SOURCE BOOK FOR SUSTAINABLE FLOOD MITIGATION STRATEGIES

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Preface

The Source Book for Sustainable Flood Mitigation Strategies has been produced with funding from the Department for International Development (DFID) of the UK Government under the Knowledge and Research (KAR) Programme. The work has been carried out as a collaborative venture between HR Wallingford (UK), Eduardo Mondlane University (Mozambique), Instituto Nacional Da Gestao De Calamidades (INGC) (Mozambique), Ministério Para A Coordenação Da Acção Ambiental (MICOA) (Mozambique) and the Department of Water Affairs and Forestry (South Africa). The Source Book responds to the growing need to bring together information on sustainable flood mitigation strategies for the Southern African Development Community (SADC). The Source Book is aimed at professionals and practitioners in southern Africa who are responsible for water and flood management.

Acknowledgements

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We also gratefully acknowledge the UN Habitats – Cities Alliance Project for permission to use illustrations from their manual entitled “Aprender a viver com as cheis, Manual de recomendações para a reducão da vulnerabilidade em zonas de ocupação informal susceptíveis a inundações.”

Contents

Figures

Boxes

1. INTRODUCTION

1.1 BACKGROUND

One billion people – one sixth of the global population, the majority of them among the world's poorest inhabitants – are estimated to live today in the potential path of a 1 in 100 year flood.

The purpose of this Source Book is to act as a reference document for methods by which the impact of flooding can be reduced. The material in the Source Book is aimed at organisations involved with water management, as well as people working in disaster management in the Southern African Development Community (SADC). However, much of the information is pertinent throughout the rest of the world. The Source Book contains a number of case studies that demonstrate appropriate solutions and measures that can be taken at a range of institutional levels. The document has been produced as part of a Department for International Development (DFID) funded Knowledge and Research project on sustainable flood mitigation measures.

Southern Africa has one of the most complex networks of international rivers and shared river basins in the world. These are shown in Figure 1.1. Every major river in the region is shared by at least two countries and every country has at least one international river. Mozambique is the extreme case with nine international river systems.

1.2 STRUCTURE OF THE SOURCE BOOK

The Source Book has been structured as follows:

Floods presently affect an estimated 520 million people per year worldwide, resulting in estimates of up to 25,000 annual deaths, extensive homelessness, disaster-induced disease, crop and livestock damage and other serious harm.

Chapter 1 **Introduction** providing details of the types of floods and their effects.

Chapter 2 **Raising flood awareness** – This details methods by which people can be made aware that they are at risk from flooding and how their awareness of the risks can be raised.

Chapter 3 **Flood forecasting and warning** – This outlines the methods by which floods can be predicted and the methods by which flood warnings can be disseminated to communities at risk.

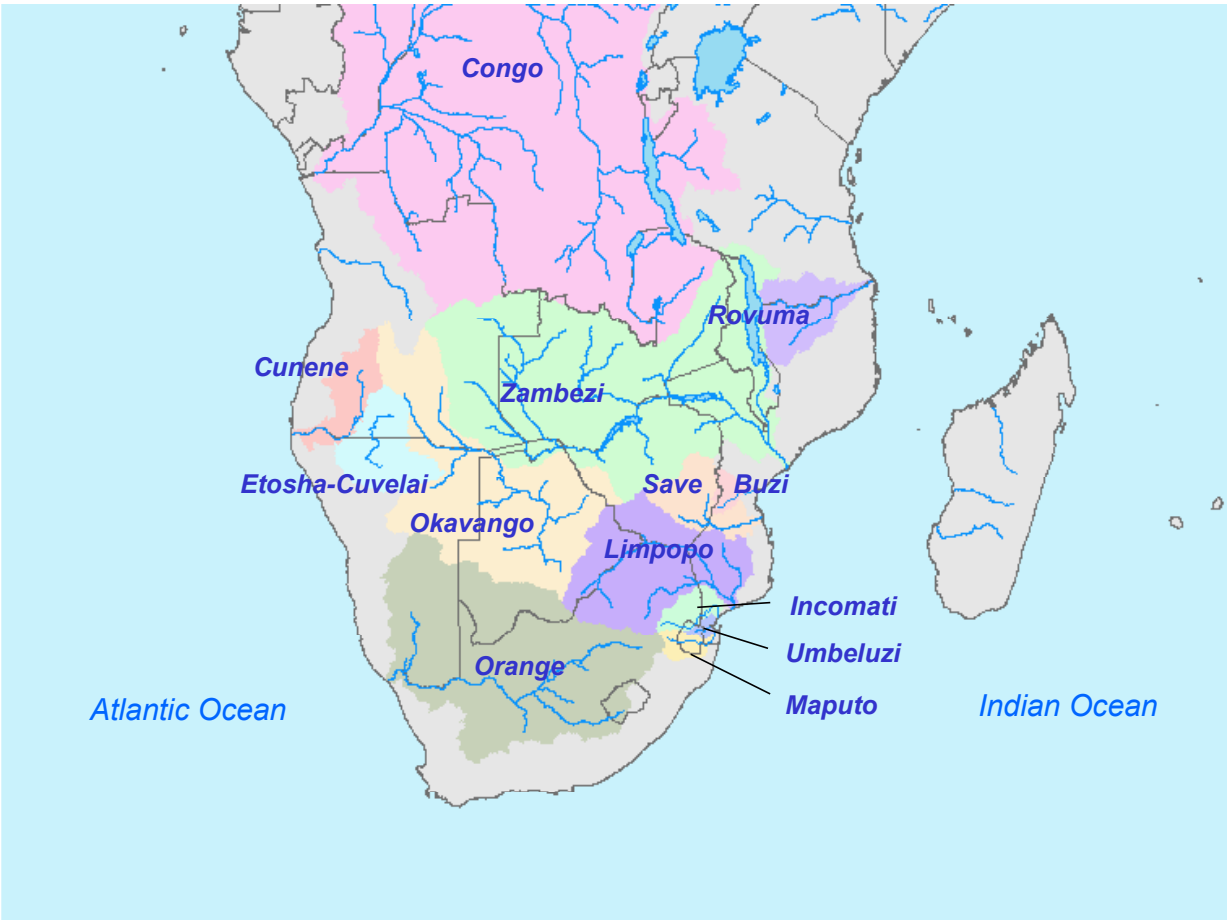
Chapter 4 **Flood preparedness measures** – This provides methods by which Government organisations and people can prepare in advance for flooding so that when floods do occur their impact is minimised.

Chapter 5 **Flood response** – This details how people can respond to floods.

Chapter 6 **Post flood recovery** – This describes the measures that can be taken to recover from floods.

Chapter 7 **Checklists** for awareness, forecasting and warning, preparedness measures, response, and recovery.

Chapter 8 **References** provides a list of relevant references used in putting the document together.



(Source: Reference 1)

Figure 1.1 Major river basins within the SADC region

The fast-growing cost to the world economy of floods and other weather-related disasters (now US$50 to US$60 billion per year, much of it in developing countries) is roughly equal to the global development aid provided by all donor countries combined. The flood-related death toll represents 15% of all natural disaster-related loss of life.

This document is aimed at organisations that are involved in water and disaster management. The Source Book can also be used both by government and non-governmental organisations to inform communities, so that they can develop their own flood mitigation strategy based on their own particular needs. The available resources and economic status of the community are key factors in strategy development. The guidance provided is based on a number of criteria including the following:

- Is the flood risk area rural or urban?
- Does flooding occur frequently or infrequently?
- Is the flood risk area close to the edge of the floodplain or far away from the edge?
- Is the depth of flooding small (surrounds houses), medium (floods houses) or large (likely to submerge houses)?
- Are there buildings and other features that could provide local safe havens?

The Source Book also presents a series of checklists that present a summary of the topics that are considered to be the main points of a comprehensive flood mitigation strategy.

1.3 AN INTRODUCTION TO DIFFERENT TYPES OF FLOODS

There are three main types of floods that occur within the SADC region. These can be defined as:

- Plain floods;
- Flash floods;
- Coastal floods.

The various types of floods are defined below.

Plains floods in Mozambique in February 2000.

1.3.1 Plains floods

These are floods that generally occur seasonally during the "rainy season". They are characterised by long durations (for example land can often be inundated for several weeks or months). Plains floods are also typified by long lead times which usually provides plenty of opportunities to issue flood warnings. Figures 1.2 and 1.3 show plains floods in the Netherlands and Mozambique respectively.

Figure 1.2 Plains floods in the Netherlands

Figure 1.3 Plains floods in Mozambique

1.3.2 Flash floods

Warning sign for flash floods used in the USA.

Flash floods can occur within several seconds to several hours, with little warning. Flash floods can be deadly because they produce rapid rises in water levels and have devastating flow velocities. Several factors can contribute to flash flooding. Among these are rainfall intensity, rainfall duration, surface conditions, and topography and slope of the receiving river catchment. Urban areas are susceptible to flash floods because a high percentage of the surface area is composed of impervious streets, roofs, and parking lots where runoff occurs very rapidly. Mountainous areas also are susceptible to flash floods, as steep topography can direct runoff quickly into narrow valleys. Figures 1.4 and 1.5 show the effects of flash floods.

Figure 1.4 Flash flooding in Australia

Figure 1.5 Aftermath of a flash flood in Rapid City, South Dakota, USA

1.3.3 Coastal flood

Winds generated from tropical storms and cyclones or intense offshore low-pressure systems can drive ocean water inland and cause significant flooding. Escape routes can be cut off and blocked by high water. Coastal flooding can also be produced by sea waves called tsunamis, sometimes referred to as tidal waves. These waves are produced by earthquakes or volcanic activity. Figures 1.6 and 1.7 show examples of coastal floods.

Figure 1.6 Coastal flooding in Micronesia, South-East Asia

Figure 1.7 Overtopping of sea walls in the UK

2 RAISING FLOOD AWARENESS

2.1 INTRODUCTION

Flooding in Maputo, Mozambique.

It is a fundamental tenet of emergency management that there is no hazard without people. The existence of a community turns what would otherwise be a mere 'event' into something that is threatening in human terms. To assist communities to mitigate against flooding it is important to raise their awareness of flood preparedness. To raise flood awareness it is important to understand the threat posed by floods in terms of:

- Flood hazard;
- Potential consequences of flooding;
- Vulnerability of the threatened community to flooding.

Methods of raising flood awareness are presented below.

2.2 DISSEMINATION OF FLOOD RISK INFORMATION

Box 2.1 Definitions of risk

Risk may be defined as a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequence of the occurrence. Risk, therefore, has two components - the chance (or probability) of an event occurring and the impact (or consequence) associated with that event.

Erosion caused by the 2000 floods in Maputo, Mozambique.

It is important that people are aware of the flood risk in the area in which they live. The dissemination of flood risk information (including flood maps, where available) involves providing information to people in flood risk areas and explaining what the information means. Information that would be disseminated may include:

- The fact that some areas are at risk from flooding;
- The time of year when the flood could occur;
- The likely frequency of flooding;
- The likely depth of flooding;
- The rate of rise of the flood;
- The sequence of flooding including, for example, the areas that flood first;
- Whether the floodwater carries debris and/or mud;
- The duration of flooding.

Communities living in areas that flood regularly will be aware that flooding occurs, and may be aware of much of the above information. They would particularly benefit from flood map information as it could be used to show where flooding is likely to occur and areas that are unlikely to flood. Communities living in areas that rarely flood, including areas that have flood defences, would benefit from the knowledge that they are at risk from flooding.

Communities living in areas that are prone to flash flooding, and associated soil erosion, would benefit from the knowledge that they are at risk of flooding, and the fact that flooding could occur very quickly

following heavy rainfall in the catchment. It is likely that part of the awareness raising process will include participatory discussions on flooding, including the history of flooding in the area. Much of the information listed above might be identified during this discussion.

2.3 PREPARATION OF FLOOD MAPS

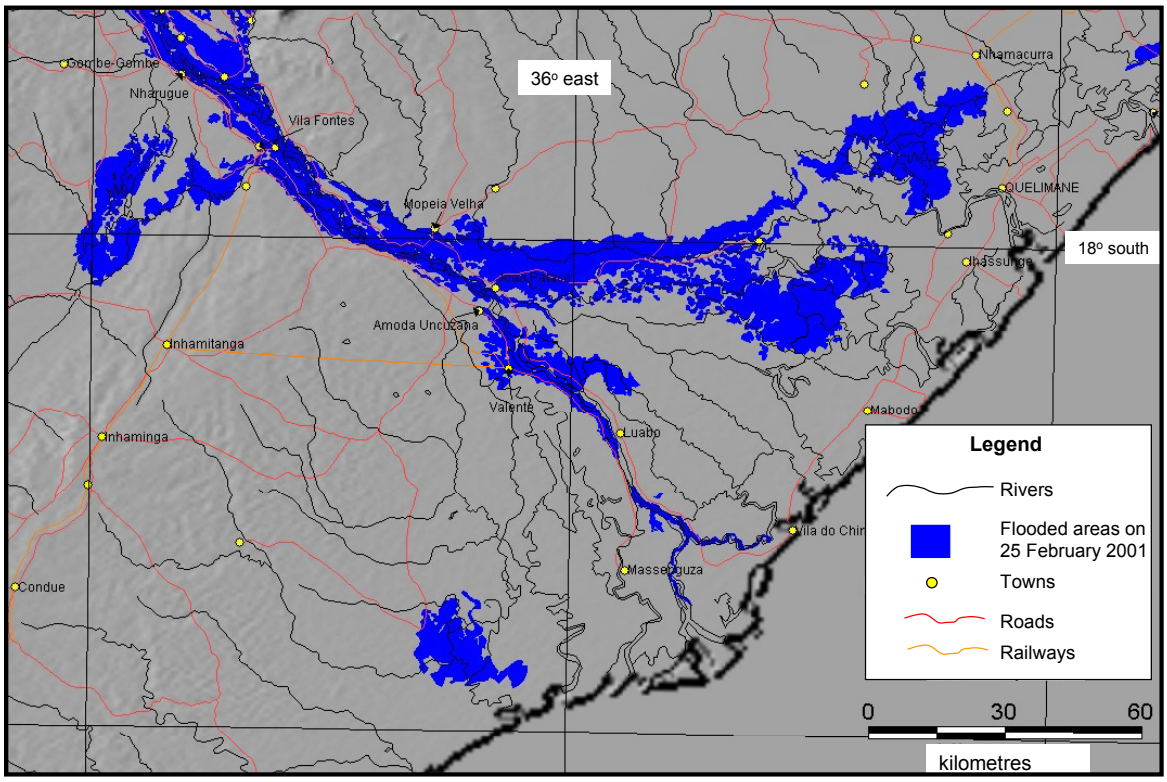
2.3.1 Background to flood mapping

The Dartmouth Flood Observatory in the USA detects, maps, measures, and analyses extreme flood events worldwide using satellite remote sensing. Microwave and optical satellite imaging of selected river reaches are used to detect overbank flood and extreme flow conditions. Annual catalogues, large-scale maps, and images of river floods, from 1985 to the present are also available.

Maps of flood risk areas provide vital reference information to all levels of flood management action. They highlight locations where flooding has or could occur, and are used to identify what is at risk. Comprehensive and accurate flood mapping is a major undertaking for any country. A combination of historic information, survey and hydrological evaluation is required. The water management authority should be assigned the duty of assembling and preparing flood mapping. Flood maps can be prepared using the following information:

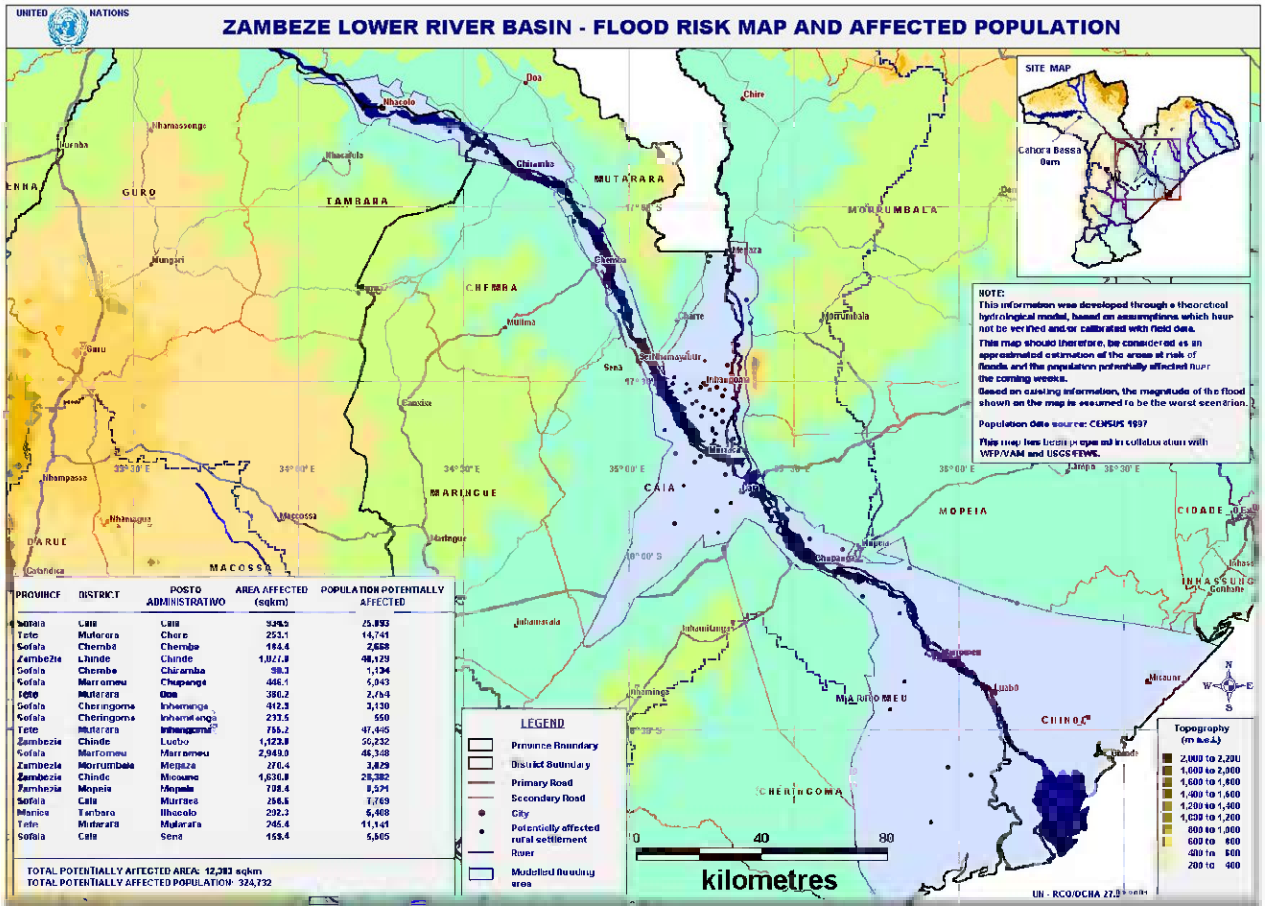
- Measurements of flood levels and flows;
- Information on previous historical floods;
- Previous recorded and observed flood water levels;
- Topographic information on the area to be mapped.

Detailed flood maps should concentrate on the most densely populated areas. Areas that are less severely affected by floods or which are sparsely inhabited, will require less detail in their flood maps. Examples of flood maps are shown in Figure 2.1 and 2.2.



(Source: Reference 2)

Figure 2.1 Inundation map of flooding in the Lower Zambezi River on 25 February 2001 based on satellite data



(Source: Reference 3)

Figure 2.2 Lower Zambezi flood risk map and the affected population

Information such as the locations of vulnerable groups or individuals and evacuation routes can then be added to these flood maps. Flood maps coupled with a reasonable flood height prediction and other flood intelligence can greatly assist response activities through identifying areas and community groups likely to be affected by floods of differing magnitudes. They can be used to develop warning systems and procedures and to generate decisions relating to evacuation, re-supply and other response tasks.

2.4 PRODUCTION AND USE OF FLOOD HAZARD MAPS

Flood hazard is the impact of floodwater on people, vehicles and buildings. The production of flood hazard maps requires knowledge of the following:

- Flood extent;
- Depth;
- Flow velocity.

These should be obtained from local knowledge of previous flood events from local communities and the river basin authority, although

they will only know about floods that have happened and not the possible larger floods that could occur in the future.

Floodplain modelling is an approach that can estimate the impact of possible larger floods, but is a high-cost technology requiring considerable effort to implement. A map of the areas at risk of flooding can be prepared by plotting all available information such as flood extents, flood depths and flow velocities from the river basin authority and local communities. Much of this information will be obtained from talking to people, so mapping should be an ongoing exercise, with information (for example, a flood depth at a particular location) being progressively added to the maps. Boxes 2.2 and 2.3 show how the hazard can be classified by knowing the velocity and depth of water in the floodplain. Box 2.4 provides an example of how flood hazard mapping was produced for the city of Naga in the Philippines. Box 2.5 details the successful use of flood hazard mapping in Japan.

Box 2.2 Flood hazard classification using velocity and depth relationships

Figure 2.3 shows the relationship between flood depth, velocity and when it becomes unsafe to drive a vehicle or wade in floodwaters.

