Nile Basin Capacity Building Network

2010

Integrated Flood and Drought Management for Sustainable Development in the Nile Basin

NBCBN-RE

Integrated Flood and Drought Management for Sustainable Development in the Nile Basin

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NBCBN - BACKGROUND

Project Title
Knowledge Networks for the Nile Basin
Using the innovative potential of Knowledge Networks and CoP's in strengthening human and institutional research capacity in the Nile region.
Implementing Leading Institute
UNESCO-IHE Institute for Water Education, Delft, The Netherlands (UNESCO-IHE)
Partner Institutes
Ten selected Universities and Ministries of Water Resources from Nile Basin Countries.
Project Secretariat Office
Hydraulics Research Institute – Cairo - Egypt
Beneficiaries
Water Sector Professionals and Institutions in the Nile Basin Countries

Short Description

The idea of establishing a Knowledge Network in the Nile region emerged after encouraging experiences with the first Regional Training Centre on River Engineering in Cairo since 1996. In January 2002 more than 50 representatives from all ten Nile basin countries signed the Cairo Declaration at the end of a kick-off workshop was held in Cairo. This declaration in which the main principles of the network were laid down marked the official start of the Nile Basin Capacity Building Network in River Engineering (NBCBN-RE) as an open network of national and regional capacity building institutions and professional sector organizations.
NBCBN is represented in the Nile basin countries through its nine nodes existing in Egypt, Sudan, Ethiopia, Tanzania, Uganda, Kenya, Rwanda, Burundi and D. R. Congo. The network includes six research clusters working on different research themes namely: Hydropower, Environmental Aspects, GIS and Modelling, River Morphology, flood Management, and River structures.
The remarkable contribution and impact of the network on both local and regional levels in the basin countries created the opportunity for the network to continue its mission for a second phase. The second phase was launched in Cairo in 2007 under the initiative of; Knowledge Networks for the Nile Basin. New capacity building activities including knowledge sharing and dissemination tools specialised training courses and new collaborative research activities were initiated. The different new research modalities adopted by the network in its second phase include; (i) regional cluster research, (ii) integrated research, (iii) local action research and (iv) Multidisciplinary research.
By involving professionals, knowledge institutes and sector organisations from all Nile Basin countries, the network succeeded to create a solid passage from potential conflict to co-operation potential and confidence building between riparian states. More than 500 water professionals representing different disciplines of the water sector and coming from various governmental and private sector institutions selected to join NBCBN to enhance and build their capacities in order to be linked to the available career opportunities. In the last ten years the network succeeded to have both regional and international recognition, and to be the most successful and sustainable capacity building provider in the Nile Basin.

FOREWORD

This report is one of the final outputs of the research activities under the second phase of the Nile Basin Capacity Building Network (NBCBN). The network was established with a main objective to build and strengthen the capacities of the Nile basin water professionals in the field of River Engineering. The first phase was officially launched in 2002. After this launch the network has become one of the most active groupings in generating and disseminating water related knowledge within the Nile region. At the moment it involves more than 500 water professionals who have teamed up in nine national networks (In-country network nodes) under the theme of "Knowledge Networks for the Nile Basin". The main platform for capacity building adopted by NBCBN is "Collaborative Research" on both regional and local levels. The main aim of collaborative research is to strengthen the individual research capabilities of water professionals through collaboration at cluster/group level on a well-defined specialized research theme within the field of River and Hydraulic Engineering.

This research project was developed under the "Integrated Research Modality". The main objective of research modality is to demonstrate the effectiveness of the network in implementing more integrated applied research that tackles real life problems in the field of river and hydraulic engineering by joining and integrating the experiences of researchers from three or more research clusters.

This report is considered a joint achievement through collaboration and sincere commitment of all the research teams involved with participation of water professionals from all the Nile Basin countries, the Research Coordinators and the Scientific Advisors. Consequently the NBCBN Network Secretariat and Management Team would like to thank all members who contributed to the implementation of these research projects and the development of these valuable outputs.

Special thanks are due to UNESCO-IHE Project Team and NBCBN-Secretariat office staff for their contribution and effort done in the follow up and development of the different research projects activities.

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Integrated Flood and Drought Management for Sustainable Development in the Nile Basin

Part One

"The case of Nzoia River Basin"

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ABBREVIATIONS & ACRONYMS

APFM	Programme on Flood Management
CFDMC	Community Flood and Drought Management Committee
CFMC	Community Flood Management Committee
GWP	Global Water Partnership
IFM	Integrated Flood Management
IWRM	Integrated Water Resource Management
KMD	Kenya Meteorology Department
LVNWRMA	Lake Victoria North Water Resources Management Authority
NGOs.	Non governmental Organisations
NOAA	National Oceanic & Atmospheric Administration
NWS	National Weather Service
PLA	Public Learning and Action
UN	United Nations
UNICEF	United Nations Children's Fund
UN-OCHA,	United Nations Office for Humanitarian Assistance
USAID	United States Aid
WKCDD&FMP	Western Kenya Community Driven Development and Flood Management Program
WMO	World Meteorological Organisations

1. INTRODUCTION

1.1. Background

One of the biggest impacts of floods and droughts on the poor is on their livelihoods. Drought and Flooding affects economic and social infrastructure, industrial activities and other business activities. If equipped with an organizational structure and improved capability (through proper training), individually and collectively, the local people can manage floods better, with damages and losses substantially reduced even during major floods. Collectively, within the framework of a local organization titled Community Flood and drought Management Committee (CFDMC), the local people not only can mobilize efforts within the flood-affected areas to effectively liaise with and secure assistance from different possible outside sources in a coordinated manner.

The approach is useful in improving the flood and drought management capacity of the communities concerned and reduces their vulnerability. A protocol based on the experiences in other countries is to be outlined. It should, however, be mentioned that the protocol provides some generalizations. Specific conditions may require specific measures. The protocol highlights a set of key common responses, which provide a broad framework, with reference to which specific measures for particular situations would need to be worked out taking into account the particular situational contexts.

1.2. The Problem

Planning for risk reduction in integrated flood and drought management requires a clear understanding and awareness of the existing and possible future flood risks. Unless the population is aware of the risks it faces, local energies cannot be mobilised to build resilience. Being aware of risks is an essential requirement for undertaking precautionary actions. As such, understanding of risks should be viewed as the first essential step in the development of an action plans. For effective community participation in the integrated flood management processes, including emergency preparedness plans, it is essential that they are made aware of the flood risks and the factors that determine them.

Perception of risks due to flooding and drought among communities and within a community differs considerably. The new settlers/migrants or refugees in a flood plain or a drought area may not be aware of the causes, frequency and likely magnitude of flooding or drought in a given area and are vulnerable due to lack of knowledge. The population in areas subject to flooding due to infrequent floods or flash floods with a return period of more than a lifetime lacks such knowledge. The demographic composition of the population, e.g., the presence of old citizens who might have experienced the highest flooding in the region also reflects on how the community perceives these risks. Perception about risks and corresponding responses within a community can also vary according to their relative education level, economic standards and political clout.

1.3. Objectives

The objective of the project was to find out how people cope with floods and droughts, what are the risks involved, how can they carry on with their lives forward after the events, and to device ways of organising themselves and improving their capacity to do the things more effectively and to identify additional critical tasks that they may undertake to improve their flood and drought management capacity and preparedness.

1.4. Methodology

Flood and drought management activities were proposed in three broad categories:

i. advance preparation
ii. real-time responses and
iii. post-flood and drought rehabilitation.

Preparation relates to such activities as are conceived for execution during a flood and where preparations are made in advance. The purpose is to reduce flood-related vulnerability of households and communities. Real-time responses to reduce damages and losses as a flood is understood to be imminent and, then, as it sets in. As flood recedes, rehabilitation phase begins.

2. CATCHMENT OVERVIEW

2.1. Definition and Extent of the River Catchment

Nzoia catchment, which is approximately 12,950 km^2, lies entirely within Kenya along the border with Uganda. The basin drains the southern and eastern slopes of Mt. Elgon and the western slopes of the Cherangani Hills. The Nzoia basin in characterized by three physiographic regions: the highlands, characterized by Mount Elgon and the Cherangany Hills; the upper plateau which includes Eldoret and Kitale; and the lowlands including Busia which experiences the majority of the flooding that occurs in the basin. The dominant topography consists of rolling hills and lowlands in the Eldoret and Kitale plains.

2.2. Topography

River Nzoia is one of the largest rivers in Western Kenya. The main stream of the river flows from the western side of the Elgeyo Escarpment (Sergoi, Sosiani and Kipkelion tributaries) and the Cherangani Hills (Chepkotet and Kaisungur tributaries) from an elevation of approximately 2,286 metres above sea level. Its tributaries, which flow from the high slopes of Mount Elgon attain maximum elevation in the river's basin and is estimated at about 4,300m above mean sea level. The tributaries in Mt. Elgon include Kuywa, Sioso, Ewaso, Rongai and Koitobos.

2.3. 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 north-western parts, which gradually reduces in the south-eastern direction.

The north-western 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.

2.4. Land Use

It is apparent in Nzoia catchment that the areas under forest cover decreased markedly between 1970's and 1986 by 48.3%, especially for the regions in the northwest and south of the catchment. But the situation changed; between 1980's and 2000's where an increase in areas under forest covers was realized 41.3% (Table 2.1). The decrease could be attributed to the cutting of trees in the forests for various uses such as firewood, timber and clearing for agricultural purposes and increase in forest cover in the later dates could be due to government intervention through tree planting campaigns and increase in area under tea plantation where forest cover is used as wind breakers. In contrast, the areas under agricultural is seen to have decreased between 1970's, 1980's and 2000's by 22.4% and 4.6% respectively. This decrease could be linked to changes in weather patterns, effects of urbanization and population growth. The change matrix results reveal that there is gradual increase in area under bush land/ Shrub land/Riverine agriculture, for the years 1970's, 1986 and 2000's the percentage increase registered 123.4% and 11.1% respectively. This changed could be linked to invasion of river banks by small scale farmers due to continued failure of enough rainfall to sustain the rain fed agricultural practices especially in the middle and the lower parts of the catchment. The built up area also changed significantly due to rapid development of urban centers such as expansion of Kakamega, Eldoret and Kitale towns. The growth of the urban centres can be attributed to high rate of rural urban migration hence the decline in agriculture.

Table 2-1: Land use change in the Nzoia Catchment

Land use types	Area in (Km^2)			Area in (Km^2)		
	1973	1986	%Change	1986	2000	%Change
Forest	1,811.33	936.82	-48.3	936.82	1,402.30	49.7
Bush land/ Shrub land/ Riverine agriculture	2,221.38	4,963.18	123.4	4,963.18	5,514.92	11.1
Agriculture	8,433.85	6,542.35	- 22.4	6,542.35	5,460.88	- 16.5
Montane forest	113.36	173.38	53	173.38	166.39	- 4.0
Sugar Cane	53.8	55.26	2.7	55.26	55.17	- 0.2
Water	16.55	16.24		16.24	37.63	
Built up area		14.23		14.23	84.77	495.7

2.5. Hydrology

The stretch of the longest Nzoia River channel is about 355 km, with a mean discharge of 118 m^3/s. However, the flow regime of the Nzoia is varied and is occasionally as low as 20m^3/s and with extreme floods that may surpass 1,100m^3/s, which is the proposed protection level for the dykes for a 25 year, return flood. The discharge varies from a low flow of 2.8m^3/s to a 100-year flood flow of 930m^3/s (ItalConsult, 1980, 1982). 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. It is in this last 20 km that the river gathers strength as it flows downstream to an extent of bursting as it reaches the Budalangi areas. The floods depend on the intensities of rainfall in the upstream regions Elgon, Cherangany and the surrounding areas.

