WMO

MWRMD

APFM

Strategy
For
Flood Management
For
Lake Victoria Basin, Kenya

SEPTEMBER 2004

STRATEGY

FOR

FLOOD MANAGEMENT

FOR

LAKE VICTORIA BASIN, KENYA

Prepared under
Associated Programme on Flood Management (APFM)

September 2004

STRATEGY FOR FLOOD MANAGEMENT FOR LAKE VICTORIA BASIN, KENYA

CONTENTS

Abbreviations ..... *(iii)*

Foreword ..... *(v)*

Preface ..... *(vii)*

Acknowledgements ..... *(ix)*

PART I BACKGROUND

1. Introduction 1
1.1 General 1
1.2 Purpose of the Document 1

2. Physical and Social Context 2
2.1 Lake Victoria Basin and the River System 2
2.2 Resources 2
2.3 Floods and their Impact 5
2.4 Rural and Urban Development 9
2.5 Future Development Imperatives 9

PART II STRATEGY FOR FLOOD MANAGEMENT

3. Rationale for a Strategy 13
3.1 Vulnerability of People to Floods 13
3.2 Factors Contributing to Increasing Flood Disasters 13

4. Strategy Formulation Process 14
4.1 Steering Committee 14
4.2 Stakeholders Perspective for Future Development 14
4.3 Policy Makers' Workshop 15

5. Elements of the Strategy 15
5.1 Reducing Vulnerability 15
5.2 Reorientation of Approach to Development and Floods 16
5.3 Integrated Approach to Water Resources Development and Flood Management 17
5.4 Protecting and Conserving Environment 18
5.5 Addressing Weather and Climate Variability and Change 18
5.6 Coordination between Various Ministries and Agencies 18

PART III FLOOD MANAGEMENT POLICY

6. Policy Principles 23

7. Policy Elements 25
7.1 Institutional Arrangements 25
7.2 Organisation Structure 26
7.3 Structural Measures 27

7.4 Non-structural Measures 28
7.5 Community Participation 31
7.6 Capacity Building....32

8. Flood Forecasting System 33
8.1 Hydro-meteorological Network 33
8.2 Data Acquisition and Processing....34
8.3 Flood Forecast Formulation....34
8.4 Dissemination....35
8.5 Recommendations....36

PART IV ACTION PLAN

9. Action Plan 41
9.1 Short Term Measures....41
9.2 Medium Term Measures....42
9.3 Long Term Measures 42

PART V ANNEX
Annex I Report on the Stakeholders' Workshop....45
Annex II Reducing Vulnerability of Farmers 49
Annex III Guidelines for Preparation of Flood Mitigation Master Plans: A Broad Approach....51
Annex IV Coordination Mechanism 53
Annex V Collection of Technical Data and Flood Damage Assessment....55
Annex VI Indicative Guidelines for Watershed development 61
Annex VII Capacity Building: Human Resource Development....69
Annex VIII Flood Forecasting System for Lake Victoria Basin....73
Annex IX RANET 85

PART VI SUPPORTING INFORMATION
Appendix I Flood Situation in Lake Victoria Basin....91
Appendix II Water Availability and Demand in Lake Victoria Basin....101
Appendix III Status of Development in Lake Victoria Basin 119
Appendix IV Institutional Arrangements in Water Sector in Kenya....133

REFERENCES 143

ABBREVIATIONS AND ACRONYMS

APFM	Associated Program on Flood Management
BCM	Billion Cubic Meters
CFFO	Central Flood Forecasting Office
DMC	Disaster Management Committees
DMU	Disaster Management Units
DOC	Disaster Operations Center
FFO	Flood Forecasting Office
FRIEWS	Flood Risk Information and Early Warning System
GCM	Global Climate Model
Geo SFM	Geo Spatial Flood Forecasting Model
GFFS	Galway Flood Forecasting System
IFM	Integrated Flood Management
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
JICA	Japan international Cooperation Agency
KMD	Kenya Meteorological Department
MWRMD	Ministry of Water Resources Management and Development
NDMA	National Disaster Management Authority
NEMA	National Environmental Authority
PC	Provincial Commissioner
PIA	Project Implementation Agency
PMF	Probable Maximum Flood
QPF	Quantitative Precipitation Forecast
RANET	Radio Internet
RBOs	River Basin Organizations
RTH	Regional Transmission Hub
SHG	Self Help Group
VFC	Village Forest Committee
UG	User Group
WA	Water Association
WC	Water Committee
WDC	Watershed Development Committee
WDT	Watershed Development Team
WMO	World Meteorological Organization
WRMA	Water Resources Management Authority

Foreword

Reducing vulnerability and increasing resilience to natural disasters, around 80 percent of which are related to weather and climate, are complex tasks for any community. Preparedness and response measures require a multidisciplinary and coordinated approach.

Preparedness and response actions of the various disaster management authorities to prevent or mitigate flood-related disasters are highly dependent on the overall flood management strategy adopted by a country. Absence of a clear strategy and policy for flood management contributes to an increase in the adverse impacts of flood disasters socially, economically as well as environmentally. The availability and proper use of accurate and timely meteorological and hydrological monitoring and forecast products and the dissemination of adequate and relevant information to authorities responsible for civil protection and the general public for effective disaster response, play an important part in this overall strategy. The difficulties are compounded when the infrastructure on which to build early warning and response systems is rudimentary, as is the case in many developing countries including Kenya.

Kenya has been experiencing some of its worst flood events during recent years. Flood management has acquired importance in certain basins of the country. The Government of Kenya enacted "The Water Act 2002", formulated a "national water resources management strategy" to protect, develop, use and mange the water resources of the country. The Act also provides for developing a "Catchments Management Strategy" for the protection and control of water resources. By adopting the Water Act 2002, the Government of Kenya has given its people a tool for sustainable development. The Ministry of Water Resources Management and Development (MWRMD) is concerned and is committed to put in place such a Flood Management Strategy for the country to prevent flood disasters hampering development processes.

The MWRMD therefore recognizes and appreciates WMO's response to the Ministry's request to help develop a Flood Management Strategy in the Lake Victoria basin as a pilot project under the WMO-GWP Associated Program on Flood Management.

This Flood Management Strategy, prepared by WMO in collaboration with Kenyan experts and in consultation with various ministries and departments will be extended to the whole country and adopted to give sustainability to water resources development projects and empower the nation to withstand flood hazards in the Lake Victoria Basin.

I would like to take this opportunity to express my appreciation and that of the Government of Kenya to WMO for its support in addressing water-related issues in Kenya.

Hon. Martha Karua, Minister
Ministry of Water Resources
Management and Development

Date: September 2004

Preface

Weather, water and climate-related hazards are being experienced more frequently and extensively the world over – and the spatial and temporal scales of these hazards vary widely. Extreme hydrometeorological conditions are not inherently catastrophic, since the natural environment shows remarkable resilience through adoption and rejuvenation. However, hazards posed by these events cause potential disasters by seriously affecting the physical infrastructure and economic activities of human beings. In one stroke, disasters can wipe out a lifetime of development and deprive countries of resources, which could otherwise be used for economic and social development.

Disaster prevention and mitigation has to be viewed as an integral part of sustainable development process. Responding to natural hazards through prevention, mitigation and preparedness – planning, legislation, appropriate land use, effective weather monitoring, environmental management, financial safety nets and public education programmes – are all essential to planning sustainable development.

The World Meteorological Organization (WMO) has been supporting Member countries in managing natural disasters through its Programmes mainly by issuing forecasts and early warning of hydrometeorological events with increasing accuracy and longer lead time for preparedness and prevention and by providing long-term data on weather, water and climate events for planning preventive measures. Realising that forecasts and warnings are not an end in themselves but a means to reduce suffering, economic losses and environmental degradation, WMO has launched the Natural Disaster Prevention and Mitigation Programme to help bring synergy among the related strategies, programmes and plans of action and to inculcate a culture of prevention.

The Associated Programme on Flood Management (APFM), is a joint initiative of WMO and the Global Water Partnership funded by the Government of Japan and the Government of the Netherlands. It promotes the concept of Integrated Flood Management (IFM), which aims at maximizing net benefits from flood plains and minimizing loss of life by reducing the vulnerability of the society to flood risks through an optimal mix of structural and non-structural measures.

The Government of Kenya has recently taken certain concrete steps toward sustainable water resources development by adopting “The Water Act 2002”. In this context, the development of this Flood Management Strategy for the Lake Victoria Basin under the APFM is a significant forward step in that direction.

On behalf of the WMO, I would like to thank all those who contributed to the successful preparation of this valuable document. In particular, I would express my special thanks to Hon. Martha Karua, MP, Minister, Ministry of Water Resources Management and Development (MWRMD), Hon. John Munyes, MP, Assistant Minister (MWRMD) and Prof. George O. Krhoda, Permanent Secretary (MWRMD) for guidance and providing clear vision in preparation of this Strategy. WMO remains committed to work closely with the authorities of Kenya and the other countries in the successful implementation of the strategy as a significant contribution to the sustainable development of the region.

M. Jarraud
Secretary-General

Date: September 2004

Acknowledgment

The World Meteorological Organization (WMO) has prepared this document for the Kenya Ministry of Water Resources Management and Development (MWRMD). It is a joint initiative of WMO and the Global Water Partnership. It is based on information obtained and documents collected from various concerned Ministries and Department in the country. Valuable information was also collected and analyzed through interaction with different stakeholders and decision makers during two workshops organized in Kisumu and Nairobi in March and April 2004 respectively. Participants in these workshops provided fruitful inputs.

This document also benefited from combined efforts and valuable contribution of a group of Kenyan experts guided by the Project Steering Committee and WMO experts. Different departments of Kenya have greatly contributed to the process of the preparation of this document and gave useful advice and suggestions in finalizing it. These, among others, include Eng. K.G. Chesang, Director of Water Development, Eng. L.N. Simitu, Chairman, Project Steering Committee, Dr J.R. Mukabana, Director, Kenya Meteorological Department, Prof. L.A. Ogallo, IGAD Climate Prediction and Application Centre (ICPAC) Coordinator, Eng. E.M. Mnyamwezi, Project coordinator and all the following Project Steering Committee members: Mr P.D. Munah, Kenya Meteorological Department; Dr A.O. Opere, University of Nairobi and Drought Monitoring Centre Nairobi DMCN; Mr M.O. Ogola, Office of the President, National Disaster Operations Centre; Mr B. Adegu, Drought Monitoring Centre, Nairobi; Mr V. Ogaye and Mr T.M. Mutie. Thanks are also due to the members of the Technical Support Unit of APFM, Mr V.K. Mathur, International consultant (India) and Ms Mimidoo Ahua, Junior editor (Nigeria) for the time they have devoted to the preparation of this valuable document.

This study has been undertaken within the Associated Programme on Flood Management which is funded by the Government of Japan and the Government of the Netherlands. We are indebted to them for their continued support to the programme and to this study.

PART I

BACKGROUND

1. INTRODUCTION

1.1 General

Water is the key element in economic, social and cultural developmental of any society. Throughout history, people have settled next to waterways and in flood plains because of the advantages they offer. In spite of these benefits, water can also cause destruction and damage. Flood devastation results in loss of lives, widespread crop destruction and associated economic disasters.

During the last couple of decades, Kenya has experienced serious incidents of flood disasters, in different parts of the country and caused major disturbances, destroying property and resulting in loss of life. Recurring floods are experienced in the Kano plains of western Kenya in the lower reaches of river Nyando.

The Dublin Conference (1992), subsequent Ministerial Declaration (2001) at The Hague and the World Summit on Sustainable Development (2002) have increasingly crystallised the world opinion in recognising that Integrated Water Resources Management (IWRM) (1)[1] is a necessary criterion for sustainable development. It is recognized as the most appropriate approach for sustainable development of water resources, of which Integrated Flood Management (IFM) forms an important subset.

The Associated Program on Flood Management (APFM), a joint program between WMO and the Global Water Partnership is an initiative to support the efforts of countries towards implementing Integrated Flood Management. A number of pilot projects are being implemented in different parts of the world to develop and apply various components of the Integrated Flood Management (2) concept.

In June 2003, Honourable Martha Karua, the Minister of Water Resources Development and Management, Kenya, asked the World Meteorological Organization (WMO) to assist Kenya in developing a Flood Management Strategy.

A pilot project for developing a Strategy for Flood Management for the Lake Victoria Basin in Kenya was therefore undertaken by WMO, with full participation of national experts from various concerned ministries, as well as the Ministry of Water Resources Management and Development (MWRMD). The long-term view of the project is to strengthen national capabilities, so that eventually national experts can develop a flood management strategy for the entire country.

The starting point in an IFM strategy is a reorientation of approach to floods and development. The strategy for flood management in Lake Victoria basin, therefore, must simultaneously address the present problems of the poor flood plain dwellers and the imperative future development of the entire fertile land that is prone to frequent flooding. The developmental planning must be pro-active and dynamic and take into consideration the likely multiplier or cascading effects on various other sectors of economy that may spread far and wide beyond the target areas.

The long-term view of the project is to strengthen national capabilities, so that eventually national experts can develop a flood management strategy for the entire country.

1.2 Purpose of the Document

This document outlines a proposed flood management strategy recommended for the Lake Victoria Basin in Kenya. It is expected to serve as a base document for developing the National Strategy and Policy for Flood Management in Kenya.

The document contains six parts. Part I provides the background, that is, the context of physical and hydro-meteorological aspects, the status of development, and future development imperatives in the Lake Victoria basin.

[1] Figures in brackets indicate the reference number from the list given at the end of the report

Part II describes the proposed Strategy for Flood Management, and identifies various initiatives to be implemented by the Ministries and Departments concerned. A mechanism for coordination is also provided.

Part III of the document outlines the basic policy principles and proposes various policy measures that include structural and non-structural options. It also provides an institutional mechanism as a compromise amongst various alternative options through community participation. An outline of a suggested Flood Forecasting System is also included.

A proposed Action Plan suggesting various short, medium and long-term measures for the implementation of the strategy are outlined in Part IV.

The annexes in Part V discuss some of the elements included in the strategy in detail, such as a coordination mechanism, a flood forecasting system, capacity building and collection of technical data for damage assessment.

Finally Part VI contains the appendices providing the detailed background socioeconomic and geographic supporting information, from which the strategy has been drawn.

2. PHYSICAL AND SOCIAL CONTEXT

2.1 Lake Victoria Basin

The River System

Lake Victoria has a total catchment area of 194,000 Sq Km shared between five countries – Uganda, Rwanda, Burundi, Kenya and Tanzania The Lake receives part inflows from rivers Sio, Nzoia, Yala, Nyando, Sondu, and several other streams, with a total catchment area of 46,229 Sq Km from the Kenyan territory. River Nzoia with a catchment area of 12,709 Sq Km and a length of 334 Km up to its outfall into the Lake is the largest among them.

Rainfall

Throughout the year in Lake Victoria Basin there is no distinctive dry season, but there are two maxima, one in April and the other in October. The highest rainfall occurs in the northwestern parts, and gradually reduces in the southeastern parts. The average annual rainfall for the basin is 1,424 mm and varies between 891 mm in parts of Mara catchment to a maximum of 2,168 mm in the middle reaches of Yala basin.

Areas affected by flooding

The rivers Nzoia, Yala, and Nyando cause extensive flooding in their lower reaches especially the Budalangi Division of Busia district and the Kano Plains. The rivers Sondu and Kuja inundate low-lying areas in their outfall reaches.

Floods in the basin affect parts of six districts; these are Busia, Kisumu, Nyando/Ahero, Bondo, Migori and Siaya Districts, which fall under Rift Valley, Western and Nyanza provinces. Out of a total area of 8770 sq km in the six districts more than a quarter falls under the water bodies or is covered with swamps.

2.2 Resources

Livelihood sources.

65 percent of the land in these districts, that is about 3.5 million hectares (mha) is arable, which also gets good rainfall. Out of this 1.14 million hectares is under food crops and 0.426 million hectares is under cash crops. More than 4.2 million people are engaged in agriculture, 2.3 million in livestock rearing and 21,500 in fishery in small ponds. Fishing forms an important part of the livelihood but agriculture is the most dominant choice.

Subsistence agriculture forms the main occupation with food crops like maize, sorghum, beans and cassava except in Busia, Migori and Kisumu districts, where cash crops like sugar and cotton are also raised. Livestock rearing forms a major activity especially in the Bondo, Siyaya and Migori districts. Kisumu with a population of about one million (2001) is the largest town in the basin.

Water Availability and Requirement

The average availability of surface water in all the major rivers of the Lake Victoria Basin is of the order of 7.09 billion cubic meters (BCM) with 80% dependability at 2.72 BCM. The safe ground water abstraction yield has been assessed as 49.63 million cubic meter (MCM) (3).

Considering the run-of-the-river abstractions and limits of land potential, the ultimate irrigation potential assessed in the National Water Master Plan is only 0.35 mha. The net area that can be provided with irrigation at the proposed cropping intensity of 163% is only 0.215 mha for which supplemental irrigation water requirement is of the order of 2.24 BCM. The total water requirement for the main uses such as irrigation, domestic supply, livestock, fisheries and industry is at present (2002) 2.505 BCM which is likely to increase to 2.745 BCM by the year 2025. The total cultivated area in the basin is 1.566 mha. The projected water requirements in the 6 flood prone districts for the above uses in the year 2025 are estimated to be 911.94 MCM as shown in the Table 1.

It would be seen from Table 1 overleaf, that all the water requirements in the basin including the flood prone districts could be reasonably met from the 80 per cent dependable flows. However, during the lean years[2], Kisumu, Siaya and Bondo may face water shortages. Shortages may also be felt during some parts of the year due to large variations in seasonal flows.

Table 1: Water Requirement in 2025 (Figures are in MCM)

District	Irrigation	Domestic use	Livestock	Industry	Fisheries	**Total**
Kisumu, Siaya & Bondo	265.42	35.97	7.18	1.40	0.283	310.25
Busia	160.50	14.63	2.92	0.49	0.121	178.66
Nyando/Ahero	20.62	12.74	2.54	0.34	0.11	36.35
Migori	356.27	24.25	4.85	1.14	0.177	386.68
	792.81	**87.59**	**17.49**	**3.37**	**0.691**	**911.94**

Source: National Water Master Plans 1992(Basic Data)

[2] Flows approximately equal to the minimum observed flows

Figure 1: The River Nile And Lake Victoria

Figure 2: Lake Victoria Basin

Figure 3: Lake Victoria Basin River System

2.3 Floods and their Impact

Despite the dry years, floods[3] are the most damaging natural disasters that affect many parts of the Lake Victoria basin. The flood impact ranges from loss of human lives and livestock to widespread destruction of crops, damage to houses and public utilities and disruption of various economic activities. Below is an outline of the occurrence and types of floods that have occurred in the Lake Victoria Basin in the past.

Past Floods

Major floods have been experienced in the low-lying parts of the Lake Victoria basin in the years 1937, 1947, 1951 and 1957-1958.

Exceptionally heavy and wide-spread rainfall occurred during October and November 1961 which caused unusually severe floods in the Kano Plains, Yala Swamp and other low-lying parts of the basin (4). In the initial stages, flooding of low-lying areas was caused by over bank spills of the six main rivers of the basin. The situation was later aggravated by the backwater effect of the rising lake level. Thousands of people had to abandon their villages, some being evacuated by helicopters. Inaccessible areas and areas marooned due to disruption of road and rail communications, were supplied food and medicines by helicopters. The Navy, the Army and the Air Force provided assistance on a massive scale to the civil authorities in flood and famine relief. As a result of these operations, loss of human lives was relatively small.

In subsequent years, Nzoia River experienced severe floods in 1963, 1975 and 1977; the Yala River in 1968, 1978 and 1979; the Nyando River in 1964, 1985 and 1988; the Sondu River in 1964, 1968 and 1990; and the Kuja in 1978 and 1990.

Recent Floods

In recent years, 3 major flood events in 1997-1998, 2002 and 2003 were experienced in the Lake Victoria Basin.

[3] A detailed description of the Flood Situation in the basin is given in Appendix I

The 1997-1998 flood was the consequence of El Nino related long and intensive rainfall during the months of October and November when precipitation was 100 to 300 percent of the normal. The floods had a tremendous impact on the environment and the population. Almost the entire Kano Plain was inundated and agricultural crops were completely destroyed. The floods also caused land degradation and increased soil erosion with consequent silting of hydropower dams. A weir on Kipchoria River, a tributary of the Nyando, was washed away and a water supply dam in Kericho district was silted up. In Uasin Gishu district, two earthen dams were washed away. Extensive damage was caused to 240 river gauging facilities due to severe bank erosion. The protective dykes were over topped and suffered breaches at several places. In Budalangi Division of Busia district more than 12,000 people were affected due to floods in Nzoia River.

The floods of 2002 and 2003 were of shorter duration. These events took place in April, May and November 2002 and April-May 2003 and affected the Kano Plains and the Budalangi area. Figure 4,5,6 and 7 are the maps showing extent of inundation due to floods of 2003, 2002 as well as February 2001 superimposed together, in the lake. These floods were caused due to heavy and concentrated rainfall in the upper catchments of Nzoia and Nyando rivers. The Sio River inundated a 3 Km wide stretch near its outfall into the lake. The Yala River inundated its flood plain upstream of Lake Kanyaboli. The problems in the Nyando river flood plains and the Budalangi division were aggravated due to breaches in the dykes during the 1997-1998 floods that had not been repaired. Figure 8 shows the ariel view of the inundation in the lower Nzoia basin near its confluence with the lake.

Impact of Floods

Loss of life: A unique feature of floods in the Lake Victoria Basin is that most of the runoff is generated in the upper catchments which receive much higher rainfall than the plains in down stream reaches. As a result, population living in the plains is often taken unawares. This causes considerable loss of human lives and livestock.

Health and developmental impact: In many low lying areas around the mouths of the rivers and natural swamps the inundation lasts for weeks leading to total loss of crops. The worst affected are the poor who inhabit the flood plains and riverine lands to eke out a meager living from agriculture, livestock farming and fisheries. Because of poverty, lack of education and poor rural infrastructure, they are the most vulnerable to floods and post-flood consequences. The floods severely limit and hamper the developmental process, further increasing the vulnerability of the rural society and thereby perpetuating and increasing the incidence of poverty. Stagnant floodwater also causes vector borne diseases, which result in high incidence of morbidity with consequent loss of alternative employment opportunities.

People from the inundated areas move to makeshift relief camps where they cluster together. Such makeshift homes soon become slums creating social problems and unhygienic conditions which are conducive for the spread of contagious diseases and sexually transmitted diseases. Often women and young girls are the worst sufferers (5).

Environmental impact: Pollution of drinking water sources like wells and tube wells, bank erosion, silting of river beds and consequent lateral shifting of river channels, displacement of wildlife and cutting down of trees for firewood around relief camps are some of the adverse environmental impacts of floods in the Lake Victoria Basin.

Financial impact: As per the assessment made after recent floods, in the last 20 Km reach of the Nzoia River the annual damage is in the order of US$[4] 800,000. Every year around 1 million US$ is spent on relief and rehabilitation of about 12,000 displaced people. In the Kano Plains, more than 5,000 people are affected every year by flood spills of Nyando River. The average annual damage is about US$ 850,000 with annual relief and rehabilitation measures costing US$ 600,000.

[4] Based on an exchange rate of 1US$= 70 KSh

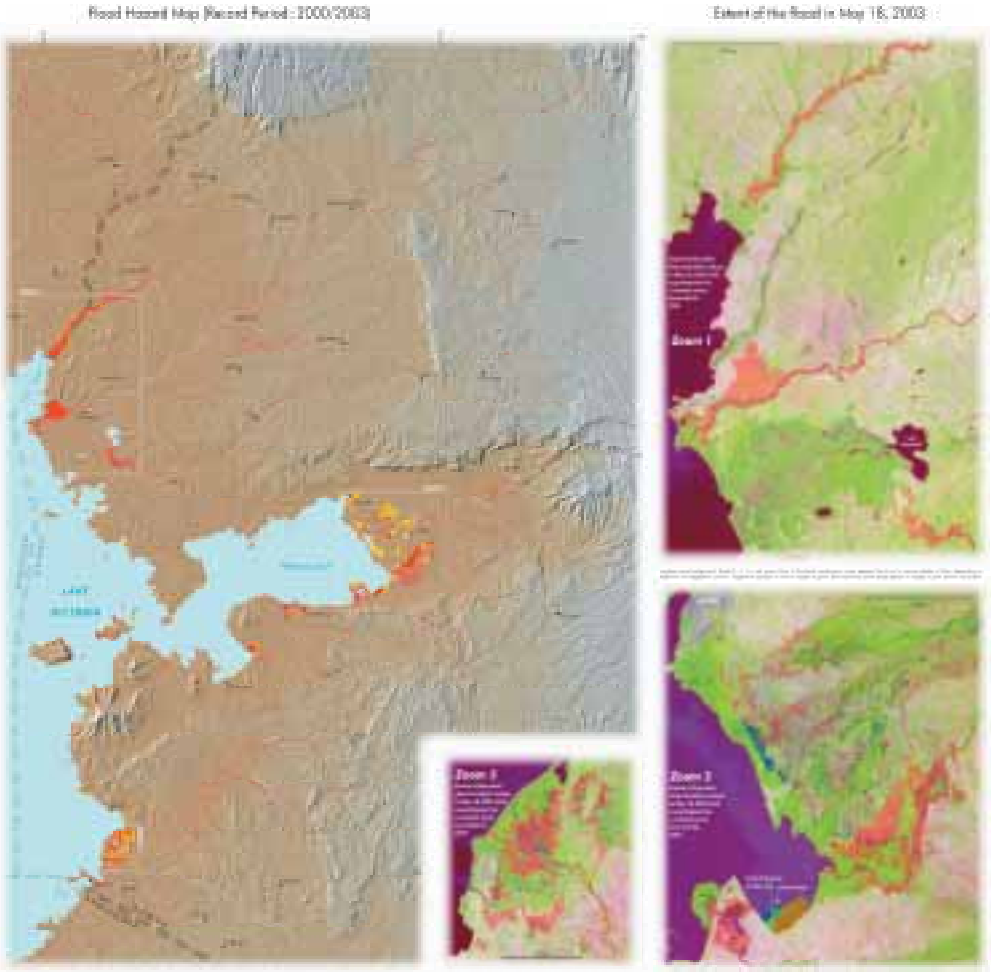


Figure 4: Landsat images showing extent of inundation on the Kenyan side of Lake Victoria

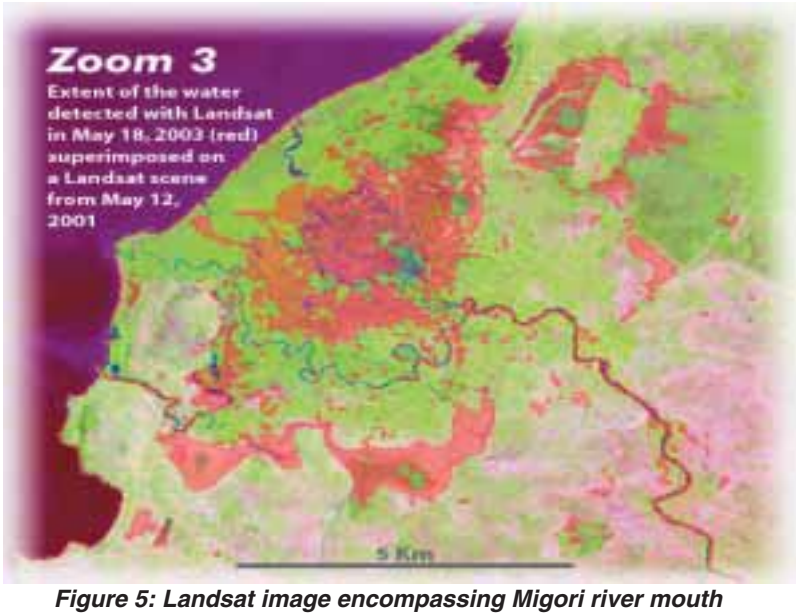


Figure 5: Landsat image encompassing Migori river mouth

Figure 6: Landsat image showing inundation near Ukwala and Ebusonga

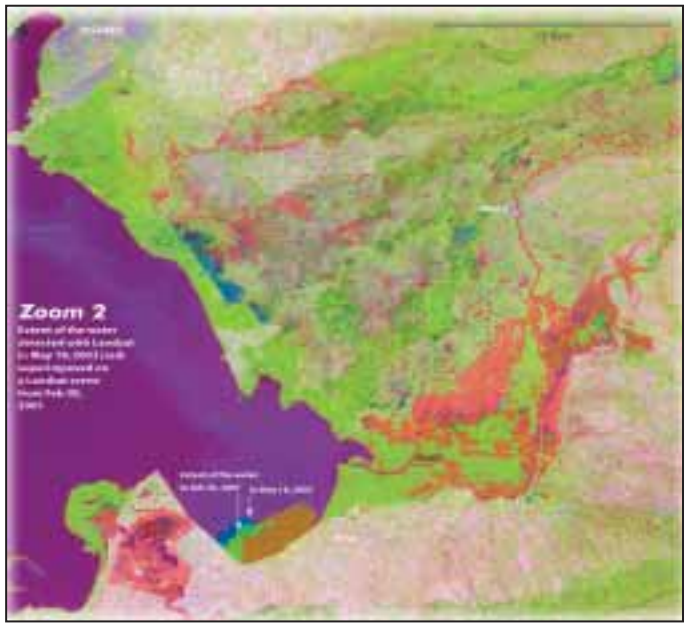


Figure 7: Landsat image showing inundation near Kisumu and Ahero

2.4 Rural and Urban Development

The incidence of rural poverty is high ranging from 53 per cent to 69 per cent. Rural overpopulation is, one of the main problems in all the three provinces in the Lake Victoria Basin. The average incomes in rural areas are much lower than in urban areas. However, infrastructure and employment opportunities in the urban areas are not adequate and sufficient to provide employment opportunities for the migrating population from rural to urban centres.

According to a study carried out by the Physical Planning Department of the Ministry of Lands and Settlement (6) the carrying capacity of land[5] in two out of five provinces in the country, has already been surpassed while in other three it is expected to be surpassed within the next 3 to 5 years. Any further intensification of land use for agriculture would be counter productive both in terms of gross agricultural production and income of individual farmers.

It is not a question of how many people should be urbanized, but of how few can be absorbed into agriculture without diluting rural income. Well planned, urbanization with appropriate policies by providing gainful employment to the growing population could help reduce further fragmentation of land. This is likely to help in creating the necessary conditions for increasing productivity in the rural areas by providing markets for agricultural products. Concentration of activities in urban centres could also provide the basis for specialization and diversification and for increased productivity in manufacturing and supporting services. If planned appropriately, urbanization could permit improved standards of education, health and other facilities, which are not possible in the countryside under the given circumstances.

2.5 Future Development Imperatives

One of the fundamental objectives of the Government is to improve the overall standard of rural life by sustainable development of basic infrastructure with focus on food security, livelihood security, and health and environment security. Besides, improved physical and social infrastructure to facilitate full exploitation of the rural potential, Integrated Water Resources Management is seen as the key developmental strategy for the rural areas (7).

The District Development plans[6] 2002-08 (8) for the 27 districts in the country with the theme "Effective Management for Sustainable Economic Growth and Poverty Reduction" have moderate development objectives since the main focus is on the reduction of extreme rural poverty. The emphasis is therefore on improving the physical and social infrastructure within the constraints of resources. Industrial development is therefore envisaged as a complement of agriculture, which is largely rain fed, and mostly at the subsistence level. The major thrust for economic development is envisaged in cash crop development and promotion, expansion and modernization of livestock farming and fisheries, agro-based industries and tourism. Water resources development is envisaged mainly for small agriculture farmers, hydropower and domestic water supply.

In the area of urban development, the emphasis is on addressing the minimum basic needs in an *ad hoc* manner rather than in an integrated and planned manner. Most of the on-going schemes are essentially for restoration and rehabilitation of the dilapidated infrastructure.

Considering the land carrying capacity, the growth of rural population and poor state of existing infrastructure, future development planning must focus on accelerated change especially from traditional crops to cash crops and on setting up the related processing industries. Simultaneously, integrated development of urban centers would be required to enable outward migration of population from the rural areas, which in turn would require massive investment in social and physical infrastructure for development of urban centres.

---

[5] Land carrying capacity has been calculated, assuming the full development of agricultural potential, a family of six persons is expected to have a reasonable per capita income from a farm size of 1.5 ha to 2.0 ha.

[6] District Development Plans are prepared for a block of 6 years by the District Development Heads of various Ministries under the coordination of the District Commissioners assisted by the District Development Officers and the members of the district planning teams. These plans are based on broad consultations among various stakeholders in the districts.

PART II

STRATEGY FOR FLOOD MANAGEMENT

3. RATIONALE FOR A STRATEGY

Flood hazards are caused by natural events, which transform into disasters through complex interactions between social, economic, political and environmental processes. A Strategy for Flood Management for the country therefore not only directly deals with the flood hazard but also has strong links with national social, economic and other development policies. Disaster prevention and mitigation due to floods is therefore a multidisciplinary endeavour wherein development activities in different sectors of the economy help in the prevention of the disasters and reduce the vulnerability of the society.

3.1 Vulnerability of People to Floods

It is the vulnerability of the community at risk that determines the extent of the flood disasters. This vulnerability is caused by a combination of physical factors such as exposure to floods, degree of protection from flood hazards, quality of infrastructure available, degree of access to resources, and ability to avoid, withstand or recover from the flood hazards. Socio-economic factors like acute poverty, high population density, lack of education, poor planning and management of agricultural and farm lands, poor quality of agricultural inputs and technology and absence of access to modern technological options to cope with the situation increases the vulnerability of the population to floods. Occupation also plays a role, for example, fishermen whose occupation requires them to live close to rivers and other water bodies, are more at risk than others and are therefore more vulnerable. People are also unaware of adaptation measures used elsewhere that can help in living with floods.

3.2 Factors Contributing to Increasing Flood Disasters

Increasing flood disasters in Lake Victoria are a complex construct of the increasing vulnerability of the population occupying the flood prone areas, and the increasing flooding instances. Floods in the Lake Victoria basin, like in most cases worldwide are caused by heavy rainfall interacting with hill slopes. These hill slopes without vegetative covers give the floods the characteristics of flash floods in the vicinity of foothills and produce large amount of sediment. Other anthropogenic factors such as increased economic use of flood plains combined with improved reporting of the impacts of floods have also given an impression of increased flood disasters. In the Lake Victoria Basin the factors contributing to increased flood disasters could be summarized as follows:

1. Population pressure: Intensive economic use of the flood plains for agriculture and livestock farming.
2. Deteriorating infrastructure: Lack of systematic and routine maintenance of flood dykes, makes them susceptible to breaches even during floods of lower magnitudes than the design flood.
3. Environmental degradation of watersheds caused by uncontrolled and unregulated human activity, especially large-scale deforestation and cultivation practices, resulting in:
   (i) Increase in flood peaks.
   (ii) Reduced flood carrying capacity of the rivers due to excessive siltation of their bed.
   (iii) Shifting of river courses causing erosion of dykes.

Increase in Flooding Instances

A recent analysis of floods by the Ministry of Water Resources Management and Development (MWRMD) at the river gauging station No 1GD03 for the period 1969 to 1997 indicates that flood discharges for different return periods have since increased significantly as shown in Table 2.

Table 2: Flood discharges for different return periods

Return Period (Years)	Discharge (Cumec)			% Variation	
	2003 Study	1983 Study	1992 Study	2003-1983	2003-1992
10	863	550	437	57	97
25	1,044	650	564	61	85
50	1,178	750	659	57	78
100	1,310	850	752	54	74

Source: Flood control on Nyando, Nzoia and Tana River, MWRMD, October 2003

The study also draws broad inferences that during the period 1980 to 1987 the peak discharges had decreased due to the forestation programs that were undertaken, whereas during 1988 to 1997 these peak discharges had increased sharply due to massive destruction of forest cover. It would be desirable to collect and analyze data from different parts of the watershed and also analyze the rainfall pattern, before drawing any firm conclusions. However, the increased discharges for various return periods shown in the above table need to be taken into consideration in planning immediate and short term measures since the effect of watershed development programs are felt only in the long term.

Climate Variability and Change

There is also a growing concern about the impact of climate change on the frequency of floods. A number of studies on the potential impacts of climate change on flooding have been carried out by IPCC (9). These studies point towards future increases in the incidence of flooding due to increased storm activity and overall increase in depth of precipitation. Increased climate variability also can lead to excessive floods or droughts with consequential adverse impacts.

The GCM based future rainfall scenarios for Kenya for the year 2030 broadly indicate that the region extending from Lake Victoria to central highlands east of the Rift Valley will experience mild increases in annual rainfall with highest increments of rainfall in the vicinity of Mount Elgon. If these projections are accurate, there are likely to be far reaching implications on intensity and frequency of regional floods (10).

4. STRATEGY FORMULATION PROCESS

4.1 Steering Committee

A steering Committee consisting of representatives from the Ministry of Water Resources Management and Development, the Kenya Meteorological Department, the Office of the President and supported by the WMO International Consultant and a National Consultant, was constituted to oversee the process of development of the strategy. Input was also provided from the Technical Support Unit of the Associated Programme on Flood Management (APFM). The Steering Committee held 8 meetings in which they guided development of the study and reviewed the sector reports prepared by the WMO Consultant, which helped in formulating the present strategy.

4.2 Stakeholders Perspective for Future Development

Development processes in most of the developing countries, after gaining self-rule have been highly centralised due to various reasons, such as lack of education among the masses and inadequate means of communication with the communities. These centralised development processes have resulted in decreasing ability of the local community to help themselves or to articulate their needs. This type of development has more often than not been unsustainable. Lately, the governments have recognised the importance of taking informed decisions by involving all stakeholders. With this new perspective in view, after detailed study of the flood issues through governmental reports and documents, the flood and other development issues were discussed with the stakeholder's to assess how they view the issues of development and flood management.

In the Stakeholders Workshop[7] held at Kisumu from 10th to 12th March 2004, the participants were unanimous in their opinion that poor quality inputs and unscientific techniques being used in agriculture, livestock and fisheries industries result in low-income levels in the country and particularly in the flood prone areas. Market access for the products is greatly hampered due to poor road network and roads, which worsens during floods. Farmers do not get remunerative prices for their products due to open market competition and inadequate support from the Government and are unable to store their produce, due to various reasons such as the risk of flooding among others.