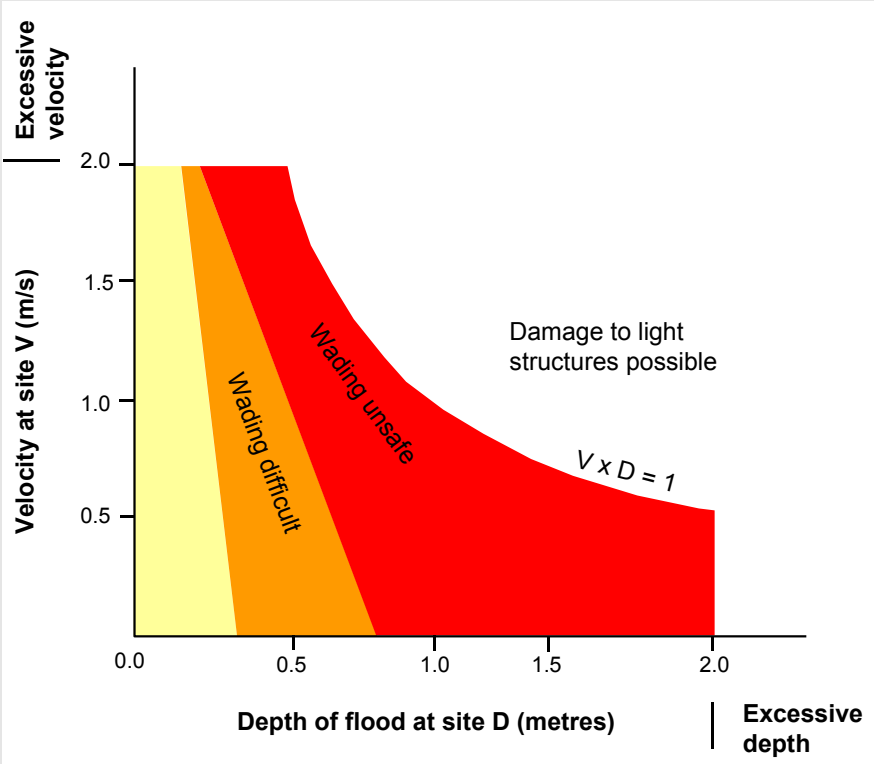


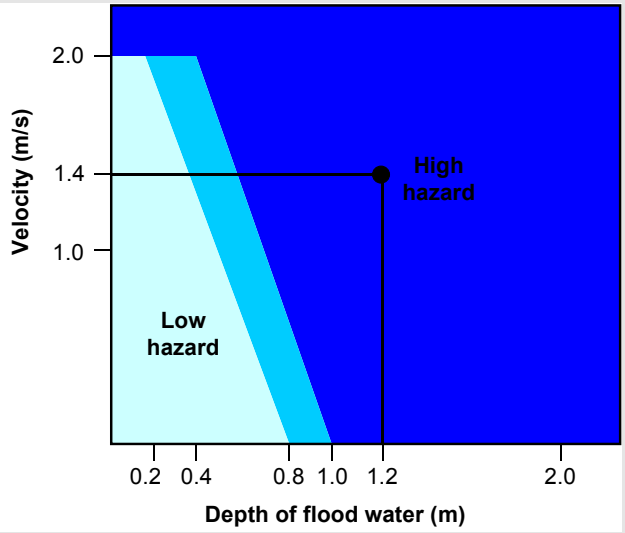
Figure 2.3 Unsafe wading depths and velocity

- At velocities in excess of 2 m/s the stability of foundations and poles can be affected by scour. Grass surfaces and earth begin to scour and become rough and unstable;
- The velocity of floodwater passing between buildings can produce a hazard that may not be apparent if only the average velocity is considered;
- Vehicle instability is caused initially by buoyancy;
- At floodwater depths in excess of two metres and even at low velocities there can be damage to light frame buildings from flotation, water pressure and debris impact.

(Source: Reference 4)

Box 2.3 Hazard classification

Figure 2.4 shows a simple method of classifying the hazard in a floodplain based on the depth of the flood water and its velocity.



The impact of the hazard on people may either be:

- Reduced by the establishment of an effective evacuation procedure;
- Increased if evacuation difficulties exist.

In the transition zone between low and high hazard the degree of hazard is dependent on the site conditions and the nature of the development. For example if the depth of water is 1.2 m and the velocity is 1.4 m/s the hazard is high.

Figure 2.4 Simple method of hazard classification

(Source: Reference 4)

Box 2.4 The production of flood hazard mapping for the city of Naga in the Philippines

Flood hazard mapping was produced for the city of Naga in the Philippines using a two-dimensional hydrodynamic river model. The flood hazard was assessed as a function of:

- The maximum depth of the inundation;
- The duration of the inundation;
- The kinetic energy of the floodwater.

These were combined to produce a flood hazard. The flood hazard map produced for Naga is shown in Figure 2.5.

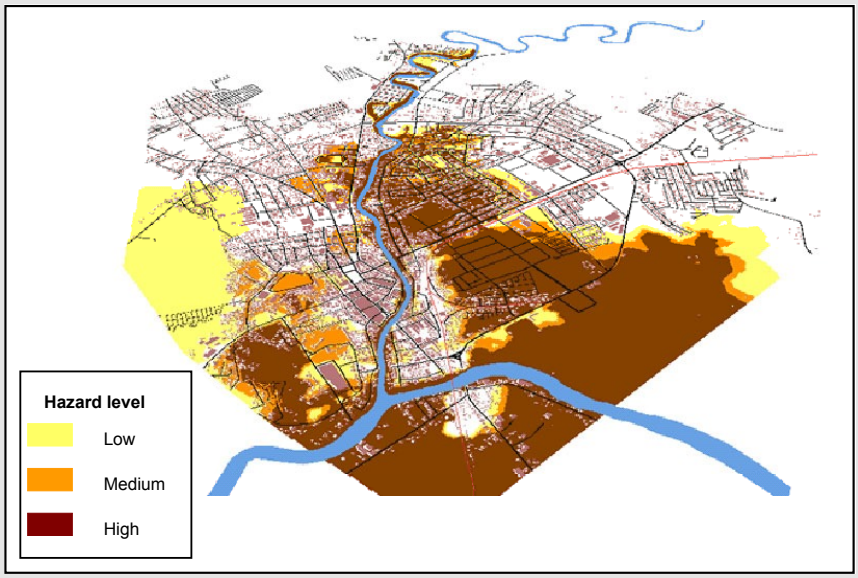


Figure 2.5 Flood hazard mapping for the city of Naga in the Philippines

(Source: Reference 5)

Box 2.5 Example of the effectiveness of flood hazard mapping in Japan

In March 2003, the Ministry of Land, Infrastructure and Transport in Japan developed a "Flood Hazard Map Manual for technology transfer". Utilising the manual, the Asian Disaster Reduction Centre (ADRC), with the co-operation with Fuji Tokoha University, developed an exercise for "Community Based Flood Hazard Mapping". The exercise is a simple and cost effective tool used to raise public awareness while fostering the active participation of the community. The tool was developed bearing in mind that in order to raise public awareness and to ensure smooth evacuation when a flood or another disaster is imminent, maps must be user-friendly and easily understandable for the community.

In the case of a flood, hazard maps need to include not only inundation areas and depth but also information such as evacuation centres and routes, disaster management centres, dangerous spots, communication channels and systems, evacuation criteria, tips for evacuation including emergency kits and other items needed in evacuation, and mechanisms and symptoms of hazards.

According to a survey recently conducted in Japan, among the residents who evacuated, those who had seen such hazard maps were 1.5 times greater in number, and they evacuated one hour earlier than their counterparts who had not seen a map. The results are shown in Figure 2.6. In case of an acute disaster such as a flash flood, this time difference could be a critical determinant in evacuation. The community must be provided with relevant information regarding hazard maps and how to utilise them. Most importantly, how effectively hazard maps are used depends on the level of community awareness. The members of the community must be taught how to understand potential disasters in their area from the map to be able to take appropriate countermeasures.

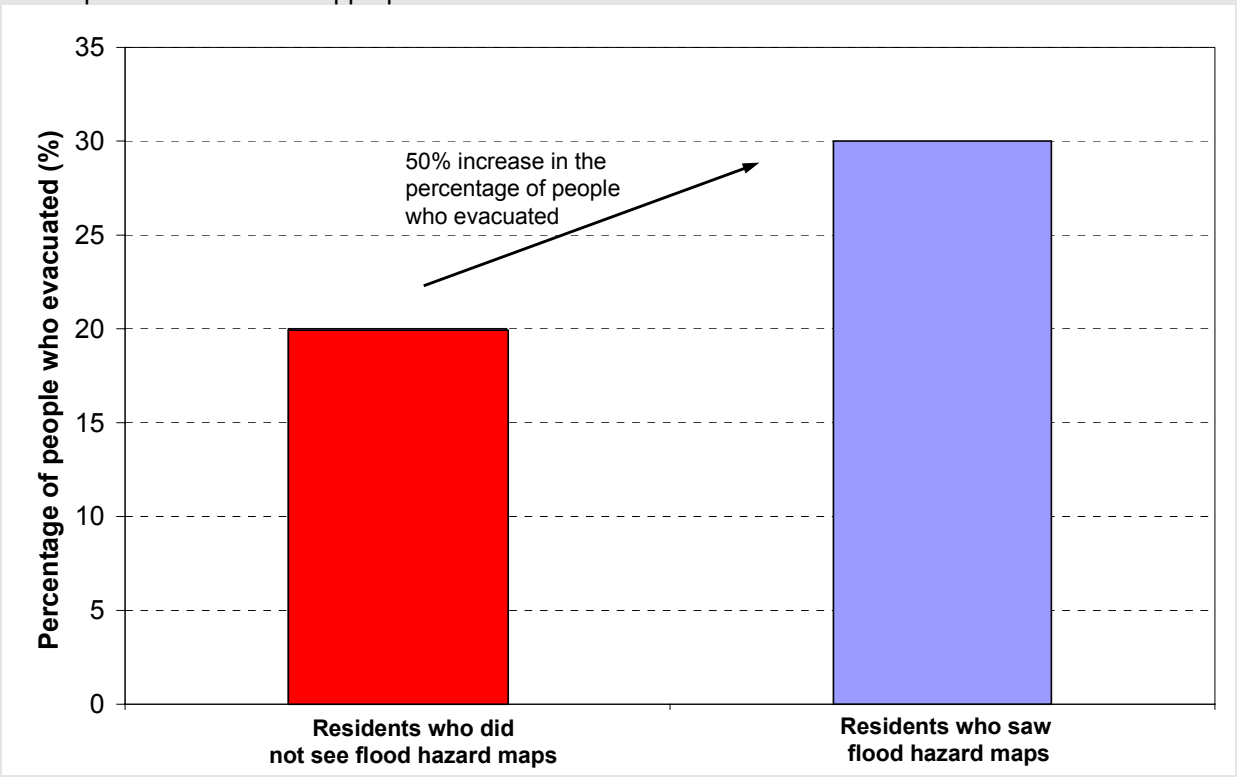
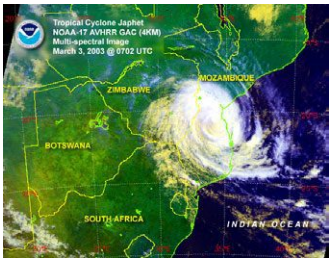


Figure 2.6 Effectiveness of flood hazard mapping in Japan

(Source: Reference 6)

2.5 DISSEMINATION OF FLOOD MITIGATION INFORMATION TO REGIONAL ORGANISATIONS

The purpose of this activity is to disseminate advice on flood mitigation to regional and local authorities and Non-Governmental Organisations (NGOs) so that they can pass information on to communities who are at



Radar image of a cyclone over Mozambique.

Bridge at Xai Xai in Mozambique during the 2000 floods.

risk from flooding. It is important that flood risk and its management is as widely understood as possible. Experience has shown that NGOs or specialists in presentation media are more effective than government departments in conveying these messages to a public audience. These specialists should:

- Examine existing flood mitigation practices;
- Be supplied with good information and data, whenever possible government departments should adopt an open policy on data availability;
- Prepare public information material in accessible forms, for example school displays, flood awareness "road show";
- Hold public awareness events at frequent intervals, preferably annually;
- Provide specific guidance and training on how to interpret flood maps and flood warnings;
- Test public awareness through surveys and questionnaires as to effectiveness of flood warnings, public understanding of warning and preparedness advice.

Considerable effort is required to present visually based information, and provide public presentations. Training of presenters in the technicalities of flood management is also required, through a team effort between respective professionals.

2.6 PROVISION OF INFORMATION ON FLOODING TO COMMUNITIES

2.6.1 Community produced flood maps

The community can develop a flood map. This should be related to known features (for example, particular buildings) and include important locations in time of flood, particularly water points, storage locations, latrines and the location of radios and other communications. Community based flood maps have been developed at Matasse in Mozambique with the assistance of the Red Cross, Box 2.6 provides further details of this work.

2.6.2 Use of a seasonal calendar

For crops, the duration of the flood has some effect but the timing of the inundation is more important. In areas where two or three crops are harvested each year, a flood that extends over the harvesting season for one crop and the planting period for the next can result in both crops being lost. Flooding may result in fertile silt being deposited, or nitrogen fixing algae brought by the floodwater can also increase subsequent crop production. However, floods may also deposit sand and reduce soil productivity.

A seasonal calendar provides information on the cycle of hydrological and meteorological conditions, which may result in flooding in the year. It can provide basic guidance as to programmes of preparation and maintenance, in flood management. The basic information can be obtained from long term rainfall and river records, giving:

Box 2.6 Development of community based disaster maps in Mozambique

Matasse is a rural community of some 2,000 people threatened by flooding from the nearby Save River. In 2001, the Mozambique Red Cross (CVM) undertook a pilot project there in community-based disaster preparedness (CBDP) with support from the Danish Red Cross. CVM emphasises the importance of respecting local tradition and involving community members in data collection, risk mapping and planning, if such projects are to succeed. So, after making contact with the District authorities and local Red Cross committee, the team approached Matasse's Headmen to explain the purpose of the proposed project. Community meetings followed to describe the project and recruit volunteers.

The community volunteers were then trained to analyse potential hazards and identify ways of preparing the community to save lives and secure livelihoods. This training was soon put to use in drawing up a history of disasters and a seasonal calendar of the area. The earliest disaster in the collective memory was flooding in 1939, followed by a pattern of drought and flood up to the present, including floods in 1999 and 2000. The disaster history also recorded how people coped in past disasters. The seasonal calendar indicated periods in the year when the population was most vulnerable to poverty and health risks.

The Red Cross team then led a transect walk with community members across the area at risk, visually identifying its physical features. On the basis of this, they mapped existing resources, infrastructure and possible risks and hazards, plotting details with a GPS (satellite-based global positioning system). Risk maps were then created using GIS (geographic information system) technology introduced by the Danish team members. The maps covered residential and farming areas and identified those most at risk from flooding, as well as the best places of refuge. Community involvement in the project helped to identify a series of objectives relevant to the real situation in Matasse and the priorities of its population: planning of mitigation activities; recruitment and training of new volunteers; improvement of wells; participation in rescue training; and distribution of radios to improve early warning.

Priority mitigation activities include planting trees to halt erosion near the riverbank, and constructing a multi-purpose community hall in a secure location to serve as a store for pre-positioned relief stocks and household goods in the event of disaster. The hall would also serve as a community meeting centre. Conscious that one organisation or community alone cannot bear the burden of disaster preparedness, CVM is mobilising support from other agencies for these activities. As a result, CARE is co-operating in the improvement of wells, the International Federation is helping with rescue training, and FEWSNET (Famine Early Warning System Network) is providing radios to Red Cross volunteers. Figure 2.7 shows an example of a community produced flood map.

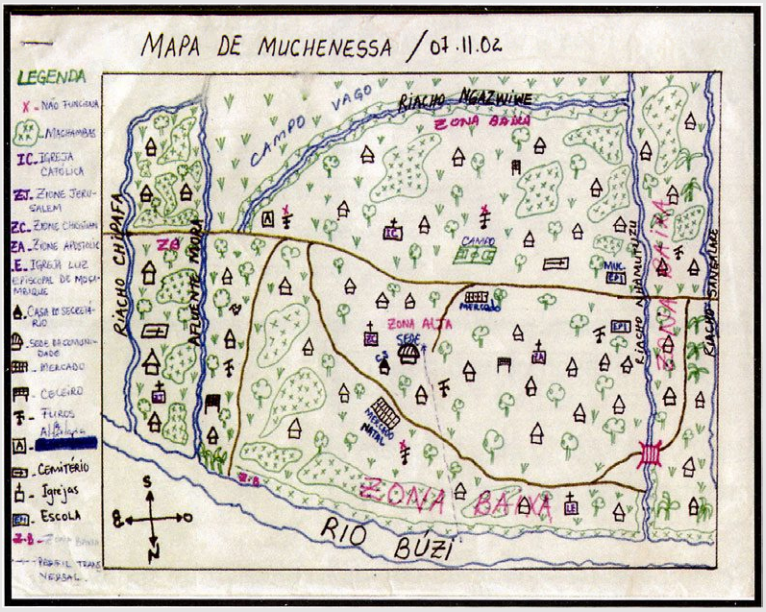


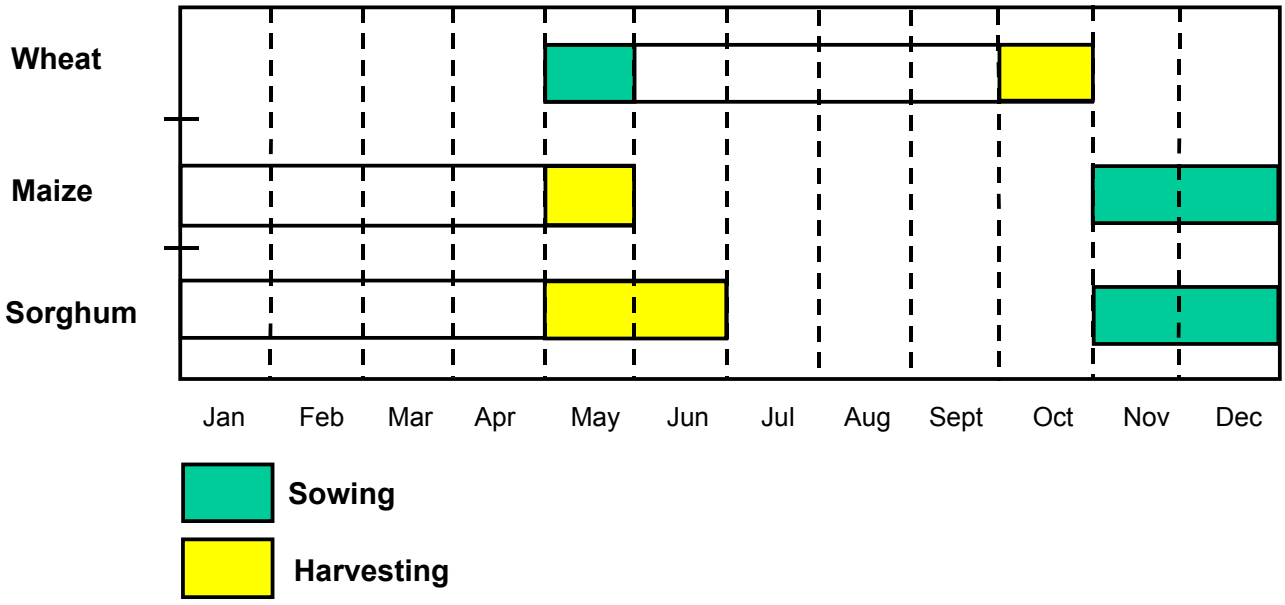
Figure 2.7 An example of a community produced flood risk map
(Source: Reference 7)

A maize crop in the USA damaged by flooding from the Mississippi River.

- Monthly rainfall totals;
- Maximum daily rainfalls and their month of occurrence;
- Monthly average flows;
- Dates and maximum flows of peak historic floods.

The calendar can be best presented as a wall chart or computer graphic. For rural communities, the relationship of the flood calendar to the agricultural activity calendar is of key importance. Using the two in combination, the high-risk periods such as planting and harvest can be identified.

Information to prepare the graph is provided by government agencies, but local knowledge is important to identify particular conditions which heighten risk, for example late rains, critical phases of the crop cycle. Community level activity should be encouraged to prepare a suitable version of the seasonal calendar, which can be disseminated locally. A typical crop calendar for Mozambique is shown in Figure 2.8.



(Source: Reference 8)

Figure 2.8 Typical crop calendar for Mozambique

2.6.3 Raising and maintaining flood awareness in communities

It is important that flood awareness campaigns, are carried out periodically to maintain and renew awareness. They must also be carefully planned to attain a critical mass of public interest.

It is important that an awareness of flooding is maintained in communities who are at risk. This activity is generally carried out by local authorities and NGOs. This can be done by:

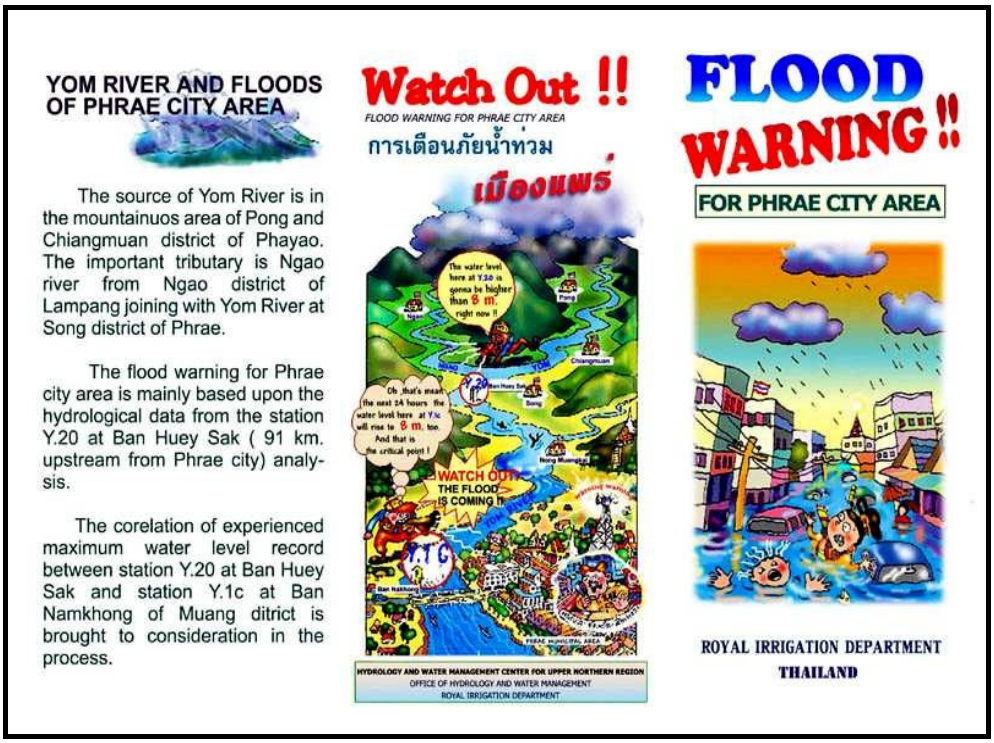
- Public meetings. The posters and booklets produced by this project could be explained at the meetings and then left as a permanent reminder of flood information;
- Educational activities in schools;
- Theatre and drama.