Figure 2.1 shows 22 rainfall stations within the Nzoia sub-catchment. It is evident from the figures that, even though the sub-basin has two distinct rainfall seasons, the April/May season has more rainfall than the September/November season. The rainfall is higher for the upstream stations, 8835035 and 8934060, than is the case with the downstream station, 8934002. The monthly mean rainfall for the three stations is 175, 150 and 50 respectively. For station 8935131, the rainfall is high, but not as much as the Northern part of the sub-basin. The two high-ground areas of Mt. Elgon and Cherengany Hills, where Nzoia River originates from, are known to have high rainfall amounts almost throughout the year. They receive average annual rainfall amounts of 1,500 - 1750mm while Budalangi area receives an average of about 1,100mm, but may at times get to as little as 800mm. The relatively low rainfall in the lower reaches of the catchment does not however justify the frequent occurrence of floods in this region. It is the high flows from the upper catchment which results to the floods when the river banks burst.

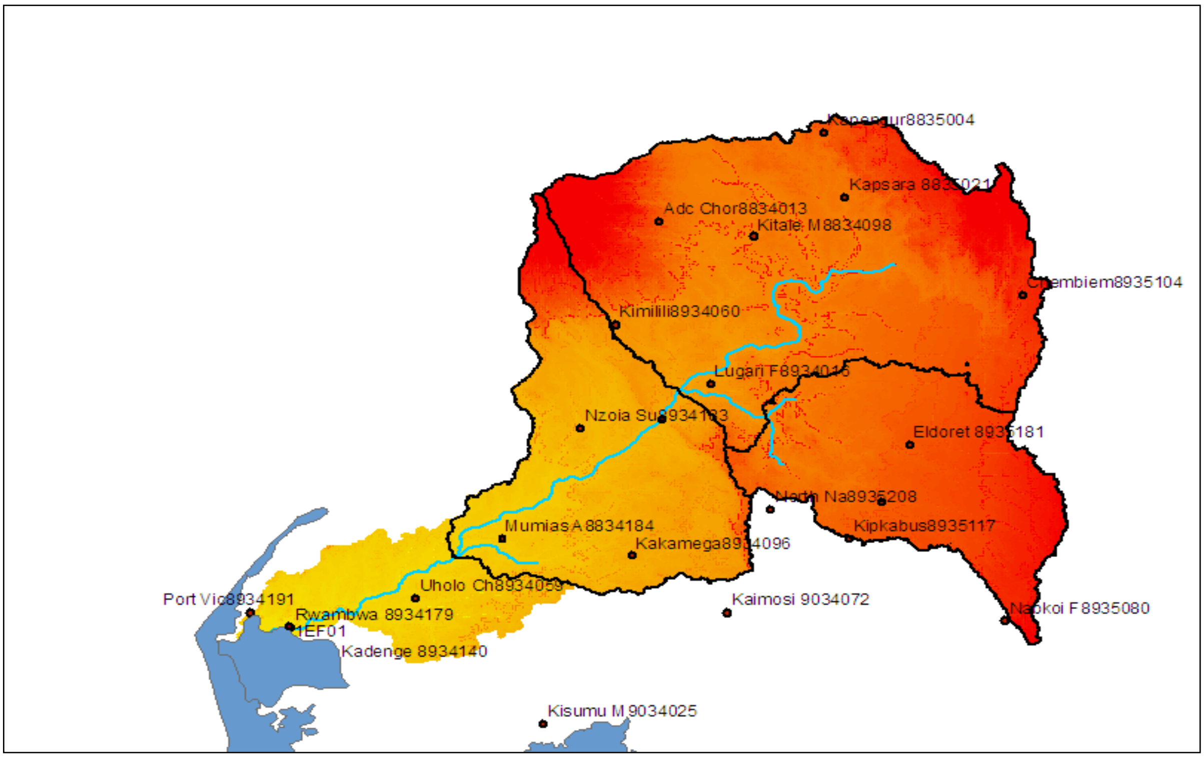

Figure 2-1: Nzoia River 30m DEM

Generally, most Kenya highlands are known to receive higher rainfall than the plains. This is the case with the Mt. Elgon and Cherangani Hills, where River Nzoia originates; hence the high flows accumulating to the plains to high levels that the river banks cannot contain. This results to increased incidences of floods in the lower Nzoia basin, the most severely affected region being the Bundalangi Division, which lies on the shores of Lake Victoria, partly on the mouth of Yala River but mainly on the mouth of River Nzoia.

Figure 2.2 show the location of two river gauging stations within Nzoia River basin. Flow remains relatively high from the months of May to September, with the peaks occurring in these two months. The flow is low for the station 1DA02, but accumulates to high values at station 1EE01D which is further downstream. The mean flow for the two stations is 950 and 2500m^3/s respectively. The constantly high rainfall throughout the year for the upstream region keeps flow high especially in the months of May to November. In the months of January to March, and June to September, the rainfall is quite low in the downstream basins. As a result, floods are rare in the basin during these periods. However, in the wet seasons, when rainfall is high for both the upstream and downstream basins, the Nzoia River channel becomes incapable of containing the high flows, hence the occasional flooding in the lower catchment.

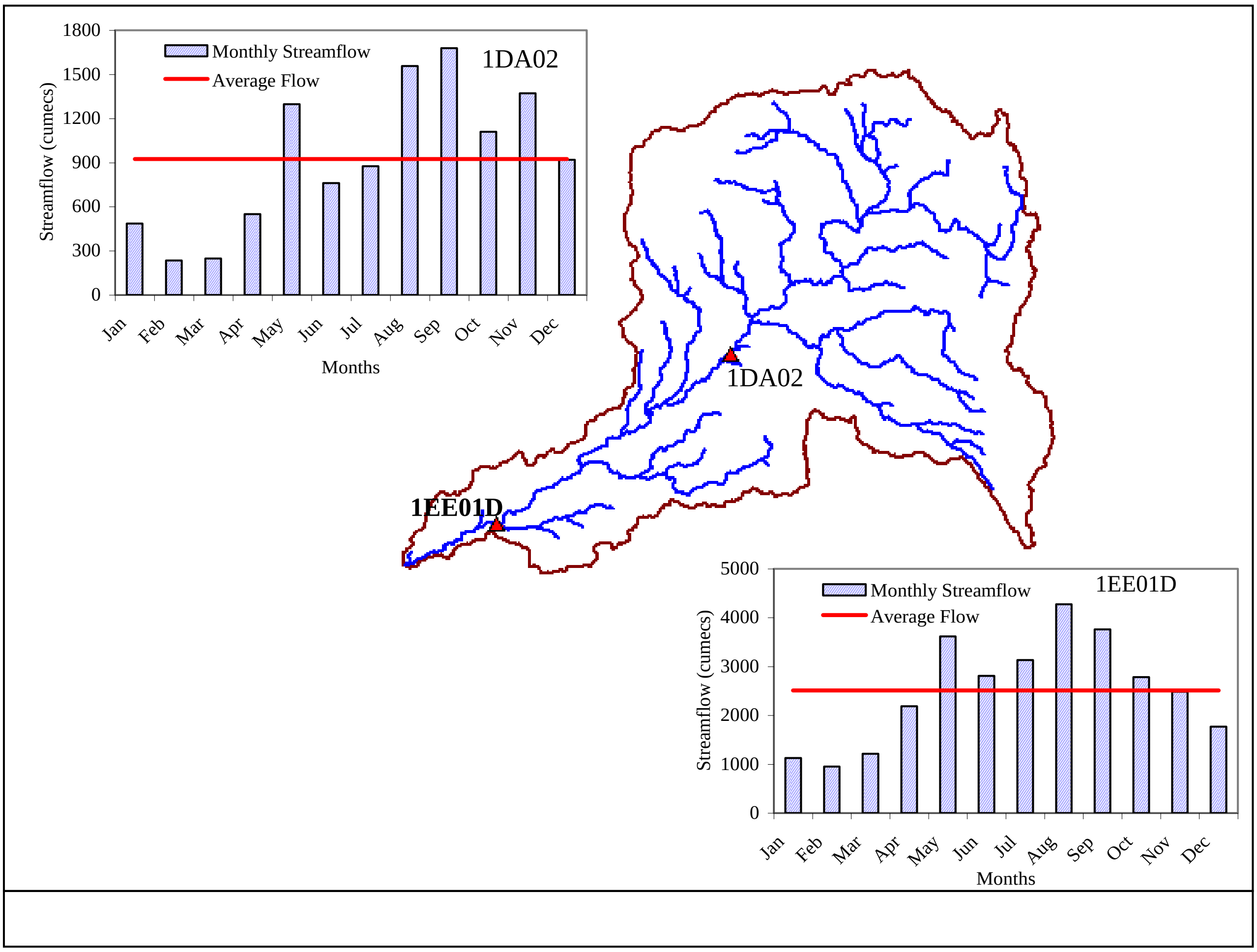

Figure 2-2: Proposed Gauging Network on Nzoia River

The change in rainfall seasons over the year makes the flow regime of the Nzoia catchment to vary and is occasionally as low as 20m^3/s. With extreme floods, the flow may surpass 1,100m^3/s, which is the proposed protection level for the dykes for a 25 year, return flood. Siltation is heavy especially at the plains, which reduce the height of the river banks, hence bank spill over (ItalConsult, 1980, 1982).

3. CURRENT RISKS AND MANAGEMENT

3.1. History of Flooding and Droughts

A considerable incentive for rethinking impact of floods and droughts as an integral part of the development process comes from the aim of achieving the goals laid out in the Millennium Declaration. The Declaration sets forth a road map for human development supported by 191 Nations. Eight Millennium Development Goals were agreed upon in 2000, which in turn have been broken down into 18 targets with 48 indicators for progress. Most goals are set for achievement by 2015. The MDGs contain cross-cutting themes in development and Floods and droughts fall in the disaster risk policy, each tied to specific targets and indicators for progress. They require international collaboration to be met. All signatory countries now claim to be working toward these goals and donors are providing sharply focused aid packages to support their endeavours.

The risk to development stemming from natural disaster, such as floods and droughts, is recognised in the Millennium Declaration in Section IV, entitled "Protecting Our Common Future". Within this section is stated the objective: "to intensify our collective efforts to reduce the number and effects of natural and man-made disasters"

The impact of floods in Africa, are extensive (USAID, 2003), causing both loss of human life and destruction of property. Serious damage to the road infrastructure, break out of waterborne diseases and food shortage follow in the affected areas. According to the early warning unit of the Kenyan Ministry of Agriculture, over 20 000 people were rendered homeless, over 10,000 hectares of crops were destroyed. They are the communities in perpetual poverty.

Most countries in the Nile Basin practice inappropriate sectoral approaches regarding planning and implementation of development projects, thereby unsustainably addressing the flooding and drought problems in the Region. Nile basin is thus experiencing inefficient resource use, duplication of efforts, stakeholder conflicts, destruction of infrastructure and ineffective flood and drought management. In Budalangi Division of Busia district, the floods combined with the spill over from the swollen River Nzoia displaced 11,450 people from 3,826 families *(Churchill Otieno, 1998).*

Government officials in Busia reported 2,633 people living as refugees in makeshift shelters in the district. About 3,011 homes in all the five locations in the division were listed as submerged in flood waters.

Climate change is challenging the task of providing sufficient water and food by exacerbating the element of uncertainty and surprise, with increased frequency of water-related events such as dry spells, droughts and floods. Conflicts between competing sectoral uses of water, and between land use and terrestrial ecosystems upstream and downstream aquatic ecosystems, are becoming more common and threaten both the internal and external security of many nations. The scenario looks bleak for Africa with projected shortfalls in agricultural production estimated at 50% due to the effects of expected climate change and variability by the year 2020. For wetter areas like the Nzoia and Kagera basins, this means more rainfall, increased variability that will impact negatively through increased floods and intra-seasonal droughts.

