An Environmental Impact Assessment is hence necessary or should be mandatory prior to commencement of any works on water resources. Projects that require environmental impact assessment are provided under section 58 of the Environmental Management and Coordination Act of 1999.

A multi-objective approach should be adopted while carrying out works on water resources to guard against adverse environmental impact. This should encompass all stages of any works right from design to commencement of works with the aim of considering all options that will reduce negative impacts on the environment.
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Table 5.8: Target and Indicators on Environmental Management

TARGET	INDICATORS
Strengthen water conservation measures	
Restoration of degraded strategic environments.	
Ensure implementation of measures related to abstraction licensing borehole drilling control levies etc.	
Provide reliable and regular data and information.	
Create awareness on environmental issues.	

Licensing National Water Sharing

The GoK has setup the requirement for reserve water: Priority over all water uses and requirements that must be met before any water can be allocated for the users is "Reserve Water". This is the quantity of water required to satisfy basic human needs for all people who are or may be supplied from a particular resource, and to protect aquatic eco-systems in order to secure ecologically sustainable development and use of water resource

Table 5.9: Targets and indicators for licensing national water sharing

TARGET	INDICATOR
Analysis of existing surface water and ground water data in terms of quantities and the existing water allocations	
Determination of projected domestic water demand	
Regularly update the datasets	
Classify all National Water Resources	

International Water Sharing

54% of Kenya's water resources are shared with other countries. Through the Lake Victoria Basin, Kenya provides 45% of surface water inflows to L. Victoria and hence to the upper Nile. Kenya also shares a large number of other important surface and groundwater resources with its neighbours namely Ethiopia, Sudan, Tanzania, and Uganda. This interdependence has considerable implications for the management of the country's resources. Actions that Kenya takes to tap any surplus water through say multipurpose investments such as hydropower development, expanded irrigation use, catchments conservation and flood control could bring benefits beyond Kenya.

Table 5.10: Water bodies shared by Kenya with its neighbours.

Water Body	Countries
Lake Victoria	Uganda and Tanzania
Lake Natron	Tanzania
Lake Turkana	Ethiopia
Various seasonal rivers	Neighbouring Countries

At the International level, the Lake Victoria Tripartite agreement set the stage for the Lake Victoria Environment Programme. The Nile Basin initiative provides the basis for cooperation of all riparian countries in the development of the water resources of the Nile Basin. The emphasis is towards the need for equitable sharing of the benefits, the sustainability of water resources, the need to build trust and cooperation between riparian countries and the need for protection of resources

Table 5.11: Targets and indicators for international water sharing

TARGETS	INDICATORS
Establishment of collaboration and cooperation mechanisms allowing for catchment wide approaches in management of international water resources to the benefit of all riparian countries.	
Establish national institutional framework to address international waters.	
Create a forum for collaboration on international water resources management issues.	
Review domestic legislation related to international waters.	
Examine the requirements of international treaties on shared water resources and adopt those that are appropriate to our country's conditions and needs	

Research and Development

Research

Research in water sector is essential if the country is to achieve its long-term development targets. Water is recognized as the engine of development. No single civilization has developed without water as the center of that development. The first known technology that has ever been documented revolved around water in the Egypt.

Methods of water abstraction, treatment, distribution and disposal systems are changing every day, especially in the present age of information technology worldwide. At the local level, there are new inventions on water related technology, which need to be harnessed and protected.

In order to move from the current technological development to higher levels, there is need to involve universities and other tertiary institutions in capacity building programmes both in theory, practice and development of standards that are equal or superior to the rest of the world. The country has the necessary human capacity on all areas of the water sector. The creation of a favorable environment and provision of relevant resources is however required to work in.

One of the favorable environments is the parastatals which have flexibility in use of funds and less bureaucracy in decision-making. Market research on innovations can be done as they have to operate at a profit. These institutions can also look for research funds on their own, with sometimes approval from the parent ministries.

Funding of research at the central government is difficult as the government has to choose between the provision of service and research,

which may not bring a direct benefit to the consumers in the short-term, particularly where there are limited resources. This has been the situation for the Research Division for the last 15 years. The Sessional Paper No.1 of 1999 on National Policy on Water Resources Management and Development, however, states that "*Water levies and fees will be introduced where necessary and applicable for utilization of water from all public water courses. Such levies/fees will be used in ensuring a health state of the nation's water and will include support for research into technologies suited to our water needs*".

The policy encourages collaboration with other research institutions nationally and internationally and other stakeholders in the water sector. It also mentions that financial resources will be increased, particularly for research programmes aimed at the development of improved water resources management based on the sector needs.

Several research areas have been identified as follows:

- The application and development of appropriate technology in combination with modern technology in Integrated Water Resources Management and Development
- Effective and efficient methods of catchment protection, pollution control, conservation and water use efficiency, and in particular agriculture.
- Effective water resources management and, in particular ground water and water re-cycling
- Efficient methods of disaster preparedness, intervention and recovery, and creation of mechanisms for disbursing of disaster contingency funds to the focal points in order to increase the coping mechanisms of the affected communities
- Effective institutional arrangements from the national to the local levels for efficient service delivery systems and control.
- Interactive communication system backed by reliable and up-to-date data bases

Despite several constraints encountered in the Division, there are several achievements that have been made, among them:

(a) Introduction of slow sand filters in some of our rural water supplies

(b) Introduction of de-fluoridation gadgets for use in fluoride prone areas. The gadget uses locally available materials.