Flood plains have the most potential productivity in agriculture and fisheries, whilst middle reaches of rivers are more productive for animal husbandry. Productivity for agriculture is relatively less in middle reaches and least in the upper catchments of rivers. Animal husbandry is least productive in flood plains. Alternative employment opportunities are perceived in sugar factories, tea and coffee plantations and transport sector. The participants of the workshop, therefore, felt that by providing these facilities, the vulnerability of the occupants of flood prone areas to flood hazards could be reduced which could also help long-term prosperity in the region.

4.3 Policy Makers' Workshop

As mentioned in Section 3 above, flood management strategy hinges on inputs not only from the water resources ministry but also from various other ministries and departments engaged in economic development and disaster management.

A policy makers' workshop was therefore organised in Nairobi on 23rd April 2004, to obtain an input from the representatives of the policy perspective of the various sectors of development. The participants were the Minister, the Permanent Secretary and a number of officials, from the Ministry of Water Resources Management and Development. Other high level officials from various ministries also participated. Officials from the Japanese Embassy in Nairobi and Japan International Cooperation Agency (JICA) also participated in the workshop.

A working paper based on a brief study of the water resources management process in the country, various policy documents from different development ministries and inputs from the stakeholders' workshop as presented. The following policy principles emerged from the policy makers' workshop:

a. Water resources development and management should be carried out in an integrated manner through the IWRM process.
b. Flood plains should be managed with the aim of maximizing their economic benefits and minimizing the loss of human lives.
c. Flood Management should be carried out within the overall framework of IWRM following a basin based approach and integrated with land management.
d. Environment protection and ecosystem system approach should be followed for the benefit of sustainable development.
e. Community participation at various stages of planning, implementation and management of floods should be encouraged and facilitated including participation of women.
f. Effective co-ordination among various development initiatives taken by the government is an essential pre-requisite for an integrated approach to development in general and Flood Management in particular.

5. ELEMENTS OF STRATEGY

5.1 Reducing Vulnerability

Element 1 *Vulnerability reduction of the flood plain occupants should be addressed through appropriate policies in different sectors.*

Steps should be taken through appropriate policy instrument and through coordination mechanism to reduce vulnerability of the flood plain occupants by improving their resource base and incomes. Raising the standards of living and economic development improve education, health, economic

[7] A report on the workshop is given at Annex I

resilience and access to resources to take preventive measures and to mitigate the post-flood affects. Reduction in vulnerability directly influences the adverse impacts of floods.

The people living in the flood plains are poor due to small land holdings and low yields due to poor quality of agricultural inputs and crop husbandry. The farmers do not get remunerative prices for their produce and the support provided by the National Cereals and Produce Board (NCPB) is often inadequate. There are no alternative livelihood options to enhance their income as such they are unable to mobilize resources to face the challenge of floods. Their vulnerability to floods is further compounded due to poor physical and social infrastructure, lack of awareness about health and hygiene leading to morbidity and high HIV/AIDS incidence.

Element 2 *Agricultural policy should be developed to exploit the full potential of the fertile flood plains.*

Agriculture is the mainstay of the income generation for majority of population in flood plains. The Agriculture Policy of the country should aim at empowering the agriculturists and facilitating special support to the weaker section of the community and addressing special problems of cultivators of the flood plains.

Element 3 *The Agriculture Ministry should develop, support and encourage flood resistant crops and cropping patterns including orchards, floriculture etc. that would help income growth in flood prone areas[8].*

The Agriculture Act (11) makes a general provision for a review of annual programmes of production of essential crops in Kenya but no special consideration has been given to the issues and problems related to crop production in areas prone to floods and droughts. The Act also does not address special agricultural research and development needs of flood prone areas and therefore needs to be revised.

Element 4 *The Physical Planning Department should prepare and implement plans for integrated development of nearby urban areas.*

The rural population in all the three provinces within the Lake Victoria Basin has almost reached the carrying capacity of the land. A major issue that needs to be addressed in future sustainable development planning is the rural overpopulation which would result in fragmentation of land holdings leading to decline in productivity and further decline in incomes. Urbanization and creation of healthy markets for agricultural products is, therefore, a necessary condition for increasing productivity and incomes in the rural areas. Intensive activities in towns are likely to provide the basis for specialization and diversification and for increased productivity in the manufacturing and supporting services and also provide sufficient grounds for improving standards of education, health and other services. This would lead to inward migration from rural areas, and help reduce further fragmentation of agricultural lands, thereby paving the way for sustainable agricultural growth.

5.2 Reorientation of Approach to Development and Floods

Element 5 *Ministry of Planning and National Development to evolve a policy that considers flood plains as national asset that is crucial for accelerated growth of GDP.*

Flood plains offer enormous advantages, the fertile alluvial soils of flood plains are ideal for high crop yields, livestock farming and other economic activities and should be made use of. Currently investment in flood management infrastructure is largely based on humanitarian considerations and that too on an ad hoc basis after major flood disaster. This perspective needs to be revised. It is important to note that forward looking developmental planning, fully exploiting the potential of the flood plains, is likely to provide greater economic justification for intensive flood management practices. On the other hand, developmental planning focused on traditional land uses for subsistence farming will fail to encourage investments in flood management.

[8] An indicative list of areas that need to be addressed through the agricultural research is given in Annex II.

The strategy for flood management in Lake Victoria Basin, therefore, must simultaneously address the present problems of the poor flood plain dwellers and the imperatives of future development of the entire fertile land that is prone to frequent flooding. The developmental planning must be pro-active and dynamic and take into consideration the likely multiplier effects development of fertile flood plains has on various other sectors of economy that spread far beyond the target areas thereby reducing the vulnerability of the flood plain dwellers.

Flood management should, therefore, have both social and economic objectives. While the social objective should be the alleviation of the suffering of the flood plain dwellers, the economic objective should be to maximise the net benefits from the flood plains in terms of GDP, employment generation, and individual income growth and income distribution.

Element 6 *Industrial policy should be formulated for flood prone areas based on the imperatives of future development and employment generation around flood plains with emphasis on agro-based industries.*

Substantial development oriented investment in and around flood prone areas are, therefore, necessary. Industrial zones, contiguous to the flood plains could be developed to make use of agricultural and aquaculture produce and provide means of alternative income for the flood plain dwellers. The infrastructure developed in and around flood plains has to compulsorily be flood proofed.

5.3 Integrated Approach to Water Resources Development and Flood Management

Element 7 *A National Policy on Flood Management should be evolved and adopted based on the Integrated Flood Management concept integrating land and water management through the process of IWRM.*

The present strategy for flood management is based on the concept of Integrated Flood Management (IFM), which in its broadest sense is a subset of Integrated Water Resources Management (IWRM) which is a necessary criterion for sustainable development. IWRM essentially means provision of water in adequate quantity and of appropriate quality for all those sectors of economy, which depend directly or indirectly on water by promoting coordinated development of land, water and related resources. Accordingly, the defining characteristic of IFM is integration, expressed simultaneously in different forms: an appropriate mix of strategies, points of intervention, types of intervention – structural or non structural, short term or long term measures and a participatory approach to decision making.

The Ministry of Water Resources Management and Development is presently preparing the IWRM plan for the country. These IWRM plans should take account of this flood management strategy and vice versa.

Element 8 *A national Land Use Policy addressing the land use in flood plains should be developed.*

Land is one of the fundamental resources available to a community for its survival and economic well being. Water at the same time plays a pivotal role in not only the economic development but also the very existence of life. Land use has enormously significant effect on both the quantity as well as the quality of the water resources available to the community.

Presently, there is no policy on land use in flood plains. A clear and long term national land use policy addressing the development issues in totality including land administration, access to land, land use planning, land information management system, public land allocations etc is essential for both water resources management and flood management.

Element 9 *The Lake Basin Development Authority should be rejuvenated to accelerate the pace of development in the basin with water as an input through implementation of comprehensive schemes aimed at optimal utilization of available water resources in various sectors of economy.*

5.4 Protecting and Conserving Environment

Element 10 *The environmental impacts of flood management options and impacts of floods on the environment should be addressed in the Environmental Management Act.*

There are both adverse as well as beneficial impacts of floods on environment. At the same time the environment influences the characteristics and other impacts of floods. The Environmental Management and coordination Act (12) has elaborate provisions for protection and conservation of environment with specific references to rivers, lakes and wetlands. Para 42 (4) empowers the National Environmental Management Authority (NEMA) to issue guidelines for management of the environment of lakes and rivers in consultation with relevant agencies. The District Environmental Committees are required under the Act to prepare, distinct environmental action plans, every five years, taking into consideration the relevant sectoral interests.

Element 11 *Land use regulations should be developed and forest protection laws enforced to protect and develop the watersheds.*

Large-scale deforestation and human activities in the watershed areas have led to serious degradation of the water resources base. The rate of deforestation is continuing unabated at an estimated rate of 6,000 to 9,000 ha per year. The serious implications of this are already in evidence in the form of excessive sheet erosion from the catchments and subsequent deposition of sediments in the river channels in the middle and lower reaches. A recent study has shown a 4-fold increase in sediment load over the estimates made in the 1983 study by Ital Consult.

Element 12 *Watershed development plans[9] should be prepared and implemented with due emphasis on the soil conservation to prevent excess sheet erosion and consequent silting of rivers.*

In order to check further degradation of the watersheds and siltation of the rivers, immediate steps have to be initiated for watershed development and management. This highlights the urgent need for taking up massive watershed development programs. However, these measures have to be planned carefully taking into consideration the livelihood options of the people living in those areas and with their active involvement at various stages.

5.5 Addressing Weather and Climate Variability and Change

Element 13 *Weather and climate forecasts and early warning should be used for risk management in developmental plans and implementation of the programmes.*

Element 14 *Long-term adaptation plans based on current predictions and forecasts for weather and climate changes should be prepared.*

Recent studies indicate a trend of significant changes in annual weather patterns (13). These changes are likely to have far reaching implications for water resources and thereby on the general well being of people in many parts of the world including Kenya (14). Even the normal predictable pattern of weather cycle to which the people have learnt to adapt themselves may become highly unpredictable making natural adaptation difficult. In the context of floods, these changes are likely to be felt in the increase in extent, intensity and frequency of floods.

5.6 Coordination between Various Ministries and Agencies

Element 15 *An effective and evolving inter-sector coordination mechanism should be established at various levels to plan and implement pre-disaster and post-disaster flood prevention and mitigation measures.*

As has already been pointed out flood management is a multi-sectoral pursuit. There are numerous stakeholders and players in the management process with variable geographical, administrative and economic jurisdiction. Each player, individuals as well as institutions, play their part under a perceived

[9] Indicative Guidelines for Watershed Development are given in Annex III

set of conditions according to their experiences and history. These perceptions often bring differences in opinions and approaches to the task at hand. It is important to bring all the players together and exchange data, information and knowledge, in order to bring the best in each player as contribution to the overall objective of economic well being. It is necessary to establish a well-organized mechanism for coordination among various ministries, departments and stakeholders clearly defining the procedures for decision making that are transparent and support community participation, in order, to adopt an integrated approach to the water resources development and for the proper implementation of various programmes in the water sector in general and flood management in particular. A typical coordination mechanism in the water sector is shown in Figure In case of flood management these coordination mechanisms would be different for dealing with pre- flood[10] and post- flood situations. Such mechanisms have to be developed through extensive consultations with all the key line ministries/departments such as and not limited to:

(i) Ministry of Water Resources Management and Development.
(ii) Ministry of Agriculture
(iii) Ministry of Planning and National Development.
(iv) Ministry of Livestock and Fisheries.
(v) Ministry of Energy/Power
(vi) Ministry of Environment, Wildlife and Natural Resources.
(vii) Ministry of Lands and Housing
(viii) Ministry of Local Government
(ix) Ministry of Transport and Communication.
(x) Ministry of Finance
(xi) Ministry of Health
(xii) Kenya Meteorological Department
(xiii) Survey of Kenya
(xiv) Geological Survey of Kenya
(xv) Department of Soil Survey
(xvi) Appropriate local administration

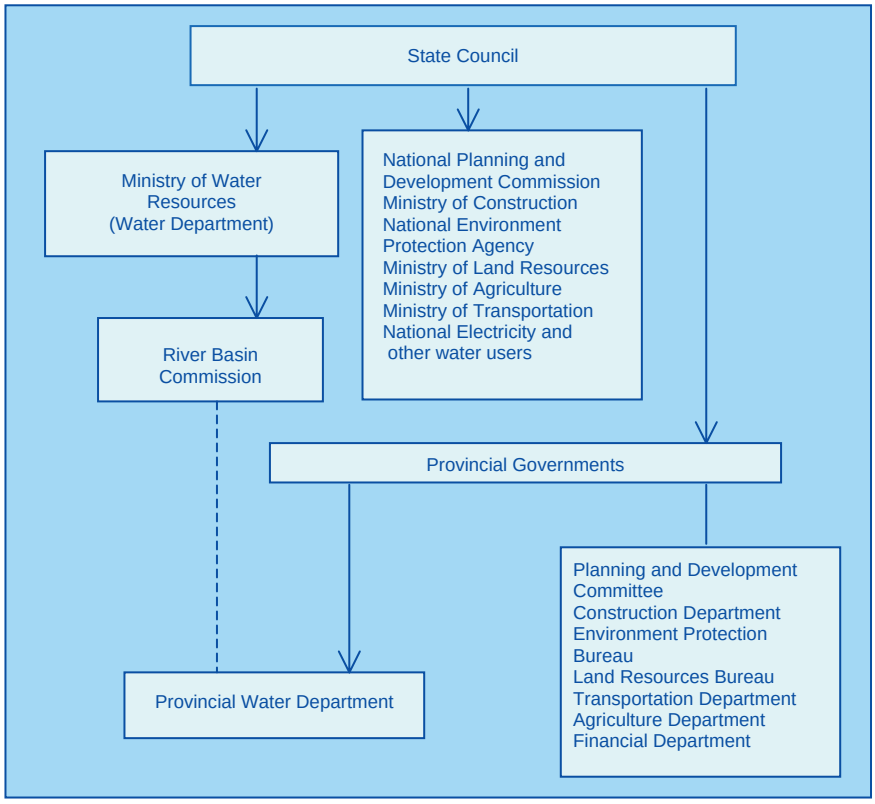


Figure 8: Typical Organizational Flowchart relating to River Basin Management

[10] An indicative coordination mechanism is given in Annex IV

PART III

FLOOD MANAGEMENT POLICIES

6. POLICY PRINCIPLES

One of the main elements of the Strategy for Flood Management, described in Part II, is formulation of a Flood Management Policy, which lays down the basic principles of flood mitigation measures. The policy has to address the institutional, including legal and organizational, issues dealing with pre and post flood situations. It should also take into consideration various options for flood mitigation based on the present hydro-meteorological, technical, financial, and other infrastructure. It should be reviewed as and when required, and at least once in ten years, in light of the changing ground situation.

This Flood Management Policy is based on the Integrated Flood Management concept with special emphasis on the following:

1. Flood management and development

- Flood management should be seen as an essential ingredient in poverty alleviation and sustainable development.
- Floodwaters are local and natural assets and must be harnessed for various economic and social uses.
- Storage and conservation of floodwaters modifies the flood hazard and is necessary to meet various requirements in periods of scarcity.
- For conservation of the ecosystem, interference with natural flow regime of the rivers has to be avoided as far as possible.

2. Integrative approach

- Integration of land and natural resources management especially water resources and the watershed development.
- Integrated Flood Management approach within the overall framework of Integrated Water Resources Management.
- The vulnerability of the flood plain occupants calls for immediate, medium and long-term measures within an overall master plan based on basin approach.
- Development and refinements in planning design and construction norms/practices.
- Preparation of standards, manuals and guidelines.

3. Risk Management

- Full protection from floods is a myth.
- Evolve criteria for allowable risks and affordable costs incorporating potential failures beyond design discharge or breaches.

4. Appropriate mix of measures

- Mitigation and non-structural measures are effective and sustainable.
- Developing adaptation measures at various levels to minimize the impact of flood.
- Effective flood forecasting and warning minimizes adverse impact of floods both in a stand-alone mode as well as in combination with other options.
- Preparedness against emergency and quick response forms the backbone of flood mitigation measures.
- Structural measures are important elements with focus on human health, safety and valuable goods and property.

Box 1 Elements and aspects of Integrated Flood Management (IFM)

1. *Managing the water cycle as a whole*

1.1 Flood management plans must be intertwined with drought management through the effective use of floodwater and/or by maximising the "positive" aspects of floods.
1.2 Manage all floods and not just some. For example, how to manage floods greater than the designed standard needs to be addressed.
1.3 Seek multi-beneficial solutions that serve several purposes simultaneously.

2. *Integrating land and water management*

2.1 Land-use planning and water management must be combined in one synthesised plan, through co-ordination of land and water management authorities, to achieve consistency in planning.
2.2 The three main elements of river basin management –i.e. wa ter quantity, water quality, and the processes of erosion and deposition –should be linked in p lanning.
2.3 Effect of land-use changes on the various elements of the hydrological cycle needs to be taken into account.

3. *Adopting a best mix of strategies*

2.4 Flood management strategies should involve a combination of complementary options.
2.5 A layered strategy appropriate to given socio-economic and geo-climatic conditions and adaptable to changing conditions should be adopted.
2.6 An appropriate combination of structural and non-structural measures must be evaluated, adopted and implemented, recognising the relative merits and demerits.

4. *Ensuring a participatory approach*

2.7 IFM should be based on a participatory approach involving users, planners and policy-makers at all levels and should be open, transparent, inclusive and communicative.
2.8 Decentralisation of decision-making is necessary, with full public consultation and involvement of stakeholders in planning and implementation.
2.9 Gender, religious and cultural differences must be taken into account.
2.10 An appropriate combination of both the "bottom-up" and "to p-down" approaches needs to be adopted.
2.11 Co-ordination at the highest level to promote co-ordination and co-operation across functional and administrative boundaries needs to be ensured.

5. *Adopting integrated hazard management approaches*

5.1 Flood management should be integrated into a wider risk management system of "all hazards" emergency planning and management.
5.2 Experts from all sectors, involving different disciplines, should be involved in the implementation of disaster management plans.
5.3 Consistency in approaches to natural hazard management in all relevant national or local plans should be ensured.
5.4 Early warnings and forecasts, that are key inputs for reducing the socio-economic impacts of all natural hazards including floods, should be strengthened.

7. POLICY ELEMENTS

7.1 Institutional Arrangements

Flood Related Legislative Arrangement

The Water Act, 2002 (15) provides for developing a "Catchment management strategy" for protection and control of water resources. It specifically provides for protection of catchment areas. This is a significant enabling provision, which, in practical application, may substantially reduce flood hazard.

River Basin organizations (RBOs) (16) are important institutions for Integrated Water Resources Management. The regional offices of the newly created Water Resources Management Authority (WRMA) are to be established in or near the 6 identified catchments (basins). According to the present thinking in MWRMD these "regional offices" of WRMA would be required to "formulate catchment management strategy" and facilitate formation of Water Uses Associations (WUAs) to assist in cooperative management of water resources and resolution of conflicts.

The term "catchment management" has a general meaning and connotation limited to land management in a watershed. It would be desirable to redefine the role of these regional offices as "formulation of basin management strategy". Planning of flood mitigation measures should also be factored in to the Integrated Water Resources Management and entrusted to RBOs. These Basin Organizations can therefore provide a forum for the effective participation of the communities in planning of flood mitigation measures considering the basin as a planning unit.

The regional office for Lake Victoria Basin could function as the secretariat of the RBO with assistance from the proposed multidisciplinary catchment Area Advisory Committees.

Policy: *The river basin approach to Integrated Water Resources Management (IWRM) adopted under Water Act 2002 should be extended to flood management in accordance with the IFM concept. Lake Victoria Basin Organization should be setup and should be charged with planning flood management measures along with IWRM.*

Disaster Management

Disaster Operations Center (DOC) under the office of the President is responsible for management of all disasters through the Disaster Management Committees (DMC) at the provincial and district levels, under the Chairmanship of the Provincial Commissioner (PC). The role of the DOC is coordination of post disaster related activities of various Ministries up to the district level. The role of MWRMD is mainly in relief operations by providing drinking water for the evacuated people in relief camps.

The Disaster Operations Centre (DOC) is provided weather forecasts and early flood warning by the Kenya Meteorological Department (KMD). DOC, after making an assessment of the magnitude of the impending flood and its disaster potential, informs the provincial Disaster Management Committees. These committees are responsible for rescue and relief operations through multidisciplinary teams at the district and community levels.

Lack of advance warning of incoming floods takes the public unaware, leaving no time to take preventive measures. Houses are prone to flooding and there are no high grounds nearby for immediate shelter and often the people do not leave their homes unguarded, for security of their meagre assets. The flood forecasting and warning system at the river level needs to be put in place with clear definition of roles.

There are no institutional arrangements to review and update the early warning system thereby improving the efficiency and preparedness or determine the adequacy and efficient utilization of resources; assess the impact of disaster management programs on the population, economy and environment and assess the role and effectiveness of various stakeholders in the implementation of these plans. There is need to strengthen linkage between MWRMD, Disaster Operations Centre (DOC) and Kenya Meteorological Department (KMD) to develop an integrated flood forecasting and disaster management system. Existing disaster management mechanism is geared primarily to deal with rescue and relief measures and not towards preventive action to minimize the disaster itself.

Policy: *Flood emergencies should be managed in an integrated manner within the overall proposed National Disaster Management Policy with clearly defined responsibility for flood forecasting and warning. The proposed National Disaster Management Authority (NDMA) should have strong link with the flood management units under the WRMA.*

Financial and economic arrangements

Repeatedly providing flood relief and compensation to flood victims may be humane but in economic terms provides an unsustainable subsidy for flood plain use. However, in practice withdrawing flood relief and compensation to flood victims raises a moral dilemma. It is therefore wiser to invest in flood management measures that concentrate on prevention and preparedness rather than spending on flood relief efforts.

Funding arrangements for such sustainable measures are a very important part of institutional arrangements. When financing flood management projects, planning funds from all the major layers of government and communities are desirable. There have to be appropriate contributions from all government levels, starting from the central to provincial, further down to the district level and if possible even from the community level. This layered funding approach is likely to increase ownership of, and commitment to flood management strategies thereby improving its sustainability and is also likely to help in mobilising funding from multiple sources such as international donors.

Policy: *There is need to develop a clear fiscal policy on flood management in consultation with the Finance Ministry.*

There are two possible criteria employed for appraisal and making choices between various available options; the benefit-cost ratio and/or the net present value. Funding and financing arrangements critically influence option choice, for example, where financial resources are faced with competing demands, benefit-cost ratio provides a good appraisal system. There is a need to develop and adopt clear guidelines for such analysis for flood management projects in the country.

A range of planning, regulatory and economic instruments such as levying taxes or flood insurance are used in many countries to encourage and develop Integrated Flood Management. However, given the economic situation in the Lake Victoria Basin, the use of economic instruments will be minimal. Government has to rely upon planning instruments, as flood protection has to be regarded as a public good.

Policy: *Guidelines for economic appraisal of flood management projects should be developed.*

7.2 Organisation Structure

Flood Management Units

The subject of flood management is presently dealt with by the Water Department under the Ministry of Water Resources Management and Development (MWRMD). The district units of MWRMD also report on the flood situation. In the water department, there is no section to deal exclusively with flood management issues. The procedure for monitoring is *ad hoc* as there are no field staff dedicated to keep track of flood situations or to take preventive or remedial measures during or after the floods.

A number of flood protection works like dykes; drainage channels river conservancy works etc were built in different river basins before and immediately after independence. The MWRMD owns these assets, but has no financial or organizational mechanism for their routine repairs and maintenance. Specific schemes for major repairs are planned and implemented from time to time without an overview plan.

In the mid-eighties a project planning unit was established to plan and design specific flood protection works but no comprehensive studies for flood management have been carried out by the unit. The Ministry had, however, commissioned Ital Consult in mid eighties and the Japan International Cooperation Agency (JICA) in 1990 to prepare water resources development plans including flood management plans. Since the preparation of the Nation Water Master Plan in 1992 by JICA, no significant follow up action has been taken for the implementation of the proposed flood control plan.

***Policy**: Flood Management Units should be setup under the newly created Water Resources Management Authority (WRMA) both at head quarters and in the field to deal with the following:*

i. Establishing a Flood Information System through compilation of flood damage data; preparation of daily, seasonal and annual flood reports and a knowledge base;
ii. Field surveys and investigations including environmental base line surveys.
iii. Planning, design and project formulation.
iv. Construction supervision and maintenance of flood management works.
v. Coordination with other related Ministries and organizations.

Flood Related Data Collection

Assessment of flood damage[11] is carried out by the department of Resource Survey and Remote Sensing, local development authorities and various Ministries and then compiled by MWRMD. However, assessment is made only occasionally and is mainly qualitative. There are no set procedures or norms for assessment of monetary value of damages under different categories. There is often considerable time lag between occurrence of damaging floods and assessment/compilation of damage data.

There is need for appropriate institutional mechanism at various levels, apportionment of mandates and responsibilities and allocation of resources for flood damage assessment and analysis on a regular basis to have a clear picture of the floods in retrospect.

In the area of hydrological data observation, database management and analysis there are significant institutional weaknesses that have led to considerable data gaps and reduced reliability of data. Over the years there has been deterioration in the condition of the river gauging stations due to lack of repairs and preventive maintenance, especially during recent years which have witnessed severe damage to a number of river gauging stations due to floods. The automatic data sensors have not been checked or recalibrated for a long time. Besides the staff gauges and automatic water level recorders have not been connected to a common reference datum. The data from these gauges therefore, cannot be used in flood forecasting based on channel routing models. There is an urgent need to review the condition of existing river gauging stations for sensors and data loggers and identify those needing replacement and calibration.

***Policy:** The National Hydrological Service should be setup under the Water Resources Management Authority charged with maintenance and management of river gauging stations, hydrological data observation, data base management and flood forecasting.*

***Policy:** A clear policy for the "sustainability of the hydrological data observation" including appropriate technology and equipment, procurement and maintenance of instrumentation, and data base management should be laid down.*

***Policy:** Appropriate mechanism, formats and protocols should be developed for smooth data exchange between different stakeholders.*

***Policy:** Regular flood damage assessment mechanism should be created under the National Disaster Management Authority.*

7.3 Structural Measures

A range of flood mitigation measures broadly categorized, as structural and non-structural measures are available for adoption in a given situation depending on the physical, hydro-meteorological, social, economical and political setting of the flood prone areas.

A long-term basin Master Plan should be prepared, choosing a best mix of options depending on the objectives and available resources, with active involvement of all stakeholders. Existing project proposals under the NWMP 1992 need to be updated taking into consideration the additional

[11] Refer Annex V

hydrological data for subsequent years, fresh baseline environmental surveys and the prevailing developmental requirements.

These Master Plans have to follow the overall IWRM approach. Detailed guidelines for preparing Flood Mitigation Master Plans need to be developed[12].

Policy: *Prepare basin wise Master Plans for integrated development of water resources including IFM after detailed surveys and investigations.*

Dykes and Multi-purpose reservoirs

Structural measures play an important role, among the range of available options. High flood discharges when in excess of the carrying capacity of river channels, spill over the banks and inundate large areas on either side. In the outfall reaches of the rivers, due to mild land slopes, there is drainage congestion, which is often aggravated due to high water levels of the lake. When the high floods in a river coincide with high lake levels, the back water effect travels far upstream causing wide spread inundation for long durations. Protection against these floods is provided with the help of dykes. However, these dykes, being earthen structures need regular maintenance and are breached sometimes due to overtopping and/or due to river erosion. The 1997-98 floods caused several such breaches in the river dykes. The effect of the floods of 2002 and 2003 was aggravated, as these breaches were not restored.

Policy: *Existing protection works including river training and anti-erosion works should be strengthened after reviewing their efficacy, engineering design adequacy, the river morphological behaviour and public acceptance.*

Policy: *Appropriate guidance material catering to the local conditions, needs and utilizing indigenous sources should be prepared in form of manuals for field investigations, design, construction and maintenance of dykes/embankments for flood protection.*

Policy: *A dedicated mechanism for maintenance of dykes and other flood management structures should be put in place.*

Policy: *Criterion for protection of critical unprotected areas with new dykes should be evolved duly accounting for the level of proposed development.*

- *Indicative criteria are as follows:*

a.	*Extensive Agricultural areas (Medium to high economic value)*	*25 year return period*
b.	*Towns and densely populated village clusters*	*50 year return period*
c.	*Important towns public utilities/infrastructure*	*100 year return period*
d.	*Cities, major infrastructure, industrial areas or monuments of national importance*	*100 year to 500 year*

Policy: *Implementation of multi-purpose reservoir projects should be initiated with appropriate environmental safeguards.*

7.4 Non-structural Measures

Development of Flood Forecasting and Warning System

Structural measures for flood protection like dykes are designed for floods of certain return period (usually 25 years), therefore there is a risk of disaster from floods of higher magnitude. It is therefore important to have other complementary measures in place. Among the non-structural measures (20), flood forecasting and warning is one of the most effective methods, of reducing risk to life and property.

The most catastrophic impact of floods is the loss of human lives. The main reason is that people are often taken unawares when floods occur due to heavy concentrated rainfall in the upper catchment of rivers with moderate or little rainfall in the plains lower down. Presently there is no established flood

[12] Broad approach for preparing Master Plans is given in Annex VI.

flow forecasting system on any of the flood prone rivers in the river basin. Some indicative forecast is made by the KMD in the form of rainfall. However, the KMD staff in the field and the headquarters is not fully outfitted for real time observation and communication of rainfall.

It is important that the flood warnings are delivered to affected communities without loss of time, and that they understand them, in order to take immediate preventive steps. However, this is a complex process and needs proper awareness building and education of both the forecasters and the communities. The local knowledge and beliefs of the communities and their special social and cultural setting have to also be kept in perspective while issuing flood warnings.

The Ministry of Water Resources Management and Development (MWRMD) has initiated programs for developing a Flood Risk Information and Early Warning System (FRIEWS) for the country and have installed the model but it is not yet operational because of logistical difficulties in obtaining weather related data for the model.

Policy: *Appropriate linkage should be developed between MWRMD and KMD for timely forecast of concentrated and localized heavy rainfall/cloud burst through radar system to enable forecasting for flash floods.*

Policy: *A river flood forecasting system should be established duly integrating the rainfall warning system of KMD.*

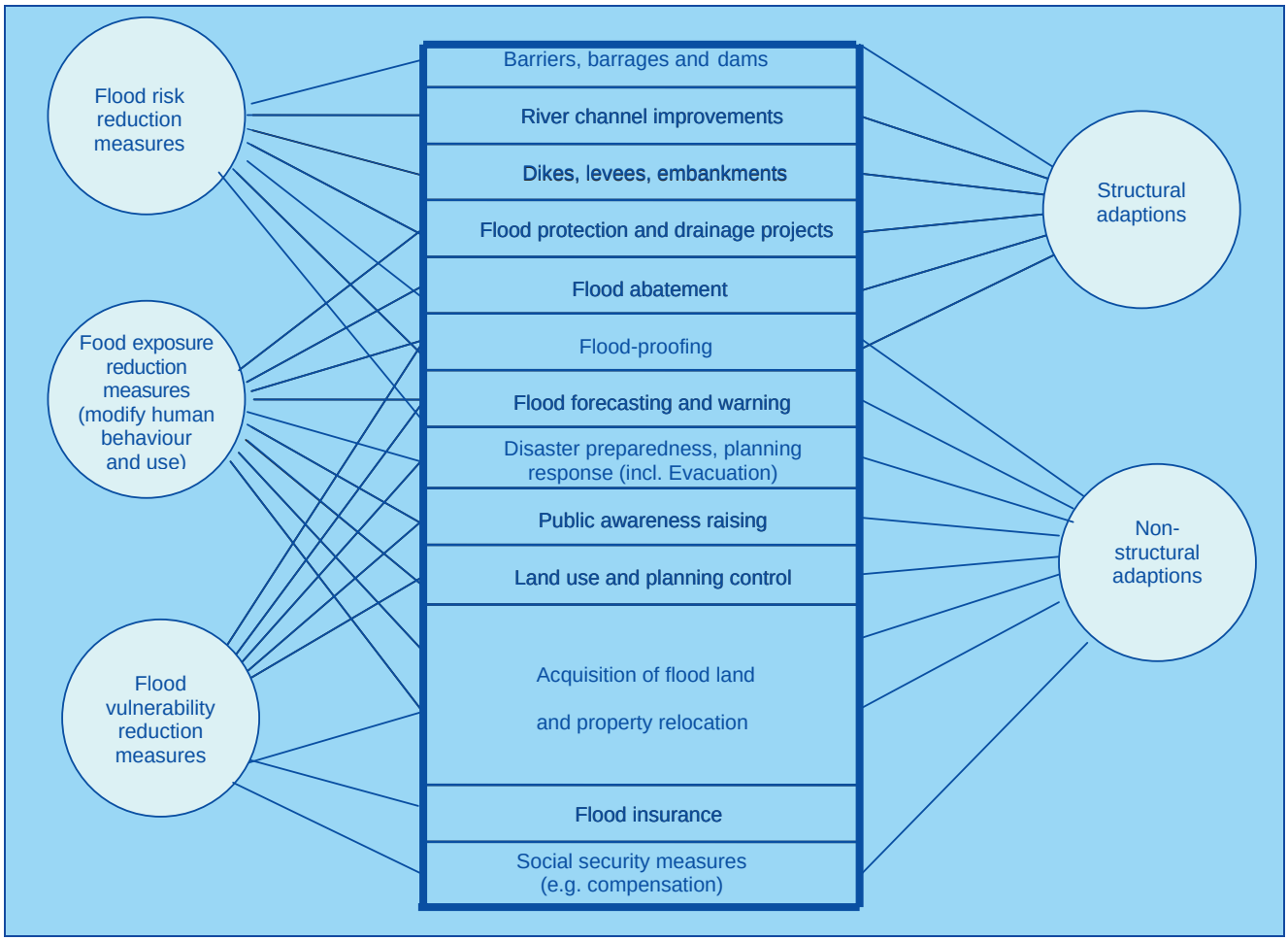


Figure 9: Various Structural and Non-structural adaptations

Figure 10: Damage to Sasumua Dam July 2003

Figure 11: Flooding in the lower reaches of Nzoia Basin, 2003

Policy: *Appropriate communication system should be setup to provide advance flood warning to the village level communities.*

Preparedness and Flood Proofing

In many situations flood protection measures are not taken because the benefits of flooding can outweigh the disadvantages caused by floods as was assessed in the National Water Management Plan 1992 in many parts of the Lake Victoria Basin. In such cases it is desirable to cope with floods through various adaptation measures like flood proofing of houses and infrastructure, flood plain management through land use regulations development and redevelopment policies, disaster preparedness and response planning; emergency measures like evacuation, flood fighting and public health measures.

Policy: *Contingency plans for both protected and unprotected flood prone areas for all floods including Probable Maximum Flood (PMF) should be prepared for rescue and relief with clear allocation of duties/functions.*

Policy: *Criteria and norms for planning, design and implementation of flood proofing measures like ring dyke around the villages, building houses on stilts with provision for cattle shelter and storage of food and fodder etc should be developed and specific schemes prepared and implemented. Appropriate coordination mechanism between the Ministries of Works and Rural Development should be established for the purpose.*

Flood Plain Regulation

In Lake Victoria Basin, there is tremendous pressure on land due to increased rural population. This has led to economic activities in the flood plains, which has in turn increased the damage potential of floods. This is mainly attributed to the lack of policy on land use and mechanism to regulate the use of flood plains. Certain infrastructure works like flood diversion works, bridges, railways and highways tend to increase the flood levels upstream, if not provided with appropriate waterways.

In the absence of lack of option of livelihood for the people in the Lake Victoria Basin, it would not be desirable to take legislative or administrative measures to deny the people the use of flood plains for livelihood. In order to regulate future development especially due to expansion of urban centers and industrial development, it would however, be necessary to put in place appropriate regulatory mechanism around prospective urban centres to regulate their development.

Policy: *Selective flood plain regulations around the developing urban centers restricting development of water polluting industries, high concentration of urban development in flood prone areas should be taken up.*

7.5 Community Participation

Developing economies are always faced with a financial resource crunch. The development plans have to prioritize various development schemes competing for limited financial resources. In addition a major concern is the allocation of resources for the proper maintenance of the infrastructure.

Further, in democratic societies, planners have to appropriately balance the aspirations of various sections of the society. In flood management planning, the conflict between the upstream and downstream stakeholders has to be resolved. Active community participation in the planning and management at all levels helps in resolving such potential conflicts through negotiations and reaching compromise solutions. It can also be beneficial in maintaining the infrastructure particularly when it is widely dispersed, as is the case of flood management structures. However, this is possible only if the community has a feeling of ownership and belonging which can only be possible through their active participation in the decision making process right from the inception stages.

Where the interests of the local people are in conflict with the objectives of the government it may not be possible to enact legislation. Where the interests of two or more groups are in conflict a process of dialogue has to be initiated to narrow down the differences and to evolve a mutually agreed action plan.

By law all water related activities including those associated with flood management fall within the public domain. These activities are performed or are required to be performed by designated government ministries/departments at National, Provincial, District and local levels. In order to promote community participation in some of these activities legal and administrative instruments to transfer the related mandates, functions, responsibility and accountability to the recognized community organizations together with detailed guidelines specifying the manner in which the activities are performed have to be put in place. The linkages between the government agencies and the community organizations have to be clearly defined in these guidelines.

Promoting active community participation requires knowledge based on basic data and information along with experiences of the community in coping with the situation, special skills and training. NGO's having services of a social scientist with specialization in mass communication can play an important role and should be entrusted with the task. However the necessary training material for them has to be prepared by a specialist organization. As a general rule, community participation is easily achieved in those activities, which hold promise for quick benefits to the participants. Demonstration schemes therefore should be taken up to convince the communities that they would indeed benefit from such schemes.