3.2. Extent of Flooding and Droughts

The foothill areas of Mount Elgon in Bungoma district were affected almost every year from the floods of small rivers like Bokoli and Myanga.

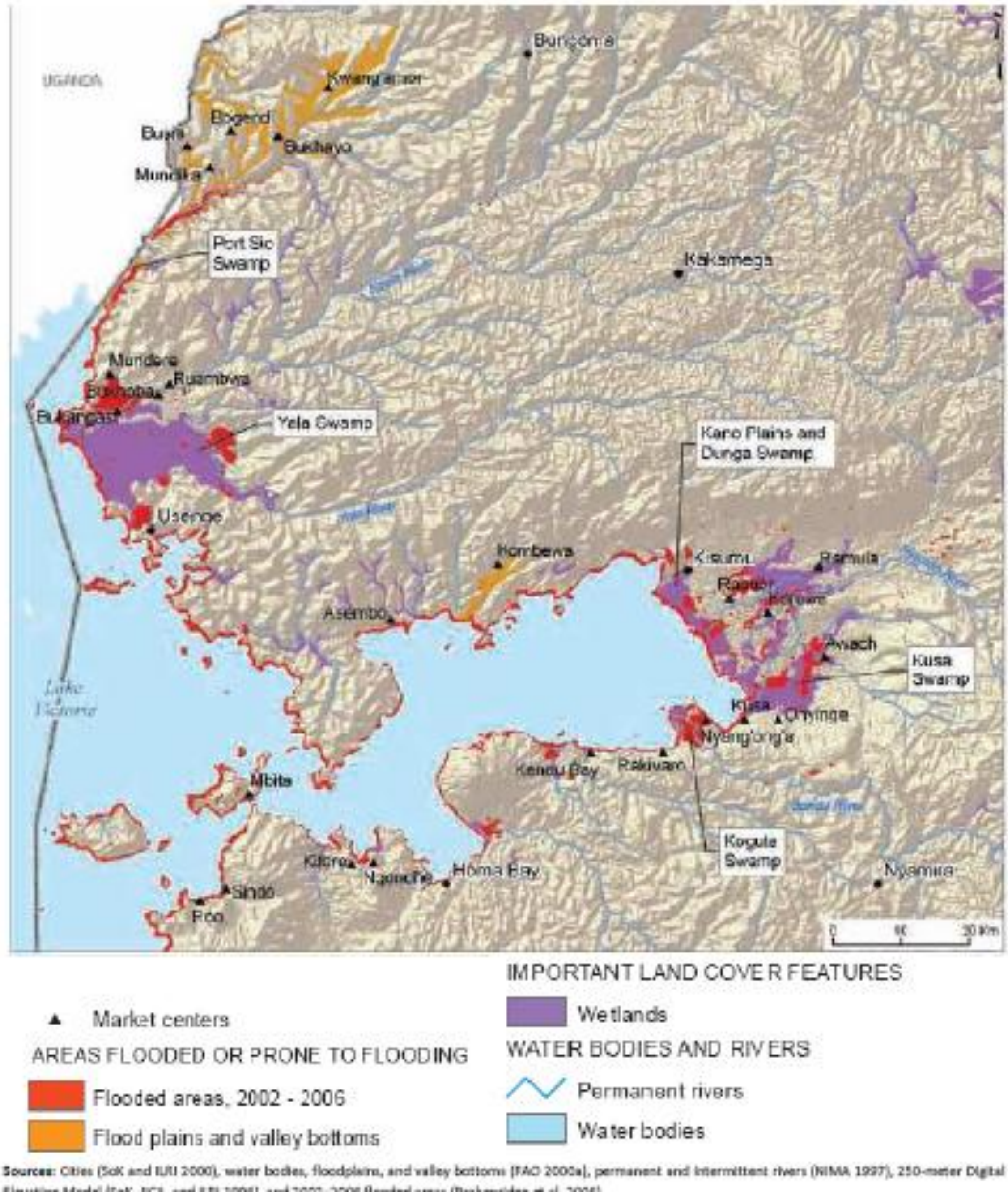

Figure 3-1: Flood Water in western Districts of Kenya

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 about0.5m 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.

4. DEVELOPING THE CATCHMENT'S FLOOD AND DROUGHT MANAGEMENT PROTOCOL

4.1. Introduction

Preparedness (Advance Preparation)

In order to begin the preparedness process, people need to understand that a flood is coming and how intense it might be in terms of areas that will be affected as well as the depth of inundation and the estimated duration of the flood event. People have been traditionally doing their own flood forecast by looking at the behaviour of the rainfall, water levels in rivers, or the behaviour of snakes, frogs, ducks and other animals. These methods are empirically weak but quite often effective in areas where no technically sound flood forecasting and warning activities are in place. But, even though such activities are in place in many places now, quite often flood-forecasting messages do not reach the affected population in time and in technical terms and language they understand. Therefore, they still have to combine their traditional knowledge with the information they receive from the bulletins aired by media, radio in particular, from time to time during flood seasons. Such bulletins are often in technical-speak and cannot be fully grasped by the ordinary rural people.

People often seek information from the chairmen or the members of the local elected bodies, local knowledgeable persons and officials but do not often receive satisfactory information. In the light of these circumstances a considerable degree of uncertainty remains. People are, therefore, constrained to rely more on empirical methods as indicated above. The conclusions have sometimes been right; but not so at other times regarding both timing and intensity of floods. Lack of timely and effective flood forecasting and warning, disseminated in local languages, remains a major problem.

Community action starts with the community mobilization to strengthen the organizational bases for local flood mitigation initiatives. In the past, most of the activities were carried out by people themselves during a flood and were based on individual initiatives. People were hastily organized, if at all, and that too primarily for the construction of physical facilities or often unplanned evacuation and rescue activities. If these activities are carried out in a community-based organized manner at community level, vulnerability and risks due to flood can be substantially reduced. For that to happen, community institutions are needed for collective action planning, implementation, monitoring and evaluation. Based on the pilot study carried out in the GBM basin described above, the basic institutional structure in the form of CFDMC has been identified to the essential building unit. Under the proposed community approach, the focus is community involvement in all phases including awareness raising, individual and community capacity building, planning, and implementation.

In the community approach, flood preparedness includes the following activities:

- Formation of a community level organization to manage floods, say Community Flood Management Committee (CFDMC)
- Assessment of various requirements to reduce flood vulnerability and to enhance capability of the community to reduce damages, losses, and sufferings of the people
- Training for capacity building at community and individual levels, as appropriate
- Planning for rescue and evacuation, flood proofing and flood moderation
- Organizing drills to facilitate effective evacuation
- Making provisions for addressing unforeseen eventualities
- Monitoring of the proceedings with respect to various activities undertaken and reporting

- Managing information for future reference
- Resource Mobilization

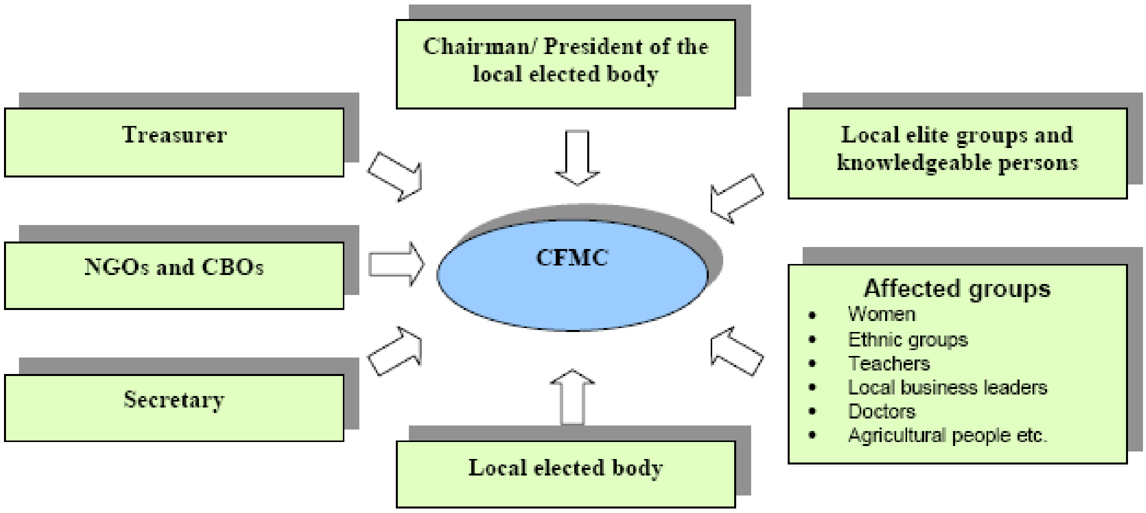

Figure 4-1: Catchment flood and drought management committee

Real-Time Responses (Pre-Flood Responses and During-Flood Responses)

Timely responses, as planned, should be implemented prior to, during, and after a flood event. People of flood-prone areas of the countries of the region have been responding to floods during all the three stages on their own, which may be considered household-level coping mechanisms against floods. Lack of organizational capacity and guidance has not allowed pooling of limited capabilities of the people, resulting in random outcomes. It is envisaged that these individual actions - if coordinated at the community level and if the community capacity is strengthened through such activities as awareness building, training, and networking - can generate an effective grassroot-based flood management approach. Key elements of this approach are outlined below.

Pre-Flood Responses

When the flood is imminent, the CFDMC may organize constant Flood Vigilance Task Activities (FVTA) to check on how an impending flood is developing (i.e. to assemble and review available information on flood record of indicators (for example, water level relating to landmarks, say, on electricity poles or old trees) observed, the corresponding warnings issued, the actual effect that took shape in terms of the extent of flooding and the mobilization of people and resources in response to the evolving situation. The data bank created thereby overtime can be a very useful background material in dealing with future floods.

According to the degree of severity of the forecasted flood, warning should be issued, giving the likely severity level in different parts of the area. Warning concerning different levels of severity should be given out that the residents could relate with actions that they are supposed to undertake in relevant parts of the area. The likely actions may include staying alert, keeping one's belongings and valuables at higher elevations, preparing for evacuation, evacuation as deemed necessary, and relocation to a safe refuge. The CFDMC may allocate specific responsibilities such as assemblage of information and issuance of warning to particular members responsible for FVTA. There are several modalities of issuing warning to choose from by showing flags (hoisting different colour-coded flags) on bamboo poles or hanging flags over tall trees at open spaces so that these can be seen from all sides of the area. During the phase of preparation and drill programmes, people should be informed of the significance of these flood signals, i.e. what colour of the flag means what is the likely extent of flooding and what actions are expected of them.

During-Flood Responses

In case of flooding, one may choose one of the following two options (a) enduring flood by staying inside the house or compound, or (b) leaving the house and taking shelter either in non-flooded areas or in nearby flood shelters, if available.

Enduring flood is indeed difficult. Many poor families tend to stay back in their marooned dwellings, often in raised platforms inside the dwelling or on rooftops to avoid moving out and risk the theft of their valuables. In doing so, they sometimes fall victim to snakebites, even drowning. Escaping flood waters and taking shelter elsewhere also depend on the availability of flood shelter or high places to move to, which are expected to be arranged by the CFDMC. In the context of the emerging circumstances, the CFDMC would need to work out procedural details regarding undertaking various tasks including the management of the proposed flood shelter (s). If a CFDMC is not in place, one may be quickly established; and if that is not feasible at the present, individuals will have to use their best judgment about what to do and how. But, it would be advisable to coordinate activities with neighbours and others as much as possible.

