Integrated Flood and Drought Management for Sustainable Development in the Nzoia River Basin

Dulo S.O[1], Odira P.M.A.[2], Nyadawa M.O.[3], Okelloh B.N [4]

[1] Senior Lecturer, School of Engineering, University of Nairobi
[2] Associate Professor, School of Engineering, University of Nairobi
[3] Senior Lecturer, School of Engineering JKUAT
[4]Lecturer, department of Geography Maseno University

Abstract
Directives and policies increasingly call for more integrated management of land and water. Frameworks such as integrated catchment management may address these calls, and yet their implementation requires decisions to be taken under conditions of extreme complexity and uncertainty. This paper establishes a basis for managing flood hazards through an integrated community based management protocol. It documents and assesses adoption/adaptation methodologies and past indigenous knowledge for coping with floods and droughts. Through earlier SWAT catchment analysis components of the Nile Basin Capacity Building Network (NBCBN) research, results from mapping and zoning of flooding and drought events have been obtained. It is apparent in Nzoia catchment that the areas under forest cover decreased markedly between 1970's and 1986 from 1811.33 Km2 to 936.82 Km2. In contrast, the area under agricultural use is seen to have decreased over the years from 8433.85 Km2 in 1970's to 6542.35 Km2 in 1980's and to 5460.88 Km2 in 2000's. A risk assessment methodology and management plans for hazard prone communities have also been derived. Impacts of floods and drought on the livelihood of the resident were also outlined. The report concludes with a summary of mitigation and intervention strategies for the basins. The significant technical challenges confronted in such an exercise may be overshadowed by the institutional challenges, including the fundamental question as to whether organisations are truly committed. However, the reward for overcoming such challenges is the opportunity to achieve genuine improvements in the social, economic and environmental quality of our catchments.

Key words: Catchment Management; Integrated; Adaptation Strategy; Flood Mitigation

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 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 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 plan. For effective community participation in the integrated flood management processes, including emergency preparedness plans, it is essential that the communities 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 the given area and are vulnerable due to lack of knowledge. In particular, 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 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 after the events, 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 are to reduce damages and losses when 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 km2, 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 with its vast catchment witnesses a large variation in rainfall 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 area 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 of 41.3% in areas under forest covers was realized (Table 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 the increase in forest cover in the later dates could be due to government intervention through tree planting campaigns and the increase in area under tea plantationd where forest cover is used as wind breakers. In contrast, the area under agricultural use is seen to have decreased between 1970's, 1980's and 2000's by 22.4% and 4.6% respectively.

Table 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

This decrease could be linked to changes in weather patterns, and 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 change could be linked to the 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 centers can be attributed to high rate of rural urban migration hence the decline in agriculture.

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 $20m^3/s$, 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 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 result in floods when the river banks burst.