(c) Improvement of pit latrines into VIP toilets, particularly for the rural poor who are encouraged to use the local materials

(d) The study of Merti Aquifer whose recharge was previously unknown. The water balance of this aquifer can now be accounted for unlike before, using the modern research techniques, including isotope hydrology and GIS. This was a collaborative effort between the ministry, the International Atomic Energy Agency (IAEA) and the local universities

(e) The on-going study on eco-sanitation for low water-table and rocky areas will go a long way in solving sanitation problems of rural households.

(f) Improvement of household rainwater harvesting where the first dirty water is collected and disposed of in a tank and clean water is automatically transferred to the main storage tank. This technology is for the rural areas where assess to clean water is limited.

(g) Improved communication and collaboration with other stakeholders from local to international levels.

Water Wisdom

Education and Training

Water sector training is carried out by: -

1) National universities. Training at the Universities is mostly undergraduate and postgraduate levels.

- In University of Nairobi, training for water sector is done at the departments of Civil Engineering, Environmental and Biosystems Engineering, Meteorology, Chemistry and Geography.
- Water training at Moi University is conducted in the Faculty of Technology where the school of environmental studies and the department of civil and structural engineering are housed.
- At Jomo Kenyatta University of Agriculture and Technology training in the water sector is done at the departments of Civil Engineering and also Agricultural Engineering.
- Water training at Kenyatta University is done at the department of Geography and Environmental Studies.

- Training at Egerton University in water is done in the Department of Water Resources.

2) National polytechnics. Training at the National polytechnics is at the Ordinary and Higher National Diploma.
3) Institutes of technology. These offer Certificate and Ordinary Diploma in water engineering.
4) Institute of meteorological training and research. This institute offers postgraduate diploma in operational hydrology for about two students per year besides its meteorological duties for the world weather.
5) Kenya Water Institute (KEWI). Kenya Water Institute trains only for the water sector up to Higher National Diploma for over the last thirty years. The Institute has introduced more rationalized long-term training programs, both Diploma and Certificate, in water engineering and service provision, which are competency-based modules. The modules allow flexibility for students to join and study for specific modules at their own time. It also allows credit transfers from one level of study to the next higher level. The number of trainees per year at these levels is 600.

The institute conducts short-term courses, which are tailor made to meet specific needs of the clients in water and sanitation sector.

- Installation and servicing of water meters
- Leak/burst detection and repair in water supply systems.
- Operation and maintenance of water management of pumping and treatment plants.
- Installation, operation and maintenance of service line and reticulation network for water supplies
- Water meter reading, billing and revenue processing.

The institute also offers operators and allied personnel courses like water supply operators, sewerage operators, pump attendants, surface and ground water assistants, water bailiff assistants, water meter readers and water pollution control assistants.

Indigenous Water Wisdom

To counter the various environmental challenges occasioned by harsh and unpredictable climatic conditions, Communities in Kenya have over the years developed customized ways of dealing with water access and quality.

Communities have indigenous knowledge on water sources for various uses including salt lick for livestock and red ochre for decorations. They have evolved coping mechanisms for survival through the dry spells.

Among the residents of the dry parts of Eastern province, water is scooped from the sand in rounded pots. This ensures pathogen-free water. When the riverbed is dry during seasons of drought, they are able to access water from the lower layers of the river floor. (sand reservoirs).

In the Central highlands, leaves from a "*Muringa*" tree are used as traditional water purifiers (treatment). Research is ongoing on the viability of the process for treating water using this on a large scale at the University of Nairobi.

Water has also been used in traditional rituals like cleansing, libations and casting away evil spirits

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Part VI: Pilot Case Study - Water and ASAL Development - Kenya

Part VI: Pilot Case Study: Water and ASAL Development, Kenya

Natural Resource Capital

Physical Capital

There is need for continuously and systematically stimulating and supporting processes in which individuals, households and groups organize themselves to find solutions to certain common problems based on their own analysis. Organizations and institutions form an important tool for ASAL communities, in which they can work systematically toward pursuing their long term goals. The Government will support the growth and development of community-based organizations such as pastoral user associations and farmers co-operative unions in order to mobilize much needed community based institutional capacity, social and economic capital necessary for the development and growth of the ASAL economy.

Social Capital

Support to local institutions and organizations will be emphasized in order to mobilize human and social capital. Improved local governance will be encouraged in order to enable communities to take charge of their own problems through effective participation in decision-making and in development issues. Investments will be made in the provision of basic social services such as health and education through appropriate institutions such as pastoral user associations.

Community management of these facilities

Where mobile health and education facilities are appropriate, the Government will support these approaches. Access to health services, education and drinking water are the most important elements to be addressed. These are common problems of under-development and poor access to these services is evidence of low social development. Poor communication facilities, few health service providers and high illiteracy lead to declining capacity to deal with development challenges.