Recovery and Rehabilitation (Post-Flood rehabilitation)

Flood affected people are keen to get back to normal life. After suffering losses in terms of crops, livestock, and property, they often find themselves in extremely difficult situations and cannot rehabilitate themselves without assistance from the government, rich benefactors, or NGOs/CBOs. Sometimes, neighbours help one another towards getting back to 'normal life'. Interpersonal relationship and kinship also play vital roles in helping some flood affected people to find their feet again. Community effort can be useful in repairing partially damaged houses, often by means of collective free labour supporting one another. Well-to-do people sometimes employ poor neighbours in restoration activities, thereby offering temporary employment. In the case of large scale flood devastation, government's role in relief and rehabilitation becomes crucial. Once the evacuees have left, the CFDMC should arrange the cleaning up of the vacated flood shelters/camps to make them usable for their usual purposes.

4.2. Opportunities and Constraints

The success of the Community Approach to Flood Management lies in the political will demonstrated to implement the approach nationwide and also in other countries in the region that were not covered by the project. Sustainability of the project depends largely on the ability of governments to further provide minimum seed funding and to support a larger number of communities. There have been no major obstacles in the implementation of the project in the three countries. The single most important lesson learnt is that the approach can be adapted to a wide variety of environmental and socio-economic settings and replicated in a large number of communities. The linkage between community-based approaches and a close uplink to national activities related to flood management and disaster reduction is important to ensure the sustainability.

4.3. CFDMP Objectives

The key objective of a CFDMP is to develop complementary policies for long-term management of flood risk within the catchment that take into account the likely impacts of changes in climate, the effects of land use and land management, deliver multiple benefits and contribute towards sustainable development.

In addition to the key objective are the following overarching objectives:

- To undertake a high-level strategic assessment of current and future flood risk from all sources (i.e. rivers, sewers, groundwater etc) within the catchment, by understanding the components that constitute the risk (i.e. both probability and impact) and the effect of current risk reduction measures. The scale of risk should be broadly quantified in economic, social and environmental terms;
- To identify opportunities and constraints within the catchment for reducing flood risk through strategic changes or responses, such as changes in land use, land management practices and/or the flood defence infrastructure;
- To identify opportunities during flood risk management to maintain, restore or enhance the total stock of natural and historic assets (including biodiversity);

- To identify the relative priorities for strategic studies, actions or projects to be undertaken to manage flood risk within the catchment, and assign responsibility to the Agency, other operating authorities, local authorities, water companies or other key stakeholders.

4.4. Early Warning System for Nzoia Basin

The Nzoia catchment has human settlement spread from the upper catchment, Cherangani; the middle catchment; the lower catchment, .The proposed early warning system must thus be a Community Based Early Warning System as presented in figure 4.2. The main components consist of a

1. Forecasting Center having access to both Meteorological data (KMD) and Hydrological data (WRMA). The functions of the forecast centre will be for;
   - Daily production and dissemination of Flood and drought early warning.
   - Dissemination of the information must be done through the community radio, direct information to community members, District Commissioners and stakeholders.
   - The forecast centre utilizes data collected through a designed network, meeting the WMO density recommendations. Where possible the installation of automatic hydromet and water level equipment is recommended.

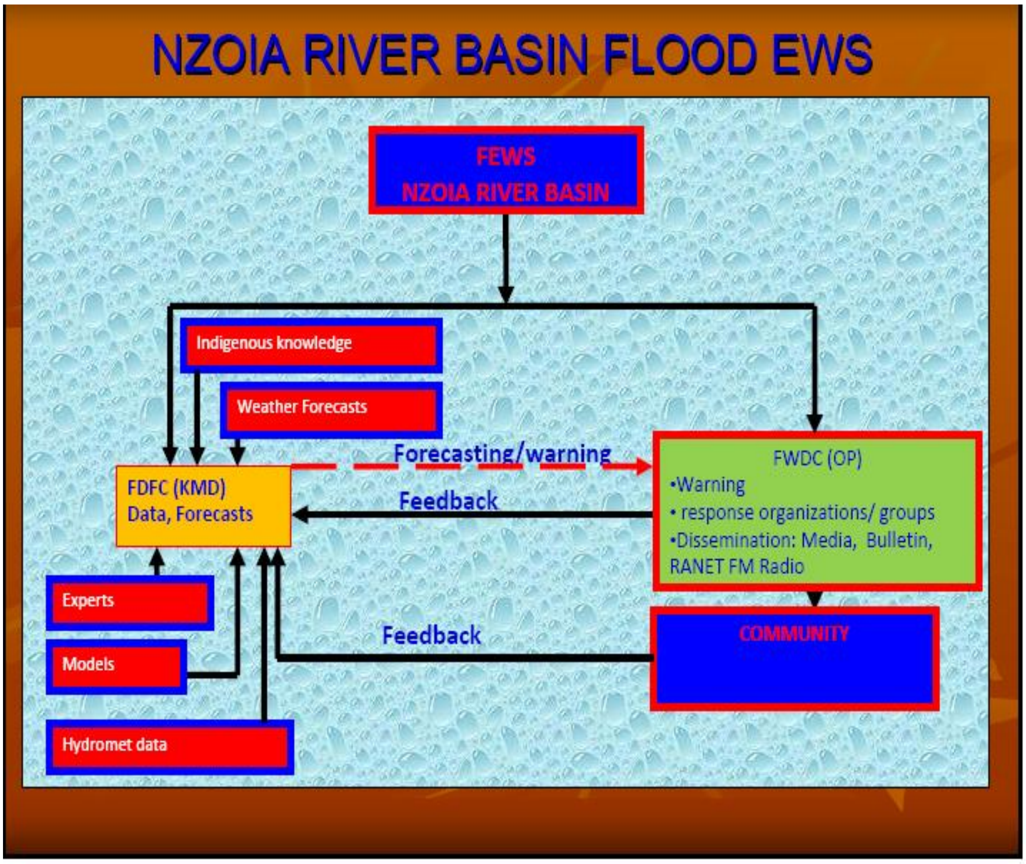

Figure 4-2: Early Warning System Components for Nzoia

2. Dissemination System – Established communication with community members where bulletins are sent on a time interval agreed. This interval (weekly to daily) varying with severity and season of the events. The project has been building its list of stakeholders receiving our bulletin information. The project is currently using some channels to reach the stakeholders, and still designing and developing more especially how to package the warnings to the affected community. Currently the project is using the following;
   - The KMD community radio installed in Budalangi
   - Emailing system to all stakeholders
   - Displaying on the World Wide Web

- Direct emailing to the Bunyala DC Office
- Direct emailing to Lake Victoria North Water Resources Management Authority (LVNWRMA).

3. The project administered a questionnaire on the effectiveness of the bulletins, and of the issues that came up from the study is the packaging of the warning for the community. This will has been made possible with the operation of the community weather radio and more community friendly warning dissemination methods are being put in place.
4. Collaborative platform – The met and flow information provided through internet to district and location levels.

Emergency Response

Through the Western Kenya Community Driven Development and Flood Management Program a forum to address flood issues has been initiated. The forum includes UN Agencies, NGOs and other Government ministries. Contingency plan for the short rains March – June was developed. The main challenge was the lack of funds allocation for this item.

Evacuation Centers

The during flood component evacuation centers have been proposed;

- Once Operational, will be coordination center
- During off flood season, the center will be used as resource centre, host workshops, seminars, training centre etc.
- Their designs and drawings are being developed,
- They have been proposed to be constructed in phases
- WKCDD&FMP will only contribute towards the final designs and the BoQs. The complete documents will then be presented for cofounding by stakeholder partners.

4.5. The Support Network for Nzoia

Weather data from 20 stations, 15 run by the project community monitors and 5 by the KMD and river level data from three gauging stations run by Ministry of water report data on a daily basis to the Flood forecasting centre. To produce the warnings, additional evaporation data and rainfall forecast are provided by the KMD.

Data collection is done between 8.30 am to 9.30 am. For the daily flood watch bulletin once the data is received, it's processed and modeling system set up in the centre used to produce warning forecasts. The warnings are packaged in bulletin and sent to stakeholders. The monthly bulletin is produced at the end of every month and gives an overall situation of the flood situation, their impacts and possible forecast for the coming month. With the envisaged upgrades, the contents and the lead time for the bulletins will greatly be improved.

The annex in this report shows a typical product from the Flood Diagnostics and Forecasting Centre (FDFC) at the Kenya Meteorological Department in Nairobi.

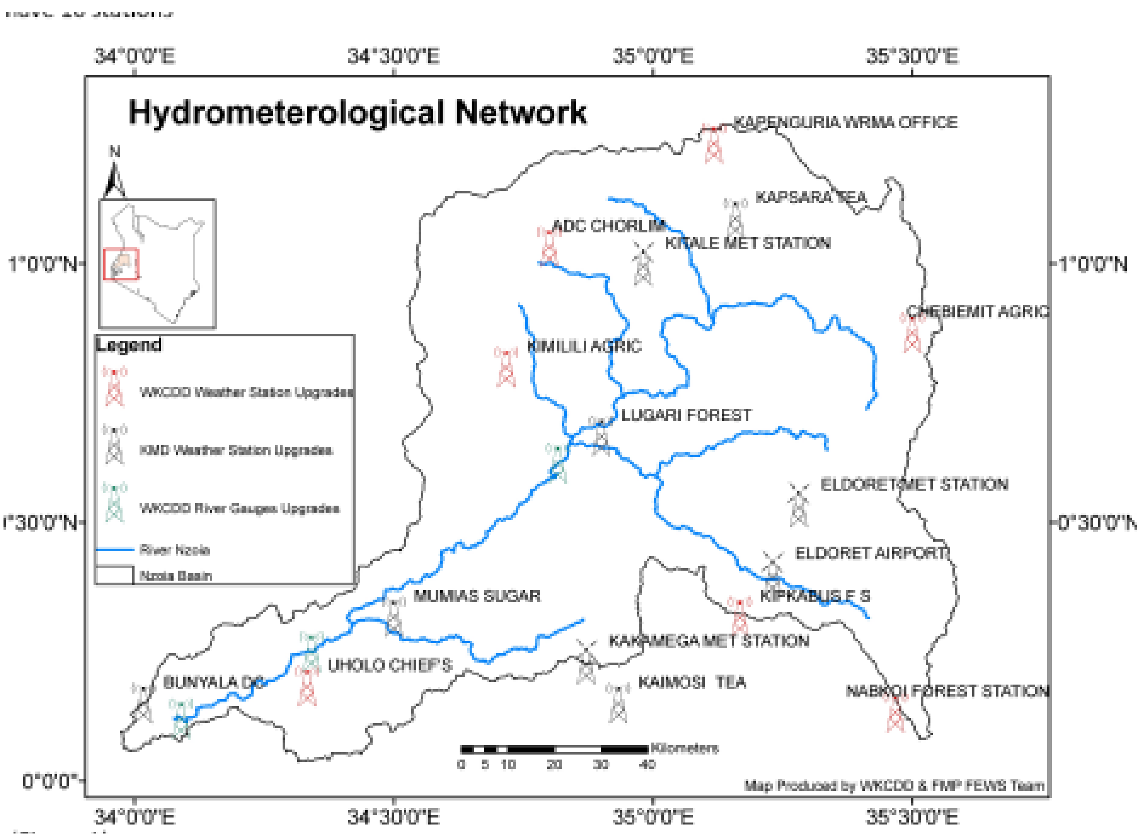

Figure 4- 3: Hydro-meteorological network

4.6. Initiative for Flood Response

The project was not allocated funds for the disaster response as such the Project has developed initiatives that make assistance available to the displaced persons during flooding. The Project has formed a stakeholder's forum for Budalang'i that has brought together UN Agencies (UN-OCHA, UNICEF, and World Food Programme) International and local NGOs. Through this forum, the first contingency plan for Budalang'i was developed for the long rains-March- April, 2009, with different organizations pledging and prepositioning resources for any eventuality. The meetings are normally held monthly.