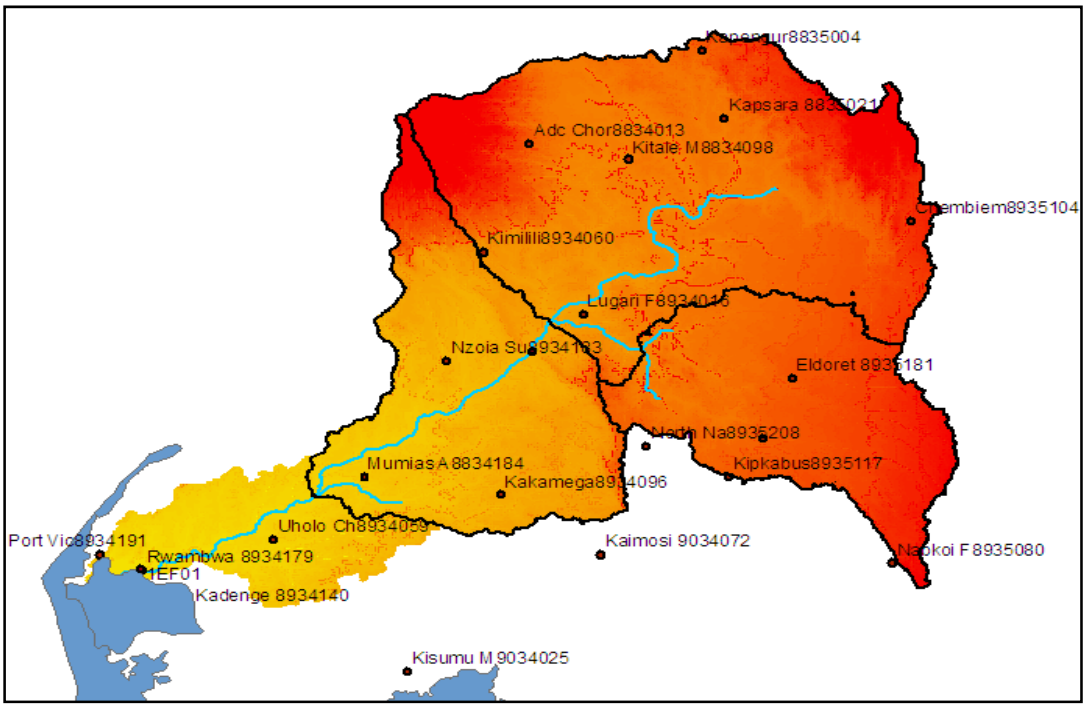

Figure 1: Nzoia River 30mDEM

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 in the plains achieve 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.

Flow in the Nzoia River 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 2500m3/s respectively. The continuous high rainfall throughout the year for the upstream region keeps the 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.

The change in rainfall seasons over the year makes the flow regime of the Nzoia catchment variable and is occasionally as low as 20m3/s. With extreme floods, the flow may surpass 1,100m3/s, which is the proposed protection level for the dykes for a 25 year return period flood. Siltation is heavy especially at the plains, which reduce the height of the river banks, and hence increase the spill over the banks (ItalConsult, 1980, 1982).

3. CURRENT RISKS AND MANAGEMENT

3.1. History of Flooding and Droughts

A considerable incentive for rethinking the 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 (MDGs) 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 endeavors.

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, outbreak 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 (Republic of Kenya, 2004). 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. The Nile basin is thus experiencing inefficient resource use, duplication of effort, stakeholder conflicts, destruction of infrastructure and ineffective flood and drought management. In Budalangi Division of Busia district, the floods combined with the overspill 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. (Republic of Kenya, 2004).

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. 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 a 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.