Human Capital

The key strategy here is in encouraging the development of human and social capital through the development of community groups and association, business development groups and the formation of small-scale farmers co-operatives. These can benefit from credit facilities and the procurement of agricultural and Livestock production inputs. Skill improvement and training of farmers, business people, especially the young, will go along way in improving the productivity capacity in these areas. Special attention will therefore be given to the development of practical skills for school leavers in order to equip them to better compete in the labour market and to help them start their own business. Provision of credit through appropriate credit schemes will be explored and implemented.

External Resources Capital

The Government will seek to develop partnerships with the ASALs communities, the private sector as well as other partners such as bilateral and multilateral donors, UN agencies, International and national NGOs and Community-based organizations. This will provide an enabling environment for the ASAL communities to engage in meaningful development that will improve economic welfare. The Government will commit more financial resources (through its medium Term Expenditure Framework, MTEF, process), to the development of basic infrastructure in the ASALs and to the provision of basic social services that will enhance the effective development of natural, social and economic capitals that will spur pro-poor socio-economic growth. It will also encourage investments and contributions from the private sector, especially from those sectors and institutions that benefit directly from the ASALs, e.g. the tourism sector, as well as from national and international partners that are interested in sustainable development of the ASALs in Kenya.

Rain Water Harvesting
Water availability and use is key in the development and sustainable use of the ASALs. The development of surface waters through appropriate structures such as pans and dams will be emphasized while groundwater will be developed only based on low cost technologies such as shallow wells fitted with hand pumps. The drilling of new boreholes and equipping them with high maintenance pumping equipment such as generator sets will only be undertaken after thorough Environmental Impact Assessment. Emphasis will be laid on rehabilitating and operationalizing existing boreholes as opposed to drilling of new ones.

The Impact of HIV/AIDs
Social-cultural issues are among the critical factors affecting rural livelihoods. Amongst these are the devastating impacts of HIV/AIDs on household security, increasing competition for common resources such as grazing land and water, recurrence of drought, the breakdown of traditional coping mechanisms, gender inequalities, and dependency syndrome in ASAL communities amongst others.

As such, the Government and other stakeholders will ensure that at all times, policy formulation will take into account gender priorities and considerations, that environmental issues are accorded sufficient attention in all development interventions and ensure that HIV/AIDs is addressed in all activities carried out with the ASAL communities.

Livestock Development In ASAL

Livestock production is the main economic activity in the pastoral areas, employing up to 70-80% of the population. However, individual pastoral families gain the value of livestock through subsistence utilization of their stock. Although the off-take of livestock is low, pastoral areas have captured a large proportion of the market. This is because they have a surplus production of meat when compared with other parts with large livestock populations. Presently, the off-take from Kenya's pastoralist areas is about 6 – 14% cattle, 3% for camels, and between 4 – 10% for sheep and goats. These are low rations but which are possible to double without threatening the base population. In the case of camels, which are hardly marketed, their population can be raised to more than five times

Livestock Population
Kenya has a large and diverse population of farm animals of which cattle, sheep, goats, camels, poultry, pigs, rabbits, bees and donkeys are the species traditionally used for food, income generation, draft power and socio-cultural functions. Cattle are the most important in terms of biomass (73%) followed by sheep and goats (19%) and camels (6%). Over 60% of the livestock population of each species are in ASAL areas while the rest are in the medium and high potential areas. The only exceptions are pigs, poultry and rabbits, which are pre-dominantly found in medium and high potential areas. The livestock population data (see table 6.1) are largely estimates in view of the fact that no national livestock census has been carried out since the sixties.

Table 6.1: Livestock population Estimates (2000) in ASALs

Species	Est. Population in millions
Beef cattle	8.1
Camels	0.8
Meat goats	10.0
Mutton goats	7.7
Poultry (indigenous)	21.7
KTB and other log-hives	1.125

Source: Ministry of Livestock and Fisheries Development Animal Report – 2000.

There are three issues that need to be dealt with in order to improve livestock production in the arid and semi-arid districts. The first is the improvement of natural pasture and water management. The second is the aspect of disease control and the third is improvement of livestock marketing and trade.

Livelihood Systems:

Pastoralism and Agro-Pastoralism: -

The Government recognizes the importance of livestock in the livelihood of pastoralist and agro-pastoralist communities. Improvements in this sector through interventions in water provision; grazing and rangeland management, animal health, genetic improvement and marketing will be supported in order to improve productivity. However, economic diversification will be exploited and supported in aspects such as processing animal by-products like hides and skins; introduction of other livestock such as poultry, bee-keeping and ostrich farming, etc., game cropping and domestication and the introduction of camels in new areas such as Laikipia, Kajiado and Narok.

In addition, most of the wildlife related tourism is in the semi-arid and arid districts. However, big national and international hotel chains dominate these areas. County Councils receive part of the funds levied as gate entrance fees, parking rent and rent from lodges, but not much of these trickles down to individual households. Nor does it economically empower them to engage in tourism-related businesses. Campsites, walks and tour guiding, community-run wildlife conservation sites, etc., will be encouraged in order to improve income sources and strengthen community-based natural resource and wildlife management practices.

Pastoralists in Transition

These are pastoralists who have lost their livestock to prolonged disasters like droughts and floods. As such they have settled near market centers and towns while depending on the government for famine relief and petty trades like selling of miraa (*Khut*), charcoal burning and firewood collection. Around the areas where they have settled, there is rampant destruction of the environment and land degradation due to high soil erosion and destruction of the vegetation.