It is important to be sensitive to local language, literacy and culture issues. If, for example, women are reluctant to speak at public meetings, separate meetings should be held just for women to enable

them to express their views. Figure 2.9 shows an example of a community meeting to describe flood evacuation routes. Figure 2.10 shows material that is used in Thailand to raise flood awareness. Boxes 2.7 and 2.8 provide details of how flood awareness is maintained in Sudan and Australia respectively.

(Source: Reference 9)

Figure 2.9 Example of a community meeting



(Source: Reference 10)

Figure 2.10 Material used to raise awareness of flooding for communities in Thailand

Box 2.7 Community based flood mitigation and preparedness project in Sudan

Recent floods in Kassala State in Sudan, shown in Figure 2.11, affected more than 200,000 people and caused extensive damage to houses and belongings. A project has recently been launched by the Sudanese Red Crescent in Sudan that focuses on community based training in flood risk reduction, community risk mapping and the development of local risk reduction plans in three flood prone areas of the country.

The main objective of the project is to reduce the risk in selected flood prone areas in Sudan through the introduction and development of effective preparedness and mitigation measures. The specific objectives of the project are:

- To improve the co-ordination and collaboration and promote the development of partnerships between key stakeholders in Sudan active in the field of (flood) risk reduction;
- To strengthen the capacity of local organisations in disaster preparedness and micro-mitigation;
- To increase the awareness of local communities on the risks related to flooding and promote self-reliance in flood risk reduction.

Figure 2.11 Flooding in Kassala State, Sudan

The main outputs from the project are as follows:

- The organisation of a national workshop on flood risk reduction involving all major stakeholders;
- The development of a dialogue between humanitarian actors and local private companies on how to reduce commercial losses to floods more effectively;
- The development of a disaster preparedness training manual (in Arabic and English);
- The establishment of National and Regional working groups on floods;
- Community awareness sessions, training on flood risk reduction, risk mapping, and the development of local flood risk reduction action plans. Seminars with local authorities and NGOs;
- Provision of digging and plastering equipment to “at risk” communities to increase local resilience to floods.

(Source: Reference 11)

2.6.4 Use of historical flood marks to maintain awareness

Flood marks are an important way of maintaining local knowledge of the extent of past flooding. In particular, they provide an immediate visual reference of flood impact. If maintained over a long term, they will give information that may be lost to other sources, or forgotten by local residents. Communities should be encouraged to record flood marks, as they may have the most direct experience of the event. They should also have the responsibility to maintain flood marks, and use them to raise awareness of flooding. Box 2.9 provides details of sources of information that can be used for flood marks. Box 2.10 provides guidance on the preparation of flood marks.

Box 2.8 An example of flood awareness raising in Australia

Many towns in Australia regularly plan for natural emergencies such as fires, storm and flood. The town of Lismore located on the Richmond River in New South Wales has been subject to flooding for the past hundred years

The FloodSafe week is held on an annual basis in the town of Lismore following serious flooding in 2001. The first week of February is designated as FloodSafe Week in Lismore. The local authorities have combined their efforts to highlight flood safety issues and plan a number of activities each year. These include:

- Roadside information sessions so that residents can ask questions about flooding;
- Distributing brochures and 'personal flood kits' to over 3,000 houses on the floodplain.

Information sessions, held in Lismore have proved a valuable reminder for residents not to be complacent about flooding. In 2004 Lismore Council won the local government category in the New South Wales Safer Communities Awards. The mayor of the town, on receiving the award, said, "The success of Flood Awareness Week can be shared among all groups that participated. As a community, we have learned an enormous amount from the 2001 floods. The task ahead is to make sure that we remain flood-ready. We have been very pleased to see the idea adopted in other river catchments". Information provide by Lismore Council is shown in Figure 2.12.

Figure 2.12 Information produced for Lismore's FloodSafe campaign

(Source: Reference 12)

Box 2.9 Sources of information on historical flood levels

- Flood level marks (for example, paint, waterproof chalk or road crayon mark made on a wall, post, door or road, indicating peak water level). The more permanent these are, the better, for example a groove chiselled in concrete is better than a painted mark;
- Anecdotal information provided by residents as to water depths above, or distances below, fixed objects (for example above floor level, door steps, window sills, blocks on a wall);
- Trash marks (e.g., damage lines on walls or wallpaper in houses, or debris such as grass or plastic bags carried in the flood and caught on the banks or in a tree);
- Photographs taken during floods from which levels can be determined, or of trash marks after floods.

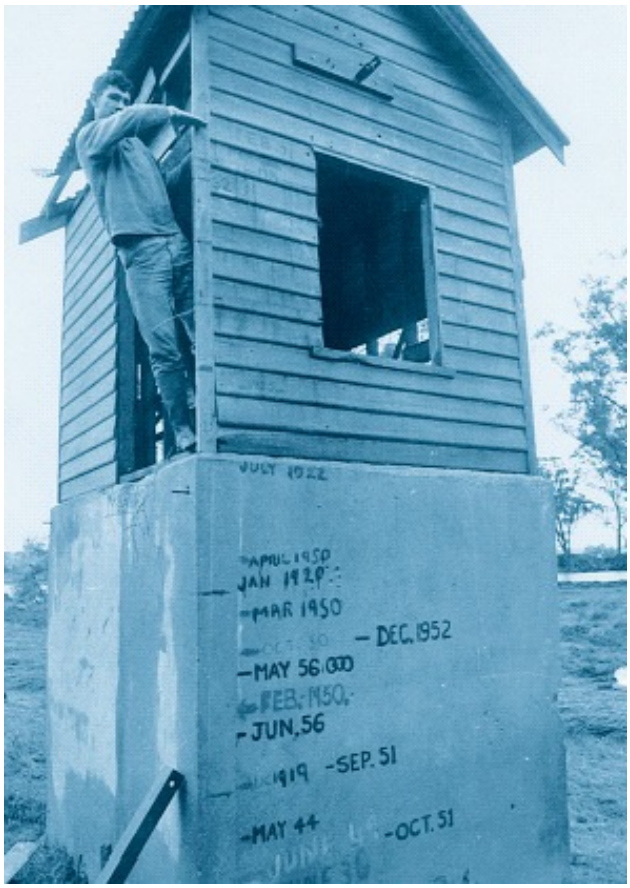
Box 2.10 Guidance for the preparation of flood marks

- Flood marks should be painted or carved as a line on a concrete or stone structure, to record the maximum height of the flood;
- The line should be dated, by day, month and year;
- The mark should be place on a permanent feature, for example a rock, a building, on a bridge parapet, or a purpose-built column;
- The location of the flood mark should be accessible and visible, so needs to be maintained, for example repainted;
- Flood marks must be updated from local observations with each major flood, whether or not they exceed previous maxima.

Typical examples of historical flood marks are shown in Figures 2.13 and 2.14.

Figure 2.13 Flood marks on a building in Canada

Figures 2.15 shows the use of a flood mark in a rural area and Figure 2.16 shows how flood marks can be used in maintaining flood awareness.



(Source: Reference 13)

Figure 2.14 Pump shed with flood marks in the Snowy River floodplain, Australia with the February 1971 flood level being shown

(Source: Reference 9)

Figure 2.15 Example of placing a flood mark on a rural building

Figure 2.16 Use of flood marks to maintain awareness

3. FLOOD FORECASTING AND WARNING

3.1 DEVELOPMENT AND MAINTENANCE OF A NATIONAL FLOOD FORECASTING AND WARNING SYSTEM

The purpose of a national flood forecasting and warning system is to provide as much advance notice as possible of an impending flood. Over time, the demands for flood forecasts often change from a simple indication of the likelihood of flooding to an accurate prediction of magnitude and timing.

Flood forecasting is a process whereby the authorities are alerted to impending conditions where floods may be likely. Flood forecasting requires understanding of meteorological and hydrological conditions, and is therefore the responsibility of the appropriate government agencies. National organisation is required, but information needs to be made available at a river basin scale. This allows forecasting to integrate with flood warning arrangements. To examine the capability for flood forecasting, the following should be investigated.

- What are the arrangements for flood forecasting, and what government services are involved?
- Is the flood forecasting operation linked to surrounding countries, especially where shared river basins are concerned?
- Does the meteorological service have access to international data and forecasts, weather satellite and weather radar information?
- What is the status of the hydrometric network (rain gauges and water level), that could be used in a forecasting system?

After reviewing the above, a needs assessment should be conducted to establish what is required to provide a real time flood forecasting system. This essentially requires:

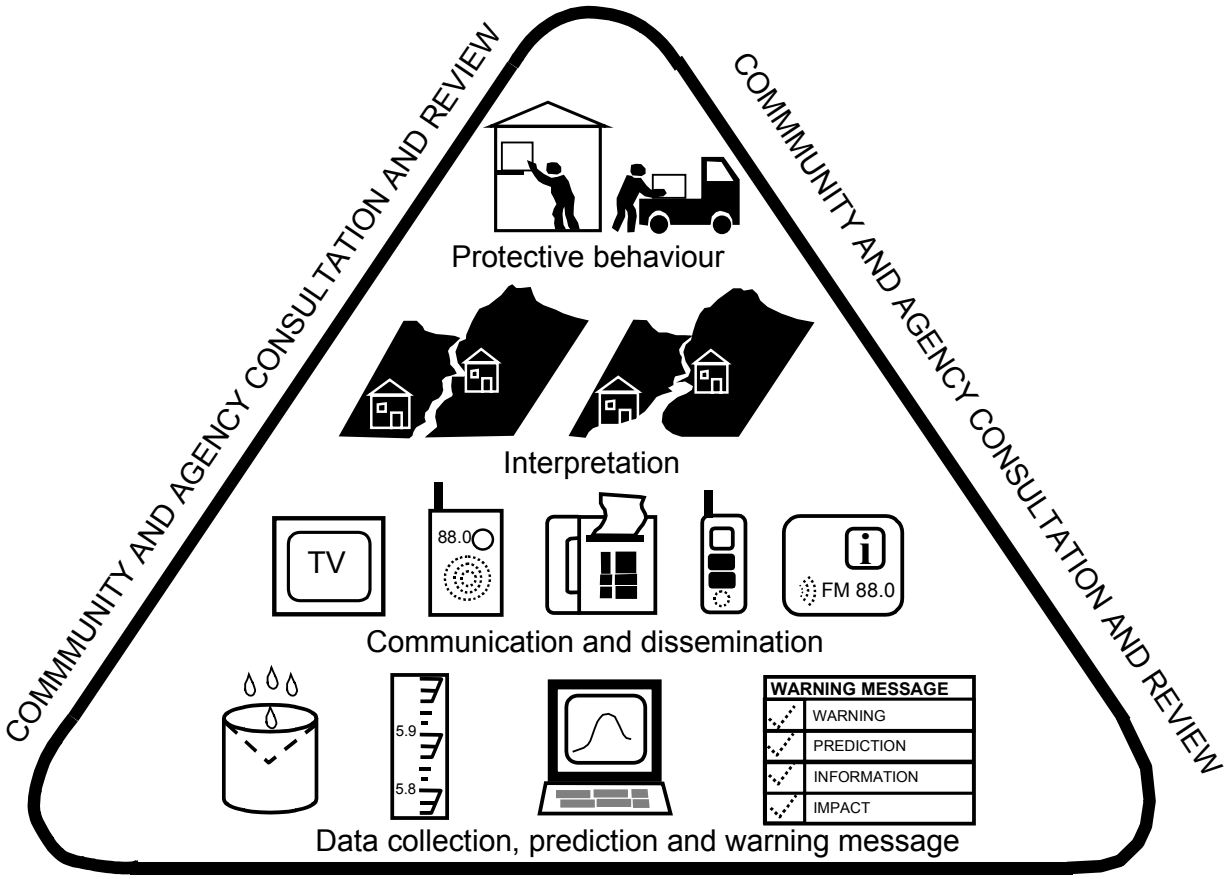
- Establishment of a network of manual or automatic hydrometric stations, linked to a central control by radio or telemetry;
- Flood forecasting model software, linked to the observing network, and operating in real time.

To be effective the modelling software has to be designed and calibrated through a period of hydrological monitoring and study. The system requires regular performance review and re-calibration, so as well as capital costs, the recurrent costs for operation and maintenance of the system need to be taken into account.

The main components of a national flood forecasting and warning system are as follows:

1. Collection of real-time data and prediction of flood severity and time of onset of particular levels of flooding;
2. Preparation of warning messages describing what is happening, predictions of what will happen and expected impact. Messages can also include what action should be taken;
3. The communication and dissemination of such messages;
4. Interpretation of the predictions and other flood information to determine flood impacts on communities;
5. Response to the warnings by the agencies involved and communities;
6. Reviews of the warning system and improvements to the system after flood events.

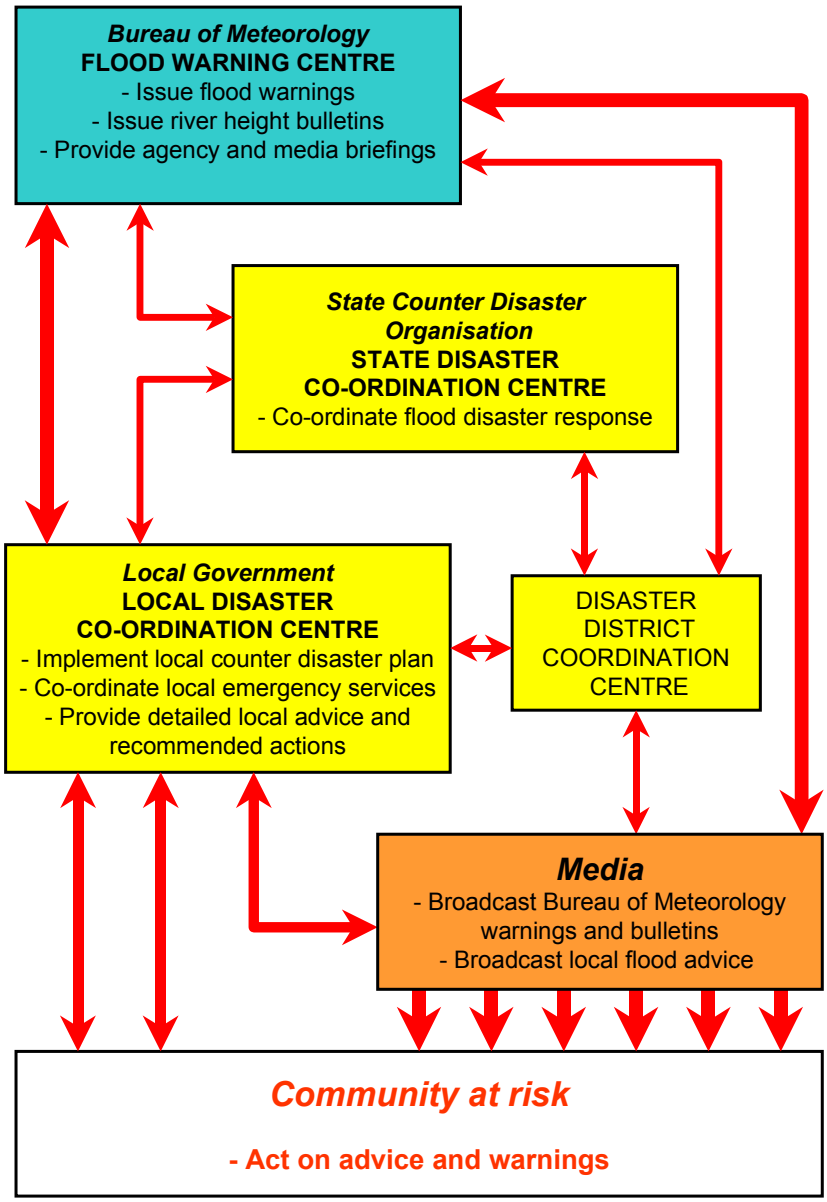
These components are shown in Figure 3.1. For a flood warning system to work effectively, these components must all be present and they must be integrated rather than operating in isolation from each other.



(Source: Reference 13)

Figure 3.1 The main elements of a flood forecasting and warning system

Figure 3.2 shows the set up for flood forecasting and warning procedures in Australia. The procedures shown in this diagram are similar all over the world.



(Source: Reference 14)

Figure 3.2 Example of the roles and responsibilities within a flood warning system in Australia

3.2 METHOD FOR PROVIDING FLOOD FORECASTS

Within the framework of a national flood forecasting system, the specific needs for a range of catchment types and sizes have to be met. General decisions are required on:

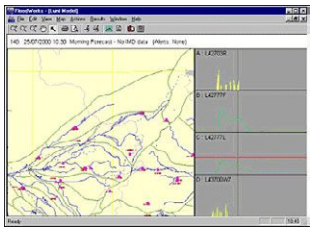
- What is the minimum lead-time that is required, i.e. the time required to produce and implement warnings?
- Is a complex or simple and robust system required?

In general, if large basins with slow flood build up are involved, relatively simple systems for observation, data transfer and forecast model are adequate. This would entail:

- Manual observation of rainfall and water level;

- Reporting of data at set intervals by telephone or radio;
- Forecast of river level to be carried out by time of travel and level-to-level correlations.

Where river response times are shorter, or there is high value associated with risk, for example a major conurbation, or remoteness prevents the use of manual instruments, the requirements would be for:



Example of a flood forecasting computer model.

- Automatic recording instruments and sensors;
- Data to be transferred automatically (telemetry) from instrument to operations centre, at frequent, regular intervals (hourly or sub-hourly);
- Automatic checking and reporting systems for data;
- Automatic input into forecast model.

The forecast model will comprise:

- A rainfall-runoff hydrological model that will convert actual or forecast rainfall to river flows;
- A routing or hydrodynamic model which transfers flows through a model of the river system.

The rainfall-runoff model is required to convert rainfall quantities and distribution over time (rainfall or storm profile) into river flow. The latter requires conversion of flow rate to river level, via a rating relationship at known river cross-sections. The hydrodynamic model requires calibration at successive points to reproduce time of travel and changes to peak levels. Cross-section measurements of the river channel and floodplain are required for this, at varying levels of precision. Box 3.1 provides details of a flood forecasting and warning system for KwaZulu- Natal in South Africa.

Box 3.1 Example of a flood forecasting system for the cities of Durban and Pietermaritzburg in South Africa

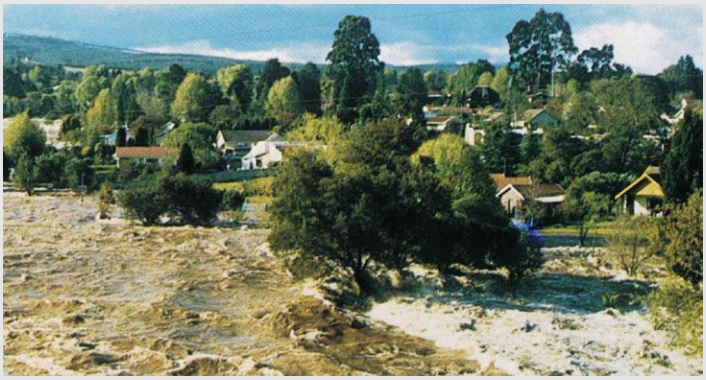


Figure 3.3 Flooding in KwaZulu-Natal in 1987

In South Africa, five flood events during the period 1994 to 1996 resulted in the loss of 173 lives, more than 7,000 people requiring evacuation and/or emergency shelter and damages to the value of US$100 million. The South African Disaster Management Bill provides for "...preventing or reducing the risk of disasters, mitigating the severity of disasters ...". To this end a pilot study funded by the South African Water Research Commission aims at providing flood forecasts for the Mgeni and Mlazi catchments near the city of Durban in South Africa.

The importance and usefulness of flood forecasting is particularly evident in an urban context where the density of population and infrastructure provide great potential for disaster. A reliable flood warning or forecasting system cannot prevent the occurrence of floods, but provides a key tool that can allow decision makers to be proactive rather than reactive in their response to a flooding event. Taking preventative measures before the fact can significantly reduce the social and economic impacts associated with a disaster.

(Source: Reference 15)

3.3 FLOOD WARNING

3.3.1 Preparation of national flood warning messages

Flood warnings are distinct from forecasts, as they are issued when an event is occurring, or is imminent. Flood warnings must be issued to a range of users, for various purposes. These include:

- Bringing operational teams and emergency personnel to a state of readiness;
- Warning the public of the timing and location of the event;
- Warning as to likely impacts on for example roads, dwellings, flood defence structures;
- Giving individuals and organisations time to take preparatory action;
- In extreme cases to give warning to prepare for evacuation and emergency procedures.

Early warning of a flood may save lives, livestock and property. Almost all damage can be reduced if people have more time to save their goods and take proper precautions. Flood warnings need to be understood quickly and clearly. Written statements must be of standard format. Verbal and written warnings should be in the appropriate local languages and therefore translation will be needed, particularly for large international river basins.

A flood warning turns a prediction or forecast into information in the form of an action statement. The purpose is to improve safety and reduce damages. They do this by communicating information to those at risk to take action to improve their safety and reduce damages: to enable individuals and communities to respond appropriately to a threat in order to reduce the risk of death, injury, property loss and damage.

The wording used in messages for broadcasters and non-specialists should be simple, but definitive. For example: *"A severe depression is passing over the north-east coasts later this evening"*, is meaningless at a community level. A better message would be: *"Heavy rainfall is expected tonight over the coastal highlands. Expect rivers to rise rapidly and flooding may occur."*

Pictorial codes are essential for better understanding of public service outputs, for example from radio and television, especially where literacy levels are low. The following process is recommended for developing flood warning messages for use in flood emergencies.