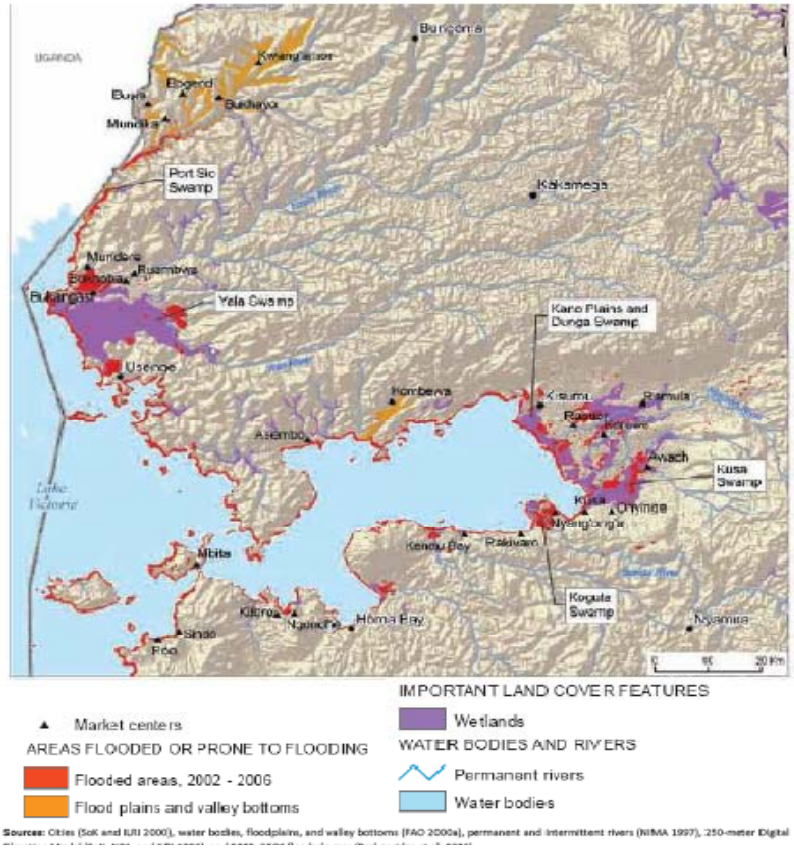

Figure 2: Flood Water in western Districts of Kenya

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

4.1. Introduction

4.1.1. 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 behavior of the rainfall, water levels in rivers, or the behavior 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 who 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 as the essential building unit. Under the proposed community approach, the focus is on community involvement in all phases including awareness raising, individual and community capacity building, planning, and implementation.

Included in the community approach to flood preparedness are the following activities:

- Formation of a community level organization to manage floods, say Community Flood Defence 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

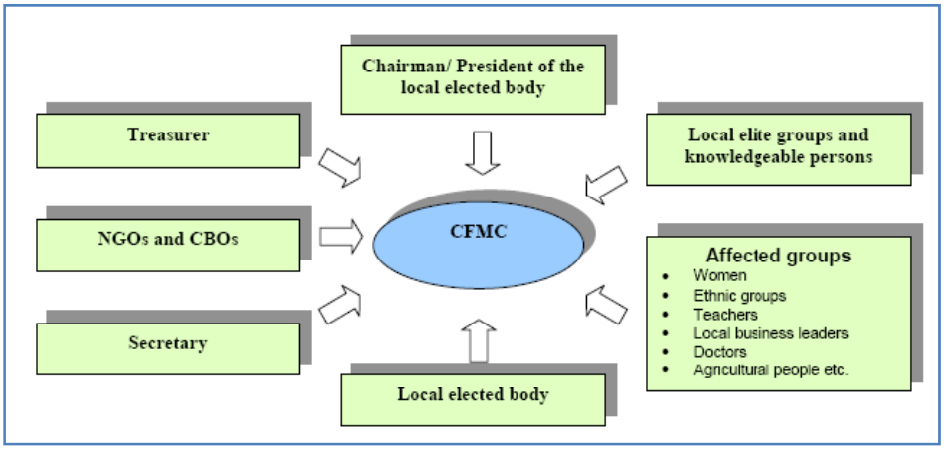

Figure 3: Catchment flood and drought management committee

4.1.2. 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 three stages on their own, which may be considered the household-level coping mechanisms against floods. Lack of organizational capacity and guidance has not allowed pooling of the 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 grassroots-based flood management approach. Key elements of this approach are outlined below.

Pre-Flood responses

When the flood is imminent, the CFDMC may organize continuous Flood Vigilance Task Activities (FVTA) to check on how an impending flood is developing, that is, to assemble and review available information on flood indicators (for example, water levels 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 very useful background material in dealing with future floods.

According to the degree of severity of the forecasted flood, warnings should be issued, giving the likely severity level in different parts of the area. Warnings 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 the likely extent of flooding is and what actions are expected of them.

During-Flood Responses

In the case of flooding, one may choose one of the following two options (a) enduring the 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 a flood is indeed difficult. Many poor families tend to stay 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, 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 linkup 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 settlements spread over 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. 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.