Both the government and Non-governmental organizations have started programmes to restore the livelihood of these people. The programme initiatives and other human activities have to be implemented with considerable care and planning in order to ensure environmental sustainability.

Rangeland rehabilitation in order to enhance desirable plant biomass will be undertaken through appropriate water harvesting technologies and through improved community based natural resources management initiatives.

Fisheries and Water Resources:

Fisheries development where water sources are available will be enhanced to ensure that fishermen improve their livelihoods as a result of improved fishing facilities and technologies.

Small-Scale Enterprises

Support will be provided to strategically located areas with growth potential. Careful studies for the various options of suitable credit system will be undertaken in an effort to design credit facilities appropriate for pastoral production systems. The concept of village banks in rural areas as now introduced by K-Rep. will be encouraged so as to cover more areas in order to provide the much needed capital for investing in enterprises such as livestock marketing.

Table 6.2 Performance and Indicators

Issues	Problem	Target	Indicator	Units of measure	Recommendation
Inadequate development of water resources	• Inadequate funding • Inadequate information and data • Insecurity	• Facilitation of coordination between Water Development Department and other stakeholders	• Number of water points and water supply schemes constructed • Number of households with access to clean water • Increase in level of funding	Number Number %	
Poor catchment protection and management	• Deforestation • Encroachment into catchment areas including wetlands • Deterioration of water quality and quantity • Land degradation	•Increase afforestation and reforestation •Enforce relevant legislations •Enhance soil and water conservation measures •Decrease levels of pollution	• Increase in area reforested and afforested • Legislations passed and enforced • Decrease in level of pollution • Increase in area rehabilitated and conserved	% Number Concentration of pollutants (ppm) %	
Lack of maintenance of water structures	• Inadequate training on operation and maintenance • Poor revenue recovery and appropriation • Lack of projects ownership by beneficiaries	•Integrate indigenous water management technologies and systems •Promote use of appropriate technologies especially for water harvesting •Enhance revenue collection •Ensure community participation at all level of project cycle	• Number of operational Water Management Committees • Number of communities who have adopted appropriate technologies in water resources development • Increase in revenue collection	Number Number %	
Lack of adequate investment in ASAL areas	• Insecurity • Lack of policy on ASAL development • Poor infrastructure	•Establish micro-financing facilities •Establish sustainable security •Develop a comprehensive ASAL development policy •Improve and expand infrastructure	• Number of micro-finance facilities established and operational • Number of projects supported by micro-finance facilities • Develop ASAL development policy • Number of infrastructures improved and developed	Number Number Number	

Inadequate human and technological capacity	• Inadequate human resource development • Inappropriate technologies	•Train and empower communities on alternative livelihoods •Promote appropriate technologies	• Number of Community Groups trained • Number of functional alternative livelihood initiatives	Number Number	
Poor coordination and management of water related projects	• Poor stakeholders coordination • Wastage of resources	•Develop partnership among all stakeholders •Ensure community participation at all level of project cycle	• Number of projects established in partnership • Number of community based project management committees • Increase in level of community financial contribution in projects	Number Number %	
Management conflicts between institutions due to sector mandate and functions	• Poor sectoral coordination • Conflict of interest • Corruption • Ignorance	•Strengthen forums for dialogue in water resources management and development •Zero tolerance to corruption •Enhance human resources development	• Number of successful dialogue forums • Number of projects started in partnership • Decrease in resources misallocation • Number of community groups trained	Number Number % Number	
Over reliance on donor funding	• Dependency syndrome • Poor policy prioritisation	•Promote high returns investments •Establish micro-finance facilities •Promote alternative livelihoods •Increase financial allocation in ASAL areas	• Decrease level of donor support • Number of functional micro-finance facilities • Number of functional alternative livelihood initiatives • Increase in level of allocation	% Number Number %	
Pressure on pasture and water resources	• Overstocking • Poor distribution of water points • Frequent droughts • Harsh climatic conditions	•Promote livestock marketing •Strengthen early warning systems on drought, floods and other disasters •Enhance balanced distribution of water points	• Number of livestock units sold • Reduction in number of communities affected by disaster • Decreased distance to the nearest water	Number %	

				Km.	
Human-wildlife conflict over resources	• High human population growth • Destruction of wildlife habitat	• Promote reproductive health • Promote eco-tourism • Separation of animal and human habitat	• Decreased birth rate • Number of game ranches/animal sanctuaries • Number of wildlife reserves and parks fenced	% Number Number	

Table 6.3: Summary Indicator Table on Domestic water

	1999	2003
Number of water points and water supply schemes constructed	1,779	1,549
Number of households with access to clean water	1,944,542	
Number of micro-finance facilities established and operational		
Decreased birth rate		
Number of wildlife reserves and parks fenced		
Reduction in number of communities affected by disaster		
Decreased distance to the nearest water		
Actual population served	9.2M	10.3M
Decreased level of donor support		
No. of employees.	12,346	10,997

Wildlife and tourism need to be included in enterprise development. Some of Kenya's wildlife resources, mainly National Parks and Reserves, and some of the tourist infrastructure are to be found in the arid districts. As a result these districts contribute to the tourism income. Despite the significant contribution to tourism, ASAL districts still remain under-developed. Mechanisms will be put in place in which such districts for example, Isiolo and Samburu could benefit directly from income generated from tourism and through the development of community – owned eco-tourism businesses.