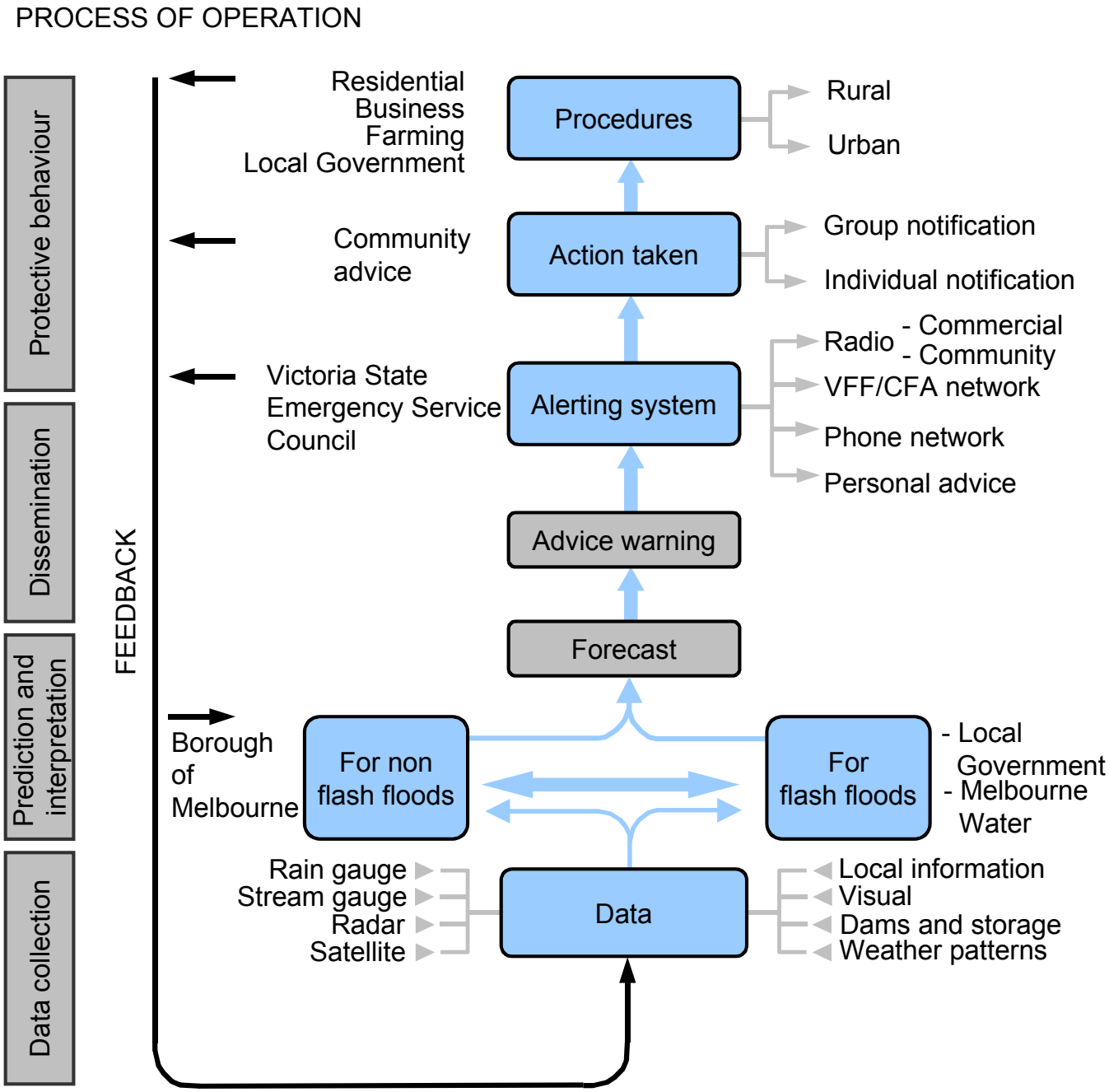
- Are standard warning messages used? If not develop suitable messages;
- Provide explanation of messages and content for various users;
- Develop system of pictograms and symbols for warning levels.

Flood warnings need to state clearly:

- The location or area at risk;
- The time that the flood is expected;
- The maximum water level anticipated (forecast);
- The expected duration for which flood levels are likely to remain above critical levels.

One way of expressing the expected magnitude of a flood is to compare it with previous floods that are likely to be in the living memory of recipients. Figure 3.4 illustrates a method for disseminating flood

warnings in Australia. Box 3.2 provides examples of the flood warning messages used in England and Wales.



(Source: Reference 13)

Figure 3.4 Process of operation for a flood warning system in Australia

Box 3.2 Examples of national flood warnings used in England and Wales

The move to a new system was prompted by the floods that occurred in England in 1998. A report, which followed, highlighted the need for better communication with the public on flooding, especially with regard to providing clearer flood warnings. These would replace the colour codes, which the report showed were confusing and misunderstood '*by nearly ll who received them*'.

FLOOD WATCH

This is the first stage of the warning. If your area is issued with a flood watch it means there is the possibility of some flooding. You're advised to keep a close eye on local radio or television reports, alert your neighbours, watch water levels, check on your pets, reconsider any travel plans, make sure you can put your flood plan into action, and ring the flood information telephone line for further information and advice.

Flood Warning

If a flood warning is issued in your area, it means flooding is expected and will cause disruption. You are advised at this stage to move pets, vehicles, food, valuables, and other items to safety, be prepared to turn off the gas and electricity, be ready to evacuate your home, and put sandbags or flood boards in place to protect your home.

Severe Flood Warning

This is the warning issued when serious flooding is expected and there is imminent danger to life and property. If your warning is upgraded to this you should be prepared for your gas, electricity, water, and telephone supplies being lost, you're advised to keep calm and reassure others, and co-operate with the emergency services.

All Clear

This is issued when the flood water levels are going down and no flood watches or warnings are in force any longer. At this stage you can check it is safe to return home.

(Source: Reference 16)

3.3.2 Reasons for failure of flood warning messages

There is a considerable volume of research regarding the reasons for failure of flood warnings. Box 3.3 summarises the reasons. The reasons are classified according to whether a "shared meaning" between the authority issuing the warning and the public has been achieved. "Shared meaning" may be difficult to achieve because sections of the population did not receive the warning or because language barriers exist. Where "shared meaning" is achieved, people may still not evacuate because they are not risk adverse, because they do not believe the warnings or because they have some impediment to evacuation such

as lack of mobility. Box 3.4 gives an example of ignored flood warnings in Botswana.

Box 3.3 Reasons why flood warnings fail or appear to fail

Shared meaning of the flood warnings exists but is of limited value:

- Some people are not flood risk averse and hence although the warnings are understood they are ignored or even taken as a challenge;
- Other priorities may interfere with people's immediate response to the warning message, for example people may be unlikely to respond until all the whereabouts of their household members are established;
- Other signals, such as the actions of neighbours or weather, may contradict the official warning. People often seek confirmation of a flood event before they act;
- Some people have an aversion to following authority and may ignore official advice. In many cases people are disinclined to follow orders preferring to make their own decisions based on the information in front of them;
- Some people cannot respond and hence warnings have no value for them for example they may lack the physical or mental capacity to respond, or they may be absent;
- Some of those at risk may not be worried about flooding until they suffer a loss.

Shared meaning of the flood warning is difficult to achieve:

- In many cases the population at risk will be very diverse. This diversity may mean that there are different priorities, languages and levels of understanding of the flood warning;
- Some groups of people may not receive any warnings even when the system appears to be perfect;
- Informal personal warning networks may reinforce, undermine or deflect official communications.

(Source: Reference 17)

Box 3.4 Report from Botswana Daily News of ignored flood warnings

In a style reminiscent of Jao Flats residents, another tiny island community of Xaxaba, situated deep in the Okavango Delta, has turned down advice from authorities in the North West District to flee the impending Okavango River floods. In a meeting addressed by members of the disaster management committee to warn them of the raging floods the residents said they would rather "wait and see what happens" than leave the land of their ancestors. Instead, they requested to be provided with tents and boats or canoes for use should the need arise. They added that they were not threatened by the floods, which they regard as normal.

At the sister Jao Flats island in the delta, authorities failed for the fourth time to convince the community to move to safer areas despite the fact that the floods had already encircled their tiny island. Even MP Joseph Kavindma's advice could not sway them as they took turns to dismiss authorities' warning as alarmist. Kavindama had told his constituents of how government was concerned about their lives, saying it would reflect badly on government if they were left to drown. He added that the residents must be careful not to make wrong decisions that might not augur well for their children. But still they would not be moved.

They told the gathering that they had existed on the island for ages. They had seen good and worse situations come and go and, above all they know the behaviour and character of the Okavango River. Tholego Motswai said only if the situation would be of the magnitude of the biblical "Noah's flood" then there was cause for alarm, adding that even in that situation she would choose to die on the island, to join her ancestors. To show that indeed the floods were not an issue to them and therefore a non-starter, Dihawa Tuelo chose to become irrelevant by asking about the formation of the long awaited community trust in their settlement, saying there were more pressing issues to discuss.

David Nthaba said it was too early to suggest that there could be any floods, adding that there were land marks such as trees that they used over ages to gauge the intensity of floods, as such there was no chance that the water could catch them unawares. Another unidentified speaker queried why in the past government did not intervene in similar situations, saying he suspected a sinister motive. Other speakers, demanding to be left alone, said they could handle a flood disaster without government intervention. Only two residents seemed perturbed by the warnings as they told the authorities that they were ready to move to a higher, safer ground. District Commissioner Badumetse Hobona agreed to supply tents as per the residents' requests and terms but warned that time was running out for the obstinate.

(Source: Reference 18)

3.4 COMMUNITY BASED FLOOD FORECASTING AND WARNING SYSTEMS

Operating an early warning system needs money to pay and train flood monitors and to provide co-ordinators with bicycles, radio batteries and mobile phones.

Flood warnings should originate from a single source that has the knowledge to produce the warning, for example the river basin management agency. However, they are not able to control the deliver of warnings to all potential users. There must therefore be a clear process of passing on warning messages and the following questions should be addressed:

- Is there a clear standing arrangement for delivery of warnings from the river basin agency to other government departments?
- Are there clear standing arrangements for delivery of warnings to individual communities?
- Do receiving organisations have standing orders for actions that are required on receipt of warnings?
- What arrangements exist for providing warnings to broadcast media, especially radio and television?

These systems need to be periodically reviewed to see if material and arrangements remain appropriate. In particular the performance of warning delivery, receipt and action needs to be reviewed after each major event. If necessary, simulation exercises should be undertaken.

It is important that the people in each community receive information as early as possible about the possibility of flooding in their area. In addition to the valuable information from the official flood warning system, communities should attempt to develop their own warning systems.
At community level, it is important that warnings are received by all individuals. The way in which messages are disseminated in communities will depend on local conditions, but may include some or all of the following:

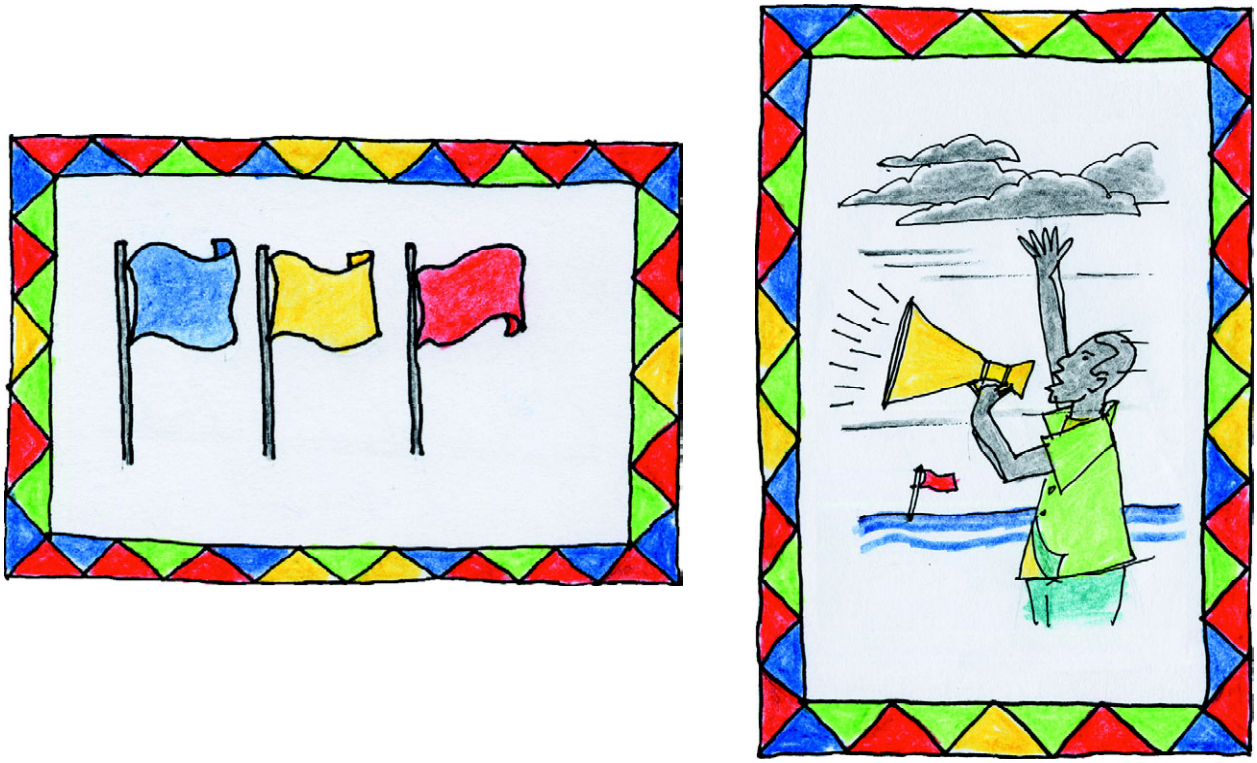
Early warning needs trust. Predicting a flood is only part of the process. Communities must trust the warnings before they will move. Involving community leaders in the early warning chain will help.

- Media warnings;
- General warning indicators, for example sirens;
- Warnings delivered to areas by community leaders or emergency services;
- Dedicated automatic telephone warnings to at-risk properties;
- Information about flooding and flood conditions in communities upstream. One approach to disseminating messages is to pass warning messages from village to village as the flood moves downstream;
- Keep watch and be regularly informed about the river level and embankment conditions in the local area. The frequency of the river and embankment watches should be increased as the flood height increases and crosses the critical danger level;
- A community-based warning system to pass any information about a coming flood to every family.

A community-based warning system should be developed and implemented by communities, and may include the following types of actions:

- Having a system to obtain information about the rise of river water and flooding from communities upstream and a way to pass the information to the next community downstream;
- Having a system for listening to the radio and passing flood information to every family;
- Ensuring that there is a network of people who will receive warnings about flood conditions and disseminate them within the community;
- Conveying information that may be useful to neighbours, but be careful that the information is correct so as not to pass rumours.

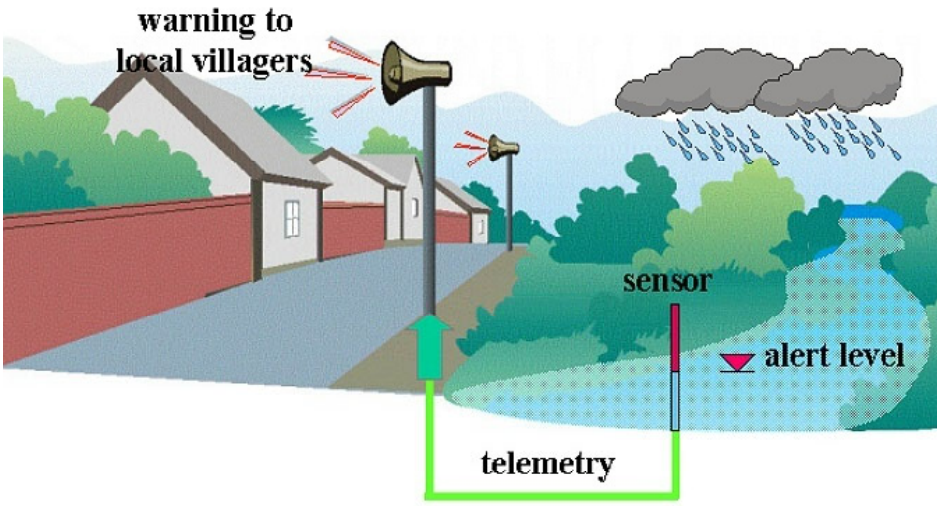
Figure 3.5 provides methods used for cyclone and flood warnings in Mozambique.



(Source: Reference 9)

Figure 3.5 Examples of flood warning signals

Figure 3.6 shows a simple community based flood warning system used in Hong Kong.



(Source: Reference 19)

Figure 3.6 Local flood warning system used in Hong Kong

3.4.1 Involvement of communities in data collection and local flood warning systems

If communities become involved in data collection for flood forecasting, and the importance of their role is understood, a sense of ownership is developed. Individuals can be appointed for the following tasks:

- Caretakers of installations;
- Be trained as gauge readers for manual instruments (rain gauges, water level recorders);
- Radio operators to report real-time observations.

Gauge readers and observers perform a two-way role. As well as reporting information, they can use their local knowledge and understanding to report conditions. They also can have an important role in receiving information from headquarters to pass on to the community.

Trained individuals within the community should be able to gather and update information to:

- Know the depth of past severe floods in the local area;
- Know the causes of flooding in the local area;
- Know how quickly the waters might rise;
- Know how long the floodwaters might remain in the locality;

- Know the direction of movement of the floodwaters.

The involvement of members of the community also helps to prevent vandalism and damage to installations going unreported. To maintain this support, local appointees need to be paid a salary or a small retainer. Box 3.5 provides an example from the USA to establish the viability of setting up a community based flood warning system.

Box 3.5 Example of determining the need for a local flood warning system in the USA

In the USA the Office of Hydrologic Development of the National Weather Service has developed a Handbook part of which provides guidance on local flood warning systems. The basic goals of the local flood warning systems are to:

- Reduce the loss of life and property damage caused by flooding;
- Reduce disruption of commerce and human activities.

The techniques for reaching these goals are:

1. Improving and maintaining an effective communication system between "need-to-know" agencies and individuals;
2. Inducing local community involvement and response planning;
3. Educating the public to respond and act accordingly to flash flood forecasts and watches/warnings;
4. Promoting effective floodplain management;
5. Minimise the response time from flash flood warning issuance.

Many of the local flood warning systems in operation in the USA today are manual self-help systems that are inexpensive and simple to operate. The manual self-help system comprises a local data collection system, a community flood co-ordinator, a simple-to-use flood forecast procedure, a communication network to distribute warnings, and a response plan. It has been found that the simplest and least expensive approach to data collection is to recruit volunteer observers to collect rainfall and stream/river stage data. Inexpensive, plastic rain gauges are available from the National Weather Service to volunteer observers who report rainfall amounts to a community flood co-ordinator. The flood co-ordinator maintains the volunteer networks. More sophisticated automated rain gages may be necessary in remote areas or in situations where observers are not available. Stream gauges also vary in sophistication from staff gauges to automatic telemetered gauges.

(Source: Reference 20)

3.4.2 Establish flood watch system including communications

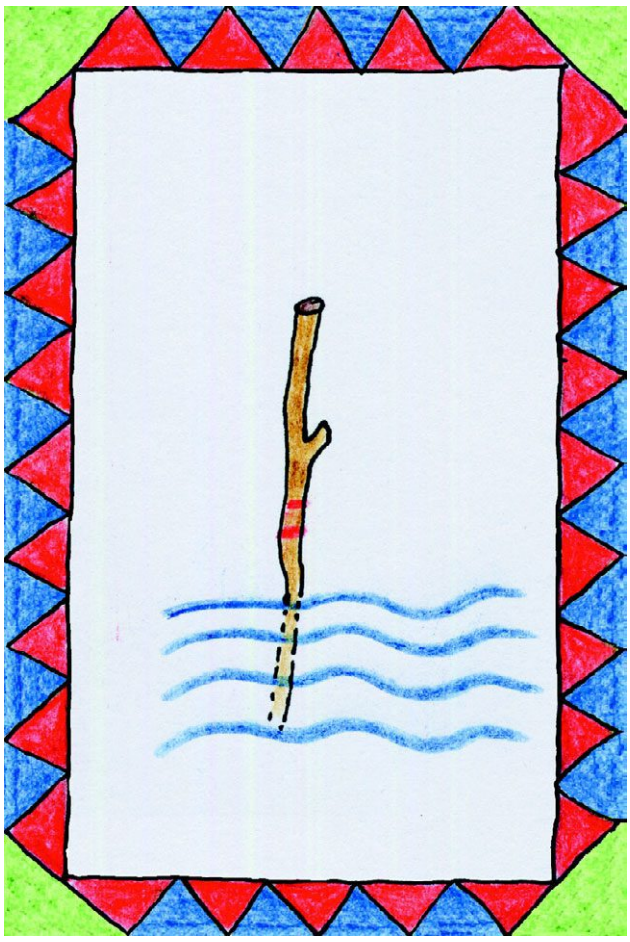
Local flood watch arrangements are very important not only for preparedness of the local community, but to allow the local watchers to provide early information to the authorities on a developing situation. Quite often localised flooding can occur without being picked up by monitoring networks. Local arrangements could include the following:

- Simple rain gauges and river level staff gauges to be read by an appointed individual. Rain gauges are particularly important in flashy catchments where flooding can occur quickly and the maximum warning time is needed;
- Keep watch on the river level and embankment conditions in the local area. The frequency of the river and embankment watches should be increased as the flood height approaches and crosses the critical level;
- Observers to be authorised to give local warnings;

- Observers to be provided with means of communication, for example two way radio, loud-hailer.