Women, being the family providers, have special concerns, which need to be addressed. Their participation in planning of flood mitigation and the relief and rescue operations needs to be ensured. Experience has shown that a community comprising of one homogenous social/ethnic group has a better chance of participating in a common cause than the one comprising of heterogeneous mix of several social groups. In the latter case it is necessary to take up suitably designed social integration programmes.

Community support could be useful in assisting the field staff of MWRMD in hourly monitoring of river water levels at the flood forecasting sites, communicating water levels to the flood forecasting office (FFO), receiving flood warning from the FFO and its dissemination, and mobilizing and directing transport to predetermine disaster management units (DMU) of the district during rescue operations. Community based NGOs can provide help to the DMC in organising relief camps and distributing essential supplies.

Policy: *All the policy instruments should incorporate the principle of community participation at various levels of planning, implementation and management with special provisions for enabling participation of women and other minority groups.*

Policy: *Appropriate communication strategy to prepare conducive atmosphere for developing trust and faith of community should be evolved through sharing data and information, developing transparent procedures for all decision making, building formal mechanisms to enable community participation and by enabling capacity building.*

Policy: *Community participation in arriving at consensual flood management option, monitoring and rescue and relief operations should be strengthened and formalized through their participation in River Basin Organisations.*

Policy: *Non-governmental Organizations should be encouraged to motivate and facilitate community participation at various stages including relief and rescue operations and capacity building at community level*

.

7.6 Capacity Building

In addition to the capacity of the institution, the capacity of individuals to perform their assigned roles is also very vital. The Kenyan water resources sector, for more than two decades, has engaged external consultants for preparation of Master Plans and individual schemes with little involvement of the departmental engineering staff. During the implementation stage also there was no serious involvement of the staff in the on-site technical supervision of the work done by the contractors. This total dependence on consultants and contractors has resulted in dependence and inexperience of the engineering/ technical staff in gaining project related experience.

There have not been significant activities in the area of flood management since the construction of dykes, drainage channels, sluices and river training works during the seventies and eighties. This also has not provided opportunities for the staff to develop the requisite skills and knowledge in planning, design, construction and maintenance of flood protection works. The existing manual on water supply does not cover all aspects of water resources development in general and flood management in particular. The planning and design norms have also not been reviewed and updated for more than two decades.

Policy: *The need for capacity building at various levels and in different organizations/ institutions is recognized. A comprehensive capacity building programme[13] on flood management issues should be prepared and implemented in phases.*

Empowerment of People to enable Participation

A knowledge of the entire basin and how different factors contribute to the development of flood situation, and an understanding of the downstream- upstream relationship are necessary for planning of flood mitigation measures on a basin scale where tradeoffs are called for. In order to enable all sections of the community to participate in the decision making process, and not only a few dominant members, it is also important that all the stakeholders are well informed.

Media could play an important role in spreading information and promoting community participation. The elected representatives of the people like members of Parliament and village chiefs could be involved in sensitizing and educating the people about the benefits of their participation in various activities. The process should avoid government propaganda and instead present a balanced approach with technical non-governmental organizations playing a lead role.

Policy: *A policy on sharing exchange of data and information on a regular basis in the local dialect should be formulated defining appropriate role for the media, education institutions, cultural organizations and other similar and innovative modes of mass communication.*

Policy: *Technical NGOs should be encouraged to play a key role in generating educative and information material in simple local language.*

8. FLOOD FORECASTING SYSTEM

The most catastrophic impact of floods is loss of human lives. People are taken unawares when the flood causing heavy rainfall occurs; this is due to the special meteorological situation in the Basin. The upper catchments receive heavy rainfall while the plains lower down receive relatively low rainfall. Establishing a viable flood forecasting and warning system, therefore, forms part of the overall Flood Management Policy. This section briefly describes[14] the essential aspects of the proposed flood forecasting system in the Lake Victoria Basin.

Following are the five main components of a flood forecasting system:

(a) Hydro-meteorological network
(b) Data acquisition and processing
(c) Forecast formulation
(d) Forecast dissemination
(e) Forecast review and development

8.1 Hydro-meteorological Network

Rainfall and the current hydrological conditions in the basin are the basic real time inputs required for predicting future flood flows and river levels. At present the field units of MWRMD have district wise functional jurisdictions, thus the river gauging stations in a river basin are under the charge of different District Water Officers. There is a need to reorganize the existing departmental structure for flood forecasting purposes, from district divisions to sub-basin divisions, which is feasible under the on-going institutional reforms process.

[13] Indicative list of areas of Capacity Building are given in Annex VII
[14] A detailed treatment of the subject is in Annex VIII

It is necessary that all hydrological observation stations in a river basin be placed under the charge of the Flood Forecasting Office (FFO) for the basin, for better coordination and supervisory control. Considering the proximity to the flood prone areas and functional requirements, location of FFO's for different river basins are recommended as follows:

(i) Rivers Nzoia and Yala FFO, Busia (presently known as District Water Office Busia)
(ii) Rivers Nyando and Sondu FFO, Ahero (presently known as District Water Office Ahero)
(iii) River Kuja/Migori FFO, Migori (presently known as District Water Office Migori)

For flood forecasting purposes river base stations have been chosen as close to the foothills as possible. Flood forecasting stations have also been chosen just upstream of the flood prone areas. River cross-sections would also be required at regular intervals and the gauges would need to be connected to a common reference datum.

Based on the rainfall pattern and the consequent floods in each sub-basin, 11 rainfall stations have been identified and selected in consultation with KMD for inclusion in the flood-forecasting network. Nine of these stations are being operated by KMD while two are under the charge of a Fire Station and Tea Garden.

8.2 Data Acquisition and Processing

The Meteorological Stations of KMD transmit data to the National Meteorological Center (NMC) every three hours. This is done through radio telephones or telephones. Presently, Kisumu Meteorological Station is responsible for the transmission of the rainfall information from the Lake Victoria Basin. The rainfall warning issued by KMD to Disaster Operation Center is normally delivered by hand. The electronic and print media receive the forecast through fax.

A VSAT communication set was recently installed in Kisumu. Most of the data is passed through the Meteorological satellite (Meteosat). The radiotelephones are used for transmitting data from synoptic stations to the collecting centers and then the data is relayed to NMC. There is also a satellite link via VSAT from main collecting centers to a Regional Transmission Hub (RTH). This link is to eventually take over the landline connections to improve data transmission. The possibility of establishing data transmission link of VSAT with the 11 rain gauges identified above should be explored.

The FFOs of MWRMD should have the same mode of data communication as the KMD, which are radiotelephones and landlines. A memorandum of understanding needs to be signed between the two departments for real time data communication. The FFO should be equipped with a separate arrangement of radiotelephones for communication with DMC/District Commissioner. It would be desirable that the office of District Commissioner uses their own staff and communication equipment in the premises of the FFO during the rainy season.

The processing of input data for the formulation of forecasts depends largely on the flood forecasting techniques being used. However it is useful to process data in a model independent database with provision for converting the data into universally acceptable format.

8.3 Flood Forecast Formulation

In view of the short travel time from base station to the forecasting station, gauge-to-gauge correlation method would not be very effective for operational flood forecasting. The numerical weather prediction section of KMD has a model that can give QPF with a lead-time of six hours and an accuracy of sixty percent.

For the flood forecast to be effective, with adequate lead-time it is absolutely necessary to have rainfall-runoff based forecasting system using quantitative precipitation forecast at least 24 hours in advance for which a system of radars may have to be installed. For the same reasons it is necessary that QPF is provided not at a fixed time in a day but every 8 hours with updates every 3 hours in case the forecast is beyond a threshold. The KMD would therefore need to make necessary arrangements for QPF accordingly.

The MWRMD has so far acquired the following flood forecasting models.

(i) Galway Flood Forecasting system (GFFS) model
(ii) Geo Spatial Flood Forecasting Model (Geo SFM)
(iii) NAM Rainfall-Runoff model.

The GFFS model has been calibrated using limited historical data of few rivers and is understood to have given encouraging simulations for Nzoia but has not been tested in the field on real time. The model holds promise for operational flood forecasting for which arrangements would need to be made with KMD for QPF with a lead-time of at least 24 hours.

The Geo SFM model has been installed at the headquarters of MWRMD but is yet to be calibrated and tested, as some of the inputs for the model require remotely sensed data using satellite therefore the requirements of the model at present cannot be met.

The Provincial Water Office of MWRMD at Kisumu has acquired the NAM rainfall-runoff model under the World Bank sponsored "Lake Victoria Environment Management Project". This is a rainfall-runoff model developed by the Danish Hydraulic Institute Denmark which together with the Hydrodynamic channel routing module constitutes the MIKE-11 Flood Forecasting model. The NAM module has been tested and calibrated for various sub-basins using 50 year historical data from 1950 to 2000.

Forecasting could be done using only the NAM module until all the gauges are connected to a common reference datum and river cross-sections are taken. However immediate arrangements would need to be made with KMD for issuing QPF on a regular basis.

8.4 Dissemination

The forecasts should be issued by the Central Flood Forecasting Office (CFFO) located in Nairobi and should be under the charge of a senior Hydrologist. The CFFO should act as the central dissemination center and mouthpiece with responsibility for link with the Press, DMA and Ministry of WRMD. A proposed Flood Forecasting and Dissemination mechanism is shown in Figure 12.

Flood forecasts need to be disseminated immediately after being received from the forecast formulation team. The nodal agencies/officials like the District Commissioner, Disaster Operations Centre and others, have to be given the forecast by wireless or telephone and it must be confirmed in writing in a standard format[15]. Internet could also be used to disseminate the forecast to a wider audience.

RANET[16] can serve as a useful tool for the dissemination of flood forecasts in the flood-affected areas. Currently there are three RANET radio transmission stations in the country but they are yet to be operational. In Lake Victoria Basin only Kisumu station has world space digital radio receiver for RANET radio transmitter. RANET has the following equipments for communication:

(i) Suitcase radio transmitters that can be used within a radius of 25 Km.
(ii) Hand held radios, which are used for receiving broadcasts. They normally use hand-winding mechanism for power. The KMD can provide about 100 sets at village level.
(iii) Budalangi is earmarked to receive world space digital receivers. Several people in this area have already been trained in the use of RANET.

The value of a forecast lies in its dissemination to the public with adequate lead-time. A late warning with little lead-time is of no use to the community. Most of the times the normal floods are not disastrous and people have learnt to live with them. In such situations people have to be educated to understand that there is always a possibility of a high flood occurring and therefore they should remain vigilant and act quickly on receiving the warning. It is however, necessary to avoid issuing unwarranted flood warnings based on inadequate data or without proper formulation of forecasts. Unwarranted warnings keep people un-necessarily tense; and if such a practice is repeated, may cause people to lose faith in the forecasting system.

[15] Indicative formats for the dissemination messages is given in Annex VIII
[16] Details of RANET are given in Annex IX

Merely issuing flood forecasts in terms of water levels is not of much use unless the significance of these levels in terms of damage potential is also explained to the people. The water level information should be translated into its impact on the area. This should be described with reference to certain threshold levels like "Warning Level" "Danger Level" and "Highest Flood Level." For public information, guideposts marked with these threshold levels should be displayed at prominent public places in the flood prone areas.

8.5 Recommendations

The followings steps are required in order to set up a Flood Forecasting and Warning system in Lake Victoria Basin:

a. Draw up a Memorandum of Understanding with KMD for exchange of real time data and the Quantitative Precipitation Forecast (QPF).
b. Re-organise the field setup of MWRMD to establish the FFOs and CFFO and provide the necessary staff.[17] For logistics, the CFFO could be initially be set up in Nairobi.
c. Organise intensive training for the staff dedicated to man the FFOs and CFFO.
d. Start flood forecast formulation based on gauge-to-gauge correlation to begin with until a suitable model is chosen and perfected.
e. After selecting one of the models discussed above, preferably the MIKE 11 (to start with NAM) obtain the selected software with multi-user license.
f. Carry out surveys to connect the river gauges with common datum, obtaining the required river cross-section and establishing Warning Levels, Danger Levels and Highest Flood Levels.
g. Establish telephone links between the 11 rain gauges and the FFOs and/or operationalise the Meteosat facilities for data transmission.
h. Operationalise the RANET and provide receiver sets in the most flood affected villages.
i. Organise a coordination meeting with all players in the flood forecasting and warning activities including the DMCs.

KMD should initiate action for radar based QPF equipment and training.

[17] Please see Annex VIII with a suggestive staff set up and their proposed functional duties.

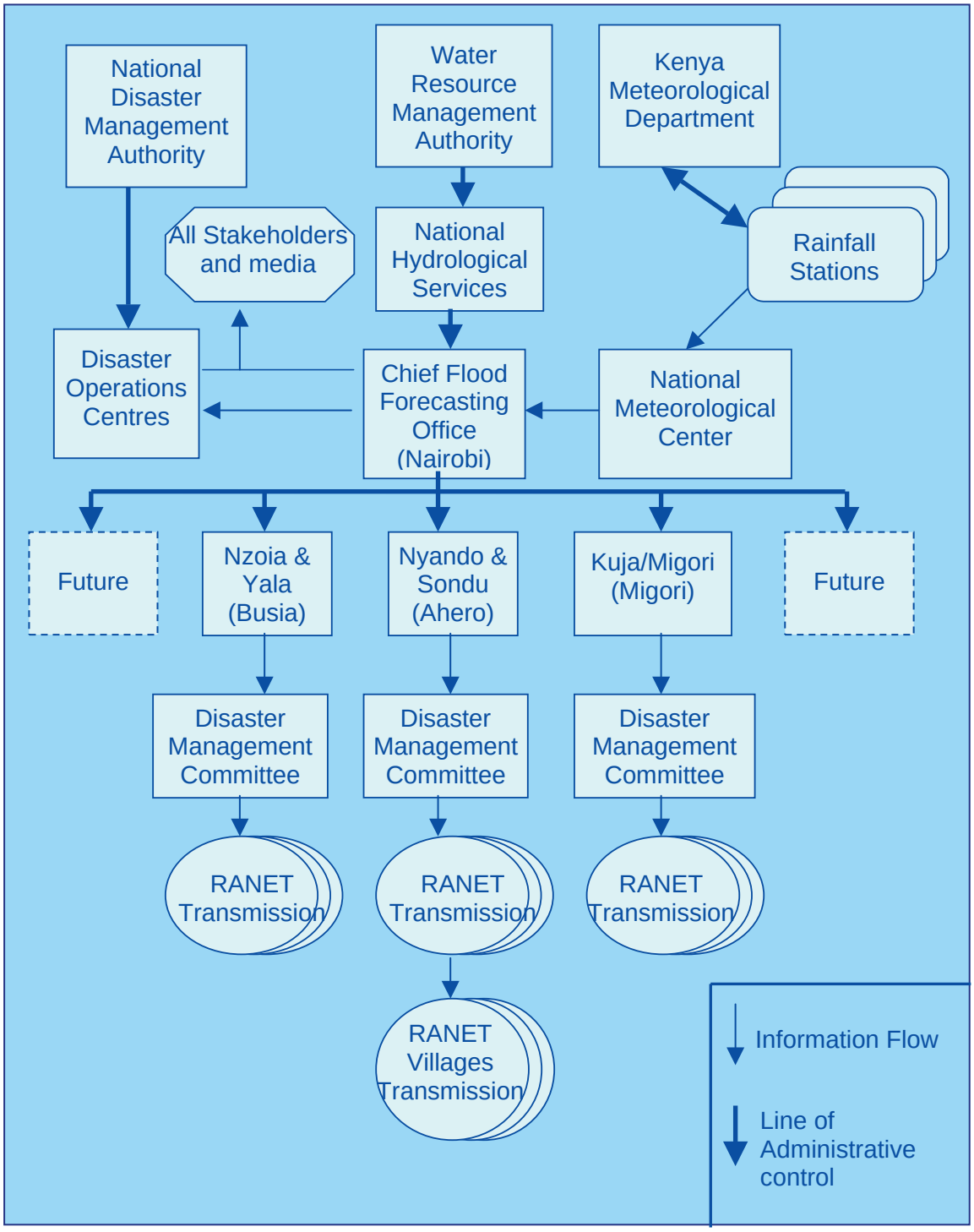


Figure 12: Flood Forecasting and Dissemination Mechanism

PART IV

ACTION PLAN

9. ACTION PLAN

This section identifies various measures that should be implemented, in order to put this Strategy for Flood Management into action. These have been classified into the short-term, medium-term and long-term measures. However, it has to be borne in mind that no irreversible actions should be taken without preparing the Master Plans for the basin on the IFM principles, except the one related to the repair/restoration of the existing dykes.

9.1 Short Term[18] Measures

Policy Reforms

1. Evolve and adopt a policy for flood management in Lake Victoria Basin (to be expanded later into a National Flood Policy). [MWRMD]
2. Evolve and adopt a policy that looks at flood plains as national assets that are crucial for accelerated growth of GDP. [Ministry of Planning & National Development]
3. Evolve and adopt agriculture policy to exploit the full potential of the flood plains. [Ministry of Agriculture]
4. Evolve and adopt industrial policy for flood plain areas based on the imperatives of future development and employment generation. [Ministry of Industries]
5. Expedite development and adoption of the proposed National Disaster Management Policy. [Disaster Operations Centre]
6. Evolve and adopt land use policy for flood plains to control and regulate future development/encroachments. [Department of Lands and Settlement]

Institutional Arrangements and Basic Infrastructure

7. Set up flood management units under the newly created Water Resources Management Authority (WRMA) both at the Head Quarters and in the field. [MWRMD]
8. Rehabilitation of existing river gauging stations and reconciliation of data observed so far [MWRMD]
9. Establish a proposed National Disaster Management Authority. [Office of the President]
10. Strengthen linkage between MWRMD, DOC and KMD to develop an integrated flood forecasting and disaster management system. [MWRMD, DOC, KMD]

Promoting Community Participation and Capacity Building

11. Capacity Building in MWRMD. [MWRMD]
12. Capacity Building in KMD. [KMD]
13. Promote and strengthen Community participation in flood monitoring and disaster management. [District Commissioners and NGO's]

Programme Implementation

14. Disaster Management to be factored into overall development plans. [All Ministries/ Departments]
15. Set up village level communication system to provide advance flood warning to communities from the existing rainfall warming mechanism of KMD. [District Commissioners]
16. Prepare contingency plans for rescue and relief with clear allocation of duties and functions. [Disaster Operations Centre]
17. Introduce flood forecasting based on gauge-to-gauge correlation and integrate it with the existing rainfall warning system.
18. Initiate action to obtain and operationalise a MIKE-11 flood-forecasting model whose NAM module has been thoroughly tested in diverse climatic and river conditions. [MWRMD/WRMA]
19. Repair, rehabilitate and improve the existing protection works like dykes, drainage channels etc. [MWRMD/WRMA]

[18] Short Term measures are those, which are expected to be completed within two years.

9.2 Medium Term[19] Measures

Programme Implementation

20. Develop small reservoirs and check dams to store floodwaters. [MWRMD/WRMA]
21. Evolve crops and cropping patterns that would increase income growth in flood plain areas and add to GDP.
22. Develop crops that are resistant to flooding and give higher returns and crops that can be grown and harvested during relatively flood free periods. Develop contingent crop options. [Department of Agriculture]
23. Set up a National Hydrological Service under the WRMA. [MWRMD/WRMA]
24. Prepare disaster management plans for probable maximum flood (PMF) and also consider sudden failure of protective structures especially large and medium dams. [KMD, MWRMD, DOC]
25. KMD to upgrade its rainfall forecasting system by acquiring and operationalising radar system to enable timely forecasts of concentrated and localized heavy rainfall/cloud burst and QPF for flood forecasting. [KMD]
26. Take up a pilot project on flood proofing of individual houses or group of houses. [Rural Development Department]
27. Prepare a long-term adaptation plan based on current predictions and forecasts of weather and climate changes. [DOC and all Ministries]
28. Protect critical unprotected areas with new dykes. [MWRMD/WRMA]
29. Prepare basin wise Master Plans for integrated development of water resources (thorough review of the 1992 Master Plan). [MWRMD/WRMA]

9.3 Long Term[20] Measures

Programme Implementation

30. Prepare and implement plans for integrated development of towns. [Departments of Physical Planning, and Urban Development]
31. Implement the schemes envisaged in the Master Plans.
32. Develop large and medium storage reservoirs to store floodwaters. [MWRMD/WRMA]
33. Take up watershed development and management to protect riverine watersheds. [WRMA/Forest Department]
34. Accelerate pace of development in the basin with water as an input. [Lake Basin Development Authority]

[19] Medium Term measures are those, which require certain measures to be taken before they could be, implemented and/ or will bring results after 3 to 5 years. Actions on these measures could be initiated immediately.

[20] Long-term measures are those, which require certain short-term measures or medium term measures to be in place or will show results in 6 to 10 years although action could be initiated on them immediately.

PART V

ANNEXES

ANNEX I

REPORT ON THE STAKEHOLDERS' WORKSHOP

1.0 Background

In June 2003 the Kenyan Minister for Water Resources Management and Development (MWRMD) requested that the World Meteorological Organization (WMO) Geneva help the Ministry in developing a strategy for flood management in the Lake Victoria Basin as a pilot project under the WMO-GWP Associated Programme on Flood Management. Accordingly WMO initiated the pilot project in December 2003 and as part of the project activities a stakeholders' Workshop was organized at Kisumu (Kenya) from 10th to 12th March 2004.

The participants for the workshop were identified through a consultative process at the National, provincial and district levels. Community Based Organizations and Non-Governmental Organizations were identified in consultation with the district level officers in various flood prone districts.

Kenya Meteorological Department (KMD) and the Drought Monitoring Centre – Nairobi (DMC-N), organized the workshop jointly, under the overall supervision and guidance of The Project Steering Committee. As part of the information material a "Lead Paper for Stakeholders Workshop" was sent to the invitees, which covered the concept of Integrated Flood Management and the issues for consideration.

2.0 Inaugural Session

Honourable Munyes, Assistant Minister, Ministry of Water Resources Management and Development inaugurated the workshop on behalf of the Minister who could not attend the session due to preoccupation. The minister expressed the commitment of the government to develop an integrated and inclusive approach to address the problem of people's vulnerability to floods and risk management through prevention, mitigation, preparedness, response and recovery.

Earlier Mr Mohamed Tawfik, of WMO Geneva gave the participants general information about the role and activities of WMO and the WMO-GWP Associated Programme on Flood Management. He also gave an overview of the concept of Integrated Flood Management within the overall framework of Integrated Water Resources Management.

Mr K.G. Chesang, Director of Water Development (MWRMD) expressed the hope that by translating the flood management strategy into action, the present misery of the people in the basin could be transformed into progress and prosperity. He expressed confidence that in spite of the resource crunch, it would still be possible to minimize the disastrous impacts of floods, with the available knowledge and expertise in the county and with the active participation of all stakeholders. Mr A.L. Alusa of the UNEP stressed the need for environmental protection and management as part of IFM and suggested establishment of early warning system to reduce the vulnerability of people due to climatic changes. He advised the participants to "be informed" of the incoming flood and to "be prepared" to deal with it. Dr Mukabana, Director, Kenya Meteorological Department (KMD) stressed the need for building dams for development and flood control and for risk management to be a part of flood management. Professor Mutua of University of Nairobi, speaking on behalf of Professor L.A. Ogallo of DMC-N emphasized the need for strong linkages for efficient functioning of the early warning systems in which MWRMD had a key role to play.

3.0 Presentations

The inaugural session was followed by presentations by Mr E.M. Mnyamwezi on Workshop Perspective and Overview of Floods In Lake Victoria Basin, Mr W. Nyakwada on Climate Extremes and Impacts, Prof. F. Mutua on Flood Forecasting systems, Dr Shivoga on Degradation of Njoro Watershed and its Impact on Runoff and sediment flow and Mr V.K. Mathur, WMO Consultant, on Integrated Flood Management.

4.0 Group Discussions

After the presentations, the participants were divided into five groups and were given a list of issues to be covered in the discussions in addition to any issues of their own choice. The group discussions were held in four sessions, spread over 14 hours. The last session in the afternoon of 12th March was devoted to a presentation on the Stakeholders Report by Mr V.K. Mathur, and discussion thereon

5.0 Stakeholders Perspective

The group discussions highlighted the stakeholders' perspective on the flood problem in Lake Victoria Basin, related issues and the key elements of the flood management strategy, which are discussed in the following paragraphs.

5.1 Nature and Extent of the Flood Problem

The river Nzoia causes extensive flooding in the Uranga, Ukwala, Karemo and Ugunda Divisions of Siaya district, Kwanza Division of Trans Nzoia district and Budalangi Division of Busia district.

In Bondo district, Usigu and Madiani Divisions are affected by the over bank spills of river Yala. The flooding around Yala Swamp covers Bunyala (central and south) and Khajula Location of Budalangi Division.

The rivers Nyando and Sondu inundate large areas in Lower Nyakach and Nyando Divisions of Nyando district. Flooding from the Kuja River affects about 168 sq km of area under central, south and west Kadem Locations.

During the floods of 2003, 57 children and 62 adults lost their lives in the Budalangi Division of Busia district. In Nyando and Migori districts (Nyatike) 5 and 7 people died. Flood damage was as follows:

District	Cropped area affected	Population affected	Wells damaged
Nyando	2000 ha	2400	-
Busia (Budalangi)	824 ha	30,000	31
Nyatike	60 ha	12000	-

In Siaya district, the areas affected were Sifuyo, Uhembo, Nyadorera, Yala swamp, Kagura, Luhano and Seje. In Migori district, 12,000 families were displaced and 8 primary schools had to be closed. In Nyatike Macaldes 10,000 children could not go to school. In Nyando district flood affected people were given shelter in 6 relief camps.

The direct impact of floods were mentioned in general terms such as loss of human lives and livestock, damage to standing crops, loss of personal property and damage to rural infrastructure. Indirect impacts were grouped as loss of income, disruption and setbacks to on going development programmes, outbreak of water and vector borne diseases during and after floods, disruption of normal family life. The problems of women, children, old and the infirm were brought out quite clearly.

The women are invariably over-worked since they have to manage the usual domestic chores under sub-normal conditions in the relief camps. Women often undertake the most physically stressful tasks of fetching water and firewood and taking care of the ailing members of the family – often ignoring their own morbidity.

The stressful conditions in the relief camps were unanimously recognized. These include sexual abuse of women by anti-social elements, exploitation of children through child-labour and general neglect of the old and infirm. The criteria of distributing relief supplies to family as a unit encouraged child marriages. Segregation of family members was mentioned as one of weaknesses of the relief operations.

The participants were unanimous about certain beneficial effects of flooding such as improved soil fertility and increased availability of fish in the river and flooded areas. They however had no idea as to how the prevention of flooding and the benefit of increased fish harvest could be harmonized.

Different groups perceived the environmental implications of floods differently. These were generally mentioned under the following main categories:

(i) Pollution of wells and bore wells
(ii) Bank erosion
(iii) Lateral shifting of river channels
(iv) Silting of river beds
(v) Loss of top soil (soil erosion)
(vi) Displacement of wildlife
(vii) Destruction of Natural vegetation
(viii) Wanton cutting down of trees for fire wood around the relief camps

5.2 Apparent Causes of Increased Flood Hazard

The participants unanimously agreed that, large-scale destruction of forests and watershed degradation due to unscientific and unregulated land use are the main causes of increased flood hazard over the years. Heavy sediment loads brought down by rivers from denuded hilly catchments and consequent aggredation of the river beds in lower reaches were identified as the main causes of decreased carrying capacity of the rivers and consequent rise in flood levels. Most farmers engaged in agriculture in steep hill slopes violate the relevant provisions of the Agriculture Act.

Excessive encroachment of the "river reserves" by people and "overstocking" of livestock far in excess of the carrying capacity of the land, and climate changes were also seen as the factors contributing to increased flood hazard. Some participants blamed both the government and the people – the government for lack of seriousness and coordination in dealing with hazards, and people for lack of awareness and slow response to the situation.

5.3 Vulnerability of People to Floods

"Cultural attachment" to the land and their unwillingness to move to safer places was mentioned as the main cause of peoples' vulnerability to floods. Poverty and lack of awareness about options for enhancing income, and lack of advance flood warming system at the village/community level were perceived as the other key factors contributing to their vulnerability. Some participants had the view that political interference hampered the implementation of various flood management schemes, which in turn did not help in reducing vulnerability. Fishermen, in particular, were seen to be the most vulnerable since their occupation required them to live close to rivers and flood plains.

5.4 Present and Future Level of Development

The districts in the Lake Victoria Basin have poor infrastructure, and poverty level is high. The main occupation of the flood plain dwellers is agriculture, livestock farming and fishery. The participants were unanimous in their opinion that due to poor quality inputs and unscientific techniques being used in these occupations the income levels are low. Market access for the products is hampered due to poor road network and condition of roads, but to a large extent due to poor marketing mechanism.

Given the high incidence of poverty, which affects about 60 per cent of the population, there are no significant plans for future development in the flood prone areas. In terms of potential, flood plains are the most productive areas for agriculture and fisheries while the middle reaches of the rivers are useful for animal husbandry. Productivity for agriculture is less in middle catchment and least in upper catchment areas. Animal husbandry is least productive in the flood plains. Employment opportunities are perceived in sugar factories, tea/coffee plantations and transport sector.

5.5 Priorities in Flood Protection

Establishment of accurate and early warning system with linkages up to the community levels was projected as the first priority option in flood management. Equally important was preparation of contingency plans for evacuation and relief measures. Land use regulation through legislative and administrative measures to reduce and regulate use of flood plains for various economic activities, was favoured by some participants.

Among the structural measures, construction of new and maintenance of old dykes and drainage channels were proposed as the top priority options followed by debris removal and desilting of river channels, and construction of dams among the long term measures. Interbasin transfer of waters to address the problems of floods and drought was suggested. Flood proofing of individual houses was also suggested by some participants. Afforestation and "conservation" of catchments, development of pastures and land use regulations were suggested as key measures to reduce flood discharges in rivers.

5.6 Monitoring and surveillance of Flood Situation

The following action points were suggested under this programme.

- Intensification of hydromet data collection.
- Setting up early warning system at the community level.
- Situation analysis.
- Monitoring and evaluation.
- Dissemination of information to all stakeholders.
- Establishing teams to monitor climatic changes and water levels in rivers.
- Identifying vulnerable points in the dykes.
- River gauge readers to be trained to explain the significance of water level to the community.
- Dyke management committees to be charged with the responsibility of bush clearance, identifying weak spots and repair of dykes and regulation of floodgates.

5.7 Disaster Management

- Empower the Disaster Management Committees with necessary skills, equipment and financial resources.
- Stock pile emergency supplies at strategic locations.
- Train the communities to act on receipt of advance warning. They should have dedicated transport arrangements for quick evacuation.
- Community participation in camp committees to oversee sanitation, general welfare of the people and distribution of relief supplies and safe drinking water.
- Provide the community with communication equipment.

5.8 Operation and Maintenance of Flood Management Works

It was generally agreed that the responsibility of operation and maintenance of flood management works should be transferred to the local communities who should form management committees for the purpose. The community groups should be given training in operations and Maintenance, and provided with appropriate communication equipment.

5.9 Policy, Legislative and Institutional Reforms and Capacity building

- The existing legislations are top-down and do not reflect the views of the target group (community).
- Relevant provisions of legislation need to be provided to communities in simple language.
- Participatory approach at all stages of planning, implementation, monitoring and evaluation. Roles and responsibilities of all stakeholders should be clearly defined to avoid duplication of effort.
- Community to be involved in data collection, post disaster response and implementation of plans.
- Knowledge base and capacity of NGOs and CBOs should be enhanced through training programmes.
- Formation of a National Flood Management Board since the existing Disaster Operations center in the Office of the President deals with all types of disasters.
- Establish disaster contingency fund.
- Allocation of funds for maintenance of dykes.

ANNEX II

REDUCING VULNERABILITY OF FARMERS

High vulnerability of the small and often poor farmers who occupy the flood plains often exacerbates the flood disaster. Disasters can be contained to a large extent, by reducing their vulnerability. The majority of the flood plain occupants depend on agriculture and fisheries, therefore the most appropriate approach to reducing their vulnerability is through reducing the vulnerability of their occupation to flood hazards. However, no indigenous adaptations in agriculture practices have evolved over the years since flooding is not a regular feature in the area. Traditional cropping patterns do not withstand the flood inundation; subsequently disastrous crop losses impoverish many farmers.

Using a variety of crops that suit the soil and climatic conditions of the area, and at the same time withstand the flood inundations; can serve a useful purpose in reducing the farmer's vulnerability to crop losses. It is important and essential that the Agricultural research and agriculture extension services provide support to the farmers, in order to reduce their losses and empower them, also by providing infrastructural support and improving their accessibility to the market. Providing remunerative prices for agricultural produce and market access can also help improve the socio-economic conditions of the farmers.

Following are major areas of Agricultural Research and related agriculture promotion initiatives that could help reduce the vulnerability of the poor farmers:

- Kenya Agriculture Research Institute to take up applied research to develop or obtain crops and cropping patterns suitable for flood prone areas.
- Crops that are resistant to flooding and give higher returns.
- Crops that can be grown and harvested during relatively flood free periods.
- Develop contingent crop options in case the standing crop is damaged. For example: Sowing late variety of the same crop or some other crop immediately after the flood recedes.
- Encourage and promote agro-forestry.
- Promote organized orchards, floriculture, dairy farming, poultry farming, and fisheries.
- Introduce improved agricultural inputs and technology to boost production.
- Introduce/Strengthen agricultural extension service to train farmers in the use of modern technology and inputs.
- Improve/Strengthen credit facilities for the farmers.
- Improve transport and communication for market access for the farm products.
- Improve marketing mechanism.
- NCPB to review procurement policy and evolve a differential support price structure in favour of designated flood prone areas. (Policy Issue)
- Develop agro-based industries just outside the flood prone areas to provide market for farm products and also employment opportunities for flood plain dwellers. (Industrial Policy Issue, Agriculture Policy Issue)

ANNEX III

GUIDELINES FOR PREPARATION OF FLOOD MITIGATION MASTER PLANS: BROAD APPROACH

Land-use planning on a basin scale is the most essential ingredient of Integrated Flood Management. It is a process where planners and other governmental professionals work together along with the community to produce the agreement on the objectives, goals, plans and action programmes. These comprehensive plans, take into account the goals in the basin as a whole and not only the flood plains. These Master Plans are in two parts, the pre-flood mitigation measures and the post-flood measures.

These Master Plans to be prepared for each basin separately essentially have four main components, the fact component, the action component, the goals component and the policies component. The policy component of the Master Plan is provided by the Flood Policy included in this document and is generally common for a country as a whole. The fact component, goals component and action component are defined after detailed consultation with all stakeholders. The fact component includes the flood hazard extent, flood hazard exposure data and the emergency response information. The planning process involves establishing a Flood Mitigation Committee, carrying out assessment studies, conducting flood mitigation studies and finally preparing the Master Plan. The key components of Flood Mitigation Master Plans are:

- Flood Hazard Maps,
- Clear Objectives and Goals,
- Flood Mitigation Policies,
- Evaluation of various options of Flood Hazard Mitigation,
- Time Action Plan clearly defining responsibilities, and
- Monitoring Mechanism.

Various approaches are available for flood mitigation. Each situation is different and therefore it is necessary to have different adjustments or a combination of adjustments from which to choose. These adjustments are classified into four main groups, each of which attempts either to deal with the floodwaters or the activities that would be affected by them:

- Attempts to modify the floods;
- Attempts to modify the susceptibility to flood damage;
- Attempts to modify the loss burden;
- Bearing the loss.

Attempts to modify the flood involve flood protection by means of physical controls, flood mitigation by land use modification of the catchment or alteration of precipitation patterns through weather modification.

Attempts to modify the damage susceptibility involve actions designed to reduce the vulnerability of property and activities in the flood plain to the flood hazard.

Attempts to modify the loss burden consist of actions designed to modify the incidence of the losses either by spreading them over a larger segment of the community than that immediately affected, or spreading them more evenly over time. Bearing the loss connotes living with floods. Each of the above adjustments could be made through a combination of structural and non-structural interventions as already described in Figure 10 in Part III.

ANNEX IV

COORDINATION MECHANISM

Flood management is not an action that can be taken in isolation. There are a number of stakeholders and players whose effective and active involvement in the entire process of flood mitigation measures is a prerequisite for its success. Different departments and ministries have their spatial and sectoral jurisdictions which mostly do not coincide with the river basins along which the IWRM or IFM are planned to be developed. Further, various players involved with flood mitigation and management have different perspectives and background knowledge.

In order to obtain a coordinated action through such a maze, it is important to have a suitable framework for coordinating their activities for moving towards the desired goals and objectives. It is important to have a mechanism in order to manage water related differences of approaches, coordinate the activities and reach acceptable solutions. Such a mechanism will depend on factors such as the administrative, political, social and economic conditions of the country or the region. Before such a mechanism is put in place it is important to clearly define and make everyone understand the goals and objectives that are to be achieved. It is also necessary to build the capacity of all the players to comprehend the complexities of the issues involved and make them aware of the various viewpoints.

These coordination mechanisms are required to be provided at Policy level, Planning level and Operational level.

Policy Level Coordination Mechanism

There should be a coordination mechanism at the highest Ministerial level in the form of a State Water Council, comprising of various ministries, departments and other stakeholders concerned with the issues related to water resources management as well as flood management. Its main function should be to harmonize the policies of various departments dealing with development in so far as they influence the water resources development and flood management. The Council should encourage the different ministries and departments to:

(i) Draw up a memorandum of understanding with Ministry of Water Resources Management and Development thereby committing themselves to be the partners in Integrated Development and Management of Water Resources and Integrated Flood Management in the country,

(ii) Have standing arrangement to provide the necessary inputs to each other on demand in all development initiatives that require or influence the water resources management and flood management,

(iii) Identify a nodal unit within each Ministry and the departments and authorize it to provide the inputs required for all water resources development issues.

Planning Level Coordination Mechanism

There should be a mechanism at the secretarial level in the form of a State Water Board which should provide a common platform at the highest official to lay down the procedures for coordination between various ministries and departments in planning and execution of the water resources development projects. The Board should address following issues, among others, depending on the needs from time to time directly or by setting up task oriented Working Groups.