Strategic Programs and Actions Cross-cutting Issues that are Significant to ASAL Communities

Gender and Development in the ASALs

Both men and women must be given equal opportunities to participate in development, in resource allocation and in decision-making on matters affecting their future and development. Therefore, development project designers must have values that compel them to promote right relationships among target group members.

In this regard, the Government will encourage and promote gender equity in all of its interventions and those of other development partner. Of special attention will be the promotion of equal education opportunities between girls and boys in the ASALs because

this is a very strategic way of achieving equity.

In addition, functional literacy initiatives, especially for women will be supported and encouraged in order to improve women's capacity to manage their own resources and business and to participate in community development forums.

Water Resources Management and Development

Small dams, water pans and boreholes are the major sources of water for livestock, humans and wildlife in ASALs. ASALs are considered to have limited water resources, poorly distributed, characterised by low ground water resources, which are completed by supply systems installed some time ago (15-30 yrs.). Most of the latter have reached the end of their nominal operational period, reveal a poor history of maintenance yet have to respond to today's significantly higher demand. Almost all the urban water supplies in ASAL areas are non-operational due to poor maintenance while other small towns depend on unprotected sub-surface dams that dry up after the rainy season, leading to costly water trucking.

Arid Lands: Water resource availability, appropriate development and use are key in the development of the ASAL and in their sustainable use. The development of surface pans and dams will be emphasized while ground water will be developed only based on low cost technologies such as shallow wells fitted with hand pumps and after thorough environmental impact assessments have been undertaken and agreed upon by the communities and other stakeholders.

Semi-Arid Lands The development of both surface and groundwater sources will be emphasized and proven ASAL water harvesting and supply technologies that are sustainable and environmental friendly will be given priority. The use of indigenous knowledge and locally available materials in the development of water harvesting and irrigation facilities will be a key consideration.

Support to Irrigation Farming in ASALs

Potential for large-scale crop production exists in a few mountain areas or along the major river valleys like Tana, Dauwa, Turkwell, Ewaso and Athi. Government and donor agencies have been encouraging the need to develop potential of the river basins through irrigation in number of areas. Irrigation development could create alternative employment for pastoralists who occupy the river basins. However, irrigation and large-scale agriculture developments have tended to alienate land from pastoralists. As a result, an integrated approach to land use in the pastoral areas needs to be explored.

Natural Resource and Environment Management

Arid Lands: - Pastoralists have developed highly resilient production systems, well adapted to the hostile climatic environment in the arid districts. The system favours a community-driven approach to utilization, development and support investments in rangelands. This aims to strengthen traditional range resource use in order to ensure effective and efficient utilization of natural resources to improve production and enhance environmental sustainability.

Semi-Arid lands: - The soils are generally low in organic matter due to the low density of plant life and fast microbial activity. They have poor fertility and are inherently shallow, permitting only limited capacities for water storage. Specific soil and water conservation and organic farming techniques should be supported in order to improve soil fertility and to prevent land degradation. Agro-forestry practices will be supported while mixed farming will continue to be encouraged.

Deforestation Impacts on Water and Sediment Yields

Removing vegetative cover on steep slopes for agricultural activities, foraging for fuel wood and other wood products, as well as over-grazing has paved way for massive soil erosion. Soil fertility and soil structure as well as crop yields are declining due to accelerated land degradation. Today, the rate at which deforestation is taking place is alarming. Out of the total forest cover of 1.4 million hectares, (Rafik.H et al. 1996) it is estimated

that 500 hectares of forest are lost annually to agricultural activities or to settlement and urban developments. Important watershed and possible high potential areas for unique biodiversity conservation are being encroached into, resulting in degradation.

Management of ASAL Ecosystems and Re-afforestation

The ecosystem approach is not limited in its application to aquatic ecosystems; it is considered as one of the holistic approaches and is frequently used in the context of sustainable development of natural resources.

ASAL ecosystems must be conserved and restored in order to ensure sustainable water resources for humanity. However, water is not just a physical substance essential to human life, but is also the environment that supports all other living things. As such we must change thinking to recognize that ecosystems are the source of water.

Managing Droughts and Flood Hazards

Droughts are inevitable in ASALs. They may occur frequently or less frequently, depending on the location, and rainfall patterns and trends but they are bound to occur. Both pastoralists and crop farmers recognize this and respond in different ways, which have been developed over time as there coping mechanisms.

Many development organization working in ASALs see drought as a risk or a problem that interferes with normal activities. They fail to see that the design of their programme needs to consider the occurrence of droughts, just like pastoralists and farmers have designed their coping strategies.

Droughts are not the only disasters that hit people in the ASALs. Warfare, killer diseases and floods also create havoc. Disasters can be natural or people-induced. Nevertheless, all these disasters can be managed.