In addition, the local observer can make a valuable contribution through local knowledge. Observing general weather conditions, the character of the river, and reactions of animals known to be associated with imminent flooding should be communicated to the authorities.

The local watcher can also have the role of disseminating information to the community. This action has a strong community involvement and can be led by accepted community leaders. There will be a need for appropriate skills to (i) install gauges and provide guidance on the meaning of rainfall depths and river levels, and (b) to read the gauges and interpret the results. In particular, local flood watchers should be aware of whether the river is rising and the rate of the rise. Figure 3.7 shows a simple method of monitoring water levels used in rural parts of southern Africa. Figure 3.8 shows an example of a flood watch system.



(Source: Reference 9)

Figure 3.7 Monitoring river levels in rural area

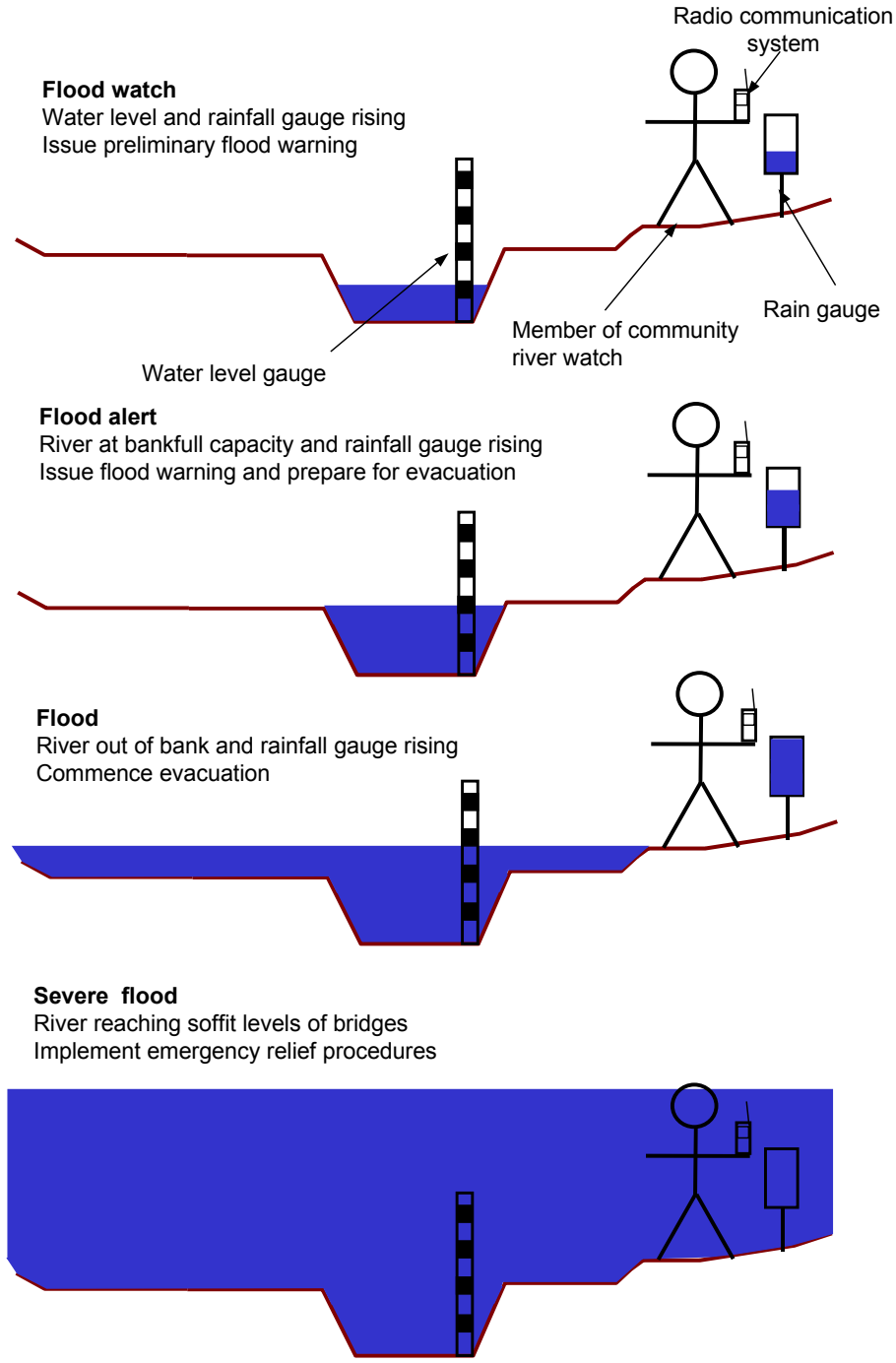


Figure 3.8 Example of a flood watch system

3.4.3 Establish gauges for local flood warning purposes

This action involves the provision of rain and/or water level gauges in communities. These gauges provide measurement of rainfall or water level that can contribute to the overall flood forecasting and warning process. The measurement equipment used should be capable of being read on the spot. These are:

- An accumulating rain gauge, which the observer must measure and record daily, but could be read more frequently, for example during heavy storms.
- A staff gauge measuring water elevation at a convenient point close to the community. This again should be read and recorded daily, but should be read more frequently during flood events.

A typical rain gauge is shown in Figure 3.9.

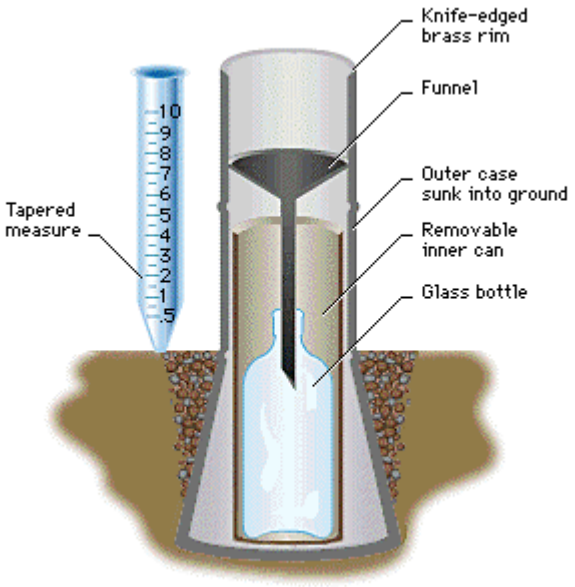


Figure 3.9 Typical rain gauge

Low cost devices are available to provide remote displays and alarm signals, and can be battery powered. This allows the observer to obtain readings without going outside in adverse conditions, which in the case of reading a river gauge in the dark, could also be dangerous. An alarm setting allows information to be noted at any time.

The gauges should be provided through government agencies or NGOs, and must comply with national standards of siting, construction, etc. Observers must be trained competently. Observers using this equipment must have their importance recognised in the community, and receive some financial support. A simple water level gauge is shown in Figure 3.10.

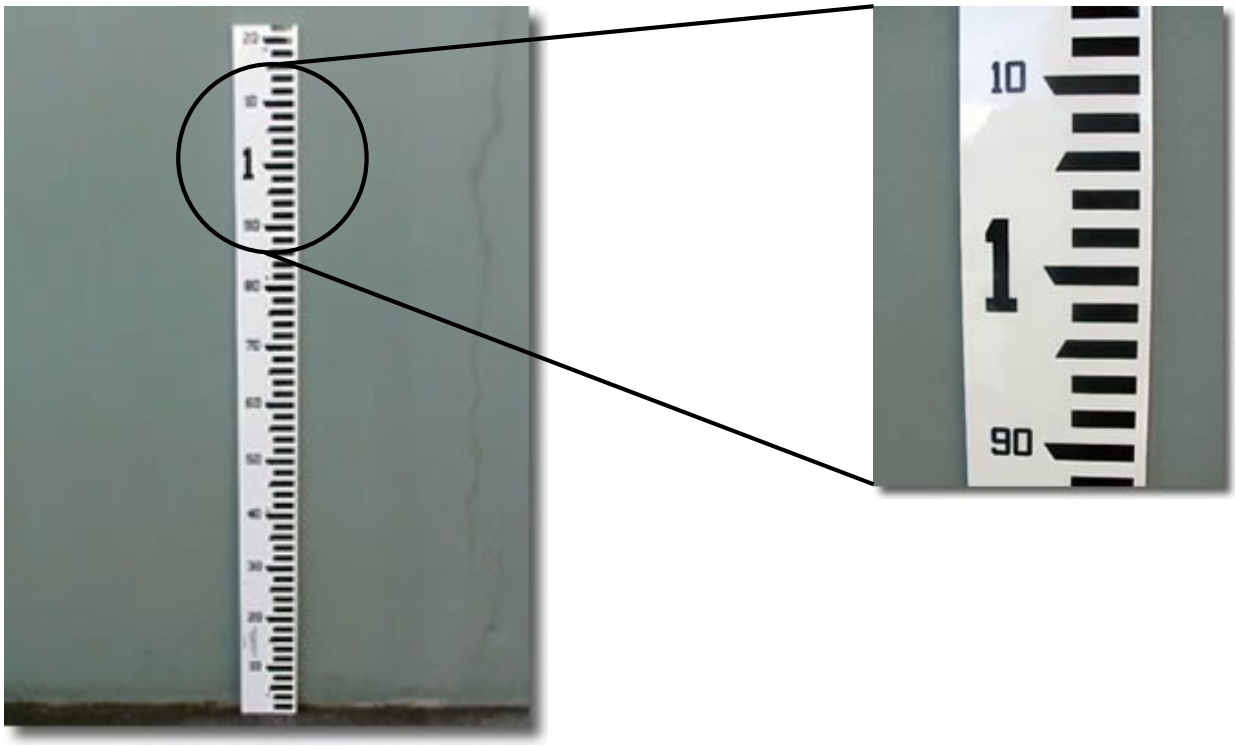


Figure 3.10 Example of a simple water level gauge

3.4.4 Establish trigger levels for action

A trigger level refers to the river level or amount of rainfall that 'triggers' certain actions or provision of information to external users. It is used to decide when to undertake certain actions during a flood event and should be designed to give enough time to undertake the response action.

For example, if a river water level reaches a certain 'trigger level' it might mean that a village will flood in a few hours and the response action could be to evacuate the village.

Triggers relating to rainfall include:

- Accumulations exceeding a threshold in a given time period, for example 100 mm in 12 hours or less. This threshold may need to be changed according to season;
- Rainfall accumulation and catchment wetness conditions;
- Rainfall intensity exceeding a given rate. This is particularly important in urban areas where drainage capacity can be exceeded and flash floods can occur.

Triggers relating to water level include:

- River level rising to within a set warning level, for example 1 m below danger level;
- Rate of rise of level is faster than a threshold level, for example 25 cm per hour.

Triggers have to be established by careful study of local conditions. The advice and knowledge of the local community, if available, is therefore important. Triggers must not be arbitrary, or standard within an organisation, but linked to local conditions. Where levels are concerned, these need to relate to significant happenings, for example:

1. Level at which water flows out of channel onto the floodplain;
2. Level of water which submerges areas of land used by livestock, or low lying roads become flooded;
3. Level where major areas, including residential and business properties, and communications are affected;
4. Level where depth and velocity combined pose a threat of structural damage and danger of loss of life.

Figure 3.11 shows how trigger levels for different levels of flood warning can be set by monitoring water levels.

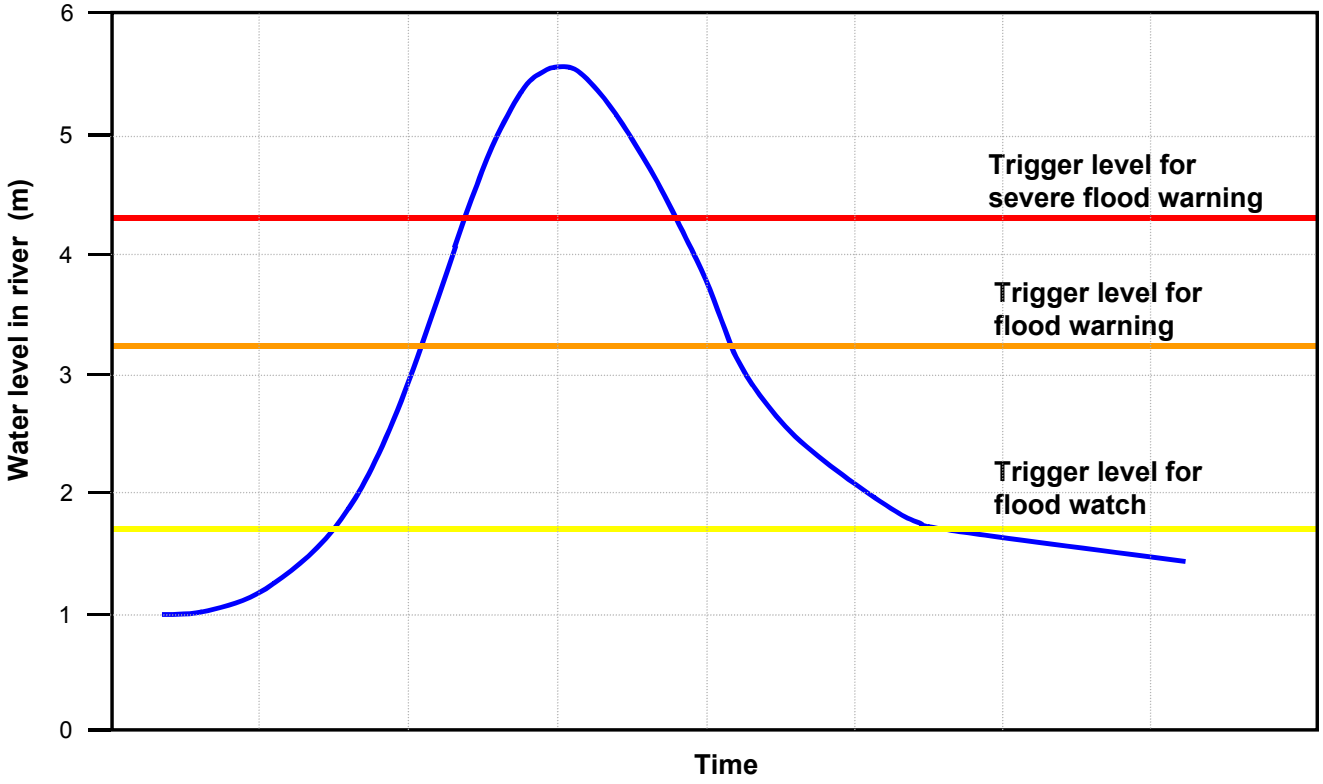


Figure 3.11 Example of the use of trigger levels based on observed water levels

3.5 PROCEDURE FOR DISSEMINATING WARNINGS TO REMOTE AREAS

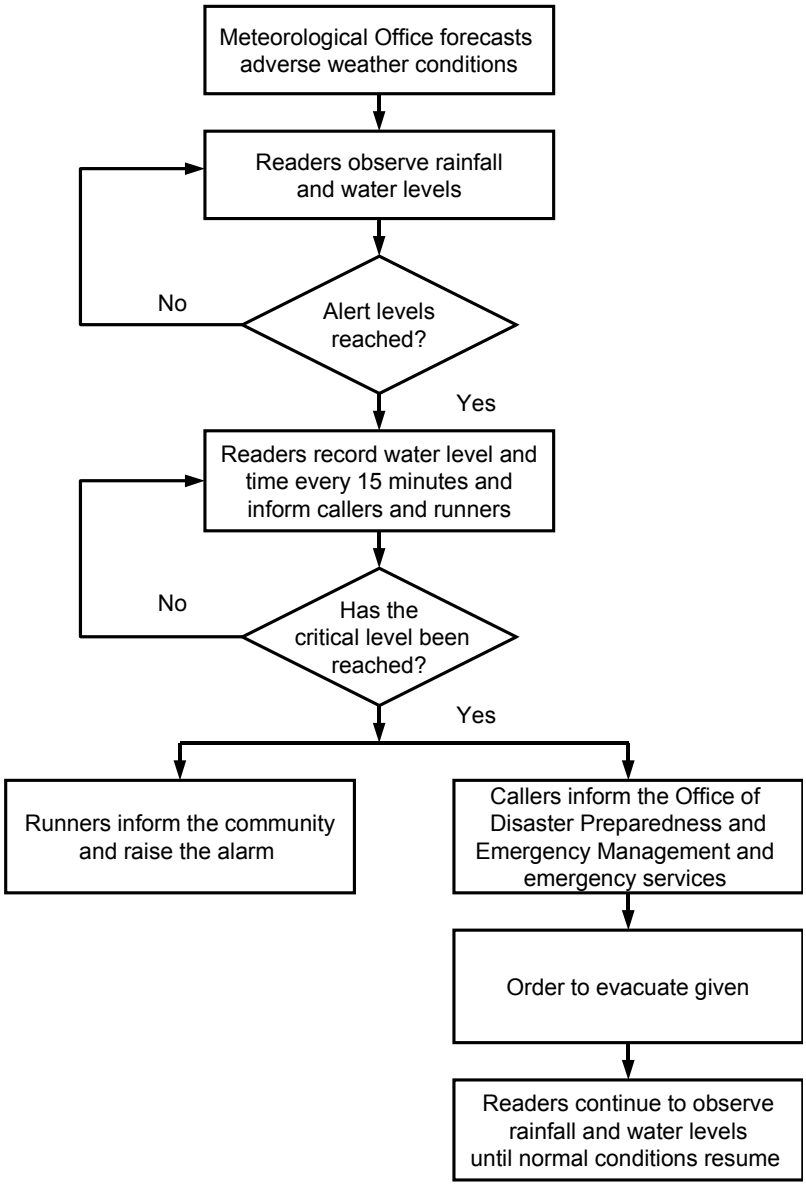
Communities in remote areas may not be able to receive the types of warnings described in the previous section. Clear responsibilities need to be defined for lower tiers of administration and the emergency services to have predefined links with communities in remote areas. This should include:

- Local radio, which should be supplied with clear, accurate information;

Flooding in Jamaica in 2001.

- Use of appointed community wardens with direct two-way radio or mobile telephone access to warning agencies and emergency authorities;
- Local means of raising alarms, for example church bells, sirens, loud hailers. The latter could be the responsibility of selected individuals or wardens, who need to be provided with equipment and transport, for example motor cycles or bicycles;
- "Sky shout" from emergency service helicopters.

The forecasting authorities, for example the meteorological and catchment management agencies need to be aware of remote communities which are at risk. Although it may not be necessary to prepare individual forecasts for these locations, there needs to be an understanding of the effects of severe conditions in a particular locality. An example of the procedures used to disseminate flood warnings to remote areas of Jamaica is shown in Figure 3.12.



(Source: Reference 21)

Figure 3.12 Procedure for issuing warning to rural communities in Jamaica

4. FLOOD PREPAREDNESS MEASURES

4.1 DEVELOPMENT OF FLOOD DEFENCE INFRASTRUCTURE

4.1.1 Main infrastructure

River embankments are very important for flood protection, but may not be suitable for every area because unplanned embankments can themselves cause flooding due to blockages in the drainage system. Other major flood protection structures include dams, gates, diversion channels and sluices.

Local communities need to be made aware of flood defence infrastructure in their immediate locality, and of its importance. This is necessary to discourage interference, damage, or cutting an embankment for access or to relieve local flood problems behind embanked areas.

There are often officials whose job it is to inspect and maintain embankments. It is important that the community has good relations with these people and makes sure that they do their job. There needs to be co-operation between villagers and officials to prevent man-made cuts in the embankment, which may weaken it. Co-operation is required to prevent building on embankments. Figure 4.1 shows a typical flood embankment. Figure 4.2 shows a sacrificial flood embankment on the River Elbe in Germany. This embankment is deliberately breached to allow water to flow into a flood storage area.

Figure 4.1 Flood embankment in the USA

Figure 4.2 Sacrificial embankment on the River Elbe in Germany

4.1.2 Local structural provisions

One type of local flood protection used in Europe is a form of artificial dam. The artificial dam is a long rubber tube with two more tubes inside for stability. It is one metre high, and is inflated with the floodwater using pumps, and works for either river or tidal flooding.

On a more local scale, there are a wide variety of flood management structures. These may include:

- Flood protection bunds around fields or communities;
- Road/rail culverts to convey minor streams and drains;
- Local land drainage and river diversion works, especially for water supply and abstraction purposes;
- Local flood storage areas, to store floodwater from local runoff.

These are all designed to deal with low intensity flooding and, in the case of severe flooding, will be ineffectual, or often damaged. They are often weak points in the local flood protection arrangement, especially if blocked or poorly maintained.

Small scale works and maintenance can be carried out by the community, for example:

- Build-up local embankments to a height above the last flood water level;
- Plant vegetation on the embankments to help stability and reduce erosion;
- Plug rat holes and any other holes, and cracks in gullies.

There is often a need to build temporary embankments or raised areas at times of flood. Sandbagging during emergencies is often vital. Local provisions should therefore include stockpiling of tools for excavation

and embanking, and sandbags or materials for sandbagging. The community must be involved in a positive manner to maintain the integrity of these emergency supplies.

After flooding, communities should be encouraged to report any damage to the embankment for quick repair. The community should also watch on any embankment repairs to ensure that contractors do the repair job correctly.

(Source: Reference 9)

Figure 4.3 Example of a football pitch being used for localised flood attenuation

4.2 RESPONSIBILITY FOR THE OPERATION AND MAINTENANCE OF FLOOD DEFENCE INFRASTRUCTURE

4.2.1 Division of governmental responsibilities

These need to be clearly defined and understood, in order that maintenance and repair responsibilities are identified and supported. Usually, major infrastructure is the responsibility of central or regional government. However, local schemes, either for agricultural or urban areas, may be the responsibility of a local agency or management group. The river basin management agency may be best placed to have the role of assessing overall integrity of embankments, as long as it has the necessary powers to bring about implementation of works.

4.2.2 Local community obligations

The level of community involvement depends very much on local capabilities. It can be very effective in assisting with maintenance and

the management of low intensity flooding. It is important that a community living close to an embankment participates in protecting and maintaining it. The most common causes of weakness in embankments are holes made by rats, steep slopes, and the crossing tracks made by people and animals. People also build houses on the embankments. The other causes of weakness are inappropriate soil (sandy soil), erosion by rainwater or defective construction.