1. The Ministry of Planning and Development in consultation with the Ministry of Finance should evolve a procedure for clearance of water related and flood related projects for funding and their inclusion in the National and Provincial Development Plans and should work toward:
   - Evolving a criteria/procedure for release of funds during the construction stage.
   - Evolving a procedure for monitoring the project expenditure and its proper accounting.
   - Setting up a vigilance mechanism to prevent possibility of misappropriation of funds.

- Evolve criteria, guidelines and procedure for provision of funds for maintenance of existing physical infrastructure in the water sector.

2. An interdepartmental Working Group should be set up to prepare detailed Guidelines for preparation of project reports of water resources development and flood management Projects/Schemes covering the following aspects:
   - Pre-feasibility studies after certain minimum field reconnaissance and data collection.
   - Detailed field surveys and investigations for preparing detailed project reports.
   - Planning, design, cost estimate and project formulation.
   - Rehabilitation and modernization of existing projects.

3. An interdepartmental Working Group should prepare detailed guidelines with checklist for techno-economic appraisal of the project reports and their clearance for implementation. The guidelines should specify the Ministries/organizations who will examine the project reports and scope of their role.

4. The Ministry of Water Resources Management and Development or the concerned ministry responsible for techno-economic appraisal of project reports should have a standard mailing list of all those Ministries/Departments who are required to examine the project reports. Adequate number of copies of project report should be prepared so that different ministries may simultaneously examine these and clearance is given within a reasonable time.

5. Various ministries should have designated units for examining the project reports and their contact addresses, telephone/fax numbers etc should be available to the nodal agency.

6. In order to minimize the possibility of misappropriation of funds, strict procedures should be laid down for preparation of working cost estimates during the implementation stage, and the process of tendering and award of work to contractors.

7. As a general rule there should be standing arrangements for exchange of information/data in laid down well-structured formats.

Operational Level Coordination Mechanism

At the execution level the coordination mechanisms have to be different for different type of projects. In the case of flood management measures these will depend on whether the measure is pre flood or post flood management. The type of mechanism that would require smooth implementation of the project would call for this coordination group which should be clearly defined in the project document itself and should be made note of by the central and provincial ministries and departments at the time of clearing the project. The requisite information then would need to be passed on to the provincial and field level functionaries.

ANNEX V

COLLECTION OF TECHNICAL DATA AND FLOOD DAMAGE ASSESSMENT

1.0 Guidelines and Standards

For field surveys and investigations to be carried out on scientific lines, it is necessary to develop manuals and standards for the purpose. This may take some time therefore, as an interim measure general guidelines based on existing practices elsewhere in the world with comparable physical and climatic conditions, should be prepared.

2.0 Field Surveys and Investigations

The flood mitigation measures implemented or proposed so far are based on scanty data and without any comprehensive field surveys. It is therefore recommended that for planning and design of flood protection works to be taken up immediately, the following technical data are required for the techno-economic appraisal of the projects flood management options. A mechanism, for collection of these data on a regular basis to ensure their availability at the time of appraisal of various options based on field surveys and investigations is necessary to be established.

2.1 Flood Extent:

(a) Historical floods
- (i) Source of information.
- (ii) Years of occurrence.
- (iii) Observed peak discharge.
- (iv) Gauge (Correlated to 'b' below).
- (v) Area affected.
- (vi) Historical records if any. (Flood damages etc).

(b) Observed floods (year wise since observations were started)
- (i) Year.
- (ii) Duration of peak, above normal (dominant flood).
- (iii) Observed/estimated peak discharge.
- (iv) Maximum recorded gauges in each year.
- (v) Area affected with average depth of flooding during flood peak(s).

(c) Catchment area upto damage center(s)

2.2 Flood Damage (year wise)

The following information should be available for at least a period of preceding 10 years.

(a) Village, Towns, Districts etc, affected.

(b) Population affected.

(c) Area affected (in the proposed project)
- (i) Gross area.
- (ii) Cultivable area.
- (iii) Cultivated area.
- (iv) Damage loss.

(d) Physical and monetary year wise (in particular river basin/sub-basin)
- (i) Property.
- (ii) Crops.
- (iii) Human Life.
- (iv) Cattle.
- (v) Public utility services.
- (vi) Any other.

(e) Flood relief, rescue and rehabilitation expenditure

2.3 Existing storage and flood mitigation works in the tributary/main river basin:

(a) Existing storage works
- (i) Location.
- (ii) Catchment area intercepted.
- (iii) Live storage.
- (iv) Specific flood storage, if any.
- (v) Flood moderation by the existing reservoir.
- (vi) Residual floods.
- (vii) Possible modification for improvement of flood situation.

(b) Details of existing works like embankments
- (i) Location.
- (ii) Spacing of embankments and distance from present river bank in case of single embankments.
- (iii) Design HFL and frequency of floods for which embankments were designed.
- (iv) Top level of embankment.
- (v) Carrying capacity of river with embankments.
- (vi) Possible modification for improvement of flood situation.

In addition, the following information are required, while considering the option of flood control reservoir**.**

- (i) Peak floods and flood hydrographs at dam site for 25, 50 and 100 year frequencies.
- (ii) Peak floods and flood hydrographs at damage centers without reservoir.
- (iii) Peak floods and floods hydrographs for sychronizable contribution of the controlled catchment up to the dam site and the uncontrolled catchment between the dam and the damage centers.
- (iv) Synchronization of the releases from the existing storage up to the damages centers.
- (v) Storage routing of the above and historical floods to determine the extent of flood moderation by providing alternative specific flood storages.
- (vi) Moderated outflows with proposed specific flood storage with reference to the peak inflows.
- (vii) Degree of flood moderation by suitable operation of reservoir without providing specific flood storage-fixation of ruling levels of reservoir.
- (viii) Impact of the proposed flood protection works including likely reduction in general damage, expenditure and relief, remission of revenues etc.
- (ix) Existing safe carrying capacity of the tributary/river in the flood prone areas.
- (x) Longitudinal profile of the river covering the entire reach to be covered under the proposed scheme.
- (xi) Cross-sections of the river up to 1 m above the highest observed flood level or 500 m on either side of the river which ever is less. If the river width is fairly uniform, the cross-sections may be taken at 5 Km interval.
- (xii) Water levels at the gauging station immediately upstream of the flood prone reach.
- (xiii) Soil properties by field/laboratory tests to determine design of dykes.

3.0 Flood Damage Assessment

3.1 Importance of scientific assessment of flood damage

Floods impact the economic activities in many ways. Most of it is directly visible, however a greater part is not so tangible, further, there are loss of human lives. These losses can also be categorised as primary, secondary and tertiary. A schematic representation of various types of losses is given in Fig V-I. It is important to quantify, assess and analyse these damage data to make appropriate choices.

At present there are only limited flood records and other technical data for floods and their impacts including on the behaviour of the rivers. There is, however, general agreement that the quality of flood damage data needs considerable improvement. This is clearly reflected in the Water Act 2002, which provides for "National Monitoring and Information Systems on Water Resources". It is difficult to evaluate flood and river condition for preparation of flood protection plans in a comprehensive and scientific manner.

Data on damages caused by floods are needed for several reasons. An important use of this data is for assessing benefits from flood control projects as part of benefit-cost analysis at the pre-sanction stage. These data also give an idea, of the adverse impacts of floods and enable the legislators and public to form an informed opinion about the extent of the flood problem affecting various parts of the country at any point of time.

3.2 Procedures for estimates of crop damages

A more correct assessment of the crop damage should be made in terms of the infructuous expenditure incurred on inputs including labor charges, seeds and loss of yield. It is likely that the preliminary estimates prepared quickly for the purpose of relief administration may not take into account the extent of replanting/re-sowing which will only be known after some time. The final estimate of damage should still take such aspects into account. This, however, would require information on crop areas completely destroyed and areas replanted/re-sown and some norms of input loss in case of areas completely destroyed. The extent of input loss would vary with the stage of the crop at the time of floods. This information can be given in terms of two distinct crop stages, (a) Tilling phase covering sowing of seeds, germination and early phase of plant growth up to tilling, and (b) The pre-flowering phase to cover plant growth from the stage of tilling to just before flowering. Damage after flowering is likely to be total without much possibility of replanting or re-sowing. Norms for the estimate of input loss per hectare in respect of both crop stages for all important crops should be evolved by the Agriculture/Statistics Department.

It is therefore, recommended that the final estimate of crop damage on areas completely destroyed but where replanting/re-sowing takes place, and should be made in terms of loss of inputs. For this purpose, information on (i) Stage of the crop at the time of flood in terms of tilling and pre-flowering stages and (ii) Crop area completely destroyed but replanted/re-sown would be required.

As regards the effect of flood on yield of partially affected crop or on replanted/re-sown crops, it should be assessed by the difference between the normally expected yield and the actually obtained yield as indicated by crop cutting experiments.

There are some factors that lead to over estimation of damages. For example, in some cases farmers start cultivation earlier, and owing to silt deposition and residual moisture content after the floods obtain additional yields in comparison to normal years. Similarly, crop yields from fields located on high lands may increase. It quite often happens fully grown crop when submerged due to floods is cut and used as fodder for cattle but no allowance is made for the element of partial recovery while estimating damages. On the other hand, excess of moisture due to non-evacuation of floodwater in them may delay sowing and consequent loss in production. These factors may, however, be ignored because the procedures for taking them into account will be too complicated to be of much use. The matter may be a subject of research for future consideration.

3.3 Integrated area and crop damage statistics with agricultural statistics

Assessment of damage is a specialized job and should be done under expert supervision of persons having professional qualification and competence. The integration of the system of collection of crop damage statistics with that of agricultural statistics will, ***ipso facto***, ensure that the former data are also collected under the supervision and guidance of officers of the Central Bureau of Statistics.

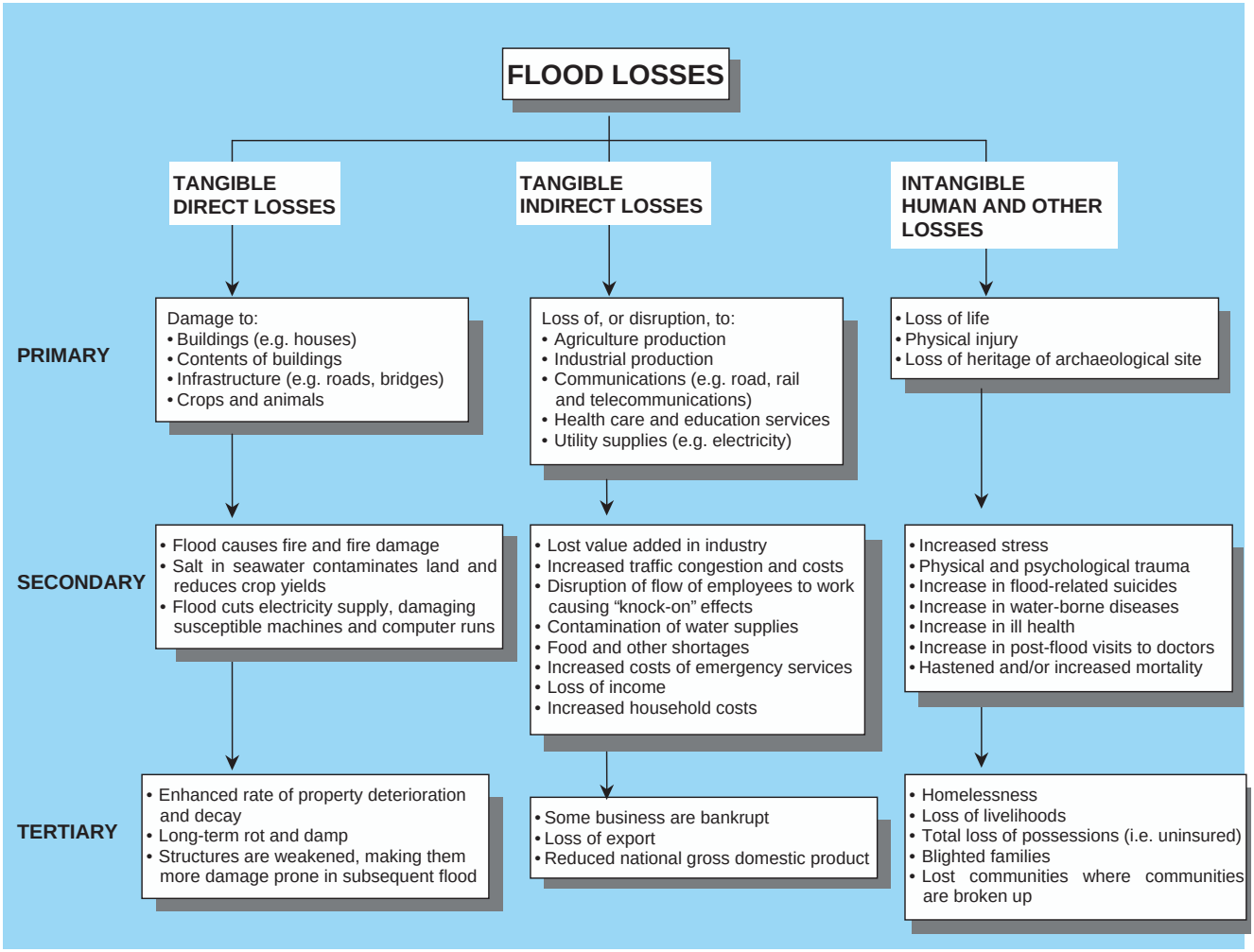


Figure V-I. Classification of different types of flood losses suffered

3.4 Use of contour maps and remote sensing technique

Contour maps of the basins are available and more are likely to be prepared in the future. These, along with data on gauges may be used by the Departments to derive an estimate of the flooded area. This will provide a quick check of area estimates provided by the agencies and may therefore be used on a sample basis to start with and extended to cover the entire flood prone basin as and when contour maps are made. Another way of exercising a sample check on the extent of the area and the cropped area affected by floods is through remote sensing techniques operated through artificial satellites.

3.5 Damages to private property and loss of lives

Besides crop damages, the agency concerned should also collect data on the number of people affected, damage to houses, loss of livestock and the loss of human lives. Some further improvement can be brought about by including household goods damaged during floods, but this is not recommended at the present stage on account of the difficult problems of estimation that will be encountered. Meanwhile necessary steps such as aiding and sponsoring research and setting up economic cells for conducting suitably designed economic surveys in order to prepare the ground for eventual collection of data on damages to household goods, on a regular basis should be taken. With respect to loss of life, it is observed that what is reported as deaths due to floods include a number of accidental deaths. It is suggested that loss of lives due to floods only should be taken into account.

3.6 Damages to public property

The respective departments on the basis of estimated cost of repairs assess these damages, but because of paucity of funds, such repairs are not necessarily carried out in the same year. As a result, the method of assessment followed leaves scope for double and multiple counting of the same damage particularly in areas subject to frequent flooding. It is therefore recommended that adequate steps should be taken to obviate such double counting. Sample checking and verification, being an integral part of any scientific methodology of data collection, should be introduced.

3.7 Indirect damages

The flood losses considered so far belong to the category of direct damages defined as damages arising out of direct contact with floodwater. However, damages may also be caused by cessation of normal economic activities on account of floods, even though persons or assets affected may not come in direct contact with it. For example, factories, shops and business in flood-affected areas may be closed resulting in loss to their owners, stoppage of industrial production and temporary unemployment of workers. Rail and road communication in affected sections may be interrupted resulting in reduced earnings for railways and transport operators. Daily wage earners and small peddlers, etc., working in the affected area may suffer loss of their daily wages/earnings. Such losses may occur not only in the areas flooded but also outside due to presence of forward and backward linkages. For example, a factory located elsewhere but depending on raw materials from the flooded area may suffer loss on account of cessation of supplies. Similarly, firms selling their output to flood affected areas may suffer losses. These examples are only illustrative and not exhaustive.

Measurement of indirect damages poses intricate problems and it may not be feasible to collect primary data after every flood event. However a fair assessment can still be made on the basis of secondary data from the departments concerned. It may take time to achieve such sophistication in assessing indirect damages but a beginning can be made under R&D program of CBS.

3.8 Additional classification of data required

While processing and tabulating data, classifications considered desirable may be introduced depending upon the requirements of concerned departments of the government. Very often, figures of damage in protected areas are needed to determine the efficacy of flood control measures adopted in the past. It is also necessary to have the information separately for protected and unprotected areas. Areas affected by drainage congestion in flood prone districts very often pass as flood affected as no distinction is made between various causes of inundation, like drainage block, local storms, and river spills etc. In view of the existence of large areas affected by drainage congestion in protected areas, it is important that the information about such areas is reported separately.

ANNEX VI

INDICATIVE GUIDELINES FOR WATERSHED DEVELOPMENT

1.0 Introduction

The watershed approach has conventionally aimed at treating degraded lands with the help of low cost and locally accessed technologies such as in situ soil and moisture conservation measures, forestation etc through a participatory approach that seeks to secure close involvement of the user communities.

These Indicative Guidelines lay down general principles for implementation of watershed development projects and should be adapted after consultation with the other relevant Ministries and Departments. Guidelines have a common set of operational norms for project formulation and implementation with scope for flexibility to deal with large variations in the main thrust and the local conditions. The guidelines should therefore ensure among others:

- Programme specific and focused project approach.
- Flexibility in implementation.
- Well-defined roles of the national, provisional, district and village level institutions.
- Avoiding overlaps.
- A provision for keeping the watershed development project on probation.
- Project Implementation Agency (PIA) to be a combination of government organizations and NGO.
- A greater role for women.
- An effective role for the Community Based Organizations (CBOs).
- Bringing to centre-stage the Self Help Groups (SHGs) comprising the rural poor from the target area.
- Establishing a credit facility from financial institutions.
- Transparency in implementation.
- Effective use of remotely sensed data.

These guidelines can be made applicable to the other similar programmes notified by the Government of Kenya in the Arid and Semi Arid Lands (ASAL), watersheds of rivers, degraded lands or any other project aimed at in situ soil and water conservation, augmentation of ground water recharge and reducing flood and sediment flow in rivers.

2.0 Objectives

The broad objective is always land and water resources management for sustainable development of natural resources for the general well being of the people, and community empowerment. It also addresses the problems of drought and floods as well as development of wastelands. While the focus of watershed development may differ from one area to another depending upon the local problems and physical conditions, the common objective is to stop degradation of the lands and the promotion of the overall economic development of the poor sections of the people living on such degraded lands. The objectives of watershed development should be:

(i) Developing wastelands/degraded lands, arid and semi-arid areas on watershed basis, keeping in view the land capability, site conditions and local needs.

(ii) Promoting the overall development and improving the socio-economic conditions of the poor and disadvantaged sections of the population in the programme areas.

(iii) Mitigating the adverse effects of extreme climate conditions such as drought and floods, on crops, human population and livestock.

(iv) Restoring ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover.

(v) Encouraging village community for

  (a) Sustained community action for the operation and maintenance of assets created and further development of the potential of the natural resources in the watershed.

  (b) Simple, easy and affordable technological solutions and institutional arrangements that make use of, and build upon local knowledge and available materials.

(c) Employment generation, poverty alleviation, community empowerment and development of human and other resources of the target area.

3.0 Implementation of Water Shed Programme

A watershed area is a geo-hydrological unit, which drains into common point. However, the actual area of a project may vary keeping in view the geographical location, the size of the beneficiary village etc. The thematic maps generated from satellite data for different themes such as land use/land cover, hydro-geomorphology, soils etc may be used for selection of a watershed area. The project should primarily aim at treatment of non-forest wastelands and identified arid and semi-arid lands. However, if any watershed area consists of some forestlands, it should also be treated simultaneously under the project, as provided in subsequent paragraphs. A suggestive organizational structure is presented in the following paragraphs.

3.1 Criteria for Selection of Watershed

The degradation of vast land and the limited availability of the resources call for prioritization of the watershed development project. The following criteria may broadly be used in prioritization and selection of the watersheds.

(a) Watershed area may be about 500 ha. However, if on actual survey, a watershed is found to have slightly less or more area, the total area may be taken up under the project. Even small contiguous watersheds with a total area of about 500 ha may be taken up for development.
(b) In case a watershed falls in two villages, it should be divided into two sub-watersheds but care should be taken to treat both areas simultaneously.
(c) Watershed, which has acute shortage of drinking water.
(d) Watershed that has a preponderance of non-forest wastelands or degraded lands.
(e) Watersheds where actual wages are significantly lower than minimum prescribed wages.
(f) Watershed, which is contiguous to another watershed that has already been developed.
(g) Watersheds where community participation is assured through contributions in the form of cash, materials or manual labor both for its development and operation and maintenance.

3.2 Development of Forest Lands in Watershed Areas

Some watersheds may encompass some forestland under the ownership of the Forest Department; the forestlands forming part of such watersheds may also be treated simultaneously as detailed below:

(a) The Forest Officer concerned should give technical sanction to the treatment plans.
(b) The programme should as far as possible be implemented by the Village Forest Committee. If no such Committee exists, their formation may be encouraged, or else the project activities in such portions of the watershed may be taken up by the Forest Department.
(c) Village Forest Committee (VFC) should be treated at par with the Watershed Committee. The VFC should be registered with the Forest Department.
(d) The Micro Watershed Development Plan for the forest areas should be in conformity with the Forest Conservation Act and should be an integral part of the forest-working plan for the area.
(e) Wherever the forest land covers a major part of the watershed, the Forest Department at the district level should be the Project Implementation Agency (PIA).

4.0 Project Management

Watershed programmes should be implemented, mainly through the District Development Committees within the overall programme of the Catchment Management Authority. However, wherever it is expedient in the interest of the programme, the projects can be implemented through any other Government Department at the national or the provincial level with the approval of the Catchment Management Authority.

4.1 Provincial Watershed Development Committee

To ensure coordination among various Government institutions, NGOs, Voluntary agencies etc, Provincial Watershed Committees (PWC) shall be constituted under the chairmanship of the Provincial Commissioners. The District Development Committee (DDC) described below shall normally be the authority competent to decide on the suitability or otherwise of the Project Implementation Agency for taking up the watershed development projects. However, the Provincial Commissioner shall be competent to change the PIA.

4.2 District Watershed Development Committees

To ensure coordination at district level, a District Watershed Development Committee (DWDC) shall be constituted under the chairmanship of the District Commissioner. The DWDC will advise the DDC on matters regarding selection of PIA, members of the Watershed Development Teams, training, Community Organizations etc. The Committee will also approve the detailed action plan for watershed development projects in the district. It should meet at least once in a quarter and review the progress of the project, assist in resolving management and administrative problems, guide in implementation, identify policy issues, if any, for reference to the Provincial Commissioner.

4.3 Project Implementation Agency (PIA)

PIA could be a government organization, NGO or CBO or a combination of these. The PIA shall normally be assigned 10-12 Watershed projects covering an area ranging from 5000 to 6000 hectares. The PIA shall engage a four member Watershed Development Team (WDT) to implement the project activities in the field.

4.4 Watershed Development Team (WDT)

The WDT may have at least four members one each from the disciplines of forestry/plant sciences, animal sciences, and Civil/Agriculture engineering and social sciences. One of the members should be designated as the Project Leader. The establishment charges of the WDT should be subject to the limits to be prescribed by the Kenya Government and debited to the Watershed Development Project. The WDT should be located at any town nearest to the project area.

4.5 Self Help Groups (SHGs)

The PIA should constitute SHGs in the Watershed area with the help of WDT. These groups shall be homogeneous having common identity such as agricultural laborers, landless persons, shepherds, women etc. Around 50% of the villagers who are directly or indirectly dependent on the watershed should generally be enrolled as members of the SHGs.

4.6 User Groups (UGs)

The PIA shall also constitute User Groups from those who may be the main beneficiaries of the project such as persons having land holdings or livestock holders depending upon the project land. The UGs should actually take over the operation and maintenance of the Community works.

4.7 Watershed Associations

Where a watershed is conterminous with a village or its area is confined within the boundaries of a village, the village committee should be designated as the Watershed Association (WA). Subject to the overall supervision and control of the WA, a Watershed Committee (WC) should carry out day-to-day activities of the watershed development project.

5.0 Project Planning Approach for Watershed Development

Initial sanction of Watershed Development Project is only indicative of location of watershed development projects, physical target and financial outlay. The detailed action plan in the form of an integrated project has to be prepared by the WDT in consultation with the Watershed Community. Community Organization is an important component; at the same time technical requirement and

feasibility of appropriate biophysical measures are to be carefully worked out for long-term sustainable interventions for the entire area of the watershed. The action plan should specify among others, the following:

(i) Pre-set deliverable output;
(ii) Elaborate road map with definite milestones;
(iii) Definite time frame for each activity;
(iv) Technological interventions;
(v) Specific success criteria; and
(vi) Clear Exit Protocol.

After the detailed action plan is approved by DWDC, it would be the responsibility of the PIA to get the same implemented through the Watershed Committees with the active involvement of WDT members.

5.1 Activities under Watershed Development

Watershed Development/Treatment Plan should be prepared for all the arable and non-arable land including degraded forestlands, government and community lands and private lands. Emphasis should be on low-cost locally available technology, simple and easy to build/operate/maintain works. The items that can be included in the Watershed Development Plan are:

(a) Land development including in-situ soil and moisture conservation measures like contour and graded bunds fortified by plantation, bench terracing in hilly terrain, nursery raising for fodder, timber, fuel wood, horticulture and Non Timber Forest Product Species.
(b) Forestation including block plantations, agro-forestry and horticultural development. Shelterbelt plantations, sand dune stabilization, etc.
(c) Drainage line treatment with a combination of vegetative and engineering structures.
(d) Development of small water harvesting structures such as low-cost farm ponds, check-dams and percolation tanks and ground water recharge measures.
(e) Renovation and augmentation of water resources, desiltation of tanks for drinking water/irrigation.
(f) Pasture development either by itself or in conjunction with plantations.
(g) Repair, restoration and up-gradation of existing common property assets and structures in the watershed to obtain optimum and sustained benefits from previous public investments.
(h) Crop demonstrations for popularizing new crops/varieties or innovative management practices.
(i) Promotion and propagation of non-conventional energy saving devices and energy conservation measures.

5.2 General Planning Approach

Each watershed has unique characteristics and problems. Its treatment and management would therefore require careful consideration of various site specific factors like topography (shape, configuration and slope of the land), nature and depth of soil cover, type of rocks and their pattern of formation and layout, water absorbing capacity of land, rainfall intensity, land use etc. measures are taken in the following manners as shown in Table below.

Table VI-1: Watershed Improvement Techniques

Nature of Terrain	Improvement Techniques
❑ Hill tops and upper reaches of watershed. ❑ Steep hill slopes a little lower down. ❑ Lower parts of watershed.	❑ Forestation ❑ Development of grass lands • Contour bunding and terracing of agricultural fields. • Contour trenching. • Contour cultivation. • Strip cropping. • Gully plugging. • Stream bank protection against erosion. • Farm ponds. • Control and regulation of grazing.

5.3 Contour Trenching

This consists of excavating shallow/intermittent trenches across the land slope and forming a small earthen bund on the downstream side. Plantation is done on the bund to stabilize the bund. The trenches retain the runoff and help in establishment of the plantations made on the bund. Trenches are useful where the land surface is fairly porous and rainwater collected in trenches can quickly percolate into the ground. The spacing of trenches and their size i.e. length, width and depth should be adequate to intercept about 50% of the peak rainfall in semi-arid regions i.e. with annual rainfall of about 400-550 mm. The trenches should be cleaned and desilted periodically.

5.4 Bench Terraces

These consist of series of platform excavated on the slope. Depending upon the rainfall conditions and crops to be grown, terraces are constructed flat, sloping inwards and sloping outwards. Continuous bench terraces differ from the tree-crop or orchard terraces. There are no idle spaces between terraces in the former case while they are prominent in the later. On a hill slope, bench terraces for vegetable and short-term crop usually are continuous. The lower terrace starts exactly from the line where the upper terrace ends. In other words, the cut section of the lower terrace begins where the fill section of the upper terrace ends. So we see benches between the riser slopes in a continuous manner. Unless the soil is extremely porous, such terraces have down-the-slope outlets, like a grassed channel with wooden drops or a prefabricated concrete channel with short drops or any other erosion control structures on the steep channel. The terraces have about 4 percent hill ward grade. The riser slopes vary with the land slope (up to 30% land slope 1:1, above 30% and up to 60% land slope 0.75:1 and above 60% land slope 0.5:1). A longitudinal grade of about 1% is provided to lead the terrace water to the outlet. Riser slopes are grassed.

5.5 Gully Plugging

Gullies are a symptom of functional disorder of the land, improper land use and are the most visible result of severe soil erosion. They are small drainage channels, which cannot be easily crossed by agricultural equipment. The gully plugging measures include vegetative plantings and brushwood check dams, boulder bunds, brick masonry and earthen bunds or a combination of both, sand bag plugs etc. the specifications for gully plugs are given in Table below.

Table VI-2: Specifications for Gully Plugs

Slope of Gully Bed (%)	Width of Gully Bed (m)	Location	Type of Gully Plug	Vertical Interval
0-5	4.5	Gully Bed	Brush wood	3.0
	4.5-10.5	Gully Bed	Earthen	2.25-3.0
	7.5-15.0	At the confluence of two gullies	Sand bag	
	7.5-15.0	At the confluence of all branches of a compound gully	Brick masonry	
5-10	4.5	Gully Bed	Brush wood	3.0
	4.5-6.0	Gully Bed and side branch	Earthen	1.5-3.0

For gullies in which no significant runoff is expected from upstream, earthen gully plugs of 1.1 m cross-section with a grassed ramp of 22.5 cm below the top level are provided at 45-60 m intervals. For gullies in which excessive runoff from the top is expected, an earthen gully plug of 2.2 m cross-section is provided with a pipe outlet. The diameter of the R.C.C. spun pipe is 15 cm for a discharge of 0.03 to 0.09 cumecs coming from a catchment area of up to 1.6 ha. A composite check dam of earth and brick masonry is necessary for catchment areas larger than 1.6 ha. The first structure is located at the confluence of two or more gullies. For long gullies, more such structures are built either at 1.2 m vertical interval or 120 m horizontal interval.

5.6 Contour Cultivation

This consists in carrying out different agricultural operations like ploughing, planting and inter-culture in horizontal lines across the sloping land. Such practices help in retaining rainwater and retarding erosion. These measures are effective when land slope is about 2% and less.

5.7 Contour Bunding

This measure involves construction of horizontal lines of small earthen or boulder bunds across the sloping land surface. The term contour bunding used is same as “level terraces” and “ridge type terraces”. The bunds act as barriers to the flow of water and at the same time impound water to build up soil moisture storage. The spacing of bunds is so arranged that the flowing water is intercepted before it attains the erosive velocity. The vertical interval between the two bunds is determined by the following formula:

$$V = 0.3 \left(\frac{S + 2}{3} \right)$$

Where,

S = Degree of slope in percent.
V = Vertical interval between two bunds.

The spacing is increased by 25% in highly permeable soils and decreased by 15% in poorly permeable soils. It is always desirable to remove local ridges and depressions before building contour bunds. If leveling is not economical, a deviation of 10 cm for crossing the ridges and 20 cm for crossing the depressions is recommended.

For narrow bunds the top width is 50 cm, height is 80 cm and side slopes of 1:1. Cross sectional area in sq m of broad based contour bunding with different height and side slope, is recommended as given in the Table below. The design of cross-section of contour bund, which can store runoff excess from 24 hrs rainstorm, can be done with the help of the following equation.

$$h = \frac{Re \times VI}{50}$$

Where,

H = Depth of impounding in m near the bund.
Re = 24 hours rainfall excess in cm.
VI = Vertical interval in m.

Using the above equation, height of impounding required for 10 years frequently (or any other frequency) can be obtained which will not cause any spill over. To the depth of impounding ‘h’, the free board of 25 to 30% may be added.

Table VI-3: Recommended Side Slope for different Heights of Bund

Height of Bund (m)	Side Slope				
	4:1	**5:1**	**6:1**	**7:1**	**8:1**
0.30	0.36	0.45	0.54	0.61	0.72
0.40	0.64	0.84	0.96	1.12	1.28
0.50	1.00	1.25	1.50	1.75	2.00

5.8 Farm Ponds

There is very little qualitative difference between a pond/tank, which usually serves the population of a village, and farm pond, which serves an individual agricultural field. Farms ponds greatly vary in size depending upon the rainfall. In high rainfall areas, these have only a few meters of length and width and are built across the flow path of natural drainage channels. Surplus water from one pond spills over to a lower pond. In some cases a series of farm ponds are built on one single stream. Each pond caters to the irrigation needs of one farm and also augments ground water recharge.

In any watershed management program farm ponds are an important component. Farm ponds are useful in storing water for irrigation. They also retard sediment and flood flows to the downstream river system. In relatively flatter terrain with good soil cover, a farm pond has an earth section with usually 3:1 side slopes on waterside and 2:1 side slopes on the downstream face (A uniform side slope of 2 ½ :1 on both sides can be adopted at some sites). A natural depression nearby may be used as an earthen spillway with minimum channel section construction. A pipe drop inlet spillway and an irrigation outlet are also provided. A key trench is dug to give a good bondage between the original ground and the filled earth. Storm riprap against wave action may be required in some cases. The pond crest usually serves as a farm road (provide 4.25 m roadway for motorable roads).

A good site should possess the following traits:

- The site for the earthen bund should be narrow gorge with a fan shaped valley above so that a small amount of earthwork gives a large capacity.
- The drainage area above the pond should be large enough to fill the pond in 2 or 3 spells of good rainfall.
- The pond should be located where it could serve a major purpose, e.g. for irrigation, it should be above the irrigated fields and for sediment control it should intercept the flow from the most erodible parts of the catchment.
- Junction of two drainage channels or large natural depressions should be preferred.
- The land surface should not have excessive seepage losses unless it is meant to serve as a percolation tank for ground water recharge.

Planning and design aspects of farm ponds are dealt with more or less in accordance with those for ponds/tanks.

ANNEX VII

CAPACITY BUILDING: THE HUMAN RESOURCES DEVELOPMENT

1.0 Introduction

Despite best efforts many projects fail to deliver the expected results and benefits. An analysis of the reasons for such a shortfall, can be traced back to the capacity of the individual as well as the organizations. Flood issues involve many stakeholders and players, eventually the capacity of each player decides the final success or failure of the project(s). The capacity building has four main components: an enabling environment with appropriate policy and legal framework; institutional development including stakeholders' participation; human resources development; and arranging for sustainable funding.

There is need for a clear policy on human resources development for personnel working in the flood management sector. This annex focuses on the education and training aspects of human resources development. A policy on the education and training for the personnel involved in flood management and hydrological activities should be prepared based on the WMO Guidelines for the Education and Training of Personnel in Hydrology[21].

Further, as flood management involves a multidisciplinary approach with active community participation it is also important that these sections of the stakeholders are also capable of playing their vital role. The study of the present institutional mechanism and the administrative setup identifies the following areas for capacity building in the area of flood management in the country.

2.0 Capacity building in MWRMD

There is a need to develop special skills in data collection and data analysis thereby bringing self-sufficiency in technical aspects of flood management issues. This requires an in-depth analysis and approach towards capacity building. Some of the specific areas which require immediate attention are listed below.

Data collection

- Hydrological data observation, data base management in real time, analysis of data for consistency.
- Rainfall-runoff modelling and channel routing of flood flows for flood forecasting. Formulation and dissemination of forecasts.
- Maintenance and management of sensors data loggers and other equipment at river gauging stations.

Data analysis

- Analysis of the flood situation and evaluation of the flood forecasting activity and preparation of flood reports after every flood season.
- Field investigations and surveys for preparation of detailed project reports.
- Planning and design of specific schemes and their integration into a comprehensive project report.

Self Sufficiency

- Emphasis should be on self-reliance. Limit the role of foreign consultants only in the area of capacity building and providing guidance in developing manuals, standards and guidelines. The in house staff should be fully involved in these activities.
- Donor funding should be used essentially for capacity building and strengthening the existing technical library.
- Have a standing arrangement with foreign organizations like USBR, USGS, Delft hydraulics, American society of hydraulic engineers etc for supply of technical journals, research papers etc for the technical library.

[21] WMO, 2003, "Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology, Vol.II Hydrology", WMO No. 258.

- Use simple, easily available cheap equipment that can be replaced or repaired locally at affordable cost.
- Construction planning and supervision with focus on quality control.

3.0 Capacity building in KMD

Kenya Meteorological Department is one of the strongest meteorological outfits in the region and provides considerable leadership in the field of regional climate outlooks and droughts. A drought monitoring centre is also located in Kenya, However while addressing water issues there are certain areas where the technical skills are required to be enhanced, These also should be identified after a detailed study. Some of the areas in respect of flood management are listed below.

Climate modelling

- Downscaling of the existing climate prediction models to basin level.
- Operationalizing the existing watershed-scale climate models and formulation of quantitative precipitation forecasts suitable for rainfall-runoff modeling as part of flood forecasting at the FFO.

Communication systems and technical installations

- Set up village level communication system to provide advance flood warning to the communities from the existing rainfall warning mechanism of the KMD.
- KMD to expand their Radio Internet (RANET) communication system to reach all rural communities in flood prone areas.
- KMD to immediately operationalize 2 24 hour stations in each sub-basin and provide daily QPF to FFO with a lead time of at least 36 hours.

Village Level Participation

- District Disaster Management Committee (DMC) to identify the flood prone villages in the districts of Kisumu, Siaya, Bondo, Busia, Nyando/Ahero and Migori; and identify the village level organization to be involved.
- Identify the village organization or its sub-group that would assist the field staff of MWRMD in monitoring and reporting river gauges to the Flood Forecasting Office (FFO) of MWRMD.
- Identify the group that would receive flood warning messages from DMC and disseminate the same immediately to the people through the public address system.
- DMC to provide the identified organization with the telecommunication system. for receiving flood warning messages from DMC; as well as public address system for warning the people of the incoming flood.
- MWRMD to determine the no-damage causing (bankful) discharge at Flood forecasting station and corresponding water level and decide the warning level and danger level in consultation with DMC. MWRMD to notify these levels to all departments concerned and the community organizations.
- DMC to identify and notify safe places where the people could move on their own on receiving the flood warning.