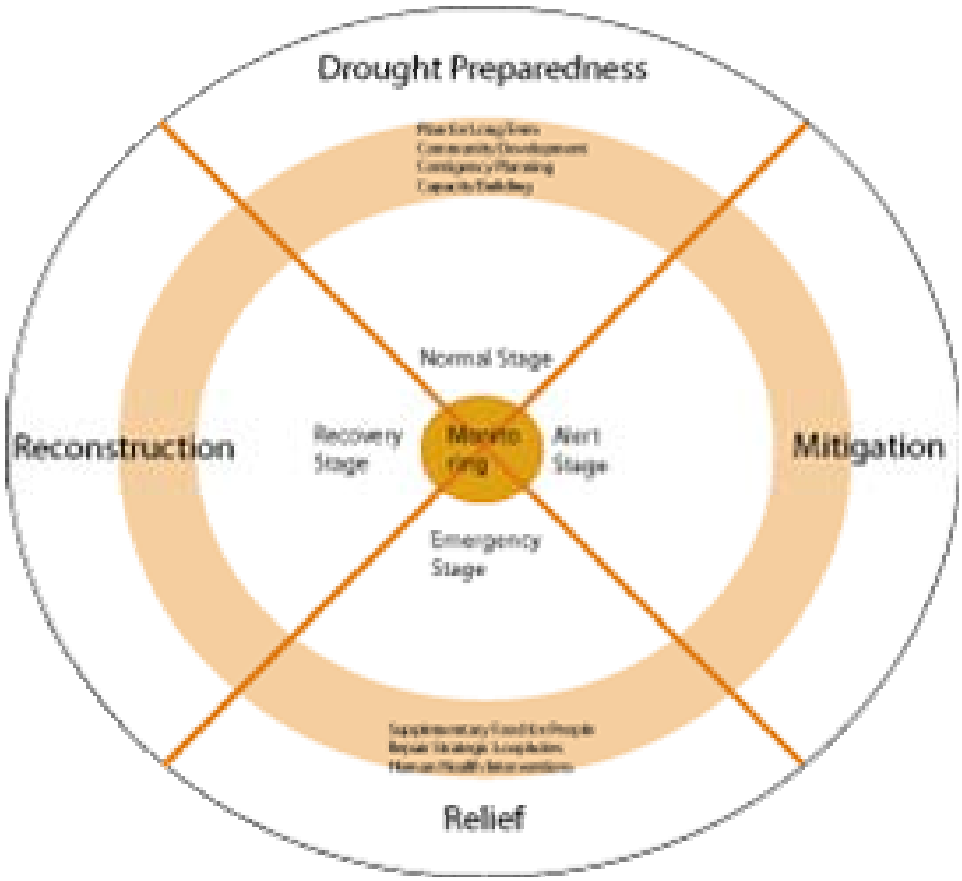

Figure 6.1: The drought Management Cycle

Four Stages
A drought cycle consists of four stages as illustrated in Figure 6.1.

1. Normal Stage: Rainfall is adequate, and there are no major problems. The danger of drought, though, is always present, and one should prepare for it.
2. Alert or Alarm Stage: The rains fall, and the early signs of drought appear. During this time, efforts focus on mitigating the effects of drought.
3. Emergency Stage: Food and water run short, causing severe malnutrition and a high death toll of people and livestock. Efforts shift to relief measures.
4. Recovery Stage: The rains return, and people and animals can begin to recover. Reconstruction activities can now be set in motion.

Managing Resource Conflicts

Conflict Management (Types of conflicts)

Various sources of conflicts affect people in dry land areas. These include: -

a) Ownership of land
b) Access to and control over natural resources, e.g. grazing land during drought, access to water points, rights to harvest fuel wood, rights to extract minerals.
c) Damage by one group that affects another, e.g. livestock damaging crops, environmental damage, e.g. culture and relationship, lack of cooperation, cultural and language differences between different grounds (pastoral and sedentary people)
d) Crime, - Banditry, cattle raids, etc,
e) Conflicts transferred from outsiders, e.g. political manipulation;
f) Policies and politics: - sedentarization, restrictions on use of nature resources and political interference.

Levels of Conflicts

Conflicts tend to follow a cycle, at first; a disagreement may be minor and may not be expressed. This may be followed by a period of rising tension, escalating into open disputes, and then into violence.

Violence may continue through a cycle of revenge and counter-revenge. It may later re-ignite.

Conflicts may occur at different scales. At the micro end, conflicts may occur within households, clans, among different groups in the community (both sedentary farmers and pastoralists), on both community groups and external organizations largest conflicts involve disputes both different.

Trigger causes of Conflicts

Conflicts among pastoralists in Kenya has contributed to significant loss of property and increased levels of poverty.

The frequency of conflicts has increased recently leading to high levels of insecurity and vulnerability among the pastoralists whereas historical data reveals that in the past raids and fights among pastoralists spared human life especially children, women, boys and girls- recent descriptions of raids from pastoral and nomadic people have shown increased violence and human killings.