Figure 4-4: Aerial view of the lower reach of River Nzoia

4.7. Way Forward

The likelihood of flooding and water shortages increases with development and population growth. As more land is developed, open expanses of wetlands are lost. Wetlands are needed in the catchment to hold excess water so it can recharge groundwater. Rainfall accumulates much more quickly on lands paved with roads and covered by homes and shopping centers.

A growing population increases the demand on our shared water resources. Demand is highest during the dry months. Even though demand can ebb and flow, overall water supplies don't change much.

We need to carefully plan for both drought and flood, as do most other local and state governments charged with managing water. Part of that planning includes finding more places to safely store excess water, exploring new sources for drinking water supplies and protecting and restoring existing natural water resources. All efforts are to be inclusive and community based.

Why Community based

- Floods and droughts affect people and their infrastructure;
- Floods destroy infrastructure and halt communication and rural access;
- Traditional ways of handling food security become a nightmare as most people cannot afford modern preservation;
- To avoid losses occasioned by these disasters there is a need for the approaches and strategies in place to be adaptive and effective to local situation. Population pressure on land;
- Changing land use patterns and activities (charcoal burning, logging, overgrazing and land clearance for planting) consequential to environmental degradation;
- Poor policies blamed for corruption of contract awards resulting in poor management and workmanship on dykes rehabilitation; and
- Climate change impact on the weather pattern.

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ANNEX
Typical Product online from the FDFC in Nairobi

FLOOD DIAGNOSTICS AND FORECASTING CENTRE (FDFC)

KENYA METEOROLOGICAL DEPARTMENT

ORIGINATOR:
Flood Diagnostic and Forecasting Center, Nairobi

Date of Issue: 22nd July 2010
Validity: 22nd to 23rd July 2010

Summary

- **Light to moderate rainfall is expected over the basin during the next 24 hours.**
- **The stream flow forecast for the next 24 hours indicates that the average water level at Rwambwa is likely to rise to about 1.96m, which is below the flood alert level.**
- **Hence, there is NO RISK of flooding within the forecast period.**

Water levels at Rwambwa Bridge RGS

Date		Level (m)	Trend	Flood Risk Category
Today's Morning water level		1.86	Rising	
Forecast water levels	22nd July 2010	1.96	Rising	
	23rd July 2010	1.90	Falling	

KEY

High flood risk
Moderate flood risk
No flood risk

Flood Risk Indicators and forecast for the Nzoia River Basin

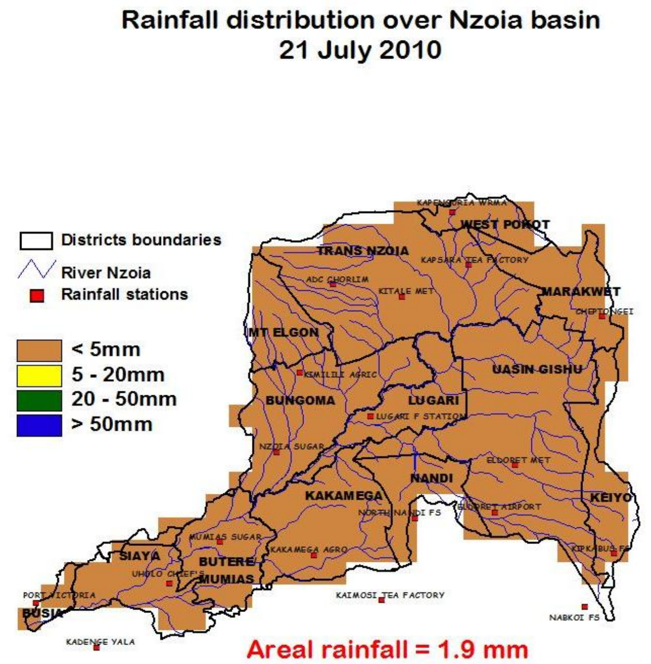
Section 1: Rainfall (mm) patterns and forecast

The figure to the right shows the rainfall patterns over Nzoia Basin on 21st July 2010. Light rainfall was received over parts of the basin. The areal rainfall reduced to 1.9mm from 11.1mm on the previous day.

Light to moderate rainfall is expected over the basin during the next 24 hours.

Classification of point rainfall on the grid map

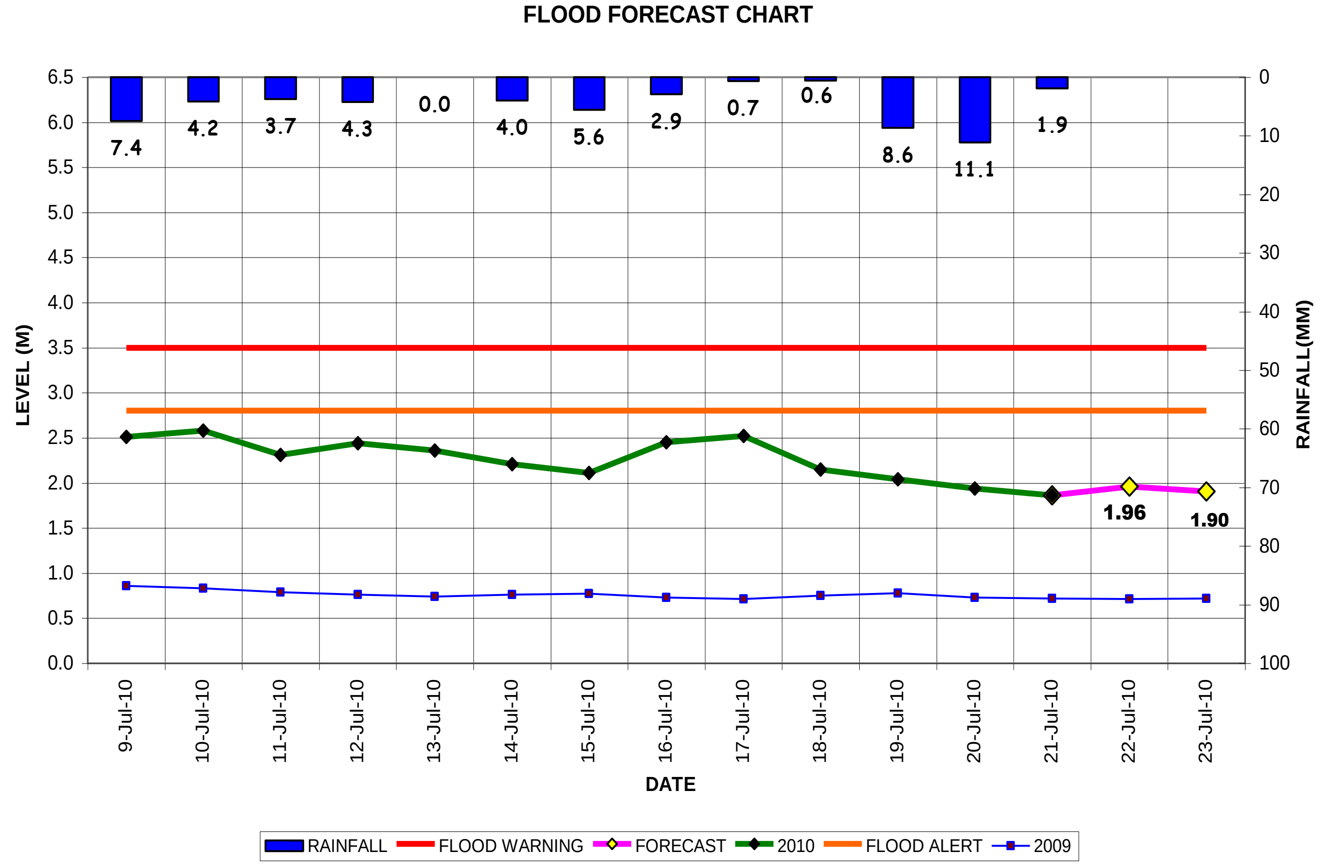
Range	Category
<5 mm	light
5 - 20mm	moderate
20 - 50 mm	heavy
>50mm	Very heavy



Section 2: Current and Forecast Water Levels at Rwambwa Bridge RGS

The plot of observed water levels is shown in green in the chart below while the blue inverted bars represent daily areal rainfall over the Nzoia Basin

- The estimated areal rainfall over the basin on 21st June 2010 was 1.9mm.
- The purple line in the plot shows the model forecast water level at Rwambwa river gauge station. It is anticipated that the river level at Rwambwa will rise to about 1.96m during the next 24hrs, which is below the alert level.
- **Therefore, No flooding** is expected within the forecast period.



Notes for readers

a) Classification of Areal Rainfall

Range	Category
<5 mm	light
5-10 mm	moderate
> 10 mm	heavy

b) Water levels

Description	*Range*	*Flood risk Colour codes*	*Remark*
Flood Warning level (m)	3.5 m		Above this point flooding can occur depending on strength of the dykes
Alert levels	2.8 -3.5 m		Watch
No risk	< 2.8 m		Safe

Disclaimers

- FDFC does not claim authority on any boundaries in the used maps.
- While extreme care is exercised in accuracy of the data collection, analysis and interpretation for production of this bulletin, users are requested to verify it before applying it.

Integrated Flood and Drought Management for Sustainable Development in the Nile Basin

<u>Part Two</u>

"The case of Kagera River Basin"

CONTENT

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Settling on flood plains has enormous advantages, as is evident from the very high densities of human settlement in, for example, the Netherlands and Bangladesh. Disaster mitigation by restricting the occupation of flood plains and wetlands limits the potential of these lands for socio-economic development. Integrate Flood Management (IFM) integrates land and water resources development in a river basin, within the context of Integrated Water Resources Management (IWRM), with a view to maximizing the efficient use of flood plains and minimizing loss to life. Thus, occasional flood losses can be accepted in favour of a long-term increase in the efficient use of flood plains.

Integrated Water Resources Management, which, as defined by the Global Water Partnership (GWP), is “a process which promotes the coordinated management and development of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems”, is based on the recognition that a single intervention has implications for the system as a whole. More positively, integrating management means multiple benefits may be achieved from a single intervention.

For flood management to be carried out within the context of IWRM, Nile river basins should be considered as integrated systems. Socio-economic activities, land-use patterns, hydro-morphological processes, etc., need to be recognized as constituent parts of these systems. A consistent approach needs to be applied to all forms of possible intervention. The entire hydrological cycle is considered rather than differentiating between Floods and droughts when planning water resources development.

The aim of IFM in the Nile basin is to put in place well-functioning integrated measures for flood management. For this, the linkages between various relevant sectors become very important. Thus, the most important key is the cooperation and co-ordination across institutional boundaries, noting that the mandates of many institutions will either cover only part of the river basin or extend well beyond the basin boundary. At the core of integration is effective communication across institutional and disciplinary boundaries, which can take place only if there is a perception of common interest. Emphasis will be on the adoption of flexible strategies tailored to each flood-prone region (characterized by their various physical, social, cultural and economic aspects) – recognizing the importance of evaluating differing options and their relative advantages and disadvantages.