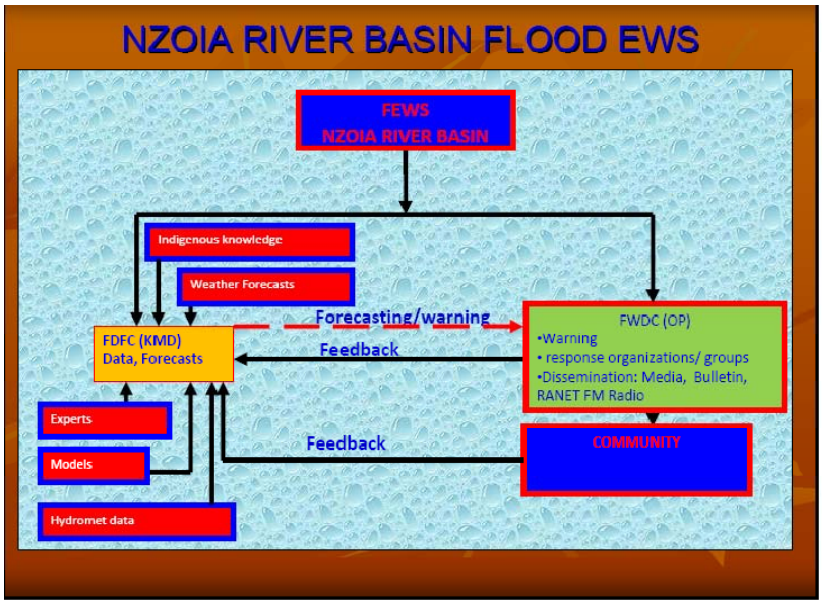

Figure 4: Early Warning System Components for Nzoia

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 is 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 meteorological and flow information provided through Internet to district and location levels.

4.4.1. 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 fund allocation for this item.

4.4.2. Evacuation centers

The during flood component evacuation centres have been proposed;

- Once operational they will be coordination centers
- During the off flood season, a center will be used as a resource, hosting workshops, seminars, training courses etc.
- Their designs and architectural drawings are being developed,
- It has been proposed that they are constructed in phases
- WKCDD&FMP will only contribute towards the final designs and the BoQs(?). The complete documents will then be presented for funding 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 is processed and the modelling system set up in the centre is used to produce warning forecasts. The warnings are packaged in a 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, impacts and a forecast for the coming month. With the envisaged upgrades, the contents and lead time for the bulletins will be greatly improved. An annex in the report shows a typical product from the Flood Diagnostics and Forecasting Centre (FDFC) at the Kenya Meteorological Department in Nairobi.