While in certain areas diverse social, cultural, economic and political contexts are known to combine to conflict, in the case of Kenyan pastoralists, the pastoral problems can be best understood to encompass:-

- The drive to control resources
- Cultural identity
- Need to meet basic needs – limited resources to share among an increasing population;
- Marginal environment and un-predictable weather (pastoralists move-in search of grazing and conflicts may occur, wanting to use the same resources).
- Periodic drought forces people to compete for decreasing amounts of food and water;
- Right to sustainable development
- Small arms proliferation, i.e. availability of automatic weaponry from macro-level conflict in the region such as the Sudan, Somalia, etc. leading to increased banditry and making commercial raids of livestock more viable.
- Migrants from the highlands settle as crop farms in areas (often on the best land) previously used for grazing, erect force that block the pastoralists' mitigation ranks and

grazing fields. This results in conflict with previous users.
- Civic war and cross border conflicts have also increased instability and insecurity.

To enable much-needed development in the ASAL, framework for tackling violence conflict based on a clear understanding of the root causes of conflict in the ASAL.

Economic Empowerment

This will involve economically empowering committees, so that they have their basic needs met, e.g. provision of water, clothing, shelter (safe), etc.,, e.g. disputes always arise over water-user fees, produce prices, competition for jobs and income from enterprises, jealousy due to wealth disparities, etc.

The empowerment will include water projects (borehole, pipeline to be managed by community members, this will provide employment opportunities for the locals, constant wages, improved infrastructure (Social amenities) and generally improved standards of living.

* Economic empowerment may include availing loan facilities (grants available for various projects (individual projects)
* Banks being actively involved to provide un-secured loans etc.
* Improved education standards may also in the long run improve the economic status of individuals (free primary).
* Provision of security-issues from Banditry, cattle raids, crop theft, and corruption, have direct impact on economic status of a community.

Capacity building to solve Conflicts

These will involve: -

A. Awareness on optimal use of the available limited resources, e.g. water resources, grazing areas and wood fuel.
B. Time scheduling for the usage of resources, e.g. morning, afternoon, etc., Times of the year.
C. Awareness on how to avoid the "tragedy of common (regulate the usage e.g. forests, grazing land, etc.
D. Providing alternative sources of watering areas, e.g. digging boreholes,
E. Involvement of Non-governmental organizations, community based organisations, women groups. These will assist in decision making by the various parties,
F. Educate the community on alternative conflict management methods. The goal is to find a "win-win" solution where all parties gain.
G. Consensus building techniques, brainstorming, group discussions, role-plays, simulations, music, dance and drama, case studies, and study of the Bible or the Koran.

Instruments to Conflicts Avoidance

Perception issues on shared Water Resources

Kenya has a fair proportion of shared water resources with Tanzania, Uganda, Somalia and Ethiopia. Besides the rivers flowing into Lake Victoria forming the headwaters of River Nile, the Omo River flows to Lake Turkana from Ethiopia, the Daua River flows from Ethiopia highlands and along the Kenya-Ethiopia border before entering into Somalia, River Umba flows from Tanzania to Kenya and back to Tanzania.

No serious conflicts have emerged between the riparian countries concerning the utilization of water in these rivers, but as more projects are proposed and developed in future, conflicts may arise.

However, in recent years, the water quality at the rivers discharging into Lake Victoria and the lake itself has deteriorated. Discharge of municipal and industrial pollutants as well as silt-laden runoff from the adjacent agricultural land and urban areas into water has caused problems.

The management of the lake Victoria Basin environment therefore requires an integrated approach in order to achieve an effective reduction of pollutant levels and to conserve the natural resources.

To this end, in a Tripartite Agreement between Kenya, Uganda and Tanzania, it is expected that after the implementation of the five programs, the environmental degradation of the Lake Victoria basin will be greatly reduced and sustainable utilization and development will proceed.

Provision of water at Convenient Locations

To facilitate on issues concerning conflicts avoidance, its imperative that the Government provide/facilitates the provision of appropriate water sources for lifespan use, e.g. pans in wet season grazing areas should be developed and strategic boreholes, e.g. contingency boreholes

should be drilled where there is plenty of pasture but inadequate water sources.

The use of boreholes should be done with a memorandum of understanding between the community members and the following groups: - the financier, (e.g. the Government, NGOs, etc.), local leaders and administration on how and when to use. This will bring about unity and harmony in the utilization of the water resources.

Watering Point and Livestock Marketing Routes

Small dams, water pans, and boreholes are the major sources of water for livestock. ASALs are considered to have limited water for resources, poorly distributed, characterised by law ground water resources.

Hence these watering points need to be shared among all people. In order to avoid conflicts, measures should be taken to rehabilitate the existing water points and to training community groups to manage these facilities on a sustainable basis.

Other measures include: -

- Strengthening of local institutions/user groups to manage community-based resources such as more water supply systems and natural resources, and
- Creating of mobile rapid units for water borehole machinery

The current poor state of most infrastructures in the ASAL acts as a major constraint on economic and social development. An improved road network would have major implications for improving livestock marketing and security; hence measures should be taken to improve the marketing routes.

These include: -

* Bituminising of major roads, e.g. Garissa-Mandera, Isiolo-Moyale,
* Rehabilitation of the existing roads, e.g. improving road to tarmac standards,
* Gravel all roads to weather road standards, and
* Maintenance of strategic feeder roads to community groups in order to provide and strengthen the purchasing power of pastoralists.

Create Appropriate Policy Instruments

Recent clashes in the region have led to a proliferation of sophisticated firearms. Inter-ethnic clashes are common, and they are particularly difficult to deal with if and when they occur across international borders. Attempts to disarm pastoral groups prevent cattle raids, and halt clashes may be successful, or may further exacerbate the problem.