ABBREVIATIONS & ACRONYMS

APFM	Programme on Flood Management.
CFDMC	Community Flood and Drought Management Committee
CFMC	Community Flood Management Committee
DEM	Digital Elevation Model
GIS	Geographical Information System
GOR	Government of Rwanda
GWP	Global Water Partnership
IDA	International Development Association
IFM	Integrated Flood Management
IWRM	Integrated Water Resource Management
MDPR	Ministry of Disaster Preparedness and Refugees.
MINELA	Ministry of Environment and Lands
MININFRA	Ministry of Infrastructures
MINITERE	Ministry of Lands, Environment, Forestry, Water and Mines
NBCBN-RE	Nile Basin Capacity Building Network for River Engineering
NELSAP	Natural Resources Management and Development.
NGOs.	Non governmental Organisations
NOAA	National Oceanic & Atmospheric Administration
NWS	National Weather Service
PLA	Public Learning and Action
REMA	Rwanda Environmental Management
UN	United Nations
UNICEF	United Nations
UN-OCHA,	United Nations Office for Humanitarian Assistance
USAID	United States Aid
USGS	United States Geological Society
WMO	World Meteorological Organisations

1
INTRODUCTION

1.1. Background

Floods are the most common and normally disrupt human activities in floodplains, causing both loss of human life and destruction of property. There is a history of flooding of rivers in Kenya, Rwanda, Tanzania and Uganda which are located in Nile Basins (NBCBN, 2005). There hardly passes a rainy season without flooding events in the floodplains of rivers such as Nzoia and Kagera. There is an urgent need to develop an integrated decision support system for flood and drought management in the Nzoia and Kagera Basins. Transboundary water resources pose particularly challenging management problems. When river basin boundaries do not match national political borders, conflicts and problems of management emerge (Ganoulis, *et al.*, 2005).

They are complex problems facing the republics confronted with unsustainable economic practices, floods and droughts, environmental degradation and serious problems in transboundary water resources management. Conflicts may take place between or within countries or between competing sectoral users. These pressures are most often related to human development and economic growth (IJGEI, 2008).

In response to the growing problems, the Nile Basin Capacity Building Network for River Engineering (NBCBN-RE) was officially launched in January 2002 in Cairo. This regional Knowledge Network is owned by the Nile basin countries and aims at building the capacity of Water Sector professionals and institutions in the Nile Basin through collaborative research, training and education. The Nile Basin Capacity Building Network for River Engineering (NBCBN) is now initiating the integrated research topics based on its six research themes. The integrated research modality is meant to increase emphasis on collaboration between the different research clusters and groups, with the main idea to make the research more applied.

In Rwanda, Kagera River is the longest Transboundary River with its 785 km long formed by 3 headstreams: Akanyaru and Nyabarongo in Rwanda and Ruvubu from Burundi. It rises in the Southern of Burundi near the northern tip of Lake Tanganyika and flows north, constituting the boundary between Tanzania in the East, and Uganda before empting into Lake Victoria, the source of Nile River (NELSAP, 2006). A large portion (67 %) of Rwanda land area is located in the Basin and drains 90 % of Rwanda national water resources towards Lake Victoria via the Kagera River (Bertilsson and Jägerskog, 2006). This makes the Kagera River from Rwanda the major source of the White Nile.

In Rwanda, a variety of climatic and non-climatic processes influence flood processes, resulting in river flood, flash floods, urban floods, glacial lake outburst floods, and coastal floods. Flood magnitude depends on precipitation intensity, volume, timing and phase. Antecedent conditions of rivers and the drainage basin (saturated or unsaturated soil) and status. A number of climatic parameter that are precipitation, wind storm surges, sea level rise, etc…

1.2. Research Problem

A considerable incentive for rethinking impact of floods and droughts as an integral part of the development process comes from the aim of achieving the goals laid out in the Millennium Declaration. The Declaration sets forth a road map for human development supported by 191 Nations. Eight Millennium Development Goals were agreed upon in 2000, which in turn have been broken down into 18 targets with 48 indicators for progress. Most goals are set for achievement by 2015. The MDGs contain cross-cutting themes in development and Floods and droughts fall in the disaster risk policy, each tied to specific targets and indicators for progress. They require international collaboration to be met. All signatory countries now claim to be working toward these goals and donors are providing sharply focused aid packages to support their endeavours.

The risk to development stemming from natural disaster, such as floods and droughts, is recognised in the Millennium Declaration in Section IV, entitled “Protecting Our Common Future”. Within this section is stated the objective: “to intensify our collective efforts to reduce the number and effects of natural and man-made disasters”.

The impact of floods in Africa, are extensive (USAID, 2003), causing both loss of human life and destruction of property. Serious damage to the road infrastructure, break out of waterborne diseases and food shortage follow in the affected areas.

Climate change is challenging the task of providing sufficient water and food by exacerbating the element of uncertainty and surprise, with increased frequency of water-related events such as dry spells, droughts and floods. Conflicts between competing sectoral uses of water, and between land use and terrestrial ecosystems upstream and downstream aquatic ecosystems, are becoming more common and threaten both the internal and external security of many nations. The scenario looks bleak for Africa with projected shortfalls in agricultural production estimated at 50% due to the effects of expected climate change and variability by the year 2020. For wetter areas like the Nzoia and Kagera basins, this means more rainfall, increased variability that will impact negatively through increased floods and intra-seasonal droughts.

1.3. Research Objectives

The main objective of the research is to focus on the development of an integrated decision support system for flood and drought management in the Kagera Basin.

Specific objectives are:

1. Develop a risk assessment methodology and management plans for hazard prone communities;
2. Develop and disseminate a community based flood and drought management and climate change preparedness protocol;
3. Suggest an implementation plan of sustainable integrated flood and drought mitigation and climate change preparedness measures for food security, water supply and sanitation development and environmental sustainability; and
4. Enhance and contribute to capacity building training and knowledge dissemination through seminars for policy makers, the general public, professionals and the riverine communities to uptake appropriate technological and management interventions for efficient and effective flood and drought management and climate change preparedness.

2
CATCHMENT OVERVIEW

The Kagera River is located east on the Lake Victoria basin and drains a basin area of 59,800 sq. km (Fig. 2.1) distributed among the countries of Burundi (22%), Rwanda (34%),Tanzania (34%) and Uganda (10%). The Kagera River catchment covers most of the surface area of Rwanda (80%) and a large share in Burundi (50%), which are the densely populated countries in the world with over 500 inhabitants per sq. km in the cultivable lands. The Kagera River drains from Burundi and Rwanda water towers, flowing into the Lake Victoria and is considered as a remote source of the Nile River. The river is formed by a confluence of the Ruvuvu and the Nyabarongo rivers, close to the northern-most point of Lake Tanganyika (Dumont, 2009), producing the largest single inflow into the lake, contributing approximately 6.4 billion cubic metres of water a year (about 28 per cent of the lake's outflow) (Rangeley, 1994). It forms parts of the Burundi– Tanzania, Rwanda–Tanzania, Burundi–Rwanda, and Tanzania–Uganda borders. Rusumo Falls are located on the river before the outfall into the lake and provide an important crossing point between Rwanda and Tanzania.

The catchment is important for human settlement, agriculture, livestock, reserved areas, forest land, wetlands, fishing and biodiversity. The Kagera River catchment can be divided into two topographical zones namely the West Rift Scarp and the Lake Victoria part. The Scarp zone encompasses the terrain on the eastern side of the volcanic West Rift in Burundi and Rwanda with elevation in the range 1500 - 4000 masl. These highlands fall away to the east into the swampy lowlands of the Nyabarongo, Ruvubu and Kagera valleys where the altitude is about 1300 masl (Prioul and Sirven, 1981). The Nyabarongo River as the main river of the West Rift Scarp zone flows over 300 km from its source in western Rwanda southwards to its outlet to Lake Rweru in south-eastern Rwanda along the border with Burundi. Its main tributary is Akanyaru River that flows from the highlands of Nyungwe National Park on the Congo-Nile divide in Ruhengeri province along the border between Rwanda and Burundi until the junction with Nyabarongo at about 50 km south of Kigali after its turn to the mainland in Rwanda (Nzeyimana, 2003).

From the confluence, Nyabarongo River flows eastwards through swampy valleys and small lakes in the lowlands of Bugesera-Gisaka in south-eastern Rwanda. From the Lake Rweru outlet, the Nyabarongo River changes its name to Akagera and meanders through a swampy terrain for about 60 km and joins the Ruvubu River flowing through the Tanzanian plateaus. The confluence of Akagera and Ruvubu rivers the river becomes Kagera River, which flows eastwards and at about two kilometres from the confluence, the river enters into the gorge of Rusumo Falls. At the waterfall, the river drops about 30 meters over a distance of less than one kilometre. Below the water fall, the valley widens and the Kagera River is enclosed by Papyrus swamps. At about 230 kilometres downstream to within a few kilometres upstream of the confluence with the Kagitumba River, the Kagera River flows northwards through lakes and swampy terrain of the Kagera National Park along the Rwanda-Tanzania border. Downstream the Kagitumba junction, which marks the border between Uganda and Tanzania, the Kagera River, changes its direction eastwards for 260 km to the Lake Victoria. The Lake Victoria part is the northerly litho logic environment around Bukoba that has summit levels in the range 1200 - 2600 masl with the high altitudes occurring in the south. Extensive swampy forests and grasslands with dense tall grasses and papyrus are important ecological components of the floodplain ecosystem of the Kagera River basin, which provides important water flow regulation and buffering functions.

Figure 2.1: The location map of the Kagera River catchment in the Lake Victoria basin (Source: http://biodiversityinformatics.amnh.org/)

3
HYDROLOGY OF THE BASIN

3.1. Meteorological Information

Climate data in Rwanda have been collected since the colonial times by Belgians, and in that time the country was a territory of the great Belgian Congo (Dushimire, 2007). The first meteorological station was established in the year 1907 at Save Station, Southern of Rwanda. A small number of other meteorological stations were then established in the thirties, on different locations all around the territory (fig. 3.1). In the year 1955 the Office of Meteorology was established in Rwanda, taking control of all meteorological stations. The total number of meteorological stations managed by this Office has once reached 195 by the past, but was reduced to 147 stations in 1990 (MINITERE, 2005). Many of these stations have been destroyed during the period of civil war and genocide between 1990-1994, majority of them in 1994.

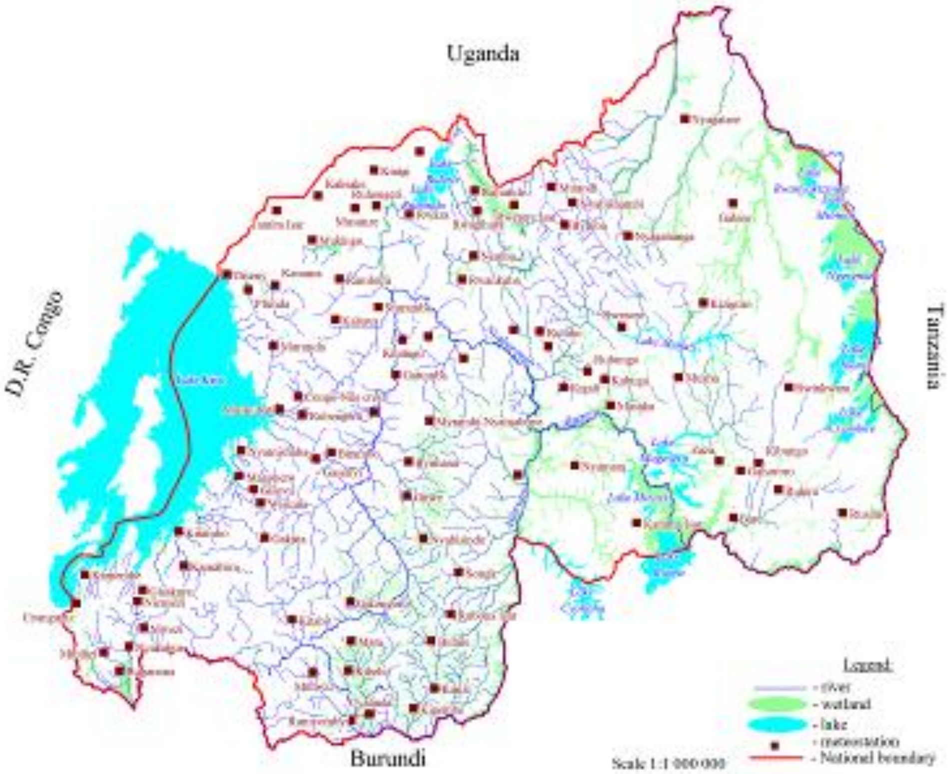


Figure 3.1: Spatial distributions of meteorological stations and location of main water resources in Rwanda (source: Mikova et al, 2010)

In the year 2004, a database was developed based on Microsoft Access in the Ministry of Lands, Environment, Forestry, Water and Mines (MINITERE) by SHER Ingenieurs-Conseils s.a., with the help of the International Development Association (IDA). The historical hydro-climatic data available in Rwanda are being compiled in this database.