4.0 Promote and strengthen community participation

It is important to involve communities in flood monitoring and disaster management especially in rescue and relief operations by training them in the following aspects.

- Operation, maintenance and monitoring of flood management works like dykes.
- Assisting the field staff of MWRMD in hourly monitoring of river water levels at the flood forecasting site.
- Communicating water levels to the flood forecasting office (FFO).
- Receiving flood warning from the FFO, through the DMC.
- Mobilizing transport arrangements for rescue.
- Directing transport to predetermine disaster management units (DMU) of the district.
- Helping the District Disaster Management Committee (DMC) in distributing essential supplies in relief camps.

5.0 Involve NGOs in capacity building at community level

- Disaster Operations Centre (DOC) to prepare training material and guidelines for the NGOs.
- Separate registration of NGOs, engaged in disaster management, with DOC.
- DOC to organize training programmes for registered NGOs and carry out periodical appraisal of their work.

ANNEX VIII

FLOOD FORECASTING SYSTEM FOR LAKE VICTORIA BASIN

1.0 Introduction

Floods in the rivers Nzoia, Yala, Nyando, Sondu and Kuja cause large-scale devastation of crops, property and physical infrastructure and hamper developmental activities. However the most catastrophic impact of floods is in the form of loss of human lives. Often people are taken unawares when the flood causing heavy rainfall occurs in the upper catchments while the plains lower down receive relatively low or even scanty rainfall. There is therefore an apparent need for establishing a flood forecasting system on these rivers.

2.0 Components of Flood Forecasting System

Establishing a viable flood forecasting and warning systems requires a combination of data inputs, the forecast tools, with trained forecasters and a dissemination mechanism through which the timely warnings could be conveyed to the communities at risk leaving them sufficient time to respond. A Flood Forecasting and Warning System must: be accurate and reliable, be timely, be resilient and at the same time flexible to adjust to the new technologies and demands. Following are the five main components of a flood forecasting system:

Hydro-meteorological network: Key rainfall and river gauging stations with facilities for data observation and communication in real time are the main components of the network. All manned stations work round the clock in shifts. The personnel responsible for functioning of the network are river and rain gauge readers, wireless operators and junior engineers/hydrologist.

Data acquisition and processing: For data to be useful to the forecaster, the data observed at the remote centres has to be communicated without loss of time to the forecast office for further processing and formulation of forecast**.** Unit in the flood forecasting office is responsible for receiving raw data from the field and processing it for consistency and transferring it to the flood forecast formulation unit. The unit is equipped with two-way communication system and keeps in constant touch with the reporting stations in the field. The unit comprises of wireless operators and hydromet personnel who have to work round the clock. In case of a telemetry system the hydromet personnel also keep watch on the consistency of automatic sensors and functioning of the communication equipment.

Forecast formulation: Based on the understanding of the process of flood formulation and the available data input an appropriate model for forecast formulation is developed. Hydrologist/engineers equipped with forecasting tools like correlation graphs/nomographs, unit hydrographs, forecasting models etc together with appropriate computer facilities have to formulate the forecast accordingly.

Forecast dissemination: Comprises of dissemination of forecast to various agencies in a prescribed format for which there should be a standard mailing list and laid down procedures for issuing forecast. This responsibility is assigned to wireless operators and junior engineers with requisite communication equipment and other resources.

Forecast review and development: A team comprising of hydrologist/hydromet should review the forecast accuracy and formulation techniques regularly. Based on current and past experience they modify/improve the techniques.

3.0 Hydro-Meteorological Network

3.1 Identification of Flood Forecasting Centres

A flood forecasting centre has to be identified, as the authentic source of flood forecasts and warnings. Interagency agreements are needed defining clearly articulated roles and responsibilities, specification of works and performance measures of all agencies involved in the process.

At present the field units of MWRMD have district wise functional jurisdictions. Thus the river gauging stations in a river basin are under the charge of different District Water Officers for Water Resources Management in general and flood forecasting operations in particular there is need to reorganize the existing departmental structure sub-basin wise which appears feasible under the on-going institutional reforms process. However for better coordination and supervisory control it is necessary that all hydrological observation stations in a river basin are placed under the charge of the Flood Forecasting Office (FFO) for that river basin. Considering the proximity to the flood prone areas and functional requirements, location of FFO's for different river basins are recommended as follows:

Rivers Nzoia and Yala FFO, Busia (presently known as District Water Office Busia)
Rivers Nyando and Sondu FFO, Ahero (presently known as District Water Office Ahero)
River Kuja/Migori FFO, Migori (presently known as District Water Office Migori)

3.1 Identification of Rainfall Stations

Based on the rainfall pattern and the consequent floods in each sub-basin, following rainfall stations have been selected in consultation with KMD for inclusion in the flood forecasting network:

River Nzoi
(i) Kitale Met Station (KMD)
(ii) Eldoret Met Station (KMD)
(iii) Kakamega Met Station (KMD)
River Yala
(i) Kakamega Met Station (KMD)
(ii) Eldoret Met Station (KMD)
River Nyando
(i) Kericho Met Station (KMD)
(ii) Nandi Hill (Tea estate, KMD should take over this station and upgrade it)
River Sondu
(i) Kericho Met Station (KMD)
(ii) Karinget (Forest Station, KMD to take over this station and upgrade it)
River Kuja
(i) Kisii Met Station (KMD)
(ii) Kilgoris (Agriculture Office, KMD to take over this station and upgrade it)

3.2 Quantitative Precipitation Forecast

The deterministic quantitative precipitation forecast can be applied to hydrological models in order to formulate hydrological forecast. The usefulness of QPF products is usually constrained to one to two days due to poor performance beyond these limits. The numerical weather prediction section of KMD has a model that can give QPF with a lead time of six hours with an accuracy of sixty percent.

In view of the short travel time from base station to the forecasting station, gauge to gauge correlation method would not be very effective for operational flood forecasting. For the flood forecast to be effective, with adequate lead-time it is absolutely necessary to have rainfall-runoff based forecasting system using quantitative precipitation forecast at least 24 hours in advance. It is necessary that QPF is provided not at a fixed time in a day but as and when the weather conditions warrant. The KMD would therefore need to make necessary arrangements for QPF accordingly.

3.3 Identification of Base and Flood Forecasting Stations

For flood forecasting purposes base stations have been chosen as close to the foothills as possible. Flood forecasting stations have been chosen just upstream of the flood prone areas. These are as follows:

River Nzoia		
Base Station:	No 1DA02	(Forecast by rainfall-runoff and channel routing)
FF Station:	No 1EF01	
River Yala		
Base Station:	No 1FE02	(Forecast by rainfall-runoff and channel routing)
FF Station:	No 1FG02	

River Nyando

FF Station:	No 1GD03	(Forecast by rainfall run-off modeling)

River Sondu

FF Station:	No 1JG01	(Forecast by rainfall-runoff modeling)

River Kuja

Base Station:	Gogo Dam	(Forecast by rainfall-runoff and channel routing)
FF Station:	No 1KB05	

4.0 Data Communication

There are a number of communication technologies that can be applied to transmit data from sites in remote location to the forecast centres. Some of these are by telephones, radio telephones, satellite, cellular radio and meteor burst. Presently, the meteorological observation stations of KMD transmit the data to the National Meteorological Center (NMC) every three hours through radio telephones or telephones. Kisumu Meteorological Station is responsible for the transmission of these observations.

Recently a VSAT communication set has also been installed in Kisumu. Most of the data is passed through the Meteosat satellite. The radio telephones are used for transmitting data from synoptic stations to the collecting centers and then the data is relayed to NMC. There is also a satellite link via VSAT from main collecting centers to RTH. This link is to eventually take over the landline connections to improve data transmission.

The FFOs of MWRMD should have the same mode of data communication as the KMD, which are radiotelephones and landlines. A memorandum of understanding needs to be signed between the two departments for real time data communication. The FFOs should have a separate arrangement of radiotelephones for communication with DDMC/District Commissioner. It would be desirable that the office of District Commissioner deputes their own staff and communication equipment in the premises of the FFO during the rainy season.

5.0 Flood Forecasting Methods

There are a large number of flood forecasting models available for use. They vary from simple statistical rainfall – runoff relationship to a sophisticated deterministic and distributed hydrological model. The model selection depends on the availability of data, needs of the user community and the basin characteristics. One of the basin characteristics is indicated by the time of concentration.

5.1 Time of Concentration

There are various methods of determining time of concentration. One of the practical formulas in vogue is based on the kinematics wave theory and which takes into consideration the basin characteristics. The formula suggested in the National Water Master Plan has been used to determine the time of concentration at various base/FF stations for different rainfall intensities. These are shown in the following table:

Table VIII-1: Concentration Time for Different Rainfall Intensities

River	Base/FFO Station	Concentration Time (Hours)		
		2 mm/hr	5 mm/hr	10 mm/hr
Nzoia	1DA02	14	10	8
Yala	1FE02	10.5	7.5	6
Nyando	1GD03	10.4	7.5	6
Sondu	1JG01	11.2	8.15	6.4
Kuja	1KB05	11.6	8.35	6.6

It would be seen from the above table that maximum time of concentration of 14 hours is for the base station number 1DA02 on river Nzoia for rainfall intensity of 2 mm/hr. The observed rainfall intensities at Eldoret and Kitale are 10 mm/hr and 16 mm/hr. Assuming an average intensity of 10 mm/hr the concentration time for this station is only 8 hours. The travel time from this base station to the FF station 1EF01 is about 14 hours. Thus the total lead time available is only about 22 hours which may not be adequate for rescue and relief operations. Considering the manual data observation and communication, formulation and dissemination of forecast, the actual lead time available will be even less. In case of other rivers the situation in terms of lead time is even more critical.

5.2 Flood Forecasting Models

The MWRMD has so far acquired the following flood forecasting models.

(i) Galway Flood Forecasting system (GFFS) model
(ii) Geo Spatial Flood Forecasting Model (Geo SFM)
(iii) NAM Rainfall-Runoff model.

The GFFS model has been calibrated and tested with limited historical data of few rivers and is understood to have given encouraging simulations for Nzoia. This is yet to be tested in real-time flood forecasting. The model holds promise for operational flood forecasting for which arrangements would need to be made with KMD for QPF with a lead-time of at least 24 hours. River cross-sections would also be required at regular intervals and the gauges would need to be connected to a common reference datum.

The Geo SFM model has been installed at the headquarters of MWRMD but is yet to be calibrated and tested. The data requirement of the model at present cannot be met since some of it is to be remotely sensed from satellite and provided in a specific format.

The Provincial Water Office of MWRMD at Kisumu has acquired the NAM rainfall-runoff model under the World Bank sponsored “Lake Victoria Environment Management Project”. This is a rainfall-runoff model developed by the Danish Hydraulic Institute Denmark which together with the Hydrodynamic channel routing module constitutes the MIKE-11 Flood forecasting model. The NAM module has been tested/calibrated for various sub-basins using 50 years historical data from 1950 to 2000. Sub-basin wise calibration results are available as follows:

River	Data used	Gauging Station
Nzoia	1979 – 1988	1EF01
Yala	1982 – 1986	1EG01
Nyando	1970 – 1973	1GD01
Sondu	1982 – 1989	1JG 01
Kuja Migori	1970 – 1976	1KB05

These calibrations have been done for the sub-basin as a single unit for the gauging stations mentioned above. Though these gauging stations are only 20 to 35 km from the river outfalls into the lake there is need to use the channel routing module in the lower reaches to take into consideration the backwater effect of the lake. The water level of the lake would, therefore, be the downstream “boundary condition” for the model. Gauges would therefore need to be installed at the out falls of the rivers. Since the lake levels do not vary significantly over short periods, these could be observed once a week.

Till such time all the gauges are connected to a common reference datum and river cross-sections are taken, forecasting could be done using only the NAM module. However immediate arrangements would need to be made with KMD for issuing QPF on a regular basis. Due to more experience of using the software, and looking at the flexibility of data, its requirements, Mike-11 model is recommended to be adopted for flood forecasting. The model comes with hardware keys (Dongles) and therefore adequate number of copies of the model would need to be arranged for installation at all FFOs.

5.3 Gauge-to-Gauge Correlation

As discussed in Para 5.1. Gauge-to-gauge correlation may not be the most suitable for any of the rivers in the Lake Victoria Basin. However, this method may be used as an interim measure, to check the forecasts formulated by other methods and to develop an in-depth understanding of the flood wave propagation under different conditions. The method involves developing mathematical correlations between upstream and downstream conditions. Typical correlations that can be are given in Fig VIII-1 to Fig VIII-5. These can be developed by analyzing the observed data of river gauges duly corrected for their zero levels (based on surveys) available with MWRMD and the rainfall information available with KMD.

Fig VIII-1 is a Nomogram of peak Floods drawn from historical data. Fig VIII-2 shows gauge-to-gauge correlations with travel time between three stations X, Y and Z on a river. Fig VIII-3 shows gauge-to-gauge relations with time lag between stations P, Q and R on a river. Fig VII-4 shows the relation between change in gauge at two stations A and B in a river time interval. Fig VIII-5 shows a typical Rainfall-run-off relation for different values of base flow. This graph is used in unit hydrograph method of flood forecasting discussed in the example in the following para.

5.4 Application of Unit Hydrograph in Forecast Formulation

Procurement of MIKE-11 model and training of personnel in its use may take some time. In the meantime flood-forecasting activity may be started by using the gauge-to-gauge correlation or unit hydrograph method. For each sub-basin-Nzoia, Yala, Nyando, Sondu and Kuja unit hydrographs would need to be developed based on historical data of rainfall and observed discharges for the corresponding events. In case of Nzoia and Yala rivers these should be developed for the Base stations and for Nyando, Sondu and Kuja/Migori at the flood forecasting stations. Once a unit hydrograph has been developed for a particular site of a river, it can be very conveniently used for forecast formulation when a dependable QPF is available. This is illustrated with the help of the following STEPS.

The unit hydrograph for any given site on a river is first developed. The ordinates of the three hour unit hydrograph are given below:

Time (Hrs)	Discharge (Cumecs)
0	0
3	8
6	34
9	103
12	130
15	141
18	119
21	83
24	59
27	40
30	28
33	20
36	14
39	8
42	4
45	2
48	0

As per the reports received at 1900 hrs on 13th September, the average rainfall observed at different hours was as follows:

Duration (Hrs)	Rainfall Amount
09 – 12	19.4mm
12 – 15	20.0mm
15 – 18	14.9mm

The discharge in the river at 09 hrs was 300 cumecs. Using the above data, the ordinates of the expected flood hydrograph, the peak discharge and time of occurrence of peak are computed as follows:

(i) Total amount of rainfall from 09 to 18 hrs is 54.3mm. From the rainfall-runoff relationship given in Fig. 5, the amount of runoff corresponding to 54.3mm of rainfall and 300 cumecs as base flow works out to 14.5 mm. This loss indicates a total of the order of 39.8mm. Assuming the loss to be uniform, the effective rainfall at various durations will be as follows.

Duration (Hrs)	Total Rainfall (mm)	Loss (mm)	Effective rainfall (mm)
09-12	19.4	13.3	6.1
12-15	20.0	13.3	6.7
15-18	14.9	13.3	1.7

(ii) The ordinates of the unit hydrograph are noted down under col. 3 of Table Annex VIII-2.

(iii) The values given on the top of columns 4, 5 and 6 of the table are the effective rainfalls in order of time.

(iv) The ordinates of the unit hydrograph are multiplied by 6.1 mm i.e the effective rainfall and the results are written under column 4.

(v) The ordinates of the unit hydrograph are multiplied by the next block of effective rainfall i.e. 6.7 mm (as written over column 5) and the results written under col. 5 after shifting by 3 hours.

TABLE VIII-2: Computation of Flood Hydrograph from Unit Hydrograph

Date	Time	Ordinates of Unit Hydrograph (cumec)	DRH due to Rainfall Amount (mm)				Base Flow	Flood Hydrograph
			6.1	6.7	1.7	Total		
1	2	3	4	5	6	7	8	9
13.9	09	0	0.00	-	-	0.00	300	300.00
	12	8	48.8	0.00	-	48.80	300	348.80
	15	34	207.40	53.60	0.00	261.00	300	561.00
	18	103	628.30	227.80	13.60	869.70	300	1169.70
	21	130	793.00	690.10	57.80	1540.90	300	1840.90
14.9	00	141	860.10	871.00	175.10	1906.20	300	2206.20
	03	119	725.90	944.70	221.00	1891.60	300	2191.60
	06	83	506.30	797.30	239.70	1543.30	300	1843.30
	09	59	359.90	556.10	202.30	1118.30	300	1418.30
	12	40	244.00	395.30	141.10	780.40	300	1080.40
	15	28	170.80	268.00	100.30	539.10	300	839.10
	18	20	122.00	187.60	68.00	377.60	300	677.60
	21	14	85.40	134.00	47.60	267.00	300	567.00
15.9	00	8	48.80	93.80	34.00	176.60	300	476.60
	03	4	24.40	53.60	23.80	101.80	300	401.80
	06	2	12.20	26.80	13.60	52.60	300	352.60
	09	0	0.00	13.40	6.80	20.20	300	320.20

6.0 Dissemination of Forecast

Currently in the whole country there are three RANET radio transmission stations but they are yet to be operationalized. In Lake Victoria Basin only Kisumu station has world space digital radio receiver for RANET radio transmitter.

RANET has the following equipments for communication:

1. Suitcase radio transmitters that can be used within a radius of 25 Kms.
2. Hand held radios, which are used for receiving broadcasts. They normally use hand winding mechanism for power. The KMD can provide about 100 sets at village level.

3. World space digital receivers. Budalangi is earmarked to receive such a receiver. Several people in this area have already been trained in the use of RANET.

Weather forecast is issued by KMD every week. These are one week ahead and four day forecasts. The rainfall warning that is issued to Disaster Operation Center is normally delivered by hand. The electronic and print media receive the forecast through fax. Dissemination of the warning of impending floods is the weakest link in the Flood Forecasting and Warning System. The warnings must reach the end user with minimum loss of time. Dissemination methodology depends on the technology development and sustainability in the given set up, the type of floods and the response mechanism as a result of the warning.

Flood forecast needs to be disseminated immediately after it is received from the forecast formulation centre. An indicative format is given in Attachments I and II. The value of a forecast lies in its dissemination to the public at the earliest with adequate lead time. A late warning with little lead-time is of no use to the community. The nodal agencies/officials like the District Commissioner, Disaster Operations Centre etc have to be given the forecast by wireless or telephone and must be confirmed in writing in a standard format. The effective flood warning system must make use of the available high technology like internet, the mass-media like television and radio and also the traditional communication means.

Significance of flood forecasts

Merely issuing flood forecasts in terms of water levels is not of much use unless the significance of these levels in terms of damage potential is also explained to the people. The water level information should be translated into its impact on the area. This should be described with reference to certain threshold levels like “Warning Level” “Danger Level” and “Highest flood level observed so far”. For the information of the public guide posts, marked with these threshold levels, should be displayed at prominent public places in the flood prone areas.

Social aspects

People react to flood hazard warning in different behavioral patterns depending on their perceptions, experiences and social conditions. At some places the normal floods are not disastrous and people have learnt to live with them. In such situations people have to be educated to understand that there is always a possibility of a high flood occurring and therefore they should remain vigilant and act quickly on receiving the warning. It is however, necessary to avoid issuing unwarranted flood warnings and alerts based on inadequate data or without proper formulation of forecasts because such warnings keep the people un-necessarily tense; and if such a practice is allowed to continue, may cause the people to lose faith in the forecasting system. It is therefore, important that the social scientists that can analyze the response behavior are also involved in the formulation and delivery of the flood-warning message.

7.0 Staff Requirement at FFO

(A)	**Field Staff**		**Regular**	**Seasonal Contract**
	Base Station and/or FF station			
	(i)	Gauge readers	1	3
	(ii)	Wireless Operator	1	2
	(iii)	Gauge reader	1	3
	(vi)	Wireless operator	1	2
	(v)	Hydrologist/Engineer Junior	1	-

The Junior/Hydrologist/Engineer will have supervisory control on both the Base/FF stations.

(B)	**Office Staff at FFO**		**Regular**	**Seasonal Contract**
	(i)	Wireless operator	1	2
	(ii)	Assistant Hydrologist	2	-
	(iii)	Hydrologist	1	-
	(iv)	Flood Forecasting Officer	1	-

(C) Duties of Staff

Gauge Reader: cum wireless operator

(i) Read and record the gauges 3 times a day during non-flood periods at 8 a.m., 12 o'clock and 4 p.m. and every hour during the flood period.
(ii) Assist the Junior Hydrologist in measuring river discharge.
(iii) Communicate to the FFO the gauge and discharge data immediately after observation.
(iv) Routine Maintenance of the wireless set, batteries and other ancillary equipment.

Junior Hydrologist:

(i) Discharge measurements once every day.
(ii) Maintaining data record.
(iii) Overall management of the gauging stations including supervisory control over the staff.

Wireless Operator (Office):

(i) Receiving the data from the field and forwarding the same to the Assistant Hydrologist in FFO.
(ii) Maintaining the register of data received and passed on.
(iii) Routine maintenance of the wireless batteries and other ancillary equipment.

Assistant Hydrologist:

(i) Processing the raw data for consistency.
(ii) Assisting the Hydrologist in FF formulation.
(iii) Database management.
(iv) Forwarding the forecast to the dissemination unit.
(v) Maintenance of forecast dispatch records.

Hydrologist:

(i) Formulation of flood forecast and opening the approval of FFO for issuing the same.
(ii) Issuing Forecast to all concern.
(iii) Review of previous forecast and reporting the level of accuracy to FFO.
(iv) Maintaining record of forecasts issued.

Flood Forecasting Officer:

(i) Checking the formulated forecast and authorizing its dissemination.
(ii) Issuing daily flood bulletins for the information of the Minister, PS, Members of Parliament and media.
(iii) Periodical review (about five years) of warning/danger levels in consultation with the district administration.
(iv) Maintenance of all gauging stations under his charge.
(v) Overall administrative, technical and financial responsibilities of the flood forecasting office.

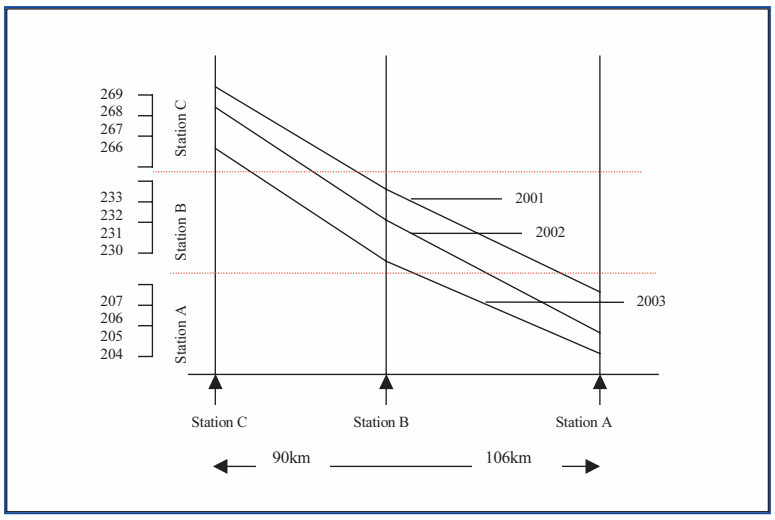


Fig VIII-1: Flood Profile Nomograph for peak flood levels

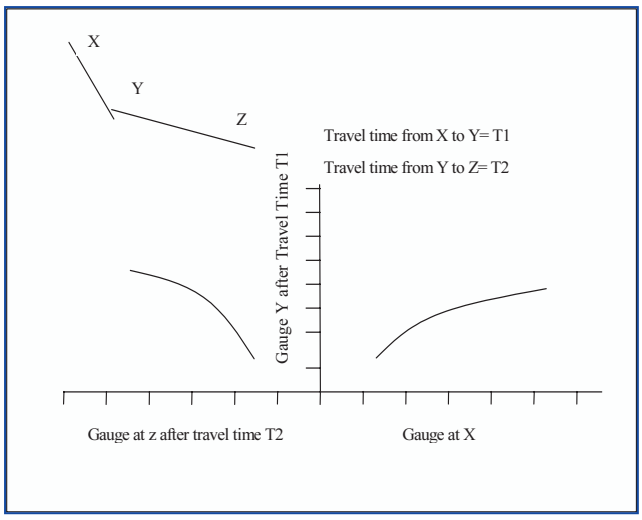


Fig VIII-2 Correlation Diagram of River between gauges at X, Y and Z stations

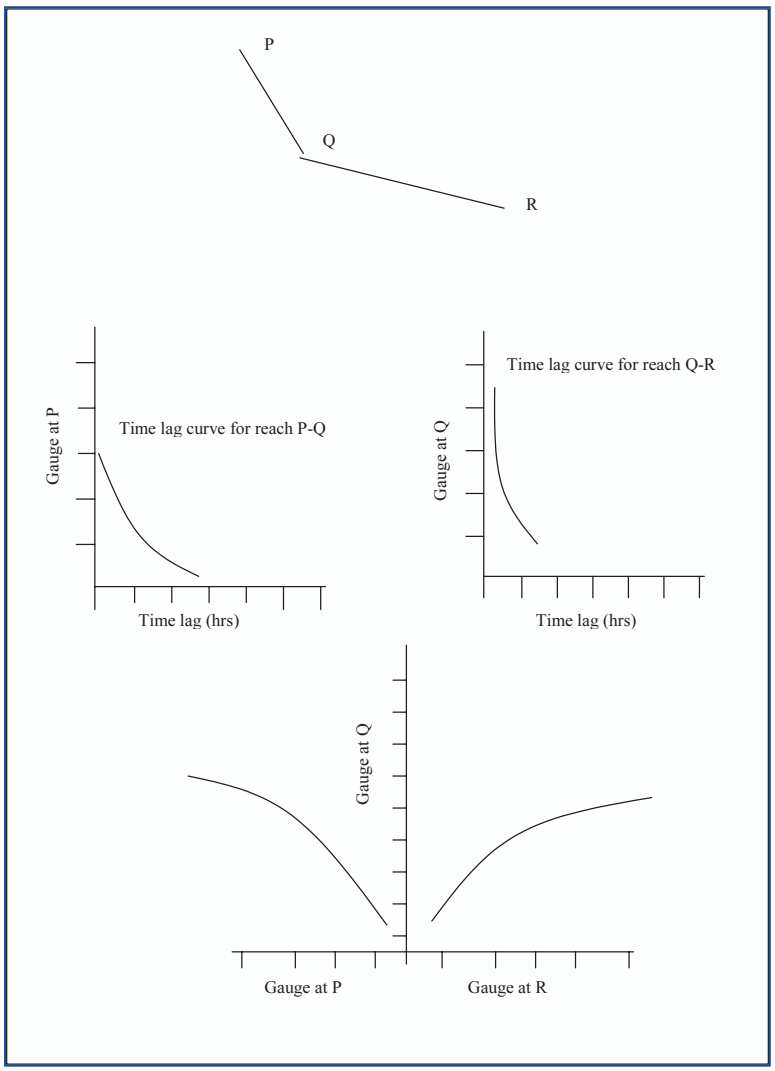


Fig VIII-3 Correlation diagram between river gauges at P, Q, and R station

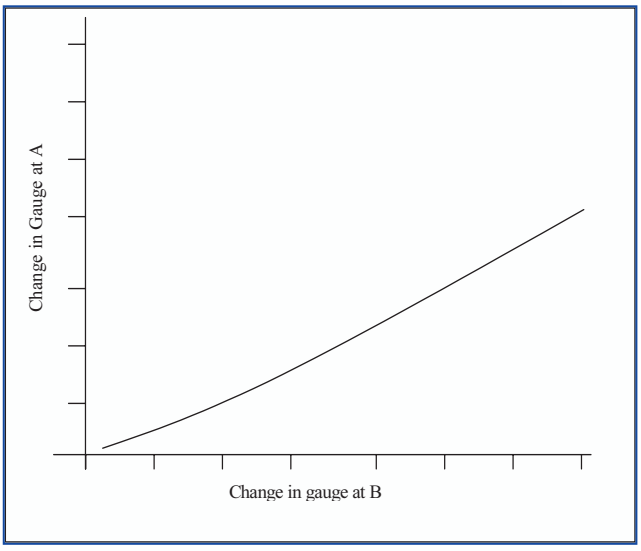
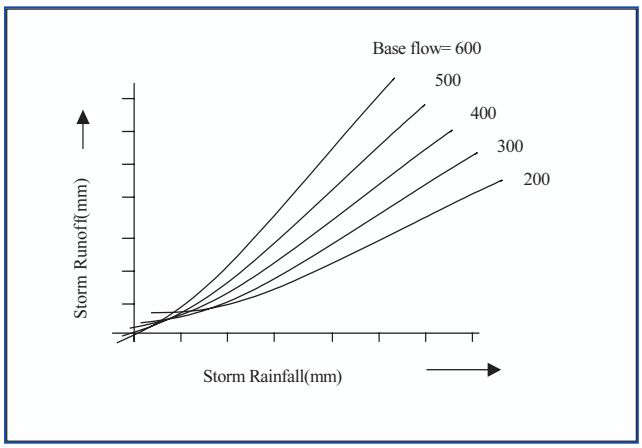


Fig VIII-4 Correlation diagram between river gauges A and B



Attachment VIII-I

Daily Water Level and Forecast Bulletin

Government of Kenya
Water Resources Management Authority

FLOOD FORECAST

Name of River …… Date of issue ……

Site …… Time of issue ……

Danger level ……..m Warning level……m

Highest flood level _____m (year)

As per WRMA, the water level of river …… at ……. … site at ……..hrs on ……..was ……. Metres. As per present indication/ data available with WRMA, it is expected that water level will rise/fall remain stationary and be near about ……m in the morning/ forenoon/ afternoon/ evening/ night of …… Thereafter the level is likely to rise/fall remain stationary. This is likely to affect the following areas:

Further forecast will be issued on receipt of fresh data

Confirmed copy by post: FFO

No…… District

Dated ……

To. (I) PWO (ii) District Commissioner (iii) Director Flood Management WRMA …….

Attachment VIII-II

Daily Inflow Forecast Bulletin

FLOOD IMMEDIATE

Phone: Office ……..
Residence……
Fax……
Mobile ……

Government of Kenya
Water Resources Management Authority

INFLOW FORECAST

Name of river ……..
Site …… Dam
Full Reservoir Level ……m
Maximum Reservoil Level ……..m (year)

Date of issue …….
Time of issue

As per WRMA, the reservoir level of …… Dam on river …… at ……
Hrs on …….. (date) was ……m

As per present indications/data available with WRMA ……. cubic meters of water is likely to flow into the reservoir between ……. hrs of …… (date) to ……hrs of ……. (date). Inflow is likely to increase/decrease/remain steady thereafter.

District Water Office

…….. District

To (As per mailing list)

ANNEX IX

RANET

RANET programs are designed to enable communities to potentially reduce their vulnerability to the impact of natural hazards and climate variations based upon the delivery of forecasts, observations, bulletins, etc. It also emphasizes the development of locally owned infrastructure that is capable of carrying a variety of other humanitarian and development information. This better ensures the sustainability of the program by encouraging the maximum amount of local involvement. Additionally, RANET believes that by improving the ability of National Hydro-Meteorological Services to serve their remote populations, the inherent value of these institutions will increase; thereby securing national government support and understanding.

Simply RANET works to build telecommunication bridges between scientific based products and remote communities that could benefit from such information. While RANET does work on developing specific technology based platforms, the program also attempts to address larger issues of information access by providing training, advising on how information could be better presented, etc.

RANET is an international collaboration to make weather, climate, and related development information more accessible to remote and resource poor populations to aid day-to-day resource decisions and prepare against natural hazards. The program combines innovative technologies with appropriate applications and partnerships at the community level to ensure that the networks created serve the entirety of household information needs, thereby making the program more sustainable and increasing the likelihood of local, positive impact.

The consortium that comprises RANET is a varied list of international, regional, and national organizations that believe environmental information, while not a panacea to the numerous challenges that face many communities, is nonetheless a vital component of any sustainable development strategy. In particular the front line organizations that provide information support in order to prepare for, militate against, and respond to natural events are the weather and related national information services of any country. RANET therefore applies a strategy that strengthens the capacities of national agencies to produce and disseminate information. Most importantly, however, to make dissemination possible and effective, RANET works with a variety of partners and community organizations to develop a network where all available information can be best and most appropriately integrated with current activities and decision-making processes at the community and household level.

Generally RANET is a two-tier information system. The first tier carries information necessary for meteorological and related services (in particular their field and extension sites) to improve their own products and services. For instance satellite imagery, ocean temperature measurements, synoptic observations, large-scale model runs, etc. These products are taken from public domain websites of many scientifically credible meteorological and related services.

The second tier is designed to serve the communities and local populations by further distributing locally/nationally produced information. This includes forecasts, bulletins, warnings, advice, etc. In several cases the communities with RANET activities have requested additional information such as crop prices, which are then also placed on the network. In all cases RANET strives to have information produced in local languages and in a non-technical format.

RANET programs are primarily managed at the country level with the weather service or similar national agency functioning as the primary facilitator. Because RANET strives to build a sustainable program, at the local level equipment is managed and owned by the communities themselves.

RANET currently broadcasts at the beginning of every hour on the WorldSpace Afristar satellite on the Foundation's Africa Learning Channel Multimedia Service (ALC DATA)(BCID 792). Depending upon the hour, 2 megabytes of information or as much as 10 megabytes of information may be transmitted. As the channel transfer rate is 64kbps, our information generally finished broadcasting 4 to 20 minutes after the beginning of the hour. Again, the amount of time will depend upon how much broadcast space RANET was allotted.

RANET primarily provides funding for demonstration sites and to subsidize start-up activities. It also negotiates access to large networks, which could not be accessed easily by any one country. The RANET consortium therefore has several regional and supra-regional management bodies. For instance the African Management Team helps to coordinate activities and provide reporting on successes and needs. Other partners such as the African Centre of Meteorological Applications for Development (ACMAD) act as the overall program facilitator and funding coordinator. The Climate Information Project (jointly supported by the NOAA Office of Global Programs and the USAID Office of Foreign Disaster Assistance helps to manage and coordinate the satellite services used by RANET.

Content which is critical in nature (warnings, etc.) or which updates on a near hourly basis (some satellite imagery, etc.) is broadcast every hour. Other material is broadcast less frequently. Generally if you manage to download over a two-day period, you should not have missing material. It is, however, currently impossible to say when specific content is broadcast as this is dynamically determined by available broadcast space, the priority in the content, and last transmission. Generally country specific content is broadcast when RANET has a 10mb slot. You can see the broadcast slots of RANET by examining the schedule provided in the broadcast. Additionally, you can see this broadcast schedule by looking at either the Africa or Asia mirrors online. Available at: http://www.ranetproject.net/bcast_mirror

The WorldSpace Corporation developed and manages the satellite system through which RANET is able to broadcast multimedia (data) content to all of Africa and most of Asia. Broadcast capacity is provided to RANET through the WorldSpace Foundation, which is endowed with 5% capacity of the WorldSpace satellites for development and humanitarian purposes.

Because RANET shares broadcast capacity on the WSF satellite channels, and because community radio stations are going to carry a variety of information beyond weather and climate, RANET activities have inevitably partnered with and resulted in a numerous development efforts focusing on health, the rights of women and children, agriculture, good municipal governance, etc.

For any Region Specific Inquiry one can contact:
- Africa, africa@ranetproject.net
- Asia, asia@ranetproject.net
- Pacific, pacific@ranetproject.net

PART VI

SUPPORTING INFORMATION

APPENDIX I

FLOOD SITUATION
IN
LAKE VICTORIA BASIN

APPENDIX I

FLOOD SITUATION IN LAKE VICTORIA BASIN

1.0 Lake Victoria Basin

Lake Victoria is situated between South Latitude 3º-0¹ and North Latitude 0º-20¹ and East Longitudes 31º-40¹ and 34º-53¹. It has a total catchment area of 194,000 Sq Km shared between five countries – Uganda, Rwanda, Burundi, Kenya and Tanzania.

The Kenyan part of the Lake receives inflows from rivers Sio, Nzoia, Yala, Nyando, Sondu, Gucha/Migori, Mara and several small streams, with a total catchment area of 46,229 Sq Km. In the North-Western part of the basin two small rivers Malaba and Malakisi flow into Uganda; their catchment areas in Kenya being 246 Sq Km and 293 Sq Km respectively. River Sio with a total length of 85 Km has a catchment area of 1338 Sq Km. It is joined on the left bank by the Naliwatsi. River Nzoia in its 334 Km long course up to its outflow into the Lake is joined by 4 main tributaries on the left bank and six relatively smaller tributaries on the right bank, and has a catchment area of 12,709 Sq Km. The next river to the south-east of Nzoia is the Yala which together with its tributaries Mogong and Edzowa drains an area of 3280 Sq Km into the Lake. The Nyando rises in the watershed dividing the Lake basin and the Rift Valley. In the upper reaches its main tributaries are the Ainamatua, Nomuting and Masaija. In its lower reaches the Awach Kano and the Asawa join it on the left bank. It drains an area of 3618 Sq Km into the Lake. The river Sondu together with its main tributaries the Kopsonoi and the Itare has a catchment area of 3481 Sq Km. The last major river to the south, joining the lake in the Kenyan territory, is the Kuja with a catchment area of 6919 Sq Km. The Mara river which joins the lake in Tanzanian territory has a length of 270 Km and catchment area of 8967 Sq Km in Kenya. Besides these main rivers, six small streams Kibos, Awach Seme, Ndate, Kabondo Awach, Magushi and Olambwe have independent outfalls into the lake.

2.0 Features of Major Sub-Basins

2.1 Nzoia Sub-Basin

In its upper reaches from Km 135 to 257 in the highlands, the river flows in a slightly meandering V shaped valley. The width of the channel is about 40m and bed gradient 1 in 240. There are a few human settlements on the valley bottom with uncontrolled cattle grazing in the watershed areas. In the middle reaches from Km 20 to 135 the river meanders over a narrow valley floor with a channel width of 50m and bed slope of 1 in 390. The area has more human settlements on the valley bottom with increased human activity, mainly in the nature of subsistence agriculture and livestock farming. In the last 20 Km reach up to its outfall into the lake, the bed slope flattens to 1 in 3400 as the river meanders through a wide flood plain and the Yala Swamp. The channel width increases to 70m and the height of the banks reduces considerably, which causes spilling of floodwaters over the banks and consequent flooding of large areas on either side. The density of human settlements is pronounced with considerable economic activity in the form of agriculture and livestock farming.