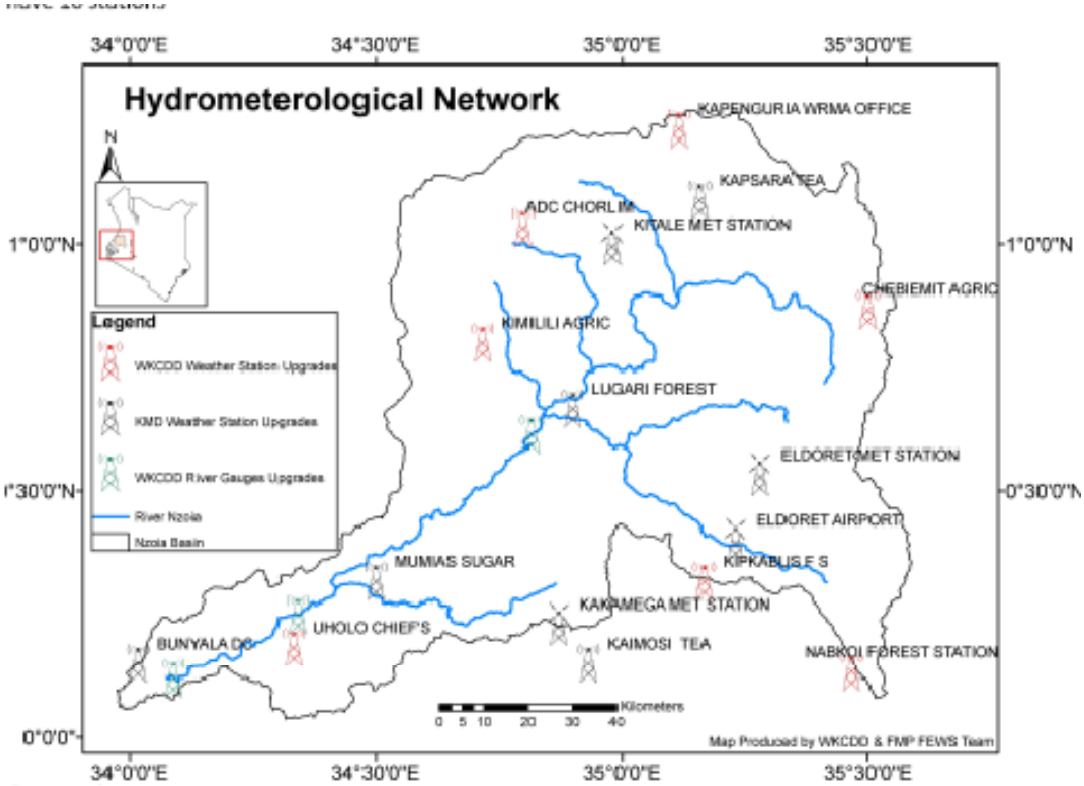

Figure 5: Hydro-meteorological network

4.6. Initiative for Flood Response

The project was not allocated funds for the disaster response. The Project has therefore 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.

5. CONCLUSIONS AND WAY FORWARD

The likelihood of flooding and water shortages increases with economic 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 land paved with roads and covered by homes and shopping centres.

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 do not 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. The reasons why they should be community based include:

- 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.

6. REFERENCES

1. APFM (2004), *Integrated Flood Management,* Edited by Technical Support Unit, The Associated Programme on Flood Management.
2. Churchill Otieno (1998), *Expert Blames Lake Victoria Flooding On `El-Nino' Rains*. Maritime Report Special Correspondent, The East African.
3. Department of the Environment, Heritage & Local Government (2008), *The Framework for Major Emergency Management*, Report by the fire services and emergency Planning Section, Dublin.
4. Environment Agency (2004), *Catchment Flood Management Plans, UK*.
5. Hernando, H. (2007), *General Guidelines for Setting-up a Community-based Flood Forecasting and Warning System*. PAGASA, Philippines.
6. Hernando, H. (2006*), Community-based Flood Mitigation & Management Program for Bulacan Province*, May 2006, Unpublished.
7. Hernando, H. (2007), *Binahaan River Local Flood Warning System,* Hydrological data monitoring aspect, July 2007, Unpublished.
8. Nicholls et al, (1999), *Vital Climate Graphics*. A United Nations Environment Programme report. http://www.grida.no/climate/vitalafrica/english/24.htm.
9. Republic of Kenya (2004), National Policy on Disaster Management (Revised Draft) p4, Nairobi, Kenya.
10. The National Oceanic & Atmospheric Administration (NOAA) National Weather Service (NWS), *ALFWS Handbook*. http://www.nws.noaa.gov/oh/docs/alfws-handbook/chap4.pdf (accessed 23 November 2006)
11. UN A/Res/55/2, (2000), *UN Millennium Declaration.*
12. http://www.unesco.org/water/wwap/facts_figures/mdgs.shtml.

13. USAID (2003), *Famine Early Warning System Network*, FEWS Flood Advisory for Greater Horn of Africa 7 - 9 May 2003.
14. WMO (2003), *Building Resilience through Community Participation*, A Report on the Pilot Project on Community Flood Management in Bangladesh, India and Nepal.