This data base has been provided to Flood Management Cluster members during the 5th Regional Workshop held in Kenya. In this data base, data from 136 meteorological stations are available and can be used for this research analysis according to the location of Kagera River basin.

3.2. Hydrological Information

In the same database developed by SHER in 2004, thirty nine (39) gauging stations were identified around the country with daily water level and corresponding discharge (fig. 3.2). Data are available from 1961 up to 2000 (between 5 to 37 years data are available). In this research data from all gauging stations located in Kagera River basin will be used for analysis.

Figure 3.2: Rwanda hydrographic networks and distribution of hydrological stations

During the field research some photos showing where gauging stations are located in Kagera River transboundary were taken. An example of Rusumo gauging station is shown on figure 3.3.

Figure 3.3: Gauging station installed at Rusumo for water level measurement of Kagera River

According to Group 2 (Flood and catchment Management project), hydro-meteorological data for Kagera River basin are presented in figure 5.2. This figure has been presented by group 2 during 5th Regional workshop on flood management held in Kenya on 20-23 April 2009.

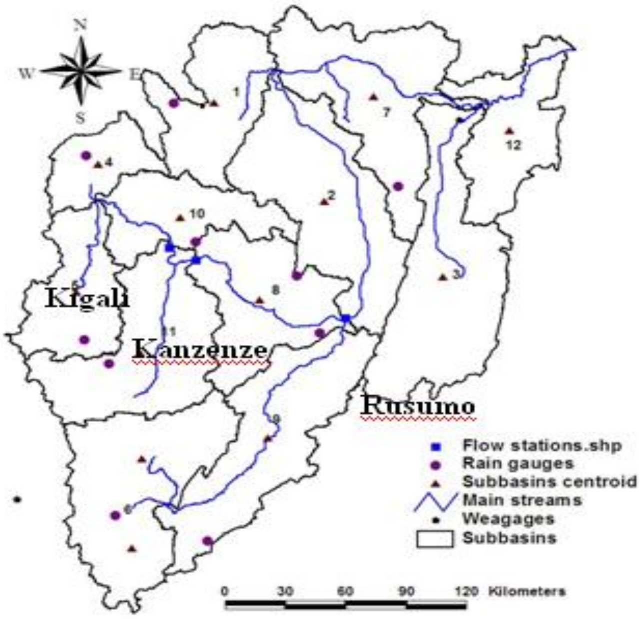


Figure 3.4: Flow and weather stations in Kagera River Basin

3.3. Land Use and Land Cover Data

In this research some categories of data, Digital Elevation Model (DEM) map or remote sensing data, are needed in order to have a clear picture of study areas. Topographic, land use and land cover maps are available and have been also presented by group 2 during the workshop on flood management held in Kenya on 20-23 April 2009 (see fig. 3.5).

The distribution of land use in Kagera River basin is given in table 1.

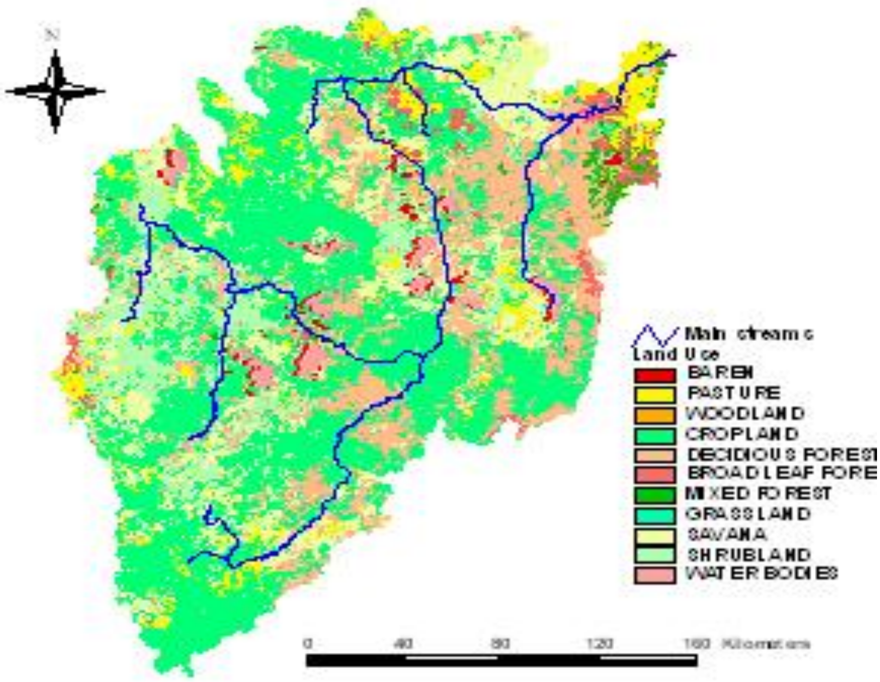


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Figure 3.5: Kagera River Basin Land use map

Table 1: Distribution of land use in Kagera River basin

Land use name	Code	Area (ha)	Percentage
Savanna	SAVA	843226.5	14.65
Cropland/Grassland Mosaic	CRGR	302.3	0.01
Shrubland	SHRB	545111.8	9.47
Baren or Sparsely Vegetated	BSVG	58935.17	1.02
Grassland	GRAS	7361.646	0.13
Deciduous Broadleaf Forest	FODB	1042175	18.11
Cropland/Woodland Mosaic	CRWO	2532743	40.02
Evergreen Broadleaf Forest	FOEB	135428	2.35
Dry land Cropland and Pasture	CRDY	414022	7.2
Water bodies	WATB	114762.4	1.99
Mixed Forest	FOMI	59968.16	1.04

3.4. Flood and Drought Definitions

Floods and droughts are extreme events in the hydrological cycle, which describes how water moves throughout the earth in different ways and at different rates (FAP, 2008). There are many pressures on water resources, including those arising from human activities. Additionally driving forces arise from the natural variability in water availability and climate change. Recent history has shown that extreme hydrological events as floods and droughts can create additional stress on water supplies essential for human and ecosystem health.

Floods:

A flood is an overflow of water, an expanse of water submerging land, a deluge (FAP, 2008). Flooding and its impacts are often influenced by a combination of natural factors and human interference. Floods are the most common natural disasters in Europe and, in terms of economic damage, the most costly ones.

Burton (2001) gives the following definitions about floods:
Flood is defined as a temporary inundation of normally dry land areas resulting from the overflowing of the natural or artificial confines of a river or other body of water.
Floodplain - any normally dry land area that is susceptible to being inundated by water from any natural source. This area is usually low land adjacent to a stream or lake.
Flood forecasting is defined as prediction of stage, discharge, time of occurrence, and duration of a flood, especially of peak discharge at a specified point on a stream, resulting from precipitation and/or snowmelt.
Flood damage - the economic loss caused by floods, including damage by inundation, erosion, and/or sediment deposition. Damages also include emergency costs and business or financial losses. Evaluation may be based on the cost of replacing, repairing, or rehabilitating; the comparative change in market or sales value; or the change in the income or production caused by flooding.

4
HISTORICAL FLOOD AND DROUGHT EVENTS

Most countries in the Nile Basin practice inappropriate sectoral approaches regarding planning and implementation of development projects, thereby unsustainably addressing the flooding and drought problems in the Region. Nile basin is thus experiencing inefficient resource use, duplication of efforts, stakeholder conflicts, destruction of infrastructure and ineffective flood and drought management. In Kenya, Budalangi Division of Busia District, the floods combined with the spill over from the swollen River Nzoia, displaced 11,450 people from 3,826 families (Churchill, 1998).

According to the early warning unit of the Kenyan Ministry of Agriculture, over 20 000 people were rendered homeless, over 10,000 hectares of crops were destroyed. They are the communities in perpetual poverty.

In Rwanda major flood events occurred during rain seasons like heavy rainy of April and May, and short rainy season of September to November, and other floods observed in dry seasons in Eastern Province in Kagera River basin . Compared to other East African countries, Rwanda is less affected by flood as reported in 2007 (http://www.hewsweb.org/floods/).

Recent floods were observed on 13 May 2010 in Northern part of Rwanda at Musanze District near Volcanoes areas and 2 people died. In this area also flood happened on 16 May 2010 and 4 people died, 40 houses destroyed, 150 ha of crops shifted away as reported by Governor of Western Province (Figure 4.1). According to local people report, the same flood happened in 1998. Other flood was observed on 16 May 2010 in North-Western at Rubavu district, Nyundo Sector where 7 people lost their life, 100 residents were destroyed and 87 ha of crops destroyed and many people displaced because of heavy rain. On 19 May 2010, the flood was also observed in Jenda Sector, Nyabihu District where many people displaced and crops removed.

In October 2009, floods occurred in Northern part of Rwanda in Musanze District resulting in households' displacement. In the night of 16 November 2009, the river Nyabugogo flooded resulting in maize crop destruction at Kiruhura side (Kigali City). In September 2008, the heavy rains and winds adversely affected 8 among 12 sectors of Rubavu District: Gisenyi, Rubavu, Nyamyumba, Nyundo, Cyanzarwe, Nyakiriba and Kanama (REMA, 2009).

In Rwanda also heavy rains occurred on 12 September 2007 in Nyabihu and Rubavu districts and led to floods and landslides which resulted in 15 deaths and caused extensive damage to houses and property, displacing 1,020 households (RWANDA, 2007). According to reports from the Rwandan Red Cross, 342 houses were completely destroyed and 678 were partially damaged. In addition, the water supply system has been interrupted, a situation which is likely to force people to look for alternative sources of water thus increasing the risk of use of contaminated water leading to the spread of waterborne diseases.

Figure 4.1: Crops destroyed by flash flood in 2009 and Crops flooded on 16th May 2010, in Northern Rwanda

Figure 4.2: Crops flooded and bridge destroyed on 7th Jan 2010, in Migina River which flows to Akanyaru River, Southern Rwanda

Degradation of environment and ecosystems is not only human-made in Rwanda but caused by climate disturbances. According to the National Adaptation Programs of Action to Climate Change (GOR, 2006b), serious floods linked to "El Niño" in 1997-1998 destroyed a large number of agricultural plantations and swamps of Nyabarongo and Akanyaru river basins. From 1999 to 2000, a prolonged drought seriously affected Bugesera, Umutara, and Mayaga regions (low land areas).

Due to the steep relief, western and northern regions are prone to landslides and flooding and consequently sensitive to erosion. In 2007, floods killed 15 people and left about 1,000 people homeless. In September 2008, a similar incident occurred and destroyed 1,982 houses and 106 schools. Heavy rains, floods, and frequent landslides affect the ecosystem negatively through water pollution, invasion of exotic aquatic species, and loss of soil fertility by leaching, increase of sediments on arable land and wetlands, and soil erosion. Negative effects of climate change in Rwanda are also driven by increases in temperature, prolonged droughts, and high evapotranspiration.