2.2 Nyando Sub-Basin

The Nyando River originates in the highlands at an altitude of 1700m above mean sea level. The river flows through Nyando and Kisumu districts of Nyanza Province. In its middle and lower reaches, the river flows through the Kano Plains with an area of about 73,000 ha.

About 50,000 ha of the Kano Plains are arable and natural vegetation areas, while an area of 13,000 ha in the lower reaches is under swamps. Approximately 50 per cent of the arable land has been developed for paddy cultivation with supplemental irrigation supply from the Nyando and other small streams. An area of about 20,000 ha is prone to flooding from over bank spills of the river.

In its upper reaches from Km 75 to 109 the river flows through a V shaped valley in the mountain area of Mount Londiani. The bed width is 20m with a gradient of 1 in 45. There are few human settlements in the area. The prominent land uses are forests and subsistence agriculture. In its middle reaches from Km 45 to 75 it meanders on a narrow valley floor with a bed width of about 40m and gradient of 1 in 160. The land use remains much the same as in the upper reaches except for cattle grazing which

is quite significant. The lower most 45 Km reach is characterized by pronounced meandering over a wide flood plain. The bed width increases to about 50m and the gradient flattens further to 1 in 700. The land use in this reach is predominantly agriculture, livestock farming and fishery with a lot of human settlements.

2.3 Yala Sub-Basin

In its upper reaches from Km 125 to Km190 the river flows in a slightly meandering channel through a V shape valley with a longitudinal gradient of 1 in 120. On either side of the 20m wide channel the main land use is grazing with few human settlements. Lower down, in the next 100 Km stretch the channel width increases to 30m and the bed gradient becomes flatter to 1 in 250. With a few human settlements close to the river the main land use is subsistence farming and cattle grazing. In the last 25 Km reach up to its outfall into the lake, the bed gradient becomes very flat to a gentle 1 in 2700. While the width of the river channel increases to only 30m, the banks on either side become low causing the flood waters to spill over a wide flood plain, a considerable part of which is the famous Yala Swamp with few human settlements. The remaining part of the plains is intensively used for agriculture.

2.4 Sondu Sub-Basin

The Sondu sub-basin has only subsistence farming in its upper reaches from Km 25 to Km 125 where the V shaped valley is fairly wide. In the 15 Km long delta reach there are a lot of settlements who depend mainly on agriculture, livestock and fishery for livelihood. The fan shaped delta has a gradient of 1 in 500.

2.5 Kuja Sub-Basin

The Kuja sub-basin with a 20 Km long fan shaped delta has extensive agriculture, cattle grazing and fisheries as the main economic activities of large number of human settlements. The river channel has a width of about 55m. In the higher reaches there are few human settlements engaged in subsistence farming on unterraced hill slopes.

2.6 Mara Sub-Basin

The Mara sub-basin in its last 120 Km reach up to the Tanzanian border covers the semi arid and arid lands of Narok district where the human settlements depend exclusively on livestock farming for livelihood. The river channel is 50m wide and has a bed gradient of 1 in 360 and a meandering plan form. The upper reaches are characterized by a slightly meandering channel flowing through a V shape valley with few human settlements on the valley floor.

3.0 Rainfall

In Lake Victoria Basin there is no distinctive dry season throughout the year but there are two maxima, one in April and the other in October. By and large, highest rainfall occurs in the northwestern parts, which gradually reduces in the southeastern direction.

The northwestern part of the basin drained by the streams Malaba, Malikisi and Alupe receives an annual rainfall of 1682mm with little spatial variation. In Sio sub-basin to the southeast the rainfall varies from 1802mm in its upper catchment to 1589mm in its outfall reaches. The Nzoia basin in its vast catchment witnesses large variation from a minimum of 1076mm in the catchment of the left bank tributary Kipkarren to a maximum of 2235mm in the south-western edge of the catchment. The average annual rainfall for the basin is 1424mm. In the catchment of the Yala the upper most parts receive 1486mm of rainfall, which gradually increases to a maximum of 2168mm in the middle reaches, falling sharply to a minimum of 1088mm in the outfall reaches. The variation in the Nyando catchment is within a relatively narrow range of 1409mm to 1179mm laterally from northwest to southeast. The Sondu basin receives an average annual rainfall of 1497mm, the maximum variation being in the range of 1100mm to 1638mm in the middle parts of the catchment. The Kuja/Migori basin receives an average of 1444mm of rainfall, with the highest rainfall in upper catchment and falling gradually in the down stream direction. The Mara catchment, further to the southeast witnesses variation from a minimum of 891mm to a maximum of 1420mm with an average of 1037mm.

4.0 Flood Problem

4.1 Past Floods

Major floods occurred in the low-lying parts of the Lake Victoria catchment in 1937, 1947, 1951, 1957-1958, 1961, 1978 and 1988.Exceptionally heavy and wide spread rainfall occurred during October and November 1961 which caused unusually severe floods in the Kano Plains,Yala Swamp and other low-lying parts of the basin. The Lake water level started rising in November 1961 and reached the highest ever level of 1136.00m.a.m.s.l in May 1964.

The total estimated run off from 1st October 1961 to 31st March 1962 in Nzoia was 1560 MCM and that in Yala was 989 MCM. In the initial stages, flooding of low-lying areas was caused by over bank spills of the six main rivers of the basin. The situation was later aggravated by the backwater effect of the rising lake level.

Many thousands of people had to abandon their villages, some being evacuated by helicopters. In inaccessible areas and areas marooned due to disruption of road and rail communications, food and medicines were supplied by helicopters. The Royal Navy, The Army and The Royal Air Force provided assistance on a massive scale to the civil authorities in flood and famine relief. As a result of these operations, the loss of human lives was relatively small.

In subsequent years, Nzoia had severe floods in 1963,1975 and 1977. The Yala River had severe floods in 1968,1978 and 1979, the Nyando River in 1964,1985 and 1988, the Sondu River in 1964,1968 and 1990 and the Kuja in 1978 and 1990.

4.2 Flood Damages

Western Province

The foothill areas of Mount Elgon in Bungoma district were affected almost every year from the floods of small rivers like Bokoli and Myanga. The floods affected mainly the riverine areas in a width of about 100m with depth of inundation of less than 0.5m. The duration of flooding was only few hours. Since there were few human settlements there was no serious damage except that a minor bridge was washed away in 1986.

In Kakamega district, the riverine areas were affected in some years due to floods in the Nzoia and Yala rivers. The area affected was only in a width of 100m with depth of inundation of less than 0.5m. Except for the floods of 1988 when a small bridge was washed away, there was no damage of any consequence.

In the lower reaches of Malakisi River, the riverine areas of Busia district were affected almost every year in a narrow width of about 100m. Though the depth of inundation was only about 0.5m it lasted for a day or more causing limited damage to agricultural crops and affected grazing. In 1987, a minor bridge was washed away. In the lower reaches of river Sio, the district witnessed considerable flooding in widths up to 3 Km. Inundation lasting a day or more affected farm lands and water supply intake for Busia Water Supply without causing any significant damage.

The low-lying areas of Busia district especially the Yala Swamp were affected due to large scale flooding from the Yala and Nzoia rivers. An area of about 110 Sq Km was affected almost every year with depth of inundation ranging from 0.5m to 1m and lasting about a month. The floods caused serious damage to agricultural crops – mainly paddy and maize, and loss of livestock. Besides, road communications were badly disrupted often with damage to roads and bridges.

Nyanza Province

The floods of Nzoia and Yala rivers also affected parts of Siaya district around Yala Swamp and the flood situation was similar to that in Busia district.

In Kisumu district, floods affected the Kano plains almost every year from the spills of river Nyando and small rivers like Kibos, Luanda, Ombeyi, Nyaidho and Awach Kano. The worst floods were, however, those of 1961,1982 and 1988. An area of about 200 Sq Km experienced flooding with inundation of 0.5m to 1m lasting for about a week. The floods affected agricultural crops of paddy, sugar cane, maize and cotton and inundated many towns and villages including the town of Ahero. Thousands of people had to be evacuated to safe places and provided with relief supplies of essential commodities. Minor roads and bridges were submerged and sometimes damaged. The lower Kadianga area of Kisumu district was affected by the flood spills of Sondu River. The area affected was about 10 Sq Km and the inundation lasted about a week affecting, to a limited extent, the farmlands and sub merging community roads and bridges.

In South Nyanza district about 10 Sq Km of Kobala area was inundated by the over bank spills of river Sondu and back waters of the lake. Flood damages included loss of crops, damage to houses and community roads and bridges and loss of cattle heads. Marooned people had to be evacuated to safer places and provided with relief supplies. The areas around the mouths of rivers Awach Tende, Lambwe and Kuja were flooded almost every year with inundation lasting from about a week to one month. The human settlements in central Kaden area were the worst affected requiring evacuation and relief measures.

Rift Valley Province

In Trans Nzoia district, the riverine areas of small rivers were flooded almost every year. At some places about 1 Km wide stretches were inundated under 0.5m depth of water. However, the flooding lasted for only a few days causing only minor damage to farmlands and bridges disrupting road communication. In some years water supply to Kitale town were also disrupted. Kericho, Uasin Gishu and Nandi districts, by virtue of their location in the highland areas, suffered only minor damage to farmlands and grazing pastures – mostly along rivers.

4.3 Recent Floods

In recent years there were 3 major flood events in 1997-1998, 2002 and 2003. The 1997- 1998 flood was the consequence of El Nino related long and intensive rainfall during the months of October and November when precipitation was upto 300 percent of the normal. The floods had a tremendous impact on the environment and the population. A weir on Kipchoria river, a tributary of the Nyando, was washed away and a water supply dam in Kericho district was silted up. Almost the entire Kaino Plain was inundated and agricultural crops were completely destroyed. The floods also caused land degradation and increased soil erosion with consequent silting of hydro power dams and extensive damage to 240 river gauging facilities due to severe bank erosion. The protective dykes were over topped and breached at several places. In Budalangi Division of Busia district more than 12,000 people were affected due to floods in Nzoia river. The dykes suffered extensive damage due to over topping and breaches which cost the government over Ksh 42 million in repair and rehabilitation. In Uasin Gishu district 2 earthen dams were washed away.

The floods of 2002 and 2003 were of shorter duration. These events took place in April, May and November 2002 and April-May 2003 and affected the Kano Plains and the Budalangi area. These floods were caused due to heavy and concentrated rainfall in the upper catchments of Nzoia and Nyando rivers. The Sio river inundated a 3 Km wide stretch near its outfall into the lake. The Yala river inundated its flood plain upstream of Lake Kanyaboli. The last 15 Km of the river in the Yala Swamp did not experience any severe flooding due to moderation of flood peak by the Lake Kanyaboli. The problem in the Nyando river flood plains and the Budalangi division was aggrevated due to breaches in the dykes caused during the 1997-1998 floods.

4.4 Flood Damages in Recent Years

There is at present no systematic arrangement for assessment of flood damages and maintenance of damage data. Damage assessment is usually made by various line departments after every major floods but due to lack of coordination, the data is rearly compiled to have a comprehensive appreciation of the actual socio-economic and environmental impact of floods. However, as per the assessment made after recent floods, in the last 20 Km reach of the Nzoia river the annual damage is of the order of Ksh 46 million. An amount of Ksh 63 million is spent every year on relief and

rehabilitation of about 12,000 displaced people. The repair and restoration of damaged dykes is expected to cost Ksh 37.2 million.

In the Kano Plains, an estimated 5,000 people are affected every year by flood spills of Nyando river. The average annual damage is about Ksh 49 million. Relief and rehabilitation measures cost Ksh 37 million.

4.5 Average Annual Damages

In the National Master Water Plan, average annual flood damages were worked out for the 1990 and 2010 conditions based on some limited field surveys, interviews and following assumptions:

- There are no damages at the discharges of probability corresponding to the bank full discharge in a river stretch and increases linearly in proportion to the probability of the flood.
- Bank erosion is approximately 5m per year.
- Farm land is 80 percent of the utilized area. Maize is the main crop in flood prone areas with unit yield of 2.8 tonnes per hectare.
- Damage rate of maize varies from 0.3 to 1.0 for various depths and duration of inundation.
- Damage rate of houses varies from a minimum of 0.03 for inundation below floor level to 0.22 for inundation 3m above floor level.
- Damage to public facilities is 50 percent of housing damage.
- Indirect damage is 30 percent of total direct damage.
- The 2010 condition is based on the assumption that all proposed flood protection works would be completed and the entire flood affected area except the swamps would be fully developed. The value of assets would increase at a uniform rate of 2.5 percent per anum.

So far no significant flood protection works have been constructed and the overall level of development in the flood prone areas has remained virtually at the 1990 level. The extent of average annual damage due to floods at present, therefore, may be assumed to be the same as was assessed for the 1990 condition. Accordingly the monetary value of flood damages has been worked out and the same is shown in Annex Ap I-I.

5.0 Increase in Flood Hazard

A recent analysis of floods at the river gauging station No 1GD3 on river Nyando for the period 1969 to 1997 indicates that flood discharges for different return periods have since increased drastically as shown in the following table:

Return Period	Discharge (Cumec)			% Variation	
	2003 Study	1983 Study by ItalConsult	1992 Master Plan Study	2003-1983	2003-1992
10	863.19	550	437	57	97.5
25	1044.22	650	564	61	85.0
50	1178.46	750	659	57	78.82
100	1310.20	850	752	54	74.22

The study also draws broad inferences that during the period 1980 to 1987 the peak discharges had decreased due to vigorous forestation programs that were under taken, where as during 1988 to 1997 these had increased sharply due to massive destruction of forest cover. Before firm conclusions can be drawn, it would be desirable to collect and analyze data from different parts of the watershed and also analyze the rainfall pattern. However, the increased discharges for various return periods shown in the above table need to be taken into consideration in planning immediate and short term measures since the effect of watershed development programs on the ground are felt only after a long time. The

study also shows a 4-fold increase in sediment load over the estimates made in the 1983 study by ItalConsult. This brings into sharp focus the urgent need for taking up massive watershed development programs.

5.1 Factors contributing to increased flood hazard

The main factors contributing to increased incidence of floods especially in the lower reaches of the river in Budalangi Division of Busia district are:

1. Reduced flood carrying capacity of the rivers due to excessive siltation of their bed.
2. Settlement of the dykes in some places reducing the effective height, thereby rendering the dyke susceptible to over topping during floods.
3. Erosion of dykes due to river attacks making them susceptible to breaches even during floods of lower magnitudes than the design flood.
4. Increase in flood discharges due to severe degradation of watersheds caused by uncontrolled and unregulated human activity, especially large-scale deforestation.
5. The dykes are, at present, overgrown with trees and shrubs resulting in loosening and cracking of the dykes.
6. Excessive encroachment of the flood plains by the people for agriculture and livestock farming and fishery.
7. There is no programme / provision for routine maintenance of dykes. Specific schemes are formulated from time to time to repair the breached or severely damaged sections.

A combination of the above factors has so far resulted in the dykes being breached at 20 places.

5.2 Back water Effect of Lake

The Owen Falls dam on the Victoria Nile, built during the period 1948-1950 was intended to raise the level of the Lake by about 3m to impound an additional 207 BCM of water in the Lake. Various water balance studies carried out from time to time indicate that about 85 percent of the inflows into the lake are due to direct rainfall over the lake itself. Though the outflows through the dam sluices and the turbines are higher than the inflows from various rivers and streams, there are occasionally large surpluses retained in the lake causing its level to rise. This surplus is believed to be mainly due to the lake rainfall exceeding the lake evaporation (Shahin). However, the effect of the dam on the lake level and the consequent large scale flooding of low lying areas due to the backwaters of various tributaries cannot be ruled out. This aspect needs to be studied to have an indepth understanding of the flood problem.

6.0 Existing Arrangements for Flood Management

6.1 River Nzoia

There are at present 16.6 Km of dykes on the southern side of the river and 16.2 Km on the northern side, in the Bunyala area of Busia district. These dykes were built during the period 1977 to 1984 at a cost of Ksh 17 million.

There is no standing arrangement for routine maintenance of these dykes. Only specific schemes are planned and implemented to repair the breached or severely damaged sections of dykes and river training works.

6.2 River Nyando

In the past, flood protection works in the form of low dykes, about 1m high, were built by the local communities under the supervision of the Chiefs. These dykes were often too close to the river and were, therefore, prone to damage during floods. Besides, the then Ministry of Agriculture built some check dams and diversion channels to protect agricultural fields. Soil conservation measures were also taken as part of on-farm practices.

In 1984 the Kenyan Government established a project unit at Ahero for planning, design and construction of flood protection works in a phased manner. The Phase I of the project envisaged a total of about 16 Km of dykes on either side of the river in its lower reaches. In Phase II, these dykes were to be extended by 18 Km in the upstream together with river training works to protect the dykes against river attack. Phase III envisaged multipurpose schemes comprising check dams and canals for irrigation, hydropower and flood control.

So far, about 8Km of dyke – 4 Km on either side, have been built with about 1 Km of river training works. Over time, about 4 Km of dykes had to be rehabilitated as part of emergency measures. These measures cost the Government a total of Ksh 29.2 million.

6.3 River Yala

As part of reclamation of land from the Yala swamp, a 23 Km long drainage channel and a 2 Km long dyke on the right bank of the Yala river were proposed, but so far only 9 Km of the channel and 2 Km of the dyke have been built.

7.0 Flood Monitoring

Though there are river-gauging stations in the basin, there is no permanent or regular arrangement for monitoring and communicating the flood situation. The only arrangement is for rainfall forecast and warning by the Kenya Meteorological Department. The forecasts are communicated to the Disaster Operations Center in the office of the President, who mobilizes the various provincial and district level units for rescue and relief operations.

Under the Disaster Operation Centre at the National level for coordination, there are provincial and district level committees to carry out disaster mitigation measures which are planned well in advance based on information received from various monitoring and surveillance systems of different organizations and departments. They deal with all disasters such as drought/famine, floods, epidemics etc. At the district level the Disaster Management Committees, headed by the District Commissioners, have representatives from various line ministries and departments such as Water Resources Management and Development, Agriculture, Environment and Natural Resources, Livestock and Fisheries, Defense, NGO's and Youth organizations.

Annex Ap. I-I

AVERAGE ANNUAL DAMAGE IN MAJOR FLOOD PRONE AREAS (AT 2003 PRICES)

Probability of flood	Average Annual flood damage (Million Ksh)			
	Yala Swamp	Kano Plains	Sondu river mouth	Kuja river mouth
5 year	22.25	35.36	0.97	1.92
10 year	33.25	74.87	2.73	4.54
15 year	38.16	94.23	3.65	5.85
20 year	41.00	105.87	4.22	6.65
25 year	42.88	113.71	4.61	7.19
50 year	47.22	132.26	5.54	8.47
100 year	49.86	143.89	6.13	9.28

Source: Basic Data – National Water Master Plan, 1992

Annex Ap. I-II

FLOOD DISCHARGES CAUSING INUNDATION

River	Location	Non damage/ Bankful Discharge (Cumec)	Flood Discharge (Cumec)	Probability	Area inundated (Sq Km)
Nzoia	Yala Swamp	270.00	680.00	7.7	128.00
Yala	Yala Swamp	80.00	200.00	4.5	128.00
Nyando	Kano Plains	200.00	430.00	10.5	227.00
Sondu	River Mouth	210.00	300.00	5.9	12.00
Kuja	River Mouth	410.00	570.00	5.9	27.00

Source: Basic Data – National Water Master Plan, 1992

APPENDIX II

WATER AVAILABILITY AND DEMAND IN LAKE VICTORIA BASIN

APPENDIX II

WATER AVAILABILITY AND DEMAND IN LAKE VICTORIA BASIN

1.0 Rainfall

The first rainfall data in Kenya was recorded at Mombassa town in the year 1890. The following year 1891**,** another station was opened in Malindi town. Both stations are located along the shores of the Indian Ocean. By 1904 there were rainfall-observing stations at Makindu, Voi, Muranga, Kapsabet and **Kisumu** towns. Later, by 1977 there were 2000 rainfall stations in Kenya. However the number of rainfall stations drastically dropped to 1653 by the year 1988 and to 1497 by 1990. At present there are only 700 rainfall stations in Kenya.

Throughout the year in Lake Victoria Basin there is no distinctive dry season, but there are two maxima rainy seasons, one in April and the other in October. The highest rainfall occurs in the northwestern parts, and gradually reduces in the southeastern parts. The average annual rainfall for the basin is 1,424 mm and varies between 891 mm in parts of Mara catchment to a maximum of 2,168 mm in the middle reaches of Yala basin. This heavy rain cause extensive flooding in rivers Nzoia, Yala, and Nyando in their lower reaches especially the Budalangi Division of Busia district and the Kano Plains. The rivers Sondu and Kuja inundate low-lying areas in their outfall reaches. The mean monthly rainfall in various sub-basin in Lake Victoria basin is presented in figure Ap.II-1.

2.0 Water Availability

2.1 Surface Water

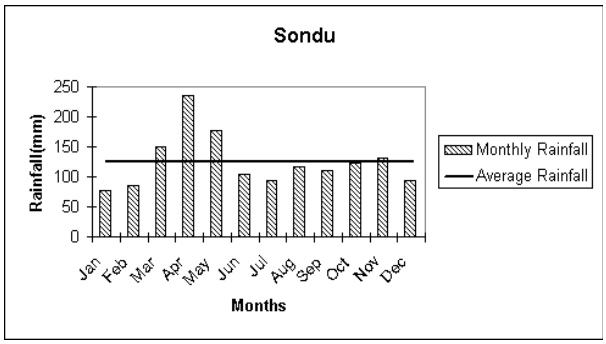
The availability of runoff at Key gauging stations in various districts is of the order of 7.09 BCM. The Sio River at the gauging station No 1AH01 in Busia district has an average annual runoff of 378.4 Million Cum (MCM) and a minimum of 214.4 MCM. In its upper reaches, the Nzoia River carries a mean annual runoff of 47.3 MCM at the gauging station No 1BB02 in Trans Nzoia district. Further lower down at station No 1BG06 in Bungoma district the runoff increases to 78.8 MCM and to 1557.8 MCM at 1DA02 in Kakamega/Vihiga district.

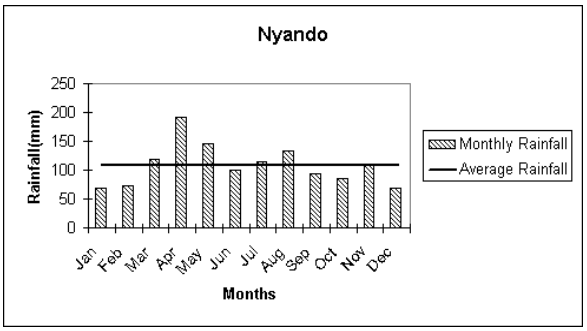
The Yala River at the gauging station No 2FC05 on the Kimondi tributary in Nakuru district has a runoff of 44.1 MCM. It increases to 517.19 MCM in Nandi district and, further lowers down, to 933.5 in Siaya district. The minimum runoffs at these locations are 9.4 MCM, 129.3 MCM and 242.8 MCM respectively.

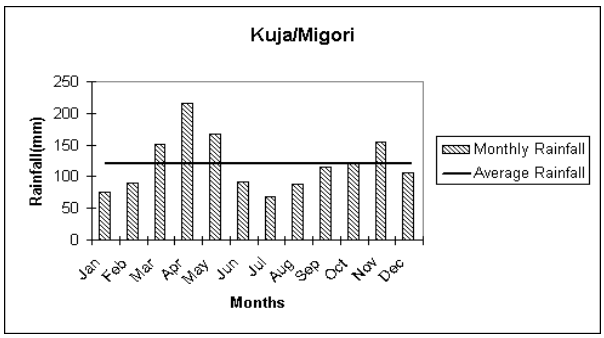
At the gauging station No 1GD02 in Kisumu district the Nyando carries a runoff of 198.6 MCM, which increased to 803.2 MCM at its outfall. The Kuja River in Narok district has an annual runoff of 179.7 MCM. In the adjoining districts of Kisii and Nyamira it increases to 189.2 MCM and to 1523 MCM in its lower reaches in Migori district. The Sondu River near its outfall into the Lake in Kericho district has an annual flow of 1784.9 MCM, the minimum being 283.8 MCM. The Mara River with a runoff of 318.5 MCM also serves part of Kericho district. Details of district wise water availability are shown in Annex Ap II-II.

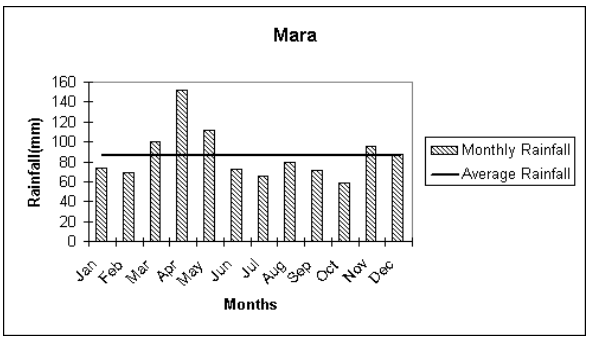
2.2 Ground Water

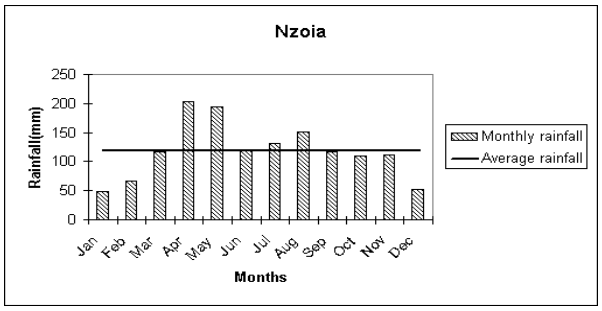
The National Water Master Plan had estimated the safe abstraction yield based on the ground water exploration data. The safe yield for the thirteen districts in the Lake Victoria Basin is of the order of 49.635 MCM and the same is shown in Annex Ap II-III. The total water availability in the basin, considering the average annual surface water and safe ground water yield works out to 7.14 BCM.

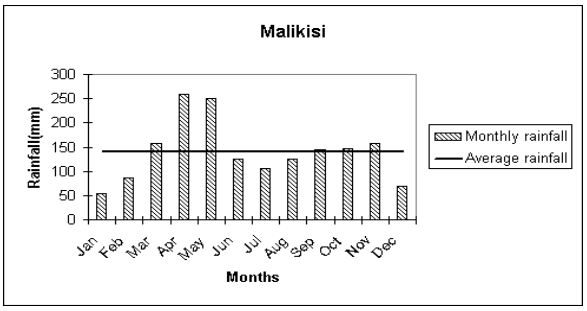


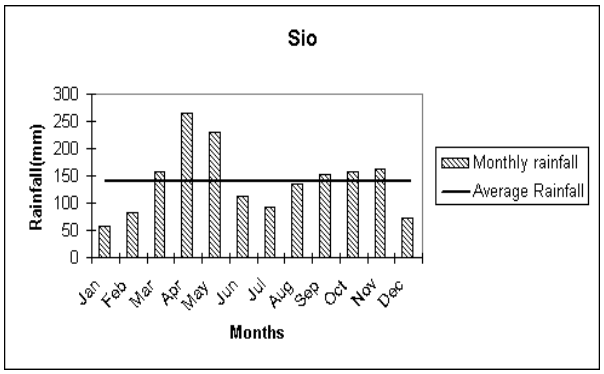












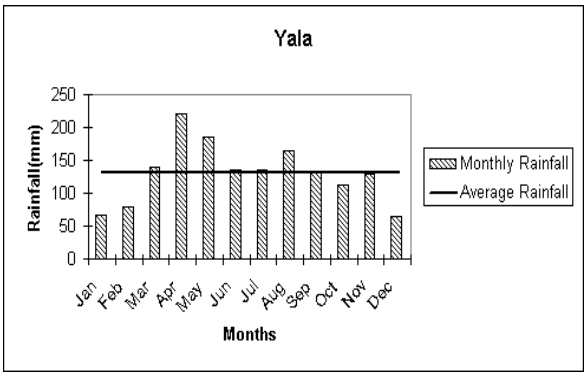


Figure Ap. II-1 Mean Monthly Rainfall in Various Sub-Basins

3.0 Water Demand

The main water uses in the Lake Victoria Basin are for agriculture, domestic water supply, livestock, inland fisheries and industry. Water used for hydro-electric power generation is non-consumptive and is therefore not considered.

The conservation and long term sustainability of wild life depends on the quality and extent of the natural habitat for various animal species. The quality of wild life habitat is determined essentially by the forest cover in its natural pristine state with abundant supply of food and water for not only the fauna but also for the flora at the lower end of the food chain. Provision of water for the wild life in isolation, to the exclusion of other elements of habitat, is therefore not considered necessary.

The water demands for the designated water uses mentioned above have been determined and are discussed in the following paragraphs and graphs.

3.1 Agriculture

The total cropped area in the 27 districts situated in the Lake Victoria Basin is 1.481 million hectares, out of the total cultivable area of 3.31 million hectares. However, considering the run-of-the river abstractions and limits of the land potential, the irrigation potential is only 0.35 million hectares Break up of this potential is available only basin wise and not district wise.

The ultimate cropping intensity proposed in the National Water Master Plan is 163%. Thus the net area that can be provided with irrigation facilities works out to 0.215 million hectares which is 21 percent of the area already under food crops and a little over 14 percent of the area under all crops. The present and future water requirements for irrigation are, therefore, limited by this potential. The composite design delta for various large irrigation schemes in different parts of the basin varies aver a narrow range of 2.1m to 2.44m with the exception of Bungoma area where it is 0.91m (Annex Ap II-IV). However, for the purpose of this study an average annual delta of 2.027m has been adopted. Considering an average rainfall of 1000mm, the net supplemental irrigation requirement for the basin is 1.027m. Applying it to the irrigable area of 0.215 mha the total supplemental irrigation water requirement works out to 2.23 BCM. Sub-basin wise irrigation water requirements are given in Annex Ap II-V.

3.2 Domestic Use

The District Development Plans 2002-2008 provide the rural and urban populations for the year 2002 together with the actual growth rates. These have been used to project the population in the year 2025 (Annex Ap II-VI).

In determining the water demand, rates of per capita consumption of 40 lpcd for low potential rural areas and 75 lpcd for urban areas with low class housing have been adopted. These norms conform to the Ministry of Water Resources Management and Development Design Manual, and do not take into consideration the likely changes in the life style of the people in future. Accordingly the present water requirement (2002) works out to 217.05 MCM which is likely to increase 409.11 MCM in the year 2025. District wise break up is shown in Annex Ap II-VII.

3.3 Livestock

In the National Water Master Plan (Sectoral Report F) the distribution of livestock population to various locations was made in proportion to the population. It was assumed that the livestock holding in urban areas are one forth of that in rural areas. The total water requirement for livestock was 20 percent of domestic water requirement.

Since the National Water Master Plan study in 1992, no scientific assessment of the livestock population has been made and the district development plans 2002-2008 do not provide this data. In the absence of this basic data, the methodology adopted in the National Water Master Plan has been adopted to project the present and future water requirements for the livestock (Annex Ap II-VIII).

3.4 Fishery

The pisciculture in Kenya started with the sport fish hatcheries during the early twentieth century. The fishpond culture started in the late 1940's and spread over to various parts of Kenya and today it is practiced mainly in small ponds.

Fish Ponds

The data on fishponds is collected by the Department of Fisheries and under the Socio-Economic Survey. The surveys do not cover the whole country and there are large disparities in the data collected by the two surveys. For the purpose of estimation of water requirement higher figures have been adopted. The available data for twelve undivided districts in the Lake Victoria Basin is given in Table Ap II-1.

The National Water Master Plan (1992) had made the following assumptions in estimating the water use in fishponds:

1. Water will be changed once a year.
2. Average water depth is 1m.
3. Water in compensation for evaporation and percolation will be supplied.

Accordingly the net water depth replenishable per annum worked out to 0.71m. Applying the same rate of annual replenishment the present water requirement for fish ponds has been worked out district wise based on the latest figures of ponds.

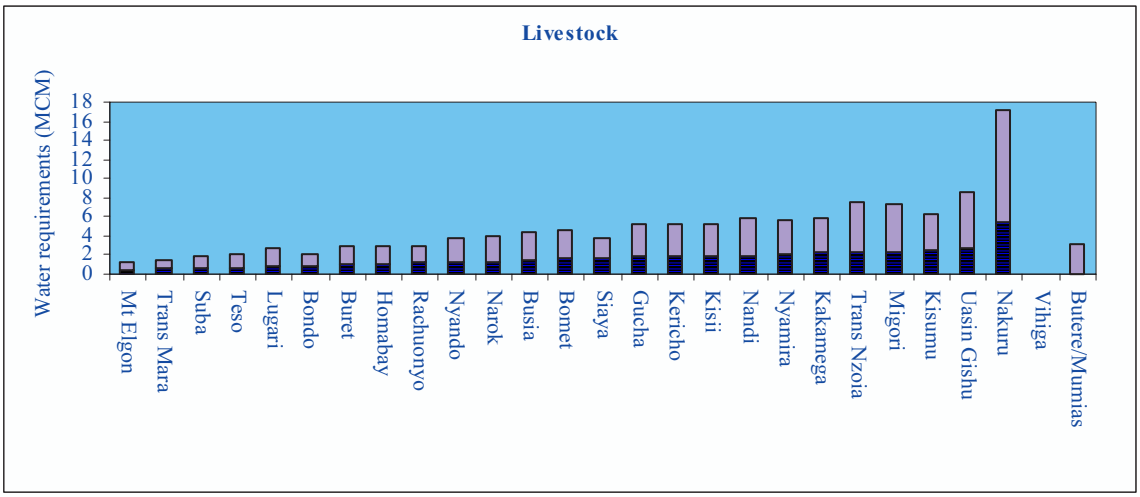
In projecting future fish consumption in the country, the National Water Master Plan had assumed a per capita consumption rate of 5.5 Kg per annum. Assuming the same rate, the fish requirement in the year 2025 for the projected population of 22.188 Million for the Lake Victoria Basin, works out to 0.122 Million tonnes. Based on the trend of fish farming vis-à-vis other modes of fish production it is estimated that 1220 tonnes of fish would be produced in fishponds and the remaining from marine and lake fishery. Assuming a uniform rate of fish production of 2.5 t/ha, adopted in the National Water Master Plan, the total pond area required in 2025 would be 488 ha against the present availability of 118 ha.

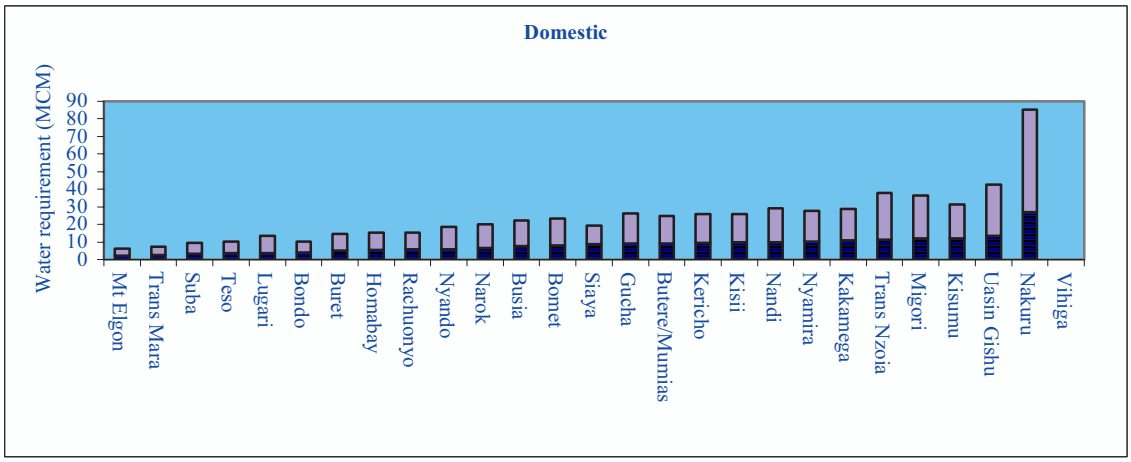
The present and future requirement of fishponds is given in Annex Ap II-IX and the corresponding water requirements in Annex Ap II-X.

3.5 Industry

According to the Economic Survey 2003, the main industries in the country are meat and dairy products, sugar and confectionary, food manufacturing, tobacco, textiles, leather and foot wear, furniture and fixtures, petroleum and chemicals, non metallic mineral products, non electrical machinery, paper and paper products, and transport equipment.

Except for the paper industry all other industries have low water consumption rates. The paper industry has very low potential for growth which is evident from the fact that its quantum index in the year 2002 was 262.5 as compared to the base index of 100 in the year 1976. There are no other high water consuming industries like coking coal, thermal power plants, heavy engineering/machinery, etc.