It is essential that conflict management and reduction provisions be integrated into the poverty reduction strategy paper as it is planned for implementation in pastoralist areas e.g. severe punishment. This will cause fear among potential offenders and/or strengthen existing traditional conflict resolution mechanism, which have deterrent by-laws, and the appropriate punishment for offences committed. The district security mechanisms will support the communities in enforcement.

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Annexes

Acronyms

ADB	African Development Bank
AFD	French Agency for Development
ASAL	Arid and Semi-Arid Lands
A.I	Artificial Insemination
AIDS	Acquired Immune Deficiency syndrome
ACRWC	African Charter on the Rights and Welfare of the Children
ARV	Anti-RetroViral
BCM	Billion Cubic Meters
BOD	Biochemical Oxygen Demand
CAAC	Catchment Area Advisory Committees
COD	Chemical Oxygen Demand
CRC	Convention on the Rights of the Child
DANIDA	Danish International Development Agency
DFID	Development
EIA	Environment Impact Assessment
EMCA	Environmental Management Coordination Act
EPZ	Export Processing Zone
ERB	Electricity Regulating Board
ERS	Economic Recovery Strategy
EU	European Union
FAO	Food and Agriculture Organization
FD	Forestry Department
FINNIDA	Finnish Development Agency
GDP	Gross Domestic Product
GOK	Government of Kenya
Gwh	Gigawatt-hours
GTs	Gas Turbines
Ha	Hectares
HIV	Human Immuno-deficiency Virus
IDA	International Development Agency
IDD	Irrigation and Drainage Department
IGAD	Inter-Governmental Agency on Development
ITCZ	Inter-Tropical Convergence Zone
IPPs	Independent Power Producers
IWRMS	Integrated Water Resources Management Systems
IWUAs	Irrigation Water Users Associations
JICA	Japan International Cooperation Agency
K.Shs.	Kenya shillings
KEFRI	Forest Research Institute
KEBS	Kenya Bureau of Standards
KenGen	Kenya Generating Company
KOEE	Kenya Organization for Environmental Education
KEWI	Kenya Water Institute
KFW/GTZ	German Development Agency
Kg	Kilogram
Km^2	Square Kilometers
Km	Kilometers
KPLC	Kenya Power and Lighting Company
KPRL	Kenya Petroleum Refineries Limited

LIFDC	Low-income Food-Deficit Country
LBDA	Lake Basin Development Authority
LPG	Liquefied Petroleum Gas
m^3	Cubic meters
m^2	Square meters
MDG	Millennium Development Goals
Mwh	Megawatt-Hours
mg/l	milligrams per liter
mm	millimeters
MOEST	Ministry of Education Science and Technology
MoA	Ministry of Agriculture
MoH	Ministry of Health
MTEF	Medium Term Expenditure Framework
MV	Millivolt, Megavolt
MW	megawatts
MWI	Ministry of Water and Irrigation
MWRMD	Ministry of Water Resources Management and Development
NACC	National AIDS Control Council
NASP	National HIV/Aids Strategic Plan
NCPB	National Cereals and Produce Board
NEAP	National Environment Action Plan
NEMA	National Environmental Management Agency
NEPAD	New Partnership for African Development's
NCC	Nairobi City Council
NGOs	Non-Governmental Organizations
NIB	National Irrigation Board
NWC	National Water Campaign
NWCPC	National Water Conservation and Pipeline Corporation
NWDR	National Water Development Report
NWSC	Nairobi Water and Sewerage Company
NWSS	National Water Services Strategy
OI	Opportunistic Infections
O&M	Operation and Maintenance
OCDC	Oil Crop Development Company
PRGF	Poverty Reduction and Growth Facility
PRSP	Poverty Reduction Strategy Paper
REP	Rural Electrification Programme
SIDA	Swedish International Development Agency
SSIU	Small Scale Irrigation Unit
STIs,	Sexually Transmitted Infections
TARDA	Tana and Athi River Development Authority
TB	Tuberculosis
TDS	Total Dissolved Solids
TOS	Total Organic Solids
UNICEF	United Nations Children's Fund
UNESCO	United Nations Educational Scientific and Cultural Organization
VCT	Voluntary Counseling and Testing
WAB	Water Apportionment Board
WB	World Bank

WFP	World Food Programme
WHO	World Health Organization
WRMA	Water Resources Management Authority
WRMA	Water Resources Management Authority
WRUA	Water Resources User Associations
WUA	Water User Associations
WSB	Water Services Board
WSRB	Water Services Regulatory Board
WSS	Water Supply and Sanitation
WSSD	Water Supply and Sanitation Department
WWAP	World Water Assessment Programme
WWAP	World Water Assessment Programme WSP
WWD	World Water Day
WWDR	**World Water Development Report**

Main Units of Measurements

CURRENCY EQUIVALENTS
(MAY 2005)
1 K.Shs=K£
1 K£= USD

LAND AREA EQUIVALENTS

Ha-m^2

WEIGHTS AND MEASURES

l/c/d = liters per capita per day
m^3 = cubic meter
m^3/d = cubic meter per day
Mm_3 = million cubic meters
Km = kilometers