Rwanda has experienced low river flows and low water levels at Lake Kivu and the hydroelectrical stations at Ntaruka and Mukungwa. Drinking water levels in Kigali have also been affected due to the reduced intake flow of the Yanze River (USAID, 2008).

5
CURRENT FLOOD MANAGEMENT CAPABILITIES

A set of educational tools have been produced to raise the awareness of flooding and assist in the development of sustainable flood mitigation strategies for communities in the SADC region (Lumbroso *et al.*, 2008). The tools include material aimed at rural communities and schoolchildren such as posters and a card game, together with a Source Book and checklists for use by water managers and emergency planners.

The impact of flooding on the rural floodplain communities in the three pilot areas has been reduced through the implementation of practical flood mitigation measures that were prioritized at a variety of workshops. It has been recognized that monitoring and evaluation of the effectiveness of the measures and implementation of other measures identified in the strategies will be a long-term activity and be largely dependent on occurrence of flood events against which to measure response.

However, the specific measures that have been implemented are valuable to the communities not only in times of floods, but on a day-to-day basis. For flood mitigation measures in rural, vulnerable communities to be successful, they need to integrate a range of risk reduction measures that are not only related to flooding but also include issues such as grain protection, sanitation and water supply.

In Rwanda the available capacities on flood management are: *Structural measures* where Channels are constructed to avoid landslides, *Non-Structural measures*, to revise the settlement especially peoples who live in Gishwati forest will leave to another environmentally sound place, as recommended by the Prime Minister after many cases of disasters observed in this natural forest Gishwati. The third measures is *Do nothing* where Rwandan authorities ask people to displace from flooded prone areas like Gishwati forest to other environmentally sound places but people are still resisting.

Note that in Rwanda, flood disaster management is structured as follows:

In Rwanda, flood as well as others disasters (fires, earthquakes, volcanic eruption, etc.) are controlled by Disaster Management Unit currently under Rwanda National Police in the Ministry of Internal Security. However, the new Ministry was created in two months ago and probably this disaster unit will be transferred to this new ministry called Ministry of Disaster Preparedness and Refugees. There is a unit called Integrated Water Resources Management (IWRM) which is under the Ministry of Environment and Lands (MINELA) and the unit is in charge of hydrological forecast. The Rwanda Meteorological Service which is under the Ministry of Infrastructures (MININFRA) has the mandate on rainfall forecast and the Rwanda Environmental Management Authority (REMA) is working in terms of legal framework and rehabilitation. During floods occurrences different institutions and ministries intervene for support like Ministry of health for health care, Ministry of Defence for life and resources saving, Ministry Information for dissemination, Ministry of Finance for financing, Universities and Research Institutions for development of DSS, and Ministry of Agriculture for support of agricultural inputs.

In the department of meteorological service, down scaled meteorological information and products are given to all stakeholders like seasonal forecasts; monthly updates; ten days updates; and daily forecasts. However, long term average rainfall pattern in Rwanda is also provided by the same office as shown in figure 5.1 (for at least 30 years rainfall data records).

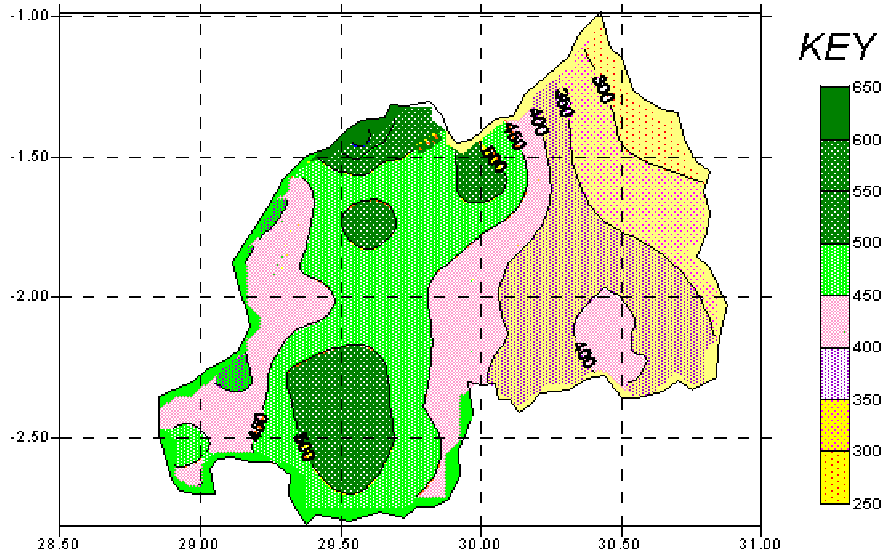

Figure 5.1: Long term average rainfall pattern in Rwanda

Droughts:

There is no universally accepted definition because: 1) drought, unlike flood, is not a distinct event, and 2) drought is often the result of many complex factors acting on and interacting within the environment. Complicating the problem of drought is the fact that drought often has neither a distinct start nor end. It is usually recognizable only after a period of time and, because a drought may be interrupted by short spells of one or more wet months, its termination is difficult to recognize."

A drought is an extended period where water availability falls below the statistical requirements for a region (FAP, 2008). Also drought is not a purely physical phenomenon, but interplay between natural water availability and human demands for water supply. Since the demand for European water resources is increasing, also the pressure on water continues to grow and Europe is becoming increasingly vulnerable to the effects of periods without rainfall.

Drought is a period of abnormally dry weather that persists long enough to produce a serious hydrologic imbalance (for example, crop damage, water supply shortage, etc.). The severity of the drought depends upon the degree of moisture deficiency, the duration, and the size of the affected area (USGS, 2003).

The most commonly used drought definitions are:

- *Meteorological or Climatological Drought* - a period of well-below-average precipitation that spans from a few months to a few years.
- *Agricultural Drought* - a period when soil moisture is inadequate to meet the demands for crops to initiate and sustain plant growth.
- *Hydrological Drought* **-** a period of below-average stream flow and/or depleted reservoir storage.

Burton (2001) defines drought as a continuous and lengthy period during which no significant precipitation is recorded.

5.1. Risk Assessment Methodologies

The concept of sustainable development not only strengthens but also extends the main principles and policies of water resource management. In sustainable and integrated water resource management, risk analysis/management for floods and droughts has received much attention. Risk and uncertainty in hydrological processes have been intensively studied, and many significant achievements have been made

(Zongxue *et al.*, 2000). Two case studies of risk assessment for flood and drought have been done by Zongxue *et al.* in 2000. In his study, a stochastic point process model for flood risk estimation is first derived by using a clustering stochastic point process. Then, several risk indices including reliability, resilience, vulnerability and risk plane for drought assessment were introduced. The proposed methodology was applied to an example water supply system with the combination of a decision support system.

According to Drugolecki (2003) there are six steps to risk assessment:

- Scope: area, purpose, timeframe, etc.
- Hazard analysis: Computer models of weather
- Exposure: geographical information system (GIS)
- Vulnerability: robustness of materials and processes
- Recovery: contingency plans
- Financing: culture/third party agreements

In Rwanda, the Strategic Plan of Action of the National Policy on Disaster Management contains *three phases* in flood disaster management**:** *prevention/mitigation* before the occurrence, *response* in case of disasters, and rehabilitation after the occurrence. Implementing mechanisms of the Policy include: Coordination of disaster management based on the following; sharing of information, synergies in programmes, getting together all strategic and technical operations and plans, legislation, planning at the national and provincial levels, followed by sector plans for disaster management, partnerships with international, regional and sub-regional organizations, resource mobilization, and financial management to reduce the costs.

6
COMMUNITY BASED FLOOD MITIGATION

The primary purpose of the research was to develop flood risk management strategies in partnership with the communities. This approach entails developing mitigation measures that fell into the following categories:

i. Things that could be done by the communities immediately;

ii. Measures that could be implemented by the communities with technical assistance from external organisations including the District Administration, local disaster management agency and NGOs;

iii. Measures that can be implemented if a small amount of funding and external technical assistance were available to the communities.

The card game, posters and manual should be used to illustrate various mitigation measures (structural or non-structural) and raise awareness of certain solutions (e.g. rainwater harvesting). Examples of measures that communities stated that they could implement immediately included (Lumbroso *et al.*, 2008):

- Raising awareness of flood issues in schools using the posters, pamphlet and cards;
- Identification of evacuation routes; and
- Implementation of a local flood watch on the river to assist with deciding whether to evacuate and when.

The main issues raised by the communities during the initial consultations that required funding and external technical assistance related to frequent loss of crops; lack of clean drinking water during a flood; food and seed storage; and protection of valuables during a flood.

Flood mitigation measures for each of the three communities can be prioritized after the consultation process. It is not possible to fully implement all the measures in the strategies within the time scale of the project.

The success of the implementation of the mitigation measures can be monitored both by the Local Administrations for each community and via Universities and research institutions. It has also been recognized by NGOs and government organizations that to be sustainable in rural areas, flood mitigation measures need to contribute to reducing other risks such as crop failure and health issues related to contaminated drinking water (UN-HABITAT, 2006).

7
WAY FORWARD

- There is neeedfor a state-wide water resources plan with goals and directions by major water basins
- This will require water resources law based on integrated water resource management
- Funding and guidance for local integrated watershed planning and implementation
- Elimination of "road blocks" and creation of incentives and/or regulation to:
    - increase rainwater infiltration as high in the watershed as possible;
    - increase rainwater infiltration on a "lot-by-lot" basis;
    - design new detention/retention basins to retain and infiltrate flows from small storms (less than or equal to the 2 year storm flows) in order to increase ground water levels and improve surface water quality;
    - retrofit existing detention basins to infiltrate flows from small storms;
    - increase water reuse and gray water systems;
    - increase land application of treated wastewater, and
    - protect ground water from over-withdrawal
- Programs to encourage water conservation
- Programs to discourage development in floodplains and encourage the restoration/naturalization of these riparian corridors
- Project and subdivision reviews that include analysis of potential watershed impacts.

The other important aspect of catchment flood and drought management is the reliability of forecasts, which can be increased in various ways, such as:

- Improvement of rainfall forecasts;
- Improved catchment modelling;
- Improved channel routing; and
- Improved model updating techniques.

- Continued rehabilitation and operationalization of hydro-meteorological stations; and
- Continue underground water exploration.

8
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2010

Integrated Flood and Drought Management for Sustainable Development in the Nile Basin

One of the biggest impacts of floods and droughts on the poor is on their livelihoods. Drought and Flooding affects economic and social infrastructure, industrial activities and other business activities. If equipped with an organizational structure and improved capability (through proper training), individually and collectively, the local people can manage floods better, with damages and losses substantially reduced even during major floods. Collectively, within the framework of a local organization titled Community Flood and drought Management Committee (CFDMC), the local people not only can mobilize efforts within the flood-affected areas to effectively liaise with and secure assistance from different possible outside sources in a coordinated manner.

Perception of risks due to flooding and drought among communities and within a community differs considerably. The new settlers/migrants or refugees in a flood plain or a drought area may not be aware of the causes, frequency and likely magnitude of flooding or drought in a given area and are vulnerable due to lack of knowledge. The population in areas subject to flooding due to infrequent floods or flash floods with a return period of more than a lifetime lacks such knowledge. The demographic composition of the population, e.g., the presence of old citizens who might have experienced the highest flooding in the region also reflects on how the community perceives these risks. Perception about risks and corresponding responses within a community can also vary according to their relative education level, economic standards and political clout.

The objective of the project was to find out how people cope with floods and droughts, what are the risks involved, how can they carry on with their lives forward after the events, and to device ways of organising themselves and improving their capacity to do the things more effectively and to identify additional critical tasks that they may undertake to improve their flood and drought management capacity and preparedness. Two case studies are introduced in this research project, Nzoia Catchment in Kenya and Kagera Catchment in Rwanda.

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Knowledge Networks for the Nile Basin