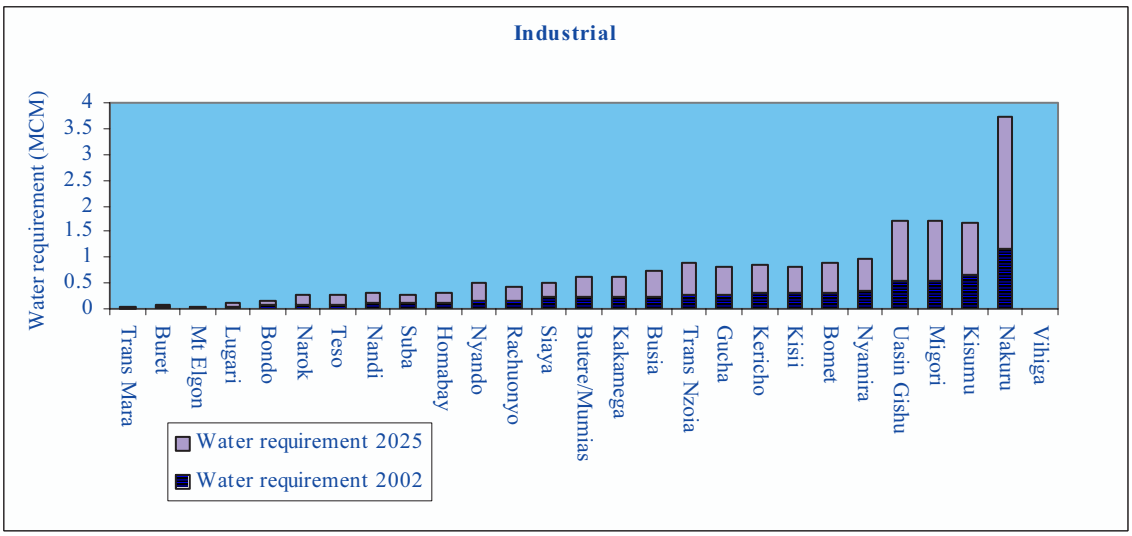


Figure Ap II-2: Present and Projected Water Requirements

Table Ap II-1: Water Requirement for Fish Ponds

District (Undivided) 1992	Number of Ponds	Total area of ponds (Sq m)
Kisii	2962	332,139
Kisumu	262	58,941
Siaya	259	31,080
Kericho	35	104,560
Nakuru	0	0
Narok	13	5,385
Trans Nzoia	95	27,360
Uasin Gishu	130	28,842
Nandi	61	23,904
Bungoma	680	106,628
Busia	269	49,002
Kakamega	1061	248,462
TOTAL	5827	1,016,303

Since the unit consumption rate for the various existing industries are not available, the consumption rates surveyed for a few industrial areas in south Asian countries have been adopted. The consumption in labour intensive industries, without recycling and reuse, is 5-7 percent of the domestic urban water use and 10-12 percent in highly mechanized industry. These rates are based on water supplied to the industrial areas as a whole rather than to individual units. In the Kenyan situation a uniform rate of 7 percent is adopted to determine the present and future water requirements for the industry. The district wise water requirements are shown in Annex Ap II-XI.

3.6 Total Water Demand

The total water demand for various uses at present (2002) is of the order of 2.505 BCM which is likely to increase 2.745 BCM in the year 2025.

As mentioned in para 3.3 the total water availability is 7.14 BCM which is adequate to meet the present and future water requirements. Even the 80 percent dependable surface water of 2.72 BCM and the safe ground water yield of 0.049 BCM would be adequate to meet all requirements. However to address the seasonal variations in surface water availability, it would be necessary to adopt water storage and conservation measures together with demand management and economical use of available water.

Annex Ap II-I

SUB-BASIN RAINFALL – MEAN MONTHLY

Unit: mm

Sub Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Malikisi	53.2	87.0	157.3	258.3	251.2	125.8	105.8	126.0	144.1	147.1	157.8	68.9	**1682. 50**
Sio	58.6	82.2	157.2	265.1	230.7	113.3	93.5	135.5	152.6	158.2	163.2	73.7	**1683. 80**
Nzoia	48.8	66.0	116.6	203.8	194.9	119.4	132.0	151.8	117.8	109.2	111.3	52.4	**1424. 00**
Yala	65.8	79.6	139.8	221.1	186.2	134.9	136.4	163.9	131.7	112.0	128.8	64.9	**1565. 00**
Nyando	67.9	73.0	119.2	191.5	144.8	99.8	114.2	132.9	92.8	86.3	107.6	68.0	**1298. 00**
Sondu	77.1	86.3	149.5	235.9	176.5	103.8	94.0	116.8	110.6	122.0	131.1	93.2	**1496. 80**
Kuja / Migori	75.6	89.8	151.4	215.8	166.5	92.4	67.9	87.3	115.7	121.8	154.0	105.6	**1443. 80**
Mara	74.1	69.2	100.0	151.6	111.5	72.6	65.5	79.2	71.1	58.8	95.6	87.6	**1036. 80**

Source: National Water Master Plan

Annex Ap II-II

DISTRICT WISE SURFACE WATER AVAILABILITY AT KEY GAUGING STATIONS

Province	District Undivided	Gauge Code	Catchment Area (Sq Km)	River	Mean Annual Flow (MCM)	Dependable Flows (MCM)			
						80%	90%	95%	Min
Nyanza	Kisii Nyamira	1KA09	398	Kuja	189.2	53.6	47.3	41.0	34.7
	Kisumu	1GD02 1HA14 1HB05	1375 104 101	Nyando Luando Awach-Seme	198.6 56.7 18.9	69.3 18.9 6.3	56.7 15.7 6.3	47.3 12.6 6.3	37.8 9.4 3.1
	Siaya	1FG02	2864	Yala	933.5	428.9	362.6	299.6	242.8
	South Nyanza	1KB05 1HD01	6600 508	Kuja Awach-Kibuon	1523.2 211.3	700.1 69.3	608.6 59.9	564.5 47.3	394.2 41.0
Rift Valley	Kericho	1JF02 1LA03	3450 679	Sondu Mara	1784.9 318.5	463.5 85.1	391.0 56.7	337.4 41.0	283.8 25.2
	Nakuru	2FC05	125	Yala	44.1	18.9	15.7	12.6	9.4
	Narok	2K03	832	Kuja	179.7	97.7	97.7	97.7	97.7
	Trans Nzoia	1BB02	140	Nzoia	47.3	15.7	12.6	12.6	12.6
	Uasin Gishu	1CA02	717	Nzoia	107.2	85.1	75.6	72.5	56.7
	Nandi	1FE02	1577	Yala	517.19	324.8	258.6	223.9	129.3
Western	Bungoma	1BG06	530	Nzoia	78.8	34.7	31.5	31.5	25.2
	Busia	1AH01	1450	Sio	378.4	264.9	264.9	246.0	214.4
	Kakamega/Vihiga	1DA02	8415	Nzoia	1557.8	529.8	372.1	312.2	201.8
	Total Availability at the lowest gauging stations				**7089.0**	**2721.2**	**2270.1**	**1986.7**	**1510.2**

Source: Basic Data – National Water Master Plan, 1992

Annex Ap II-III

DISTRICT WISE GROUND WATER AVAILABILITY

District	Area (Sq Km)	Annual Rainfall (mm)	Safe Abstraction Yield (MCM)	G W Recharge Coefficient
Kisii/Nyamira	2196	1, 536	2.759	0.00125
Kisumu	2660	1,320	3.477	0.00130
Siaya	3528	1,217	2.866	0.00081
South Nyanza	7778	1,480	6.529	0.00084
Kericho	4890	1,393	2.473	0.00051
Nakuru	7200	949	3.341	0.00046
Narok	18,513	972	12.681	0.00068
Trans Nzoia	2,468	1,281	2.322	0.00094
Uasin Gishu	3,784	1,231	1.632	0.00043
Nandi	2,745	1,524	2.132	0.00077
Bungoma	3,074	1,623	3.000	0.00097
Busia	1,766	1,558	2.159	0.00122
Kakamega/Vihiga	3,520	1,755	4.264	0.00121
TOTAL	**64,122**	**---**	**49.635**	**---**

Source: Basic Data – National Water Master Plan, 1992

Annex Ap II-IV

DISTRICT WISE AVERAGE DELTA FOR LARGE IRRIGATION SCHEMES

District	Area (ha)	Water Demand (MCM)	Average Delta (m)
Kisumu	25,640	540.4	2.10
Siaya	10,480	240.8	2.29
South Nyanza	3,900	83.8	2.15
Bungoma	7,550	68.4	0.91
Busia	7,540	184.2	2.44
TOTAL	**55110**	**1117.6**	**2.027**

Source: Basic Data – National Water Master Plan, 1992

Annex Ap II-V

PRESENT AND FUTURE REQUIREMENT OF WATER FOR IRRIGATION

Sub-Basin	Irrigation Potential (ha)	Net Irrigable Area (ha)	Supplemental Irrigation Demand (MCM)
Malikisi	6030	3699	37.99
Sio	8212	5038	51.74
Nzoia (upper)	13,582	8332	85.57
Sergoit Kipkarren	5335	3273	33.61
Nzoia (mid)	24,720	15,166	155.75
Isiukhu Lusumu Wuoroya Nzoia	66,314	40,683	417.81
Yala	39,825	24,432	250.91
Nyando Awach Kano Malaget Kipurere	31,102	19,081	195.96
Luando Awach Seme Awach Kibuon Awach Tende Lambwe	39,060	23,963	246.10
Itare Kitol Yurith Kopsonoi Sondu	21,767	13,354	137.14
Kuja/Migori	55,796	34,231	351.55
Mara	43,478	26,673	273.93
TOTAL	**355,221**	**217,925**	**2238.06**

Source: Basic Data – National Water Master Plan, 1992

Annex Ap II-VI

DISTRICT WISE POPULATION – 2002 AND 2025

District	Area Sq Km	Population (2002) In Millions			Growth Rate for the District In %	Population (2025) In Millions		
		Urban	Rural	Total		Urban	Rural	Total
Nyamira	896.4	0.188	0.347	0.535	2.4	0.324	0.598	0.922
Homabay	1160.4	0.061	0.252	0.313	2.7	0.112	0.465	0.577
Nyando	1168.4	0.084	0.248	0.332	3.4	0.181	0.534	0.715
Teso	558.5	0.049	0.148	0.197	2.8	0.092	0.279	0.371
Buret	1100.0	0.013	0.330	0.343	2.7	0.024	0.609	0.633
Kericho	2110.6	0.165	0.338	0.503	2.4	0.284	0.583	0.867
Bondo	1972.0	0.035	0.213	0.248	1.79	0.053	0.320	0.373
Kisii	648.9	0.165	0.357	0.522	2.19	0.271	0.587	0.858
Kisumu	919.0	0.343	0.193	0.536	2.0	0.540	0.304	0.844
Nakuru	7242.0	0.616	0.696	1.312	3.4	1.328	1.501	2.829
Butere / Mumias	919.3	0.124	0.388	0.512	2.41	0.214	0.670	0.884
Kakamega	1394.8	0.129	0.514	0.643	2.12	0.208	0.832	1.040
Mt Elgon	936.7	0.011	0.134	0.145	2.3	0.018	0.226	0.244
Lugasi	670.2	0.016	0.228	0.244	4.13	0.041	0.578	0.619
Trans Nzoia	2487.0	0.143	0.502	0.645	3.8	0.337	1.183	1.52
Nandi	2873.0	0.056	0.575	0.631	2.9	0.108	1.109	1.217
Trans Mara	2932.0	0.006	0.176	0.182	2.25	0.010	0.293	0.303
Uasin Gishu	3327.8	0.286	0.396	0.682	3.35	0.610	0.844	1.454
Gucha	660.8	0.146	0.346	0.492	2.8	0.275	0.652	0.927
Vihiga	563.0	NA	NA	0.551	3.3	--	--	1.162
Narok	15087.8	0.045	0.358	0.403	3.3	0.095	0.755	0.850
Siaya	1520.0	0.116	0.377	0.493	0.9	0.142	0.463	0.605
Rachuonyo	945.2	0.089	0.233	0.322	2.1	0.143	0.375	0.518
Busia	1261.3	0.133	0.272	0.405	2.89	0.256	0.523	0.779
Bomet	1416.2	0.167	0.248	0.415	2.7	0.308	0.457	0.765
Migori	2030.0	0.296	0.269	0.565	3.1	0.597	0.542	1.139
Suba	1056.0	0.052	0.118	0.170	3.0	0.102	0.233	0.335
TOTAL	**57,857.3**	**3.534**	**8.256**	**11.790**	**---**	**6.673**	**15.515**	**22.188**

Source: District Development Plans 2002-2008

Annex Ap II-VII

DISTRICT WISE DOMESTIC WATER REQUIREMENT

District	Water Requirement in MCM (2002)			Water Requirement in MCM (2025)		
	Urban	Rural	Total	Urban	Rural	Total
Nyamira	5.14	5.06	10.20	8.87	8.73	17.60
Homabay	1.67	3.67	5.34	3.06	6.78	9.84
Nyando	2.30	3.62	5.92	4.95	7.79	12.74
Teso	1.34	2.16	3.50	2.51	4.07	6.58
Buret	0.35	4.81	5.16	0.65	8.89	9.54
Kericho	4.51	4.93	9.44	7.77	8.51	16.28
Bondo	0.95	3.10	4.05	1.45	4.67	6.12
Kisii	4.51	5.21	9.72	7.41	8.57	15.98
Kisumu	9.38	2.81	12.19	14.78	4.43	19.21
Nakuru	16.86	10.16	27.02	36.35	22.04	58.39
Butere/Mumias	3.39	5.66	9.05	5.85	9.78	15.63
Kakamega	3.53	7.50	11.03	5.69	12.14	17.83
Mt Elgon	0.30	1.95	2.25	0.49	3.30	3.79
Lugari	0.43	3.32	3.75	1.12	8.43	9.55
Trans Nzoia	3.91	7.33	11.24	9.22	17.27	26.49
Nandi	1.53	8.39	9.92	2.95	16.19	19.14
Trans Mara	0.16	2.56	2.72	0.27	4.27	4.54
Uasin Gishu	7.82	5.78	13.60	16.69	12.32	29.01
Gucha	3.99	5.05	9.04	7.52	9.52	17.04
Vihiga	--	--	--	--	--	--
Narok	1.23	5.22	6.45	2.60	11.02	13.62
Siaya	3.17	5.50	8.67	3.88	6.76	10.64
Rachuonyo	2.43	3.40	5.83	3.91	5.47	9.38
Busia	3.64	3.97	7.61	7.00	7.63	14.63
Bomet	4.57	3.62	8.19	8.43	6.67	15.10
Migori	8.10	3.92	12.02	16.34	7.91	24.25
Suba	1.42	1.72	3.14	2.79	3.40	6.19
TOTAL	**96.63**	**120.42**	**217.05**	**182.55**	**226.56**	**409.11**

Source: Basic Data - District Development Plans 2002-2008

WATER REQUIREMENT FOR LIVESTOCK

District	Water Requirement (MCM)	
	2002	2025
Nyamira	2.04	3.52
Homabay	1.06	1.97
Nyando	1.18	2.54
Teso	0.70	1.31
Buret	1.03	1.90
Kericho	1.88	3.25
Bondo	0.81	1.22
Kisii	1.94	3.19
Kisumu	2.44	3.84
Nakuru	5.40	11.68
Butere/Mumias	1.81.	3.12
Kakamega	2.20	3.56
Mt Elgon	0.45	0.75
Lugari	0.75	1.91
Trans Nzoia	2.25	5.30
Nandi	1.98	3.82
Trans Mara	0.54	0.90
Uasin Gishu	2.72	5.80
Gucha	1.80	3.40
Vihiga	--	--
Narok	1.29	2.72
Siaya	1.73	2.12
Rachuonyo	1.16	1.87
Busia	1.52	2.92
Bomet	1.64	3.02
Migori	2.40	4.85
Suba	0.63	1.23
TOTAL	**43.35**	**81.71**

Source: (i) District Development Plans 2002-2008
(ii) National Water Master Plan, 1992

EXISTING FISH PONDS AND FUTURE REQUIREMENTS

District (Reorganized)	Existing Fish Ponds (2002)		Requirement 2025	
	No	Area (Ha)	No	Area (Ha)
Nyamira	1064	18.20	1164	20.25
Homabay	166	2.89	728	12.68
Nyando	95	1.65	903	15.71
Teso	NIL	NIL	468	8.15
Buret	NIL	NIL	798	13.90
Kericho	166	2.89	1094	19.03
Bondo	9	0.16	470	8.19
Kisii	554	9.64	1065	18.54
Kisumu	200	3.48	1065	18.54
Nakuru	109	1.90	3000	52.21
Butere/Mumias	878	15.27	1116	19.42
Kakamega	NA	NA	1312	22.84
Mt Elgon	160	2.78	305	5.32
Lugari	279	4.85	779	13.56
Trans Nzoia	287	4.99	1640	28.55
Nandi	na	NA	1256	21.86
Trans Mara	9	0.15	382	6.64
Uasin Gishu	583	10.14	1556	27.08
Gucha	321	5.58	1170	20.35
Vihiga	507	8.01	1467	25.52
Narok	24	0.42	1074	18.69
Siaya	227	3.95	762	13.27
Rachuonyo	135	2.35	653	11.37
Busia	468	8.14	984	17.13
Bomet	192	3.34	965	16.79
Migori	406	7.06	1438	25.03
Suba	NIL	NIL	420	7.32
TOTAL	**6839**	**117.84**	**28,034**	**487.94**

Source: (i) District Development Plans 2002-2008
(ii) Basic Data - National Water Master Plan, 1992

Annex Ap II-X

REQUIREMENTS OF WATER FOR FISH PONDS

District	Water Requirements (MCM)	
	2002	2025
Nyamira	0.129	0.144
Homabay	0.020	0.090
Nyando	0.011	0.110
Teso	NIL	0.058
Buret	NIL	0.098
Kericho	0.020	0.135
Bondo	0.001	0.058
Kisii	0.068	0.131
Kisumu	0.025	0.131
Nakuru	0.013	0.370
Butere/Mumias	0.108	0.137
Kakamega	NIL	0.162
Mt Elgon	0.019	0.038
Lugari	0.034	0.096
Trans Nzoia	0.035	0.203
Nandi	NIL	0.155
Trans Mara	0.001	0.047
Uasin Gishu	0.072	0.192
Gucha	0.040	0.144
Vihiga	0.057	0.181
Narok	0.003	0.133
Siaya	0.028	0.094
Rachuonyo	0.017	0.081
Busia	0.058	0.121
Bomet	0.024	0.119
Migori	0.050	0.177
Suba	NIL	0.052
TOTAL	**0.833**	**3.457**

Source: (i) District Development Plans 2002-2008
(ii) Basic Data - National Water Master Plan, 1992

DISTRICT WISE INDUSTRIAL WATER REQUIREMENTS

District	Water Requirements (MCM)	
	2002	2025
Nyamira	0.36	0.62
Homabay	0.12	0.21
Nyando	0.16	0.34
Teso	0.09	0.17
Buret	0.02	0.04
Kericho	0.31	0.54
Bondo	0.06	0.10
Kisii	0.31	0.51
Kisumu	0.65	1.03
Nakuru	1.18	2.54
Butere/Mumias	0.23	0.41
Kakamega	0.24	0.40
Mt Elgon	0.02	0.03
Lugari	0.03	0.07
Trans Nzoia	0.27	0.64
Nandi	0.10	0.20
Trans Mara	0.01	0.02
Uasin Gishu	0.54	1.16
Gucha	0.28	0.52
Vihiga	--	--
Narok	0.08	0.18
Siaya	0.22	0.27
Rachuonyo	0.17	0.27
Busia	0.25	0.49
Bomet	0.32	0.59
Migori	0.56	1.14
Suba	0.10	0.19
TOTAL	**6.68**	**12.68**

Source: (i) District Development Plans 2002-2008
(ii) South Asian Technical Advisory Committee - GWP.

APPENDIX III

STATUS OF DEVELOPMENT IN LAKE VICTORIA BASIN

APPENDIX III

STATUS OF DEVELOPMENT IN LAKE VICTORIA BASIN

1.0 Physiography

The Lake Victoria Basin covers 27 districts in three provinces the Western, Nyanza and Rift Valley. The total geographical area of these districts is 57877 Sq Km. The forest cover is only 289.3 Sq Km which is just about 5 percent of the total area, urban area a little over 3520 Sq Km and the remaining 15468 Sq Km is under non-arable land and water bodies.

2.0 Population

There are 70 towns or urban centre each with population over 10,000. Nakuru district with 9 towns has the highest urban population of 0.616 million followed by Kisumu town the district head quarters with a population of 0.343 million. Trans Mara is the only district head quarters with an urban population of less than 10,000. Narok the largest district in terms of area (15,088 Sq Km) has an urban population of only 45,000 mostly concentrated in and around the district head quarters. Nakuru district has the highest rural population of 0.696 million followed by Nandi with a figure of 0.575 million. Kisumu is the only district that has higher urban population than the rural. The total population of the 27 districts is 11.79 million (2002) comprising of urban and rural populations of 3.53 million and 8.26 million respectively. The population growth rate during the last decade was about 2.6 percent with a minimum of 0.9 percent for Siaya and a maximum of 4.13 percent for Lugari. District wise details are shown in Annex Ap III–I.

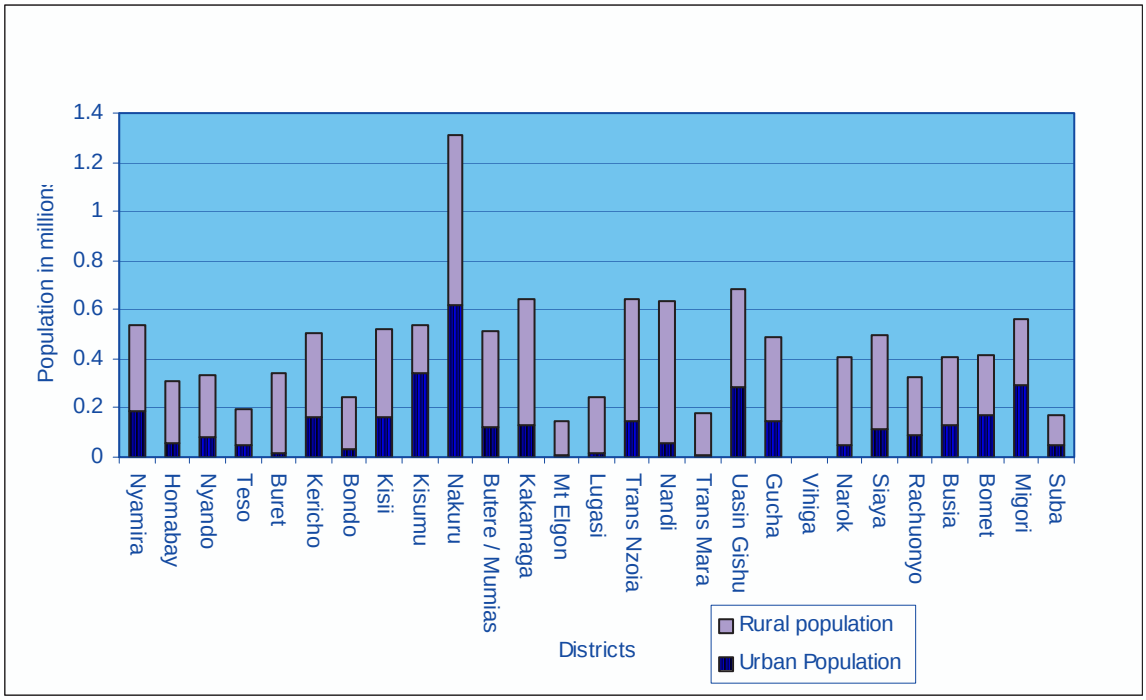


Figure App III-I: Urban and Rural Population

3.0 Infrastructure Development

3.1 Physical Infrastructure

Transport

The total length of roads in the basin under all categories –b itumen, gravel, earth, is 32,636 Km. Only 8 percent of these are all weather bitumen roads, 62 percent fair weather gravel roads and the remaining 30 percent are earth roads. Siaya district has the largest network of roads with a total length

of 7912 Km followed by Narok with 4348 Km and Nakuru with 2004 Km. Mt Elgon and Suba have the smallest network with 346 Km and 393 Km of roads. In the total railway network of Kenya, the share of the Lake basin is relatively small, being of the order of only 800 Km. Nakuru district, on the main Nairobi – Kisumu rail link, with 292 Km of rail track and 21 stations provides the best rail service. Kisumu, Kericho, Nyando, Butere Mumias, Lugari, Trans Nzoia and Uasin Gishu are the other districts served by railway with limited operational frequency. The exact number of airports and airstrips in the 27 districts is not known. According to the District Development Plans 2002-2008, there are 35 airports / airstrips in the basin but many of these are common for two or more adjoining districts. However, most of the small airstrips are owned by large industries and are not suitable for large public transport aircraft.

Communication

The total number of households and public / private organizations having telephone connections is of the order of 0.275 million of which more than 84 percent are in Kisumu district alone. Among the remaining 26 districts sharing the 16 percent of the connections, more than half the connections are in Nakuru, Uasin Gishu and Kisii. Thus the overall coverage in terms of area and population is meager. The figures of coverage by mobile telephone are not known. According to the information broadly provided in the District Development Plans the bulk of the coverage is confined to the above 4 main towns.

The Lake basin has 311 post offices and sub-post offices spread over the 27 districts. Nakuru with a population of 1.31 million is served by 34 post / sub-post offices. In contrast, Siaya and Rachuonyo each with about one third the population of Nakuru have better service levels with 29 and 27 post offices respectively. Trans Mara district has only 1 post office. The overall coverage for the basin is 1 post office for a population of 37,900. District wise details of these infrastructure facilities are shown in Annex Ap III-II.

Energy

There are no systematic records of energy use in urban and rural areas. The latest district-wise reports (2002) do not provide consistent information. While some districts provide information for the whole district, others provide the figures either for urban areas or for rural areas. As per the available data, out of a total of about 2 million households only 0.12 million have electricity connections. Most households depend on oil or firewood to meet their energy requirements. District –wise electricity connections are shown in Annex-II.

3.2 Social Infrastructure

Water Supply and Sanitation

In the 27 districts, 1.12 million households have access to potable water and 0.43 million have piped water supply. The main water sources are 0.124 millions bore wells and dug wells, 1,274 dams/pans and 8,541 protected springs, besides 172 rivers and streams. Distribution of these sources varies over a wide range from district to district. Uasin Gishu, Nakuru, Kericho and Nandi get most of their supply from ground water. Kisii and Nandi have numerous protected springs for water supply. Dams/pans provide considerable amount of water in Uasin Gishu, Trans Nzoia and Nakuru.

Rainwater harvesting from roof catchments is practiced by 0.285 million households. Vihiga, Kisumu, Nakuru, Butere Mumias and Nandi districts have large number of this harvesting system installed by the households. In Kisii the coverage is about 70 percent.

Provision of VIP latrines varies greatly from one district to another. Besides the well developed districts of Nakuru and Kisumu, notable achievements in this area are in the districts of Kisii, Lugari and Migori. Busia and Mt Elgon have 71 percent and 52 percent coverage respectively under this scheme. District wise development of the above infrastructure is shown in Annex Ap III–III.

Education and Health

There are in all 19,377 pre primary and primary schools, 1,565 secondary schools and 2,374 tertiary institutions, more than 90 percent of the tertiary institutions provide adult literacy/education. In the entire Lake Basin, there are 124 hospitals, 628 health centers and 784 other clinics and dispensaries spread over 27 districts. District wise distributions of these facilities are shown in Annex Ap III– IV.

4.0 Agriculture Development

With about 3.5 million hectares of arable land and good rainfall, agriculture is the obvious choice of the rural people in the basin. About 1.14 million hectares of this land is under food crops and 0.426 million hectares under cash crops. More than 4.2 million people are engaged in agriculture, 2.3 million in livestock rearing and about 21,500 in fishery mainly in small ponds. District wise figures are shown in Annex Ap III–V.

Though the total cropped area in the Lake basin is 1.566 million hectares, considering the run-of-the river abstractions and limits of land potential, the ultimate irrigation potential assessed in the National Water Master Plan is only 0.35 million hectares. With the proposed cropping intensity of 163% the net area that can be provided with irrigation is only 0.215 mha.

5.0 Tourism, Trade and Commerce

5.1 Tourism

There are 44 identified places of tourist interest in the basin. Considering the natural ambience of the un-spoilt country side in almost all but three districts a total of 56 places could be developed for promoting tourism. There are 144 tourist class hotels in 19 districts. More than 50% of these are in Nakuru alone. Narok, Kakamega, Uasin Gishu and Trans Mara have several good hotels.

5.2 Trades and Commerce

Kisumu, Nakuru and Nandi are among the major trading districts with a total of 541 trading centers out of 1,357 centers in the entire Lake basin. There are more than 94,000 licensed businesses in the basin as shown in Annex Ap III–VI.

6.0 Development in Flood Prone Districts

6.1 Siaya

The 1997-2001 Development Plan covered both Siaya and Bondo districts. The creation of Bondo district in 1998 witnessed the decline of fishing industry in Siaya district because much of the fishing activities were in areas that are now in Bondo district. While fishing activities have reduced drastically and are now confined mainly in Lake Kanyaboli and in various fishponds around the district, trade in fish products is still a source of livelihood for part of the districts population. Siaya is a food deficit district with an ability to meet food requirement for only 4 months in a year. This can be attributed to the continued use of local seeds, low use of modern farm inputs, poor crop husbandry and erratic rainfall conditions. The districts main cash crops of sugarcane, cotton and coffee are not performing well mainly due to poor management and marketing problems. Due to reforms in the Public sector and consequent reduction in staff, planned targets in Key sectors such as Agriculture, Water, Health and Public Works could not be achieved during the 1997-2001 Plan the implementation being 0, 8, 80 and 19 percent respectively.

The absolute poverty in urban and rural areas is 37.9 and 57.9 percent respectively. The district contributes 1.85 percent to National Poverty.

6.2 Bondo

The district has poor infrastructure both in urban and rural areas. Only 10 percent of its population has access to potable water. There is only 1 hospital and 6 health centers. More than 50 percent of the population depends on livestock for livelihood. Only 8 percent of its road network consists of all-

weather bitumen roads, 55 percent gravel and 37 percent earth roads. The implementation of the 1997-2002 Plan was only 22 percent and the objective of industrial growth remained totally unrealized. Absolute poverty stands at 58 percent with contribution of 0.9 percent to National Poverty.

6.3 Kisumu

Kisumu district has a total population of 0.53 million of which 64 percent lives in urban areas. Only about 25 percent of the population has access to potable water and 10 percent has piped water supply. Rural electrification coverage is a little over 7 percent. Out of a total road network of 457 Km, all weather bitumen roads are only 133.6 Km, the district has 139 Km of railways most of which is part of the rail-link with the National Capital Nairobi. Communication facilities are well developed which cover almost 43 percent of the districts population with 669 pre primary and primary and 55 secondary schools covering both urban and rural population, the teacher-pupil ratio is about 1:40 that is fairly good. The district has 1 university, 1 polytechnic and 1 institute of advanced technology. Health facilities are fairly well distributed. About 59 percent of the rural population depends on agriculture for livelihood, the remaining being engaged in various services and business/trade.

The main agricultural activities are growing rice, sugarcane, cotton, coffee and fishing. However, due to lack of market and dilapidated infrastructure, the income levels are low. During the 1997-2001 Plan periods implementation rate of various programs in the sector was only 12 percent. About 53 percent of the population lives in absolute poverty that is 1.78 percent of the National Poverty level.

6.4 Nyando

The district has considerable potential for development of the Key sectors of economy, but the level of development has been low during the previous Plan period. The performance of the Agriculture Sector has been low resulting in food deficit. During the 1997-2002 Plan period, the implementation of projects in Agriculture and Livestock sectors was 36% and in the water sector only 19%. The overall implementation of developmental programs was 29.7%. There is over reliance on sugarcane for income neglecting other cash crops. After the collapse of the cotton industry, the farmers have been abandoned cotton growing thereby reducing the income levels. Fishery has been adversely affected by the invasion of the Lake by water hyacinth and collapse of a number of fishermen cooperative societies.

The level of access to safe drinking water is low. The district is prone to flooding which causes contamination of water sources and there by, upsurge of water borne diseases. The district lacks the necessary educational facilities like classrooms and desks in most primary schools. A number of secondary schools do not have science laboratories. There is a general lack of medical facilities and the problem is further compounded due to people's inability to afford the available facilities.

The decline in the sugar industry, which has been the main stay of the districts economy, has caused considerable increase in the incidence of poverty that in absolute terms stands at about 69 percent and contributes 3.05 percent to the National Poverty.

6.5 Busia

The condition of roads in the district is poor except for the newly tarmacked Busia-Kisumu Road and Busia-Mumias Road. Consequently the flow of agricultural produce to the markets is severely constrained. Telephone services have not spread into rural areas mainly due to high costs. Electricity supply is still not available in rural markets and strategic investment locations and public utilities. The rate of utilization of primary and secondary schools is low. The overall implementation of projects during the 1997-2001 Plan period was 40 percent in Agriculture and livestock sectors, 29 percent in Fisheries, 50 percent in Energy, 23 percent in Health and 33 percent in Water sectors. The district has an absolute poverty level at 66 percent and contributes 2.43 percent to the National Poverty.

6.6 Migori

At the beginning of the 1997-2001 Plan the major impediment to industrial growth and alleviation of poverty were the inadequate infrastructural facilities such as roads, power/energy, telecommunication, under developed human resources and local raw materials, poor marketing etc. With only 30 percent

implementation of planned projects, these constraints still remain. The main constraints in the implementation were low funding levels, unclear policies and poor project management. The district has poor infrastructure. Out of a total of 1282 Km of roads, only 98 Km of roads are all weather bitumen roads, 612 Km gravel roads and the remaining 572 Km are earth roads. It has no rail links for mass transportation. For a population of 0.565 million it has only 748 telephone and 7006 electricity connections. Though about 50% of the population has access to portable water, piped water supply coverage is only 4.6%. About 58 percent of the districts population lives in absolute poverty and contributes 2.17 percent to the National Poverty.

6.7 Suba

The district has a total area of 1056 Sq Km of which urban area is only 117 Sq Km. Suba the district head quarters is the only town, with a population of 52,000. The district has virtually no electricity and has only 147 telephone connections. There are only 393 Km of roads of which 311 Km are murram roads and the remaining 82 Km are earth roads. With no all weather roads connecting the district with other parts of the country, transportation is the major problem hampering its development. About 50% of the population has access to portable water from 108 bore wells and dug wells and the piped water supply coverage is only 7%. 51% of the population is engaged in agriculture and 40% in fishery. Absolute poverty is 50.5% and contribution to national poverty is 0.7%.