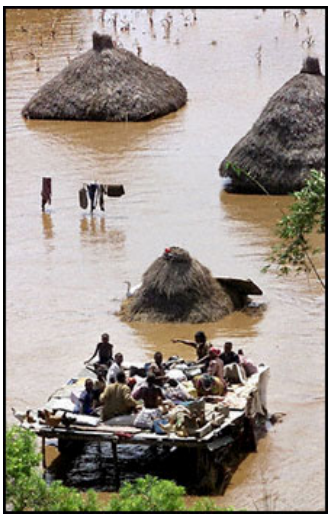
Actions that can be taken to maintain and operate flood defence infrastructure include:

- Plugging holes made by rats and other animals;
- Filling in crossing tracks made by people and animals. Crossing points can be constructed by providing ramps to the top of the embankment, and reinforcing the ramps and embankment using sandbags or other materials to prevent erosion;
- Planting vegetation on embankments to prevent erosion. Trees should not be used as their roots can break up embankments;
- Providing erosion protection at locations where velocities might be high, for example on bends or locations where the embankments are close to the edge of the river channel;
- Keeping culverts and other structures free from blockage by debris or other material;
- Operating gates where these exist for flood control purposes;
- Maintaining a store of repair materials and tools for repair work. Repairs should be carried out before the flood season and also during floods.

There is a need to provide a workforce and finance to undertake this work. As far as possible the work should be carried out by members of the community, particularly during floods.

4.3 PREPARING HOUSES AND OTHER BUILDINGS FOR FLOODS

4.3.1 Use of safe havens



People using the roof of a house as a safe haven during floods in Mozambique.

A safe haven is an area that is constructed so that it will not flood, where people can congregate in times of flood. It could consist of a raised area of earth or a structure made using local materials, for example tree trunks. It should be strong enough to resist the flow of floodwater that is likely to occur in the area where it is constructed.

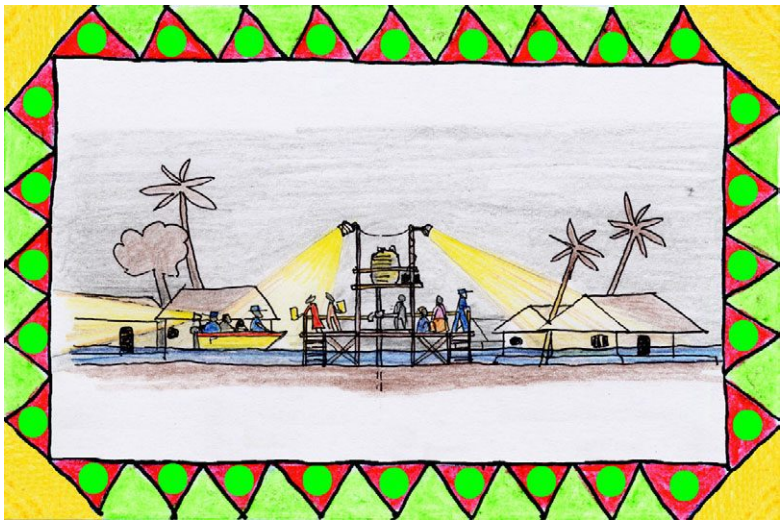
Other types of safe haven include:

- Platforms built inside individual houses;
- Flat roofs of large buildings, for example shops or offices.

A safe haven can provide a temporary or permanent refuge for people during floods, and avoid the need for evacuation, an example is shown in Figure 4.4. A safe haven will require construction materials and the necessary equipment and labour to build it. It should have an alternative use during normal periods, for example as a local market or community centre. The safe haven should as far as possible be constructed by the community but external assistance may be needed,

particularly in the provision of equipment. The community should be aware of the purpose of the safe haven.

A safe haven could be flooded in extreme events, when the flood level exceeds the top level of the safe haven. The community should also be aware that it could occur and know what to do if it does. Either the community should be evacuated, if a very large flood is expected, or boats will be needed to evacuate people once the safe haven is surrounded by water. Box 4.1 provides an example of how safe havens are used in Bangladesh.



(Source: Reference 9)

Figure 4.4 Example of a platform that could be used as a safe haven

Box 4.1 Use of safe havens in Bangladesh

Bangladesh, a low lying delta nation at the foot of the Himalayas, is prone to many natural disasters, especially floods and wind storms, including tornadoes and cyclones. More than three million people live in high risk areas along the 400 km coast. In April 1991 a cyclone killed more than 138,000 people and left 300,000 homeless. The estimated damage caused by the cyclone was US$1.8 billion. Following this the Government of Bangladesh along with many NGOs began a programme of disaster preparedness and management, which included the construction of cyclone shelters in vulnerable coastal areas. Disaster warning systems and evacuation procedures were put in place and some 1,200 multi-storey concrete cyclone shelters constructed adjacent to the coast. A typical shelter is shown in Figure 4.5.

The result of this programme was that when a severe cyclone occurred in 1997, even though the number of homeless reached one million, the number of people killed was 111, demonstrating a great improvement on the 1991 figures. Many of the cyclone shelters, such as the one shown in Figure 4.5, are used as primary schools on a day-to-day basis.

Figure 4.5 Primary school designed for use as a cyclone shelter in Bangladesh
(Source: Reference 22)

4.3.2 Modify houses to provide safe havens

Houses can be modified to provide better facilities during floods, and avoid the need for evacuation. Measures include:

- Constructing platforms inside the houses above flood level, to provide shelter and sleeping areas during a flood;
- Providing false ceilings for storage of seed and other essentials;
- Making houses strong enough so that families can live on roofs during floods. Where families live on roofs, shelter will be needed to protect people from the elements, particularly rain and sun;
- Modify houses to collect rainwater that falls on roofs and shelters, thus providing a possible source of clean water during floods;
- Where families live on platforms or roofs, guard rails will be needed for children.

The modifications could be carried out by communities, possibly with some external assistance. Care should be taken to ensure that any platform is above the level of most floods. People should also be aware that floods can occur which would flood the platform. In this case, arrangements for emergency evacuation will also be needed. Figure 4.6 shows modifications that can be made to rural households.

4.3.3 Make houses and other buildings flood resilient

Flooding can destroy or severely damage houses and community buildings. The damage to buildings can be reduced if they are made more flood resilient. This will reduce the need for repairs after a flood, and make it easier to resume a normal life after a flood has receded.

Existing buildings can be made more flood resilient by strengthening the structure of the house, using materials that are not damaged by floodwater (in particular, avoid the use of mud walls), or protecting the house by external means. There are many measures that can be applied, depending on the type and quality of house construction. Examples include:

- Raising the thresholds at entrances to concrete and brick houses to reduce the chances of floodwater entering the house. It must be remembered that such buildings can still flood if the level of water exceeds the threshold. Measures will therefore be needed to allow floodwater to escape.
- Strengthening the corner posts and roofs. Houses in flood risk areas may have to resist high flow velocities and high winds
- Using wires and other materials to strengthen houses and tie joints
- Raising floors inside houses
- Construct earth embankments around houses for low depths of flooding
- Provision of erosion protection around buildings, to avoid the building being undermined by erosion. Methods of erosion protection include planting vegetation, or the use of sandbags or rocks.

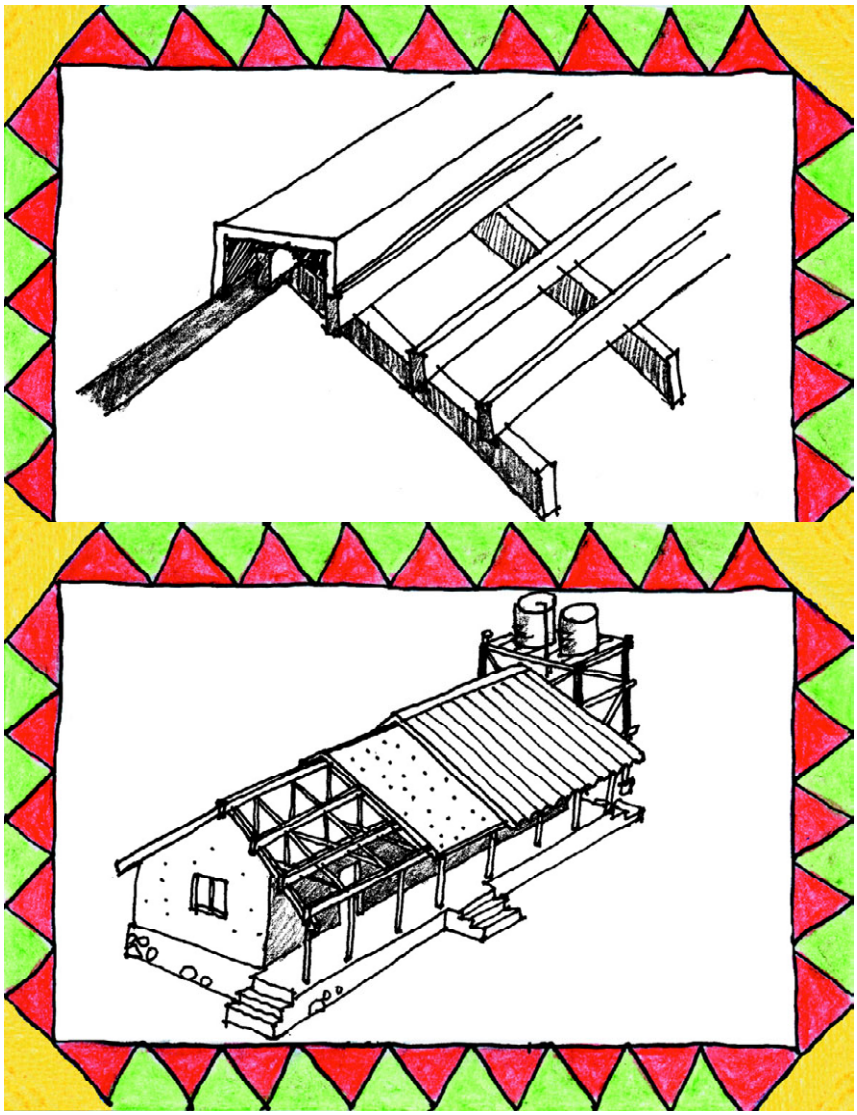
(Source: Reference 9)

Figure 4.6 Modifications to rural homes to provide safe havens

New houses and other buildings can be constructed with flood risk in mind. This could include:

- Constructing buildings on raised ground;
- Constructing buildings on stilts (with storage underneath);
- Using flood resistant materials;
- Constructing buildings away from areas that are subject to erosion, for example river banks.

Important community buildings should be constructed on raised ground to reduce the risk of flooding. Figure 4.7 shows modifications that can be made to buildings.



(Source: Reference 9)

Figure 4.7 Improving flood resilience of buildings

Where buildings have services such as electricity supplies, these could be raised above flood level to avoid damage during floods. Houses could also be designed to collect rainwater that falls on roofs, thus providing a source of clean water during floods.

Houses and other buildings should be made flood resistant by communities but external help may be needed. Knowledge of the most suitable methods will be needed. This should take account of local skills and the availability of resources including materials. The external help could include advice on suitable methods and the provision of materials, skilled labour or assistance with the cost of improving houses.

Methods of floodproofing houses should be publicised so that communities are aware of what they can do to reduce the impact of a flood. The likely depth of flooding is a key factor in deciding the method of floodproofing a house. Boxes 4.2, 4.3 and 4.4 provide examples of a number of flood resilient buildings.

Box 4.2 Movable homes in India

OXFAM and local partner organisations have helped families to build specially designed homes made of jute canes. During the floods they can be dismantled and taken to higher ground. A typical movable home is shown in Figure 4.8.

Figure 4.8 Example of a movable home made from jute in India

(Source: Reference 23)

Box 4.3 Example of flood proof church

Figure 4.9 shows an example of a flood proof church constructed in the USA. The church structure had to be maintained for public use and be open at the sides to allow floodwater to flow through it.

While much of the original structure had to be redesigned the firm that designed the structure met all of the requirements whilst maintaining architectural integrity.

Figure 4.9 Example of a flood proof church in the USA

Box 4.4 Methods of flood proofing used in Bangladesh

The methods below have been used in Bangladesh to help improve the resistance to floods of traditional buildings.

Jute panels make resilient walls that cost very little yet are quick and easy to replace. Treated bamboo poles on concrete bases are strengthened with metal tie rods to hold the wall firm and safe.

A plinth raises a house up. Made from soil, a little cement and some pieces of stone and brick – strong and high enough to last through repeated floods, unlike the traditional earthen floors that simply wash away.

Poultry and livestock have a separate area in the improved houses, to improve hygiene – and the henhouse can be picked up and carried to safety, out of the way of the floodwater.

Bracings and fastenings bind the walls firmly to the house 'skeleton' through a network of holes and notches – locally called a 'clam system' – and the whole building can stay standing through the strongest of winds and rain.

(Source: Reference 24)

4.4 GENERAL PREPAREDNESS MEASURES FOR HOUSES AND SAFE HAVENS

Both in the emergency shelter, and in homes in the community, a certain amount of preparation can be vitally important, should a flood emergency occur. Individuals and families should:

- Identify and devise a system in common with other families (or with the whole village) regarding storage of water and food. If the community is not evacuated, stores should be kept in false roofs inside houses, in trees or on high ground. It is important to keep seed and other supplies as dry as possible;
- If possible, maintain a supply of safe drinking water where it cannot be washed away or polluted during a flood. This could be done by placing a water tank above flood level and keeping it full of water during the flood season;
- Attempt to secure a container that will safely protect whatever food supplies you have from floodwater damage;
- Some people are unable to store food and buy food daily. The community should plan to provide food for everyone;
- Be prepared to change food habits to dry food, and stockpile dry food;
- Store or identify access to fuel for cooking;
- Ensure cooking utensils and portable stoves are available;
- Keep ropes and bags, as these can be used to protect things and enable them to be hung from high places, for example trees;
- Keep money safe – it may be needed to buy food and other essentials;
- Identify sources for emergency water supply;
- Store medicines and other important personal items in a safe place;
- Prepare an emergency kit in advance, containing survival essentials;
- Keep spanners and other tools available to dismantle and store equipment such as pump engines, and facilitate capping of water supply wells to prevent the entry of silt;
- Keep bicycles readily available before floods, as they may be needed to disseminate warnings to remote locations;
- Keep equipment for fishing, to obtain additional food supplies during floods;
- Keep boats well maintained and tied up at all times when not in use during the flood season. In addition, rafts can be constructed from trees and other materials. These may be needed for evacuation, saving livestock and transporting dead bodies.

The use of boat for the evacuation of flood affected areas in Thailand.

4.5 RELOCATION OF HOUSES

Permanent relocation of communities away from floodplains is becoming an important mitigation option for emergency management authorities throughout the world. The main advantage in moving people permanently way from floodplains is that death and injury can be prevented where structural mitigation measures are ineffective and forewarning is insufficient for simple evacuation. However, the upheaval caused by relocating communities can have a number of negative impacts. It should be noted that many communities live in floodplains because they are fertile.

Houses could be built in new locations outside the flood risk area. This may be appropriate where the community is near the edge of the floodplain, and the distance to the new houses is small. Where the distance to the edge of the floodplain is large, this could result in moving the whole community. Alternativly, families could have their main home in the floodplain, near their crops, and a second smaller home outside the floodplain for use during periods of flooding.

Materials and labour will be needed to construct new houses. As far as possible this should be provided by the community but external help may be needed. It is obviously vital to ensure that any site where the new houses are located is outside areas of flood or erosion risk.

Box 4.5 Examples of relocation of flood prone communities

Resettlement; the relocation of people and/or property either from high risk to low risk floodplain land, or from floodplain to flood-free land is a strategy which is used in extremis, normally when frequent and severe flooding occurs. In Bangladesh some rural householders are used to dismantling their homes as floods rise and moving them by boat to high ground, such as the top of flood embankments. The homes may then be moved back to their original locations after flooding has subsided.

In the United States property relocation has become more common. The North American cities of Rapid City (South Dakota) Prairie du Chien (Wisconsin) and Soldiers Grove (Wisconsin) have relocated some properties from the floodplain. Following the Mississippi floods of 1993, federal policies encouraged flood-damaged property acquisition and demolition (so-called 'buy-out' policies).

In Gujarat, India, 30 villages have been relocated to higher ground to alleviate the impact of flooding from the Narmadi and Tupti rivers, and similar resettlement projects have been undertaken in eastern Peninsular Malaysia. The scope for such resettlement policies clearly depends both upon the number of people and properties involved and the availability of alternative areas to which they can relocate. The normal conditions governing resettlement also apply.

4.6 EVACUATION AND SHELTER MANAGEMENT

4.6.1 The need for evacuation

Evacuation of people from flood risk areas is a hazardous activity. In areas where land tenure is not secure, there is a risk that others might take over land previously occupied by a family or community. There is also a risk that homes will be looted when the occupiers are away. For these and other reasons, it is strongly advised that strategies are developed that avoid the need for evacuation and the communities are able to "live with rivers", even in extreme conditions. Evacuation is therefore regarded as a last resort when there are no other alternatives. An example of a common form of evacuation in the SADC region is shown in Figure 4.10.

(Source: Reference 9)

Figure 4.10 Evacuation of affected communities

In the case of the Limpopo River floods in Mozambique in 2000, the floods were much deeper than other floods in living memory, and evacuation was the only option. However serious thought should be given to whether communities can stay near their homes even in these extreme conditions (for example, by the provision of safe havens or rafts).

4.6.2 Identify evacuation routes

The Zambezi Valley Mozambique 2000

Safe evacuation routes should be identified. The evacuation routes should:

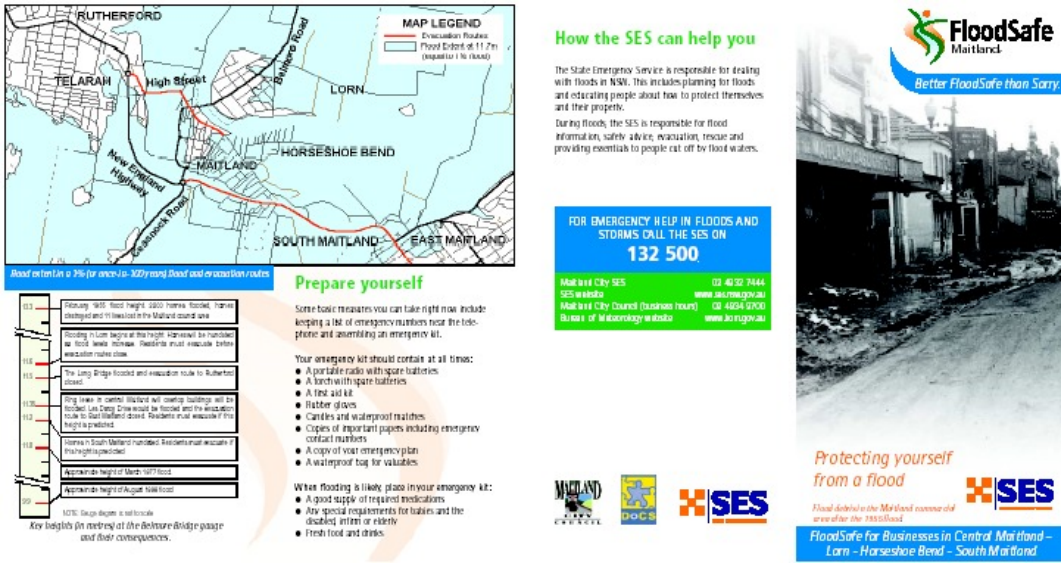
- Lead to high ground that is safe from flooding;
- Not cross areas that could be flooded, for example areas of low ground;
- Avoid bridges and other crossings of watercourses that could be washed away during a flood.

The evacuation routes are needed to enable people to escape safely from areas that flood.

Flooding in Mozambique 2000

The routes should be identified using local knowledge and flood maps (if available). It may be necessary to survey the route to ensure it is above flood level. The evacuation route should, where possible, be signposted. Where the evacuation route could be dangerous in times of flood, this should be indicated on the signposts.

The community should be responsible for identifying the evacuation routes, and making sure that everyone in the community is aware of them. Communities should also be aware of areas where people could be cut off by floodwater. These areas should be evacuated first. Evacuation routes should not be identified if there are no safe places to evacuate people. An example of a flood evacuation map is shown in Figure 4.11.



(Source: Reference 12)

Figure 4.11 Example of a flood evacuation map used in Australia

4.6.3 Provide adequate shelter and evacuation facilities

Flood evacuation in Australia.

When no local evacuation plan exists in a village or community, groups usually depend on external help, or as far as possible, help themselves. People have a tendency to evacuate at the very last moment: at that time it is usually more difficult to do so. The following are key parts of any evacuation plan:

- Define the location of evacuation points for each community;
- Provide information on evacuation procedures and routes;
- Establish evacuation procedures;
- Provide warnings where access routes are dangerous during floods;
- Select and construct safe havens, for use as alternative to full evacuation.

Local safe havens may be an alternative where it is impossible to reach organised emergency shelters. The community needs to play a major role in deciding on local arrangements, which should consider the following.