Annex Ap. III-I

DISTRICT WISE AREA, TOWNS AND POPULATION IN LAKE VICTORIA BASIN

District	Total Area (Sq Km)	Urban Area (Sq Km)	No of Towns	Population (2002)		
				Urban	Rural	Total
Nyamira	896.40	36.4	3	0.188	0.347	0.535
Homabay	1160.40	2.7	2	0.061	0.252	0.313
Nyando	1168.40	NA	4	0.084	0.248	0.332
Teso	558.50	8.0	1	0.049	0.148	0.197
Buret	1100.00	8.2	2	0.013	0.330	0.343
Kericho	2110.60	10.6	3	0.165	0.338	0.503
Bondo	1972.00	123.0	2	0.035	0.213	0.248
Kisii	648.90	NA	4	0.165	0.357	0.522
Kisumu	919.00	141.0	1	0.343	0.193	0.536
Nakuru	7242.00	424.5	9	0.616	0.696	1.312
Butere/Mumias	939.30	31.0	2	0.124	0.388	0.512
Kakamega	1394.80	186.1	2	0.129	0.514	0.643
Mt Elgon	936.70	24.0	2	0.011	0.134	0.145
Lugari	670.20	45.5	2	0.016	0.228	0.244
Trans Nzoia	2487.00	111.5	1	0.143	0.502	0.645
Nandi	2873.00	4.2	2	0.056	0.575	0.631
Trans Mara	2932.00	10.0	1	0.006	0.176	0.182
Uasin Gishu	3327.80	186.9	4	0.286	0.396	0.682
Gucha	660.80	20.8	4	0.146	0.346	0.492
Vihiga	563.00	NA	1	NA	NA	0.551
Narok	15087.80	943.0	1	0.045	0.358	0.403
Siaya	1520.00	282.6	5	0.116	0.377	0.493
Rachuonyo	945.20	186.0	2	0.089	0.233	0.322
Busia	1261.30	249.0	5	0.133	0.272	0.405
Bomet	1416.20	225.0	1	0.167	0.248	0.415
Migori	2030.00	140.0	4	0.296	0.269	0.565
Suba	1056.00	117.0	1	0.052	0.118	0.170
TOTAL	**57877.30**	**3517.0**	**71**	**3.534**	**8.256**	**11.790**

Source: District Development Plans, 2002-2008

Annex Ap. III-II

PHYSICAL INFRASTRUCTURE

District	Households Tcs with electricity (No)	Transport			Communication	
		Roads (Km)	Rail (Km)	Airport / Strip	Telephone Connections	Post Offices
Nyamira	6,099	662	NIL	--	388	15
Homabay	1,882	507	NIL	1	488	7
Nyando	1,802	1,122	40	--	561	NA
Teso	NA	326	11	--	213	7
Buret	598	530	NIL	--	654	3
Kericho	5,090	830	80	1	2,386	12
Bondo	717	554	NIL	1	377	12
Kisii	13,510	482	NIL	1	4,051	4
Kisumu	14,335 (Rural)	457	139	1	2,32,393	17
Nakuru	25,346	2,004	292	4	13,929	34
Butere/Mumias	1,065	556	25	1	522	15
Kakamega	18,898	761	NIL	1	2,013	15
Mt Elgon	56	346	NIL	--	99	5
Lugari	39	442	20	--	NA	8
Trans Nzoia	4,609	1,110	23	3	2,147	7
Nandi	2,279	1,704	NIL	--	1,993	18
Trans Mara	203	455	NIL	6	150	1
Uasin Gishu	6,165	1,236	179	1	6,591	20
Gucha	2,247	650	NIL	--	88	4
Vihiga	2,441	801	NIL	--	970	NA
Narok	8,003	4,348	NIL	4	776	5
Siaya	1,077	7,912	NA	2	953	29
Rachuonyo	1,368	1,816	NA	--	750	27
Busia	2,722	586	NA	2	651	16
Bomet	420	764	NIL	1	673	11
Migori	7,006	1,282	NIL	2	748	12
Suba	NIL	393	NIL	3	147	7
TOTAL	**127,977**	**32,636**	**809**	**35**	**2,74,711**	**311**

Source: District Development Plans, 2002-2008

SOCIAL INFRASTRUCTURE – I
Water and Sanitation Facilities

District	Household with access to		Bores/ Wells (no)	Dams / Pans	Roof Catchments (No)	VIP Latrines
	Piped W.S (No)	Potable Water (No)				
Nyamira	4,880	40,080	312	14	NA	897
Homabay	2,000	2,284	122	62	58	157
Nyando	11,624	22,110	447	5	848	2,100
Teso	2,039	28,854	162	4	8,416	62
Buret	23,034	29,954	43	3	499	2,998
Kericho	30,359	47,958	8,369	20	835	988
Bondo	13,350	10,625	137	21	297	1,800
Kisii	19,435	47,152	72	NA	70%	70,225
Kisumu	37,232	84,984	304	8	56,740	76,915
Nakuru	1,38,789	2,11,527	21,926	122	36,435	1,40,296
Butere/Mumias	2,130	31,050	535	NIL	20,000	NA
Kakamega	12,480	1,25,901	1,042	1	338	1,500
Mt Elgon	4,000	17,000	54	1	10	52%
Lugari	3,377	17,728	19	43	140	22,472
Trans Nzoia	18,411	34,836	1,150	200	11,612	300
Nandi	3,500	30,000	5,620	15	20,000	25%
Trans Mara	5,850	8,663	51	12	576	NA
Uasin Gishu	40,926	1,03,064	80,843	525	5,488	5,785
Gucha	5,500	55,635	10	NA	NA	NA
Vihiga	12,000	22,000	64	1	99,188	16,419
Narok	6,835	16,750	96	35	6,768	2,111
Siaya	6,005	2,628	887	20	209	2,123
Rachuonyo	377	24,609	30	24	353	2,000
Busia	18,785	48,312	650	12	NA	71%
Bomet	2,200	1,500	1,041	59	750	200
Migori	4,364	43,402	357	41	330	79,757
Suba	2,174	15,217	108	26	15,217	11,923
TOTAL	**4,31,656**	**1,123,823**	**1,24,451**	**1,274**	**2,85,107**	**4,41,028**

Source: District Development Plans, 2002-2008

Annex Ap. III-IV

SOCIAL INFRASTRUCTURE – II
Education and Health

District	Schools/Colleges/Institutions			Health Care		
	Pre/Primary	Secondary	Tertiary	Hospitals	Health Centers	Others
Nyamira	772	128	192	2	21	NA
Homabay	624	32	114	1	20	15
Nyando	607	45	87	6	9	21
Teso	251	15	6	8	4	1
Buret	447	46	11	4	5	34
Kericho	733	57	133	7	7	NA
Bondo	519	34	NA	1	6	46
Kisii	819	105	65	5	20	27
Kisumu	669	55	132	9	9	NA
Nakuru	1,777	140	215	15	279	NA
Butere/Mumias	557	62	73	4	11	45
Kakamega	854	87	77	12	15	28
Mt Elgon	190	18	54	1	3	6
Lugari	447	26	38	1	50	NA
Trans Nzoia	885	61	123	4	4	33
Nandi	1,122	80	165	3	15	88
Trans Mara	322	11	56	5	5	NA
Uasin Gishu	1,169	86	150	9	18	191
Gucha	1,130	126	17	2	5	26
Vihiga	946	84	100	3	20	57
Narok	651	19	91	1	8	98
Siaya	766	56	90	3	15	19
Rachuonyo	688	58	98	4	36	NA
Busia	547	28	47	5	21	NA
Bomet	723	50	68	2	7	39
Migori	822	44	117	5	6	NA
Suba	340	12	55	2	9	10
TOTAL	**19,377**	**1,565**	**2,374**	**124**	**628**	**784**

Source: District Development Plans, 2002-2008

Annex Ap. III-V

AGRICULTURE DEVELOPMENT

District	Cropped Area (ha)			Population engaged in Sector		
	Food Crops	Cash Crop	Total	Agriculture	Livestock	Fishery
Nyamira	13,960	NA	13,960	4,23,729	NA	842
Homabay	52,651	2,823	55,474	77,000	77,000	110
Nyando	18,200	24,000	42,200	1,25,348	83,700	440
Teso	NA	8,526	8,526	96,200	NA	NA
Buret	33,080	20,675	53,755	2,67,412	1,98,000	NA
Kericho	47,585	9,339	56,924	2,03,716	50,000	116
Bondo	NA	1,500	1,500	38,600	1,29,018	5
Kisii	10,000	5,424	15,424	3,00,000	2,50,000	440
Kisumu	1,546	6,028	7,574	2,05,684	20%	180
Nakuru	1,30,098	23,481	1,53,579	2,24,051	2,24,051	90
Butere/Mumias	29,554	30,493	60,047	2,50,000	2,50,000	583
Kakamega	63,526	24,873	88,399	4,82,285	4,82,285	1,171
Mt Elgon	8,484	18,000	26,484	1,07,000	53,757	96
Lugari	32,390	2,220	34,610	54,307	34,400	253
Trans Nzoia	50,509	61,910	1,12,419	1,06,584	1,06,584	279
Nandi	1,00,000	19,112	1,19,112	3,25,000	93,552	438
Trans Mara	18,700	1,720	20,420	1,23,000	NA	7
Uasin Gishu	85,525	40,786	1,26,311	2,04,000	NA	450
Gucha	45,847	10,913	56,760	2,02,529	NA	245
Vihiga	40,000	NA	40,000	3,58,000	1,85,000	NA
Narok	40,800	68,000	1,08,800	29,820	69,680	24
Siaya	71,229	15,000	86,229	1,20,000	2,26,000	163
Rachuonyo	25,320	1,897	27,217	1,26,309	54,796	119
Busia	58,165	4,935	63,100	2,20,000	NA	311
Bomet	45,777	561	46,338	1,36,500	45,000	160
Migori	1,00,000	23,750	1,24,250	4,36,500	4,36,500	186
Suba	19,594	606	20,000	43,870	20,000	14,782
TOTAL	**1,143,040**	**4,26,572**	**1,569,612**	**5,286,844**	**3,107,923**	**21,490**

Source: District Development Plans, 2002-2008

Annex Ap. III- VI

TOURISM TRADE AND COMMERCE

District	Tourism			Trade and Commerce	
	Tourist Attractions	Hotels		Trading Centers (No)	Licenced Businesses (No)
		Tourist	Total		
Nyamira	5	1	18	53	7,098
Homabay	NIL	2	10	6	3,772
Nyando	NIL	NIL	NA	7	NA
Teso	2	1	12	24	11,490
Buret	NIL	NIL	9	8	350
Kericho	1	2	200	14	2,650
Bondo	3	2	107	44	752
Kisii	4	1	26	4	389
Kisumu	5	2	156	145	6,515
Nakuru	4	76	236	147	7,129
Butere/Mumias	5	NIL	228	39	1,446
Kakamega	1	7	12	28	4,939
Mt Elgon	1	NIL	14	3	700
Lugari	2	2	4	39	3,415
Trans Nzoia	1	4	52	30	3,350
Nandi	4	NIL	183	249	3,221
Trans Mara	1	5	48	23	659
Uasin Gishu	1	6	48	85	12,748
Gucha	1	NIL	100	55	1,700
Vihiga	1	4	6	50	4,443
Narok	1	13	74	21	1,532
Siaya	3	7	40	45	8,500
Rachuonyo	4	2	120	20	916
Busia	1	2	8	55	4,350
Bomet	1	NIL	20	7	1,527
Migori	1	NIL	24	83	8
Suba	3	5	12	73	524
TOTAL	**56**	**144**	**1,767**	**1,357**	**94,123**

Source: District Development Plans, 2002-2008

APPENDIX IV

INSTITUTIONAL ARRANGEMENTS IN THE WATER SECTOR

APPENDIX IV

INSTITUTIONAL ARRANGEMENTS IN THE WATER SECTOR

1.0 Introduction

Water resources development in the country was initiated during British rule when the basic infrastructure for the purpose was established and many development projects were implemented. Immediately after the independence the Government realized that provision of water was going to be a major factor in promoting development in all sectors of economy. Although there was no comprehensive documented framework to guide the development of the water sector, various water resources development projects were implemented to meet the immediate requirements of various sectors and the people at large. However, due to the rapid population increase, the annual per capita availability of water gradually declined and is at present about $650m^3$, which places Kenya in the category of water scarce countries of the world.

With the steady rise in population over time, and the consequent increase in water demand, need is being felt to accelerate the pace of development in the sector with increased focus on addressing the problems of drought and floods together with environmental safeguards. This would require an Integrated Water Resources Management (IWRM) approach. The major challenges in this approach are, highly uneven availability of water in space and time, operation and maintenance of the physical infrastructure, lack of proper coordination among different organizations, weak policy, legislative and institutional framework, lack of skilled manpower and paucity of financial resources.

Realising the enormity of these challenges, the Government prepared a Sessional Paper on "National Policy on Water Resources Management and Development" in 1999 and its legal framework in the Water Act – 2002. These documents provide the necessary enabling environment and empowerment for requisite institutional restructuring and strengthening and other reforms. In accordance with the guiding principles and directions provided by these documents the Government has initiated the process of institutional restructuring in the water sector.

The objective of this report is to present the current status of institutional arrangements in the water sector, their linkages with institutions outside the sector and to identify the key areas where strengthening of existing institutions is necessary in the context of flood management.

2.0 Flood Related Legislative Arrangement

2.1 The Water Act

The Water Act 2002 provides for developing a "Catchment management strategy" for protection and control of water resources. It specifically provides for protection of catchment areas. This is a significant enabling provision which, on translation into actual practice, would go a long way in reducing intensity of floods.

The Act also addresses the existing weaknesses in the existing data collection mechanism, flood monitoring system and dissemination of timely information; by providing for a broad based "national monitoring and information systems on water resources". Appropriate institutional strengthening could, therefore, be done under this provision.

The Act provides for land acquisition for state schemes in accordance with relevant laws. In order to facilitate land acquisition for water resources and flood protection schemes in a time bound manner, the relevant provisions under the Forest Act and Land Use Act together with relevant laws there under, would need to be reviewed and suitably modified.

2.2 The Forest Act

The Forest Act Cap: 385 (Presently under revision) prohibit, interalia, breaking up land for any purpose except under the license from the Director of Forestry. In order to facilitate development of the country's water resources including flood protection, this provision of The Forest Act and the rules there under would need to be harmonized with the relevant provisions under the Water Act – 2002.

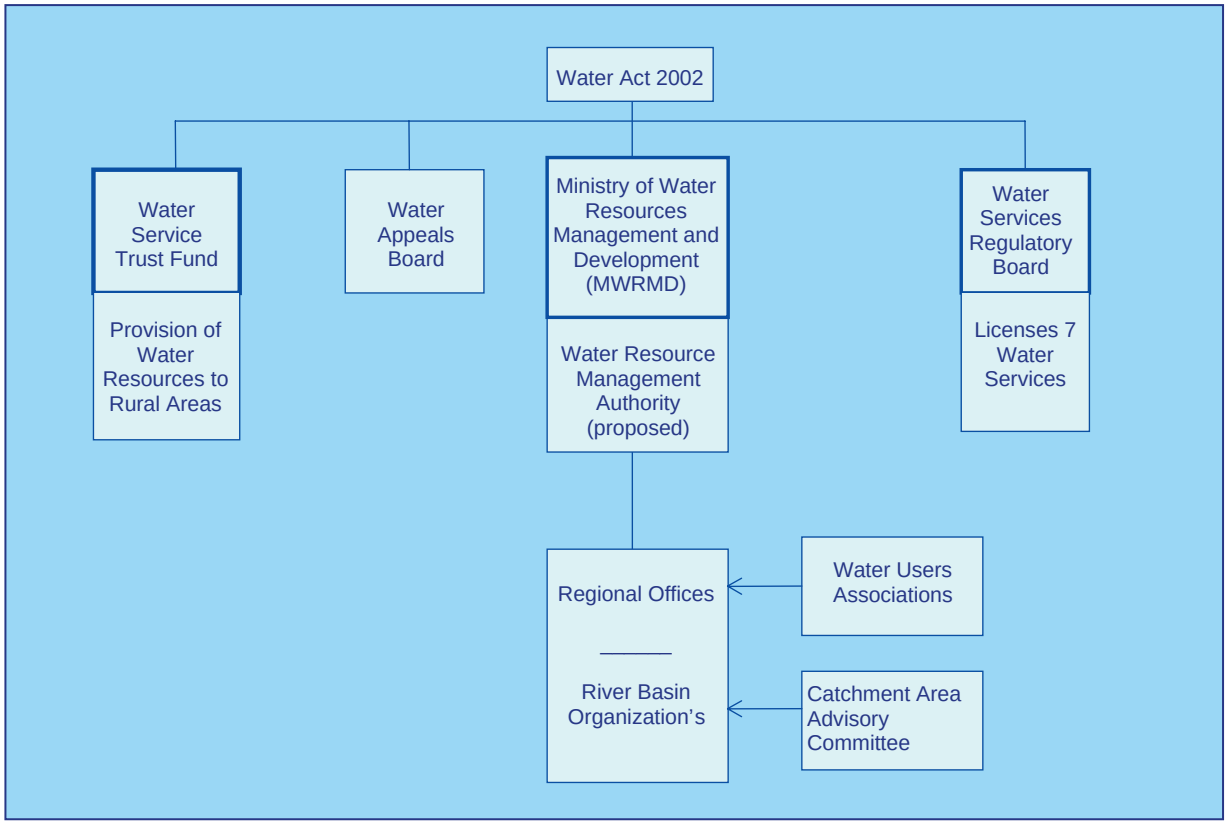


Figure App IV-I Institutional structure provided under Water Act 2002

2.3 The Agriculture Act

The Agriculture Act Cap 318 makes a general provision for a review of annual programmes of production of essential crops in Kenya. There is no specific mention of crop production in areas prone to floods and drought. The provisions for securing efficient agricultural production also do not address the problems of drought and flood prone areas where the production levels are uncertain due to the vagaries of nature. Part V of the Act on Land Development provides for proper development of land and adoption of appropriate farming practices. However, in actual practice, there is no mechanism to develop and promote appropriate agriculture practices in flood prone areas.

2.4 Environmental Management Act

The Environmental Management and Coordination Act –1999 (Part V) has elaborate provisions for protection and conservation of environment with specific references to rivers, lakes and wetlands. Para. 42(4) empower The National Environmental Management Authority (NEMA) to issue guidelines for the management of the environment of lakes and rivers, in consultation with the relevant lead agencies. The District Environmental Committees are required, under the Act, to prepare every five years, district environmental action plans taking into consideration the relevant sectorial interests.

2.5 Land Policy

Kenya does not have a clearly defined or codified National Land Policy and therefore, important issues such as land administration, access to land, land use planning, land information management systems environmental concerns, public land allocations etc are currently inadequately addressed through the existing systems. The government has initiated the process of broad based consultations with all key stakeholders for the implementation of the recommendations of the "Njonjo Commission" which include a number of new policy principles and institutional changes for the land sector.

3.0 Institutional Setup

3.1 Ministry of Water Resources Management and Development

The dominant institutional structure of the Kenya Government is departmental in which there is division of responsibilities among departments both in the secretariats of the Ministries and at the implementing levels from the heads of departments down to the field level functionaries. Since the Government has traditionally been the sole provider of water supply services for various uses it has, over time, established a full fledged Ministry of Water Resources Management and Development (MWRMD) with a large network of departments and sub-ordinate offices at the national, provincial, district and Divisional levels.

The water Act 2002 empowers the Minister to be the custodian of all the water resources of the country with control over all water bodies. He/she is responsible for the development, conservation and protection of water resources against depletion and pollution. The Minister appoints the Board Members of the institutions responsible for control and management of water resources. The Minister has under him/her the Kenya Water Institute, National Water conservation and Pipeline Corporation and the National Irrigation Board. According to the Water Act 2002 the Minister is assisted by Director of Water in all matters concerning the governance of the water sector. The Assistant Minister is the principal assistant to the Minister. The organizational setup for the Ministry of Water Resources Management and Development is shown in Figure App IV-II.

3.2 Water Department

The Permanent Secretary is the accounting officer and the chief executive responsible for the Departments of Water and Land Reclamation; Irrigation, Drainage and ASAL Development as well as General Administration and Planning for the Ministry.

Water Department is headed by Director of Water Development, and has under it three Branches to deal with Water Resources Management, Water Resources Development and Applied Water Research.

The Water Resources Management Branch deals with surface water, ground water exploration and investigation, water quality and pollution control and water rights. The following sections deal with these aspects.

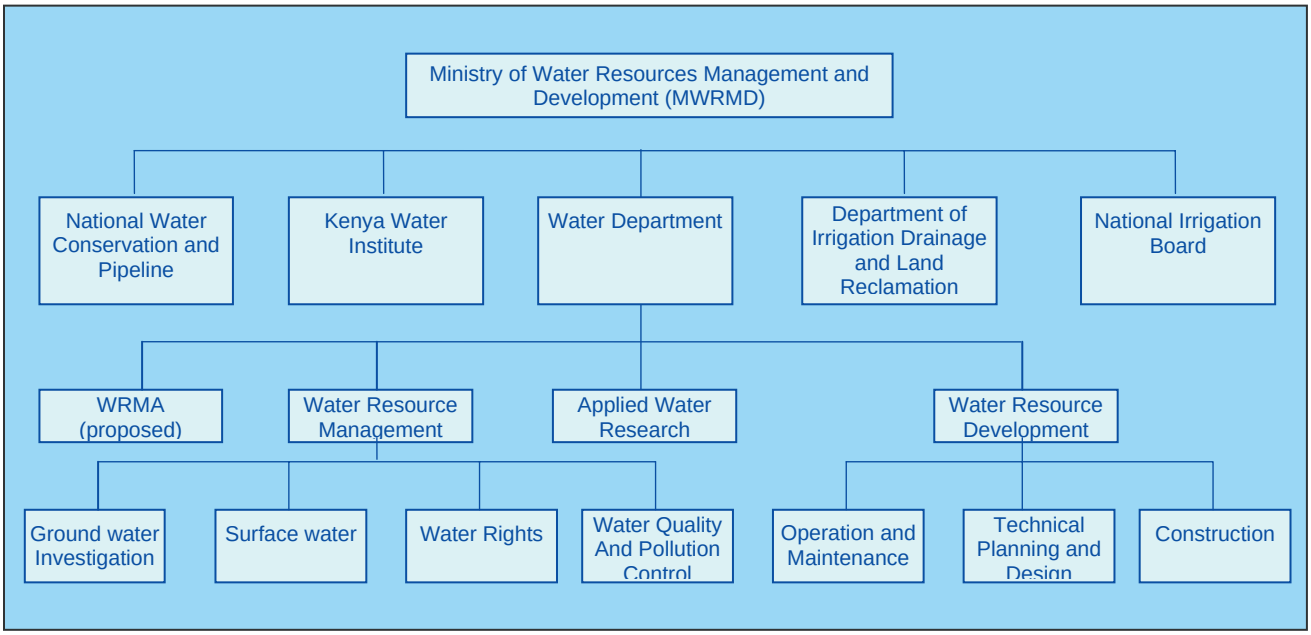


Figure App IV-II: Organisational Setup of Ministry and Water resource Management and Development

(i) Surface Water
- Monitoring Section
- Data Analysis Section
- Programmes Coordination Section
- Publication Section

(ii) Ground Water Exploration
- Operations Section
- Maintenance Section
- Rehabilitation Section

(iii) Ground Water Investigation
- Hydrogeological Section
- Geophysics Section
- Engineering Geology Section
- Conservation Section
- Development Supervision Section

(iv) Water Quality and Pollution Control
- Monitoring Section
- Pollution Control Section
- Surveillance Section
- Data and Documentation Section

(v) Water Rights
- Water Resources Data Base Section
  (i) Ground water data base unit
  (ii) Surface water data base unit
  (iii) Water permits data unit
  (iv) Data documentation unit
- Water Resources Assessment and Apportionment Section
  (i) Lake Victoria catchment unit
  (ii) Rift Valley catchment unit
  (iii) Tana river catchment unit
  (iv) Northern Ewaso Ngiro catchment unit
  (v) Arthi river catchment unit
  (vi) Water Resources Assessment coordination unit

The Water Resources Development Branch deals with technical planning and designs; construction, water conservation, irrigation and drainage; and operations and maintenance. The following sections deal with these aspects.

(i) Technical Planning and Design
- Technical Planning Section
- Design Section
- Survey and Drawing Section

(ii) Construction
- Water Supplies Construction Section
- Sewerage Schemes Construction Section

(iii) Operation and Maintenance of Water supplies and sanitation
- Water Supplies Monitoring Section
- Water Supplies Maintenance Section
- Local Authorities Water Supplies Monitoring Section
- Sanitation Monitoring and Maintenance Section

The Applied Water Research Branch deals with research in water technology, hydrology and meteorology, hydrogeology and land use including irrigation, soil conservation and environmental impact of water development. In addition to the above, recently a new Department of Irrigation Drainage and Land Reclamation has been created.

3.3 Field Organisation

Provincial Water Offices

The Ministry of Water Resources Management and Development has offices in all the 8 provinces, which are responsible for development, maintenance, control and supervision of all the Ministry's operations. These include implementation of water resources development schemes and management of supplies to various users.

District Water Offices
Under each Provincial Water Office are District Water Offices whose number now is 67 in the country. They are headed by District Water Officers. Their functions are overall planning, control and management of all water related matters in the Districts including financial management thereof.

Divisional Water Offices
Every district is divided into divisions, which are headed by Divisional Water Officers. Most of the rural water supply schemes and other related services are provided at Divisional level.

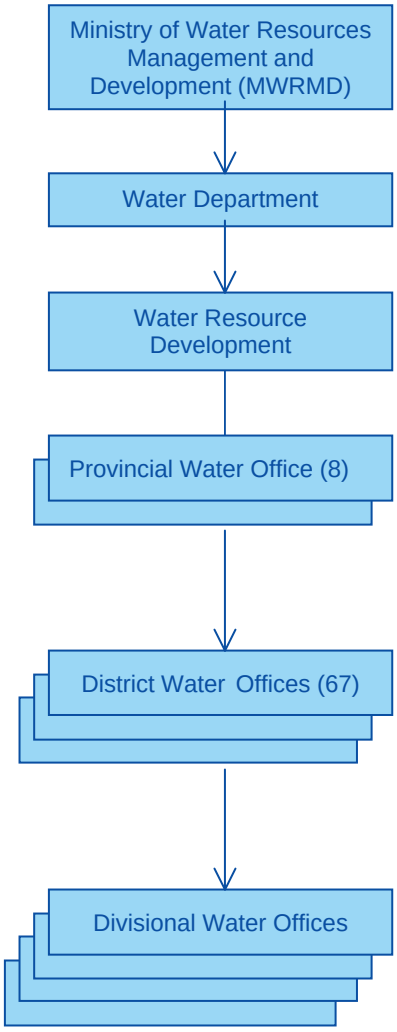


Figure App IV-III Field Setup Under Existing Ministry of Water Resources Management and Development.

3.4 Kenya Water Institute

The Institute is responsible for implementation of training policies, approved curriculum and standards applicable to courses; planning and organisation of suitable courses, seminars, workshops etc for the Ministry's staff; assessment and recruitment of applicants for pre-service training in liaison with the

Directorate of Personnel Management, the Public Service Commission and the Ministry; coordination of training programmes for the Ministry's personnel conducted at the National Polytechnics and other local training institutes. The Academic Division of the Institute is responsible for manpower analysis and assessment of training needs, development of curriculum and training schedules.

3.5 The National Water Conservation and Pipeline Corporation (NWCPC)

The NWCPC was established in June 1988 in accordance with the provisions of the State Corporations Act. The corporation is an implementing body responsible for relatively large scale water development projects. The main functions of the corporation in connection with the water projects specified in the schedule are:

(i) To supply water in bulk to such water undertakers as the Minister may, after consultation with the Water Apportionment Board, designate through a notice in the Gazette.
(ii) To supply water in bulk or otherwise to such persons or class of persons as the Minister may, after consultation with the Board, designate through a notice in the Gazette.
(iii) To develop and manage water projects and ensure an adequate supply of water. The specific responsibilities in this connection include planning and management of construction of dams and water supply systems, promoting efficiency in the operation of existing major projects and ensuring generation of revenue.
(iv) To assist the Government in formulation and execution of national water development policy.

3.6 National Irrigation Board

The National Irrigation Board was established in 1966 under the Ministry of Agriculture under the Irrigation Act. As part of reorganization of Ministries, the Board was placed under the Ministry of Water Resources Management and Development in January 2003. The Board is responsible for the development, control and improvement of national irrigation schemes in the country; research and investigation, provision of land in irrigation schemes for public purposes; promote the marketing of crops and produce, facilitate processing of agricultural produce.

4.0 On-Going Reforms

The Water Act, 2002 provides for separation of roles of the mainstream Ministry of Water Resources Management and Development and the organizations responsible for providing services and Water Resources Management. While policy formulation would remain with the Ministry, service provision would be devolved to existing and proposed autonomous boards. The Water Act, 2002 also provides for separation of Water Resources Management from the Water Supply and Sewerage services. This is proposed to be achieved through establishment and operationalisation of:

(i) Water Resources Management Authority
(ii) Water Services Regulatory Board and seven (7) water services Boards

4.1 Water Resources Management Authority (WRMA)

So far only chairman and the Board Members have been appointed. The supporting staff are yet to be appointed. When fully operational the WRMA will set up regional offices in all the 6 identified catchment areas. The law also requires them to formulate catchment management strategy and facilitate setting up Water Users Associations (WUAs) to assist in cooperative management of water and resolution of conflicts/disputes. To be also appointed are the catchment Area Advisory Committees for each of the 6 catchments whose membership must be multidisciplinary of up to 15 drawn from various ministries, public bodies, regional development authorities, farmers, business community, NGOs and persons with proven competence in WRM.

4.2 Water Services Regulatory Board (WSRB)

The Chairman of the Board has not been appointed but Members have been appointed. When fully operational the Board will have under it 7 Water services Boards and Water services providers. The WSRB is responsible for regulation of water and sewerage services including issuing licenses, determining service standards etc.

4.3 Water Services Boards (WSB)

WSB are licensed by WSRB and are responsible for the efficient and economical provision of water and sewerage services authorized by the license. The water services will be provided by an Agent or Agents of WSB designated as Water Services Providers (WSPs) except in the circumstances where WSRB is satisfied that the procurement of such Agent is not possible or that the provision of services by an Agent is not practicable. The WSPs may be communities, NGOs Local Authorities or the private sector.

4.4 Water Services Trust Fund (WSTF)

WSTF will assist in financing the provision of water services to rural areas without adequate water services. Trustees appointed under a Trust Deed shall manage it.

4.5 Water Appeals Board

The function of the Board is to hear and determine appeal from any person who has a right or proprietary interest, which is directly effected by a decision or order of the Minister or the Regulatory Board concerning a permit or license under the Water Act 2002.

5.0 Other Institutions related to Water

5.1 Ministry of Regional Development

It is responsible for regional development and has under it, Lake Basin Development Authority, Coast Development Authority and Ewaso Ngiro (North and South) River Basin Development Authority, Tana and Athi Development Authority.

5.2 River Catchment Development Authorities

These are special bodies under the Ministry each under specific Act. The main function of these Authorities is the development of their respective basins by using water as an input to development.

5.3 Ministry of Energy (MOE)

The Ministry has several parastatals under it such as Kenya Power and Lighting Company, Kenya Electricity Generating Company, which are all involved in hydropower development. The Ministry also has linkage with various independent power companies in connection with power supply management. Storage based hydro power development can significantly help in moderating flood discharges in the down stream thereby reducing flood hazard and damage potential. Multi purpose schemes with substantial hydropower component are economically attractive since they can recover the capital cost with interest within 6 to 8 years of operation.

5.4 Ministry of Agriculture

The Ministry is responsible for crop production and marketing, agriculture policy and services, agricultural credit, soil conservation, agricultural research and survey and control of locusts. Development of special crops and cropping patterns for flood prone areas can help in reducing crop damage due to floods. Contingent crop options after floods can provide better food security for the farmers. The Ministry therefore has significant role in reducing the vulnerability of the farmers to floods.

5.5 Ministry of Environment, Natural Resources and Wildlife

The Ministry is responsible for formulation of policies on environment, mining, forestry development and conservation of wild life; inventory and protection of natural resources, conservation and exploitation protection and control of water catchment areas, mineral exploration and mining etc. Protection of riverine watersheds through various structural and non-structural measures can greatly help in reducing the flood intensities. Reduction in sediment loads in rivers can, to a large extent, prevent aggradations of riverbeds thereby preventing rise in flood levels. The Ministry therefore has an important role in reducing flood hazard. The Ministry has under it the following organizations:

(i) National Environment Management Authority.
(ii) Kenya Forestry Research Institute, and
(iii) Kenya Wildlife Service.
(iv) Forest Department.

5.6 Disaster Operations Centre – Office of the President

The role of the Disaster Operations Centre is that of coordination of disaster related activities of the line Ministries up to the District level. In the area of flood disaster, the centre coordinates rescue and relief operations on receipt of advance warning of impending threat of floods from the Kenya Meteorological Department.

5.7 Kenya Meteorological Department (KMD)

The KMD maintains a large network of rain gauge stations throughout the country and issues weekly rainfall bulletins and advance warning of impending drought and floods to the agencies concerned. They provide meteorological and climatologic services to agriculture, forestry, water resources management, civil aviation, and private sector including industry, shipping in the western Indian Ocean, military aviation etc and cyclone warning. The Department also coordinates research in meteorology and climatology and co-operates with various authorities in applied research.

5.8 Drought Monitoring Centre – Nairobi (DMC-N)

This is a regional organization, which monitors the drought situation in all the countries in the Horn of Africa, in association with respective meteorological departments. The operational activities of the centre are development of regional and national quality controlled databanks, development of basic climatological statistics, timely acquisition of near real-time remotely sensed data, and capacity building in climate monitoring, modeling and prediction services.

5.8 Non-Governmental and Community Organisations

As per the report on Actors in Water Sector there are about 300 Non-governmental and Community Organizations in the country which deal directly or indirectly with various aspects of water resources development and management.

6.0 Mainstream Flood and Drought Management

There is need to establish dedicated units to deal with the problems of drought and floods as at present there are no institutions specifically mandated to deal with these problems at National level.

6.1 Hydrological Observations and Data Analysis

Though river gauging stations have been set-up on various rivers and their tributaries, data is collected and analyzed only occasionally for planning and design of specific projects. There is no standing arrangement for a comprehensive review of water availability from time to time. In view of the growing apprehensions about the adverse consequences of likely climatic changes in the East African region it is necessary that such a review is made mandatory for the Water Resources Department.

6.2 Monitoring the flood situation

The district units of MWRMD are responsible for monitoring the flood situation. The procedure for monitoring is ad hoc and there is no field staff dedicated for the purpose. There is no established flood forecasting system on any of the flood prone rivers though there is some functioning river gauging stations under the Ministry.

The Kenya Meteorological Department (KMD) issues weather forecasts and early warning to the Disaster Operations Centre in the Office of the President who after making an assessment of the magnitude of the impending flood and its disaster potential, inform the Provincial Disaster Committees concerned under the Chairmanship of the Provincial Commissioners (PCs) for rescue and relief operations through their multidisciplinary teams at the district and community level.

The role of the Disaster Operations Centre is basically that of coordination of disaster related activities of various line Ministries up to district levels. The role of the MWRMD is mainly in relief operations by providing drinking water for the evacuated people. There is therefore need for the Ministry to play a pro-active role in flood forecasting and warning in active collaboration with KMD.

6.3 Maintenance of Flood Protection Works

The MWRMD has constructed a number of flood protection works like dykes, drainage channels, river conservancy works etc; and though the Ministry owns these assets, there is no mechanism for their routine repairs and maintenance. The field units, therefore, need to be suitably strengthened and made accountable for proper maintenance of assets under their charge. Procedures, standards and codes need to be laid down for periodical inspection especially before the onset of rainy season in association with the local community organisations. In order to ensure long term sustainability of these assets legislative and administrative measures would be required to gradually transfer their ownership to the community organisations.

6.4 Flood Damage Assessment

The department of Resource Survey and Remote Sensing, local development authorities and various line Ministries do assessment of flood damage. Compilation is done by MWRMD. However, assessment is made only occasionally and is mostly qualitative. There are no set procedures or norms for assessment of monetary value of damages under different categories. There is often considerable time lag between occurrence of damaging floods and assessment/compilation of damage data. There is therefore, need for appropriate institutional strengthening at various levels together with apportionment of mandates and responsibilities; and allocation of resources.

LIST OF REFERENCES

1 Global Water Partnership, 2000, "Integrated Water Resources Management", TAC Background Paper No. 4.

2 World Meteorological Organisation, 2003, "Integrated Flood Management Concept Paper", Associated Programme on Flood Management.

3 Government of Kenya, 1992, "National Water Master Plan-1992", Prepared by Japan International Cooperation Agency.

4 Grundy, Frank, 1963 "Rainfall and River discharge in Kenya during the floods of 1961-1962" Report to the Government of Kenya, Nairobi, Kenya. 34p.

5 UNEP, 2004, "Coping With Floods in Kenya: Vulnerability, Impacts and Adaptation Options for the Flood Prone Areas of Western Kenya".

6 Government of Kenya, "Human Settlement in Kenya", Prepared by the Physical Planning Department of the Ministry of Lands and Settlement.

7 Government of Kenya, 2002, "Country Strategy on Integrated Water Resources Management", Ministry of Water Resources Management and Development.

8 Government of Kenya, District development plans (2002-2008) for 27 districts. Various Ministries

9 WMO and UNEP, 2001, "Coping with Impacts of Climate Variability and Climate Change in Water Management", Intergovernmental Panel on Climate Change.

10 Government of Kenya, 2003, "Flood Control on Nyando, Nzoia and Tana Rivers-Pre Investment Study", Ministry of Planning and National Development.

11 Government of Kenya, 1986, "Agriculture Act-Chapter 318", Ministry of Agriculture.

12 Government of Kenya, 1999, "The Environmental Management and Coordination Act", Ministry of Environment, Forests and Wild Life.

13 WMO, 1992, "International Conference on Water and the Environment: Development Issues for the 21st Century".

14 WWC, 2000, " Ministerial Declaration of the Hague on Waters Security in the 21st Century", The Hague, Netherlands.

15 Government of Kenya, 2002, "The Water Act", Ministry of Water Resources Management and Development.

16 Government of Kenya, 1992, "The Forest Act, Chapter 385", Ministry of Environment, Forests and Wild Life.

FURTHER REFERENCES

AWTF, 2002, "Water and Sustainable Development in Africa: An African Position Paper", published by IWMI.

Dartmouth Flood Observatory, 2002, "Large Floods on the Kenyan Side of Lake Victoria" Dartmouth College.

Dialogue on Water and Climate, 2003, "Climate Changes the Water Rules: How Water Managers can cope with Today's Climate Variability and Tomorrow's Climate Change".

Global Water Partnership, 1999, "The Dublin Principles for Water as Reflected in a Comparative Assessment of Institutional and Legal Arrangements for Integrated Water Resources Management", TAC Background Paper No 3.

Global Water Partnership, 2003, "Poverty Reduction and IWRM", TAC Background Paper No 8.

Government of Kenya, 2000, "Kenya gazette supplement-Acts 2000".

Government of Kenya, 1999, "Sessional Paper No.1 of 1999 on National Policy on Water Resources Management and Development".

Government of Kenya, 1999, "Schedule of duties for Ministry of Water Resources-January 1999".
Government of Kenya, 2003, "National Land Policy Formulation Process", Ministry of Lands and Settlements.

Government of Kenya, “District Development Plans (2002-2008) for 27 districts.

Government of Kenya, “Human Settlement in Kenya”, Ministry of Lands and Settlement.

Government of Kenya, 2003, “Economic Survey – 2003”.

WMO, 1996, “Rain and Floods in Our Cities: Gauging the Problem”, WMO TD No. 741.

Government of India, 1985, “Manual on Flood Forecasting”, Central Water Commission.

IUCN, 2003, “Change: Adaptation of Water Resources Management to Climate Change”.

IUCN, 2003, “Flow: The Essentials of Environment Flows”.

Mamdouh Shahin, 2002, “Hydrology and Water Resources of Africa”, Kluwer Academic Publishers.

UN, “Guidelines on Participatory Planning and Management for Flood Mitigation and Preparedness”, UN Water Series No.82.

UN-DESA, 2004, “Guidelines for Reducing Flood Losses”.

UN-ECA, 2000, “Trans-boundary River/Lake Basin Water Development in Africa: Prospects, Problems, and Achievements”.

World Bank, 2004, “Towards Water Secure Kenya”. Water Resources Sector Memorandum: Vol 1 of 1.

WMO, 1980, “Manual on Stream Gauging: Volume I Field Work”, WMO No. 519.

WMO, 1980, “Manual on Stream Gauging: Volume II Computation”, WMO No. 519.

WMO, 1994, “Guide to Hydrological Practices”, WMO No. 168.

WMO and UNESCO, 1997, “Water Resources Assessment: Handbook of Review of National Capabilities”.

WMO and ACMAD, 1998,”Climate Forecast in Africa”, WMO Technical Document No. 927.

WMO, 2001, “The Role and Operation of National Hydrological Services”, Technical Reports in Hydrology and Water Resources, WMO Technical Document No 1056.

WMO, 2001, “Exchange of Hydrological Data and Products”, Technical Reports in Hydrology and Water Resources, WMO Technical Document No 1097.

WMO, 2003, “Climate into the 21st Century”, Cambridge University Press.

WMO, 2003, “Manual on Sediment Management and Measurement”, Operational Hydrology Report, WMO No 948

WMO, 2004, “Guidance for Managers of Hydrological Services”, Under Printing

WMO, 2003, “Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology: Vol. II Hydrology”, WMO No. 258.

APFM
http://www.apfm.info

WMO
World Meteorological Organization
7*bis*, avenue de la Paix
P.O.Box 2300
CH 1211 Geneva 2 Switzerland
Tel: +41 (0) 22 730 81 11
Fax: +41 (0) 22 730 81 81
E-mail: wmo@wmo.int
http://www.wmo.int

MWRMD
Ministry of
Water Resources Management and Development
Maji House
Ngong Road
P.O.Box 30521 Nairobi
Telegrams: "Water", Nairobi
Tel: Nairobi 271 61 03
Fax: Nairobi 272 76 22