- Evacuation centres are usually set up on the upper stories of higher buildings, or in tented camps on embankments on roads, railway lines or high ground;
- Living in evacuation centres can be difficult when the facilities are inadequate. This will result from over-crowding, when supplies are in short supply, when there is inadequate fuel and cooking utensils, when safe water is difficult to acquire, when adequate latrines are not available, and when the surroundings are not kept clean;
- Communities should be involved in the selection and management of evacuation centres. This is important for their satisfactory operation;

- Evacuation centres should if possible have a social purpose during normal periods. This will help to ensure the centres are maintained and that the community is aware of them;
- In planning evacuation centres it is extremely important to make provision for people's personal belongings and for animals;
- Men and women usually have to live together in evacuation centres. If the community does not want this to happen, this has to be discussed and planned ahead of time;
- Arrangements for group cooking. This is preferable to individual cooking as it saves fuel

4.6.4 Establish operational and management plans for evacuation and shelter management

Plans for the establishment and operation of evacuation shelters should be thoroughly established, and be reviewed each year before the flood season. The details of government evacuation plans must be publicised to the community and to the various services involved at a local level. This includes the NGOs connected with emergency services, which are involved with communities.
Within the community, careful planning needs to be carried out for the following:

- Ensure that people can be evacuated safely. Transport including boats may be needed;
- Decide whether anyone will stay with family or friends, whose houses are not at risk, rather than go to the evacuation. This should be encouraged as it is generally a better option;
- Decide which individuals will set up arrangements and manage the centre;
- Either build permanent sanitation and safe water systems at the evacuation site, or have a plan for the construction of temporary sanitation and safe water systems;
- Establish a system for ensuring that required food and supplies are available;
- Ensure that cooking utensils including cooking facilities will be available;
- Decide on what type of goods and supplies families should be encouraged to bring with them;
- Make arrangements to isolate and look after the sick;
- Identify ways to keep people occupied.

Women in Mozambique.

When it is necessary to open the emergency centre, it is important that it is done promptly, and before it is actually needed. This allows organisers time to ensure that tube wells are available and working and that temporary (or permanent) latrines are available at the evacuation site. Timely preparation also allows people time to gather supplies and belongings and reach the centre in safety.

Planning must ensure that the evacuation centre has good local management with the participation of evacuees / beneficiaries, in order that discipline is accepted. There need to be very tough rules that insist that everyone (men, women and children) use the latrines and do not soil the ground.

4.7 PREPARATION OF WATER AND FOOD SUPPLIES AND EQUIPMENT

There are two general methods by which small quantities of water can be effectively disinfected. One method is boiling. It is one of the simplest methods by which water can be made bacterially safe to drink. Another method is chemical treatment. If applied with care, certain chemicals will make most water free from harmful or pathogenic organisms.

The most serious consequence of flooding is large-scale contamination of drinking water. In such situations water-borne illnesses, usually associated with poor hygiene and sanitation, can affect a large part of the population. Such illnesses include typhoid and cholera, where they are endemic, as well as dysentery, infectious hepatitis, and gastro-enteritis. Methods of water treatment with chemical sterilisation (such as chlorine) or boiling water for human consumption are of primary importance because of the serious risk of appearance of these illnesses.

Contamination of drinking and groundwater can be caused by:

- Contamination of surface sources of drinking water due to animal dung near intakes, excessive increase in the turbidity of water, or pollution from other types of contaminants;
- Flood levels that surpass the height of well head walls, or waters that flow directly over wells and other intakes;
- The rise of water levels in sewer outfalls can cause wastewater to back up and flood the interiors of homes, lower levels of buildings, and public throughways. In homes this occurs through toilets and washbasins; in streets it occurs through manholes and rainwater sinks
- If fuels, such as wood, mix with floodwaters, it will be more difficult to boil water for sterilisation.

Figure 4.12 shows a portable water purification unit used in Beira, Mozambique after the floods in 2000. Figure 4.13 illustrate an example of raised water tanks. Figure 4.14 shows a raised handpump. Box 4.6 details simple methods by which water can be purified. Box 4.7 outlines an example of maintaining a supply of safe water in India.

Figure 4.12 Water purification unit in Sofala Province, near Beira, Mozambique

(Source: Reference 9)

Figure 4.13 Example of a raised water tank

(Source: Reference 9)

Figure 4.14 Raised water point

Box 4.6 Methods of purifying water

The following information is taken from emergency preparedness advice produced in the USA

Water treatment - Boiling

Boiling is the most effective method for treating water. To purify water by boiling the following steps should be taken:

1. Place the water in a clean container and bring it to the boil. Continue boiling for five minutes.
2. Allow the boiled water to cool slowly to a drinkable temperature. Keep water covered while cooling.
3. The boiled water may taste flat. The flavour can be improved by pouring the water back and forth between two clean containers.

During a flood there may not be a source of energy readily available.

Water treatment - Disinfection

Although boiling is the most reliable method for treating germ contaminated water, it may not be possible to boil water during an emergency. In this instance, water can be treated with unscented, liquid household bleach that contains 5.25% sodium hypochlorite.

To purify water with bleach the following steps should be taken:

1. Place the water in a clean container. Add eight drops of bleach to water for each two litres of water.
2. Mix water and bleach thoroughly and allow to stand for at least 30 minutes. If the water is cloudy, or very cold, increase the standing time to 60 minutes. If the water does not have a slight bleach odour after the standing time, repeat the bleach treatment and let the water stand for another 15 minutes.

It should be noted that treating contaminated water with bleach will not kill crytosporidium cysts that may be present in floodwaters or other contaminated waters. Neither boiling nor the use of bleach will remove chemical contamination.

(Source: Reference 25)

Box 4.7 Example of maintaining a supply of safe water during floods in India

OXFAM's River Basin Programme in India works with villagers to maintain safe supplies of water. Flooding can contaminate water supplies, which can lead to potentially fatal diseases such as cholera and diarrhoea. Figure 4.15 shows two villagers from Teghori in India sinking a borehole. The top of the pipe can be raised quickly, so that it remains above the level of any expected floods.

Figure 4.15 Borehole in Teghori, India the height of which can be raised during floods

(Source: Reference 26)

4.8 HEALTH AND SANITATION INCLUDING DISEASE PREVENTION

Drinking water and sanitation are vital in ensuring the health and wellbeing of populations. Flood damage can lead to the contamination of drinking water, breaks in pipelines, damage to structures, water shortages and collapse of the entire system. It is therefore imperative to reduce the vulnerability of drinking water supplies and sanitation systems in floods and restore these basic services as soon as possible.

Collecting water from a river in Indonesia

In preparing a strategy and plans for health and sanitation support during flood events, a number of steps are required.

- Vulnerability analysis: to identify and quantify the hazards that can affect health and sanitation arrangements. This should identify the physical shortcomings of the system, and estimate the susceptibility of components to damage;
- Design an emergency management and response programme, which must be based on the most reliable and up-to-date information available. This will provide a reasonable degree of confidence that the decisions taken in an emergency or disaster are the most appropriate, both technically and financially;
- Prepare detailed plans and information on suitable sanitation structures, for example latrines, and water supply in communities and flood shelters;
- Promote hygiene methods by providing information, and most importantly, provide supplies and distribution plans for materials and facilities to enable people to follow good hygienic practices;
- Conduct information campaigns, both to implementing agencies (including NGOs) and communities, to develop awareness of emergency provisions for sanitation and water supply.

Drainage channel In Nairobi, Kenya.

The community should be closely involved at all stages in preparing strategy and plans. This allows community members to understand their vulnerability, and the extent in which they can be affected by water-related disasters. Introducing matters of policy and advocating contingency arrangements establishes legitimacy and political public trust. Awareness can be improved by using meetings with specific groups, such as the family, clan or section. Captive audiences can be found at clinics, feeding centres, food distribution centres and water collection points.

4.9 SANITATION

Lack of appropriate sanitation facilities in flood-prone areas of Bangladesh is one of the important contributing factors for health and environmental degradation. In flood-prone areas, overflow of pit latrines during floods pose a high health risk. The major problems of sanitation in flood-prone areas are surface water contamination and loss of accessibility to the latrine during floods. One method that can be used is to raise the latrine. This also increases the size of the pit. A raised latrine is illustrated in Figure 4.16.

(Source: Reference 9)

Figure 4.16 Raised pit latrines

A view of the back of some makeshift housing in Accra, Ghana. The latrine, in the centre of the photograph, is located over one of the many small watercourses susceptible to flash floods. The effluent from the latrine goes straight into the stream. During a flood rubbish and waste wash into people's houses creating perfect conditions for outbreaks of cholera and malaria.

Particular health issues that can reduce the impacts of flooding on communities include:

- People should take precautions to avoid injury and illness. Injuries are not only debilitating but can lead to infection;
- There should be a store of emergency medical supplies, either kept centrally or by individual families. The supplies should include such items as Vitamin A tablets, Oral Rehydration Saline (ORS) and water purification tablets;
- Where possible, precautions should be taken against malaria and other diseases, for example the use of mosquito nets;
- People should be trained in water purification and sanitation procedures to be adopted during floods;
- Advice should be given on how to treat common illnesses during floods, particularly diarrhoea;
- People should be aware of other health dangers, for example snakes.

Box 4.8 details common post flood diseases.

Box 4.8 Common post-flood diseases

Malaria is caused by a parasitic protozoa. It is carried from person to person by mosquitoes that multiply in standing water. Early stages of malaria resemble influenza with fever and muscle ache. In 2000 when there was flooding in Mozambique there were 3.13 million cases of malaria compared with 2.34 million reported cases in 1999.

Diarrheal diseases are caused by bacterial infections that transmitted by contaminated water and food, and by person to person contact. The most serious of the diarrhoea diseases is shigellosis. In some people, especially young children and the elderly, the diarrhoea can be so severe that the patient needs to be hospitalized.

Cholera is a bacterial infection transmitted via contaminated water or food. Once in humans, the bacteria infect the lining of the small intestine causing diarrhoea, vomiting and dehydration that can in severe cases cause death. Although cholera occurs more commonly in connection with droughts, where water is limited and easily contaminated, post-flood incidence can occur in accommodation camps depending on sanitary conditions. It results in stomach cramps and fever and causes death in 5% to 15% of cases.

Figure 4.17 shows the incidence of malaria and dysentery in the Limpopo basin between 1998 and 2001.

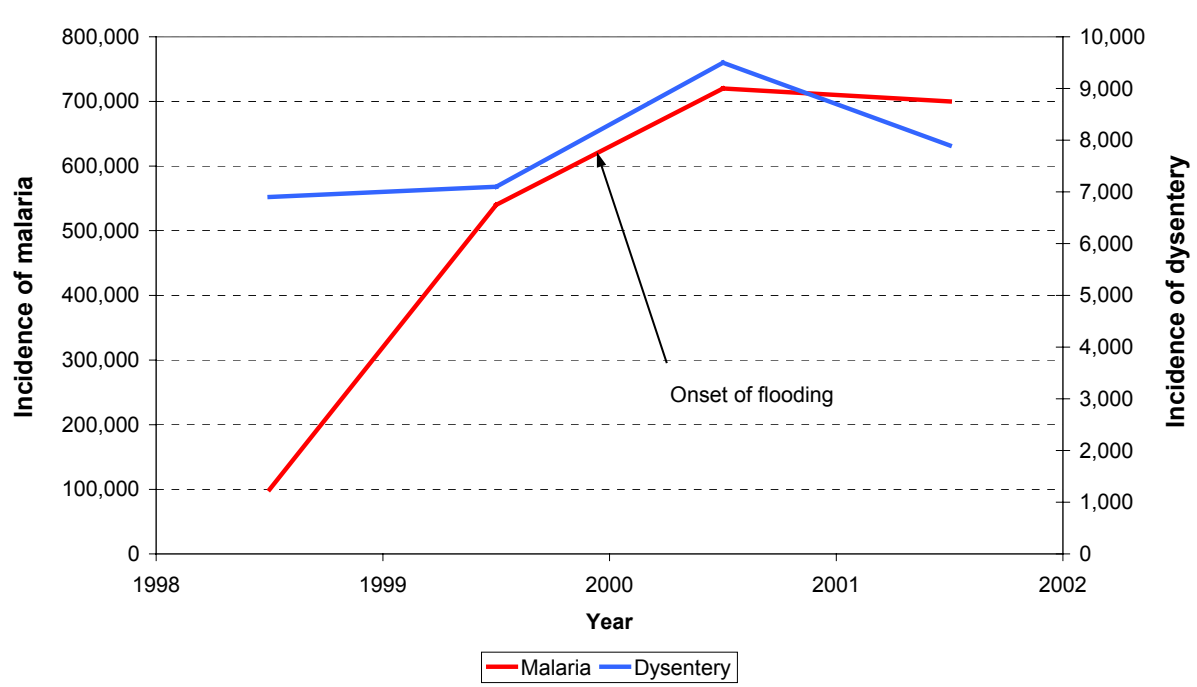


Figure 4.17 Disease incidence in the Limpopo river basin 1998 to 2001

(Source: Reference 1)

4.10 IDENTIFICATION OF GROUPS THAT ARE VULNERABLE TO FLOODING

It is important to establish the groups that are most vulnerable to floods. These are generally:

- **The elderly**, who are often unable to respond quickly without assistance;

Elderly person being rescued during flooding in Eastern Europe.

- **The poor** who tend to lack resources that would give them independence of decision making and action;
- **Pregnant women and women with children;**
- **Women and child headed households** which, especially if large or if the children are very young, are often characterised by unfavourable adult: child ratios rendering evacuation difficult;
- **The ill or infirm** who need special consideration with respect to mobility, special needs, support and 'management' to ensure they continue to receive appropriate care and information;
- **Those whose homes are isolated by floods**.

Knowing where the most vulnerable people are should help when allocating appropriate resources before, during and after flood events. It will make it easier to plan effectively for floods. However, not all people who live in flood prone locations can develop effective strategies to cope with flooding because they have been in their present locations for only short periods of time and as a result they are likely to be relatively unfamiliar with the environment.

4.11 PROTECT ESSENTIAL SERVICES

This action involves undertaking work to, as far as possible, maintain water supplies, communications and other essential services to minimise damage and impacts on society during a flood event. This also helps to minimise the work needed to restore services after a flood and helps damaged services to be restored more promptly.

In order to undertake this action it is necessary to know what essential services must be protected, what damage could occur during a flood, and (hence) what protection is needed. In small rural communities, the most essential service is water supply. Also in flood situations some form of communication is also very important (for example, two-way radio). In larger communities, sanitation, telephone and electricity services are also considered to be essential services.

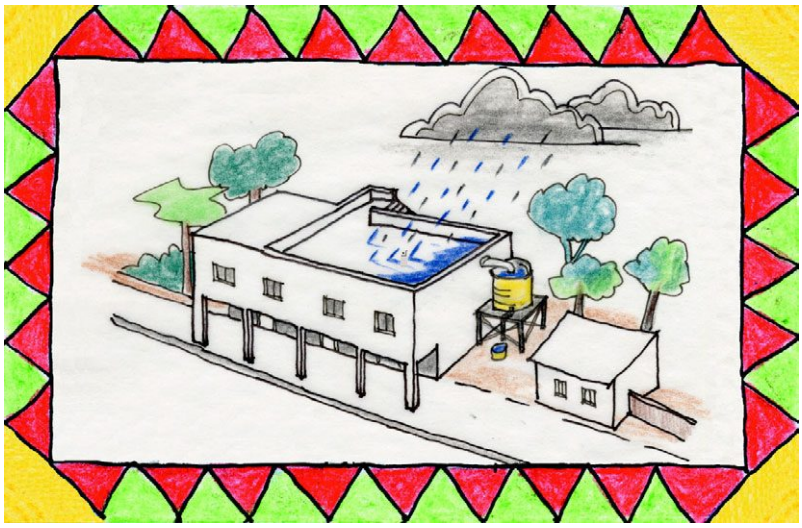
The action is carried out either by moving key parts of services to a location outside the flood risk area or by undertaking works to protect the service infrastructure. For example, the fitting of a cover to a well would prevent the well filling with silt during a flood, and the water becoming polluted. The cover would be removed after a flood. Alternatively, access to the water supply (for example, a hand pump) could be raised above the flood level. This would require the provision of access to the pump during normal periods. In addition, emergency plans should include arrangements for emergency repairs and support for essential services.

This action can be carried out with considerable inputs by communities. The community would decide what action should be taken and arrange for the work to be carried out, but may require external assistance, for example if a telephone line has to be protected or moved.

At higher organisational levels, plans should be prepared to provide emergency support and repair to essential transport links. Plans also need to be in place to maintain or provide emergency support for water supplies and sanitation.

4.11.1 Establish alternative water supplies

When a flood occurs, one of the most crucial requirements is access to safe drinking water. It is possible to store water but during a prolonged flood, or when stored water is not available, an alternative water supply will be needed. Figures 4.18 and 4.19 show methods by which rainwater can be collected from roofs in urban and rural areas.



(Source: Reference 9)

Figure 4.18 Rainwater collection in an urban area

Methods for providing alternative water supplies will depend on how the community responds to the flood. If the people stay in their community, it will be necessary to distribute water to families by boat. If people are evacuated, they could either be evacuated to a place where a water supply is available or emergency supplies could be provided by tanker. Ideally the community should identify a safe alternative supply, for example a well situated on land that is outside the flood risk area.

(Source: Reference 9)

Figure 4.19 Rainwater collection from a roof in a rural area

4.11.2 Store food and other survival essentials in a safe place

Floods destroy food, medicines and other items. Storage of such items above flood level will ensure their availability during times of flood. Safe storage is therefore needed above flood level. This could be on the roofs of buildings, in trees or on specially constructed towers. It must be possible to access the store in times of flood. Members of communities should provide storage for themselves and their families. Knowledge of the maximum flood level will be needed. To be safe, the store should be well above this level. Figure 4.20 provides an example of a food store used in southern Africa.

(Source: Reference 9)

Figure 4.20 Example of food store

4.11.3 Alternative energy supplies

Floods will disrupt electricity supplies and destroy cooking facilities and fuel. Alternative energy supplies will be needed. These could include portable cookers and fuel, torches and candles. In more sophisticated situations, options might include solar or wind power. Members of communities should be encouraged to provide their own alternative energy source for cooking, light and heat. These should be stored above flood level or in such a way that they can easily be moved.

4.12 PROTECTION OF HOMES FROM LOOTING

One of the main reasons why people do not leave their homes in time of flood is the fear of looting. This is a serious concern that is difficult to prevent. As a result, people leave their homes at the last minute before the flood arrives, and try to return as soon as the flood recedes.

One possible measure is to leave guards in safe places, for example strong trees. However whether they are able to prevent looting by a determined gang of thieves is doubtful. Evacuation should be avoided where possible, but where evacuation is necessary measures for preventing looting might include:

Looting of homes in Macedonia.

- People taking small items with them;
- Providing a store for valuables in a safe place;
- Burying items that would not be damaged by water underground. These items should be packed in containers or plastic bags to minimise exposure to damage.

This activity should be carried out by the community. It is essential that those who look after a store are trustworthy. Items should not be buried in areas where there is a high risk of serious erosion.

It may be possible for the community to build a store for valuables during times of flood. The store would have to be guarded by people who are trusted by the community. It should also be constructed at a location and in such a way that items kept inside will not be damaged during a flood.

For example, the community could construct a house on stilts (or with more than one storey). The house would be used for community activities during normal times and used to store things during times of flood. A building of this type may be beyond the capabilities of the community, and external help in the form of materials and skilled labour may be needed to construct it. A store should not be built in areas where it could be washed away or if, for any reason, it is not possible to guard it adequately.

4.13 REDUCE THE IMPACT OF FLOODS ON INFRASTRUCTURE INCLUDING ROADS AND BRIDGES

Flood damaged bridge in South Africa.

This action helps to minimise the work needed to restore infrastructure after a flood and therefore facilitates the rapid recovery towards normality. This is particularly important for roads, to permit access for relief supplies and repair materials, and to permit the transport of goods to market.

Knowledge of which infrastructure is in flood risk areas is needed, and the flood hazard to which they are likely to be subjected (in terms of water depth, flow velocity and debris). Knowledge is also needed of appropriate methods of floodproofing. This should take account of local skills and the availability of resources, including materials.

Flood damaged bridge in South Africa.

Flood damaged bridge in the USA.

The action is carried out by undertaking work on infrastructure to increase its resilience to flooding. In extreme cases this could involve reconstruction at a location out of the flood risk area. For example, an earth track could be diverted onto high ground for as much of its length as possible. Other measures to reduce the impact of flooding include providing protection for roads where erosion could occur.

In addition, emergency plans should include arrangements for emergency repairs to essential main transport links and other infrastructure. Communities can undertake some of the work on local infrastructure to reduce the impacts of flooding. In particular, they could identify and clear access routes that are outside the flood risk areas. Figure 4.21 shows repairs being made to a major road, Meiringspoort Pass, in South Africa. Damage caused by flooding to the Meiringspoort Pass in 1996 was only temporarily repaired by the Roads Authority. The design of the necessary repairs was carried out as cost-effectively as possible, whilst ensuring that future flood damage would be reduced if not eliminated entirely.

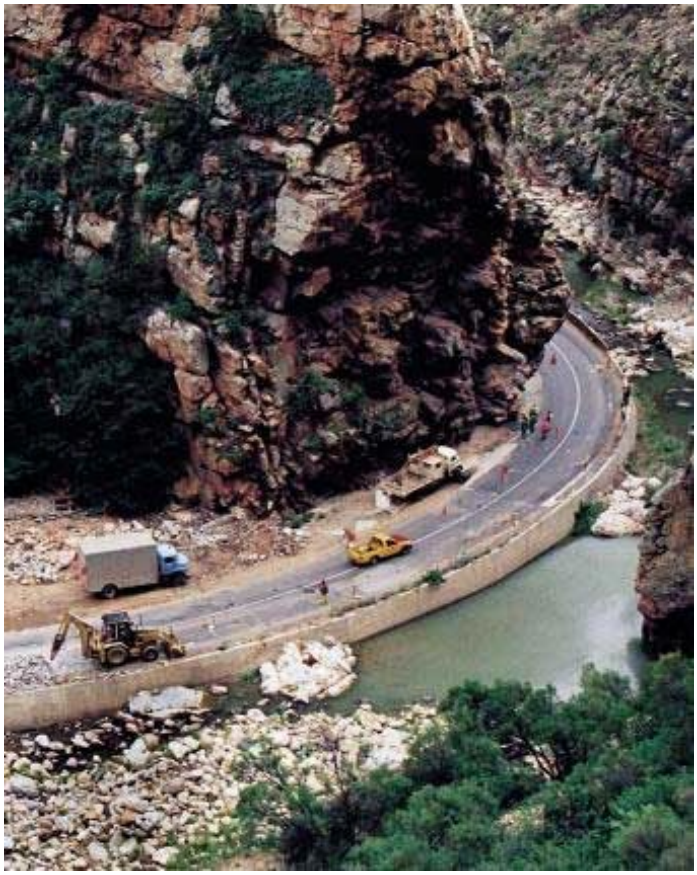


Figure 4.21 Repairs being made to a flood damaged road in the Western Cape, South Africa

4.14 PROTECT ANIMALS, CROPS AND FISHERIES

The livelihoods of many communities depend on farming, livestock and fisheries. The impact of floods on these activities can be devastating. The measures that can be taken to minimise the impact of floods will depend on local conditions and the type of activities carried out.

Cow caught in a flood in the USA.

Animals are at risk from drowning, disease, starvation and being trapped in pens. Possible measures to protect animals include:

- Release animals from pens before the flood;
- Sell some animals at the beginning of the flood season;
- Vaccinate animals against disease;
- Animals can be moved to high ground (such as a road embankment) during floods. There may be very limited space for animals on safe havens;
- Cages can be used to transport poultry to safety;
- Stockpile fodder. Food will be needed for animals if the refuge does not have suitable natural vegetation.

The impact of floods on crops is particularly difficult to mitigate. Crops are often grown on floodplains, where there is good soil, during the rainy season. Thus flooding of crops is an unavoidable risk. In a country such as Bangladesh, for example, where vast areas may be flooded, it may not be possible to protect crops. It is suggested that agricultural extension services are trained on the measures that can be taken to minimise the risk to crops. These might include:

Flooding of a village and crops in Senegal.

- Move cut crops to safety;
- Staggering times of planting to reduce the risk to an entire crop;
- Change crop cycles and patterns, although this is difficult for rain-fed agriculture. Irrigated agriculture has more flexibility;
- Introduction of crops that have a greater resistance to water logging and flooding. It is recognised that extended periods of inundation will destroy any crop;
- Consider alternative crops that are likely to provide a more reliable crop in flood risk areas
- Cutting part of the crop to provide fodder for animals. Transport may be needed to move the cut crop to a safe place;
- Ensuring that there is an adequate supply of seed to re-plant as soon as a flood has receded;
- Use late varieties of seed for planting straight after the flood;
- Use of portable/floating seedbeds for new crops;
- Assessing the impact of the deposition of river silts on fields. In some cases this may enhance the soil, but sandy deposits could have the opposite effect.

The effect of floods on fishing in rivers will be small providing that boats and other equipment are not washed away during the flood. Constructed fisheries will require protection to prevent the fishery becoming inundated and the fish being washed away. One possible measure is to trap the fish in secure nets.

Actions to minimise the impact of floods on agriculture are a matter of national and regional importance. Possible methods should be developed at all levels and disseminated via agricultural extension services and other activities to raise awareness of the effects of flooding.

4.15 STORE SEEDS AND OTHER ESSENTIALS TO AID RECOVERY

This action involves storing seed and other essentials to permit rapid recovery of a community after a flood. The other essentials to be stored will depend on local requirements, but could include fuel for vehicles and building materials to repair roads. The purpose of this action is to minimise the impact of flooding on livelihoods and enable farmers to get back into production as quickly as possible.

A store of seed should be kept in reserve at all times. This may either be held in communities or by local government. In the latter case, transport will be needed to distribute seed after a flood event. Figure 4.22 shows a traditional seed storage system used in Mozambique.

(Source: Reference 1)

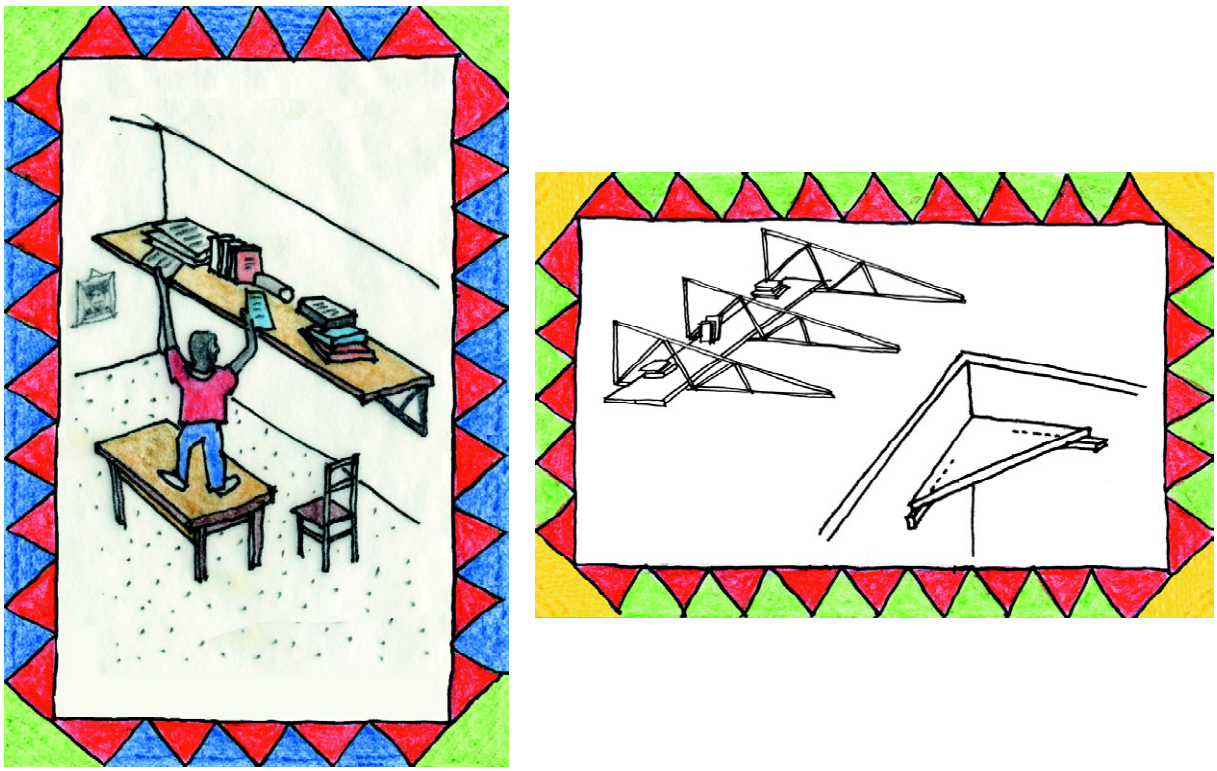
Figure 4.22 Traditional seed store

It is important that seeds are kept dry. Watertight containers should be used where available and, if seed gets wet, it should be dried as quickly as possible.

Delivery of maize in central Mozambique during the 20000 floods.

It is advisable that communities are as independent as possible, in case for any reason it is not possible to distribute essentials after a flood. As part of a community's emergency plan, the needs for post-flood recovery should be identified and measures taken to ensure that seed and other essentials are stored in a safe place.

Following disasters it is often assumed that there is a lack of seed, but the problem is more often one of farmers not having the resources to purchase or barter for locally available seed. Based on this misdiagnosis of the problem well-meaning agencies import seed that is not always appropriate. Seed is such an essential asset for future household food security that farmers normally find means to safeguard at least a small quantity even during a disaster. Figure 4.23 shows simple mechanisms by which important items such as title deeds of land can be stored.



(Source: Reference 9)

Figure 4.23 Example of methods by which documents can be stored

4.16 PLANNING FOR FLOOD EMERGENCIES

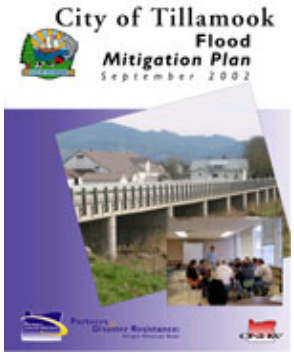
4.16.1 Institutional framework

In major flooding emergencies, the responsibility for management and response goes far beyond the capabilities and responsibilities of the river management agency or local authority. Such situations normally entail an escalation of activity and involvement, even as far as national or international level. Emergency management groups operate at a number of administrative levels, for example regional and local, as well as the emergency services, i.e. police, fire brigade, medical. These are established to deal with a wide range of emergency responses, and it is likely that experience of flood emergencies, certainly on a large scale, will be limited. A review of the emergency plans for floods is therefore essential, and should include:

- What is the structure of responsibility for disaster management within the government?
- Examine the institutional framework at all levels;
- Identify the role of NGOs, including the main agencies such as Red Cross, Oxfam, and national NGOs;
- Review infrastructure and facilities needed for flood disaster preparedness planning;
- Prepare flood disaster plan, to include community actions;

All the above should be considered with reference to reports and experiences from previous major events.

4.16.2 Preparation of a community plan



Community flood mitigation plan for the city of Tillamook in the USA.

The purpose of this activity is to prepare a plan for a community. The plan should be prepared by the community with assistance from other organisations, particularly local authorities and NGOs. In particular, the community should be made aware of the flood mitigation options available, particularly those that are known to be effective in their region.

The way in which the plan is organised and implemented will depend on the local community. A common approach is to organise a committee with members who are trusted by the community. These should include local leaders and NGO representatives. The question of whether the committee is elected or nominated is a matter for the community. It may be appropriate to use an existing committee (for example, a village council) rather than create a new committee.

The community level plan must be carefully matched to the higher level plans. Communities can reduce losses and hardship if they think about and plan how best to respond to flood emergencies in advance. This means that they need to think in advance about what effects a flood might cause, what problems they might encounter, and try to work out ways to overcome those problems. The main emergency concerns that a community should plan for include:

- Safety, including dangers from electricity, snakes;
- Water supply and sanitation;
- Health and injury/disease prevention;
- Agriculture including standing crops, harvested crops and livestock;
- Food and family stocks;
- Care for the vulnerable including pregnant women;
- Emergency needs;
- Property protection including household items and public buildings;
- Embankment protection;
- Flood warning and dissemination;
- Search, rescue and evacuation;
- Law and order during a flood;
- Evacuation centre management;
- Repair works;
- Co-ordination and liaison with officials;
- Practising the plan. In addition to the benefits of regular practice, this will help to maintain awareness during periods when there are no floods.

Planning also means deciding what needs to be done during the flood and deciding who will do those tasks. It may be more effective if each member of the village committee has a specific responsibility. Box 4.9 gives an example of a community action plan in Cambodia and Box 4.10 provides details of points to be considered when developing a community based emergency plan.

Box 4.9 Example of community flood action plan in Cambodia

The Cambodian Community Based Flood Mitigation and Preparedness Project was launched in September 1998 under the Asian Disaster Mitigation Program. It was jointly implemented by the Cambodian Red Cross, Pact and The International Federation of Red Cross and Red Crescent Societies. The objective of the program was to establish sustainable, replicable non-government mechanisms for disaster mitigation and preparedness with a focus on flooding.
This was accomplished through:

- Empowering communities to develop solutions to flooding;
- Providing communities with a higher degree of security from natural disasters;
- Training local village volunteers in Disaster Preparedness concepts and techniques;
- Establishing Village Disaster Committees to implement participatory processes for identifying solutions to reduce impact of natural hazards to their communities; and,
- Mobilizing funds to create or refurbish disaster preparedness infrastructure.

Under the demonstration phase of the project, Red Cross volunteers were seen as the best vehicle to assist in implementing the project at the local level with target communities given their broad based network throughout the country. The Red Cross volunteers were trained in disaster preparedness techniques and supported local communities living along the country's two major watersheds of the Mekong River and Tonle Sap. The project was implemented in the three highly flood-prone provinces of Kompong Cham, Prey Veng and Kandal. The project had the unique opportunity to measure the impact and gather lessons learned from implementation before and after one of the area's worst floods in four to seven decades that occurred in 2000. The three target provinces made up 48.9% of the people in the country affected by the flood and 58.4% of the deaths.

The major lessons learned from the project included:

- Involve local level communities in developing solutions to flood preparedness;
- The use of community development best practice methodologies can enhance the success of community-based flood mitigation and preparedness projects;
- Use traditional organizational structures in communities to assist in flood mitigation measures;
- Ensure that community level project implementers are well trained in flood preparedness techniques and empowered to mobilize community members in developing solutions;
- Where flood preparedness demands are greater than financial resources available, it is essential to train and mobilize local communities to seek for funding outside the community;
- It is important to develop relationships between communities, government national disaster management departments and donors focusing on disaster preparedness to instill sustainability measures for continued activity support;
- Distinguish between activities that are useful for community organizers and the community themselves.

The demonstration showed that community involvement in flood preparedness is an essential component to flood mitigation. By involving community members it not only increases the likelihood of increased action by communities to help mitigate flood disaster but also brings communities together to address flood issues cooperatively. In the event of a flood, cooperative actions among communities can lead to a great probability of decreased damage, deaths and economic devastation in the affected communities.

(Source: Reference 27)

Box 4.10 Points to consider when developing a community based emergency agency and response plan

Consideration of the following questions will help community based organisations to formulate a response plan:

1. **How will a disaster affect the mission of the organisation?** Given the overwhelming number of new needs and people requiring attention post disaster, will this change the agency's mission – perhaps expanding services or by providing new and different services? In other words, what role (if any) will your agency play in meeting the new demands that are presented by a local disaster?
2. **What specific agency responsibilities and services must continue post disaster?** What are the critical material and staff resources necessary to maintain these services or Operations? How might volunteers be used to support these operations?
3. **What responsibilities can be postponed in a disaster?** Given a shortage of resources, can some functions be suspended in favour of more critical operations?
4. **What is the agency's emergency mobilisation plan?** Is there a plan of action for what the agency must do immediately following a disaster? Have staff and people the agency serves been informed about individual disaster preparedness?
5. **Can the organisation expect staff to be available in the aftermath?** If a major disaster occurs during non-working hours and disrupts phone service, is there a plan for how staff will communicate with each other?
6. **How will the organisation assess the impact of a disaster on people or key operations?** Are adequate supplies available to respond to the personal needs or treat the medical needs of people at your agency following a disaster?
7. **Who in the organisation will do what in the response effort?** Do staff have specific assignments or duties to carry out following a disaster?
8. **Are there mutual assistance agreements in place?** Does the agency have an understanding with other local groups to share resources in an emergency to maintain operations and ensure the care of people that are served?
9. **When and how is the organisation's emergency response plan activated and who is contacted?** Are there critical personnel to notify to implement the plan?
10. **Does your agency have a plan or information for obtaining funding?**

(Source: Reference 28).

4.16.3 Identify equipment and other improvements needed for an emergency plan

Emergency plans are for implementation in major flood events. They need to concentrate on extreme measures to provide shelter, evacuation and rescue. The following are important:

- What limitations are there on the use of trucks and other wheeled vehicles?
- Are there arrangements for rescue boats and other transportation?
- Are there arrangements to remove and store community equipment (for example, water pumps) and protect water supplies (for example, by capping wells to avoid silt entering them)?
- Are there designated safe-havens or flood shelters?
- Are the location of boats and safe havens known to all levels of emergency operators and to the community members?
- Who should be evacuated first?
- What should individuals and groups take with them when homes are evacuated?
- Do communities know what height the flood water will have to reach before leaving houses to go to higher ground

- What are the procurement issues related to provision of equipment and facilities.
- What arrangements exist with the emergency services for supply of equipment and personnel.

4.16.4 Practice community emergency plan

Flooding in Maputo, Mozambique.

Once a Community Plan has been prepared, it should be practised regularly so that the community is ready to respond when a flood occurs. The practice will require collaboration between the communities and other relevant organisations including NGOs and emergency services. As far as practicable, the whole community should participate in the practice.

4.16.5 Provide funding for emergencies

During floods there is a need for funding provision as an established part of preparedness exercises. When flood emergencies occur many actions are required ranging from flood fighting and the rescue of people, to providing temporary accommodation and rebuilding homes. All these actions cost money and therefore there is need to provide funding outside of reactive post-event funding.

In order to implement this action it is necessary to know what the potential sources of funds are and how they can be accessed. There is a wide range of potential sources including Central Government, Local Government, NGOs and aid agencies. An assessment should be made of likely needs for funding if a flood emergency occurs, and agreeing with the potential funders the amount of funding that could be provided and the exact procedure for releasing the funds. This action is normally carried out by Central Government (major flood) or Local Government (smaller flood). It is important to ensure that the needs are identified by the recipients to avoid agencies wasting resources on things that are not needed.

Fund raising in 1927 in the USA. In response to flooding on the Mississippi River.

Communities can assist by advising Local Government of their likely needs for flood emergency response, which would help Local Government decide their overall need for funding. The community needs should generally be developed on the assumption that communities will undertake response and recovery work unless there is a reason why this is not possible.

4.17 CONTROL OF DEVELOPMENT IN FLOOD RISK AREAS

This section discusses the various methods that can be employed to control developments in flood risk areas. It is important that flood risk and hazard are clearly defined. Box 2.1 gives the definitions of flood risk as used in this document.

4.17.1 Floodplain zoning

Floodplain zoning involves dividing the floodplain into areas where the flood risk is different, and defining the types of development and land use that are suitable in each zone. Its purpose is to reduce the risk or

damage to a community during a flood by preventing certain types of development and land use in areas where the flood risk is high. It is first necessary to decide how the floodplains should be zoned. This is done by deciding what flood conditions are unacceptable for particular uses of the floodplain. For example, houses constructed of mud or light vegetation could be destroyed in areas where flood flow velocities are high, and they should therefore not be built in such areas.

Flooded house in the USA.

Mapping is used to select zones on the maps where certain floodplain uses should be avoided, and this information should be passed on to local communities and others involved in land use and development. Communities can not only assist with providing information but could also agree their own system of floodplain zoning based on their previous experience of flooding. Before embarking on an extensive programme of floodplain zoning, the baseline situation should be reviewed. The review should cover the following issues:

- To what extent is floodplain zoning developed as a planning tool to cover the country/river basin;
- Is flood plain zoning a feasible option for planning and catchment management;
- Establish the extent of the task to prepare floodplain zoning in critical areas.

4.17.2 Prevent development within a certain level of risk

The implementation of floodplain zoning is primarily used in urban areas. It is generally more effective in the long term to develop in locations that have a lower probability of flooding rather then implementing flood mitigation measures (for example flood walls) to protect new developments. Flood zoning is used in many metropolitan areas in South Africa, Box 4.11 gives an example of this. Development is prevented in areas where a certain level of flood risk is likely to be exceeded, for example where the flood depth is very high, the flow velocities are very high, or the land could be eroded thereby destroying all development on it. This allows the damage to a community during a flood to be minimised. To implement flood zoning effectively relevant statutory instruments need to be in place and a consistent policy needs to be employed.

Box 4.11 Key elements of the city of Cape Town's policy for development control near watercourses

The city of Cape Town in South Africa has a policy of development control near to watercourses. Figure 4.24 shows the key elements of this policy

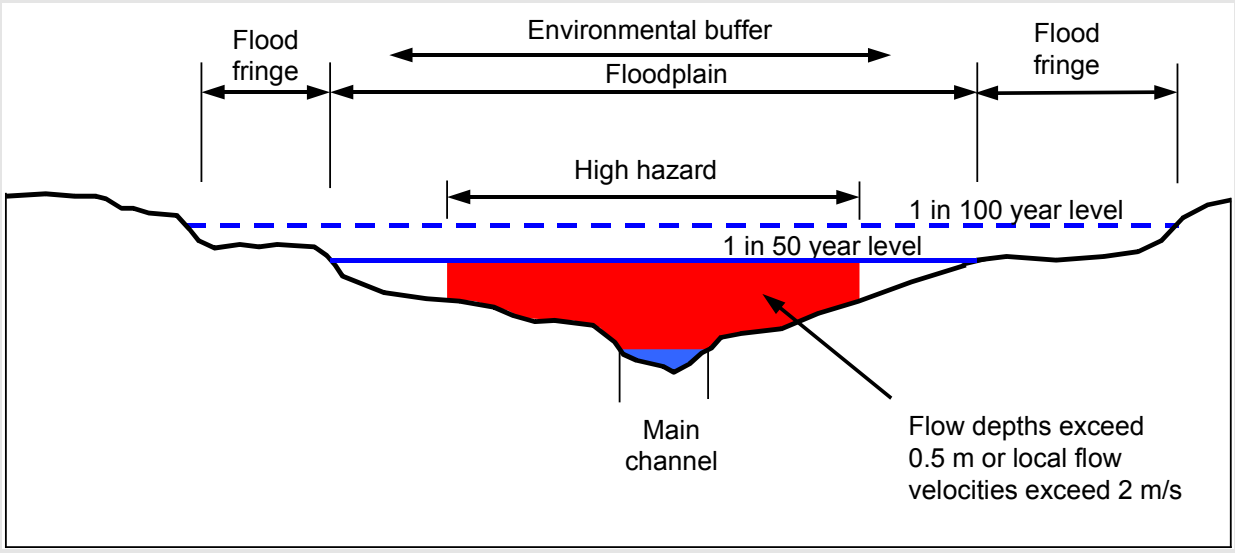


Figure 4.24 Development control policy in Cape Town

The key features of the policy are as follows:

- The **floodplain** is defined as the area susceptible to inundation by the 1 in 50 year flood;
- The **flood fringe** is defined as the area between 1 in 50 year and 1 in 100 year flood envelope. Most development types are permissible in this zone with limited requirements or conditions;
- The **high hazard zone** is defined as the area where flow depths exceed 0.5 m or local flow velocities exceed 2 m/s;
- Boundary walls and/or fences capable of retaining water or restricting free flow of water are to be avoided;
- Parking to be located above 1 in 20 year flood level;
- Ground floor levels of associated non-habitable structures to be at least above the 1 in 20 year flood level and where feasible above the 1 in 50 year flood level. Ground levels of habitable structures to be at least above the 1 in 50 year level and where feasible above the 1 in 100 year level;
- Ground floor levels of associated habitable and non-habitable structures to be above the 1 in 100 year flood level. Basements (where applicable) to be flood proofed to at least the 1 in 50 year level.

(Source: Reference 29)

4.17.3 Legislative tools to control development

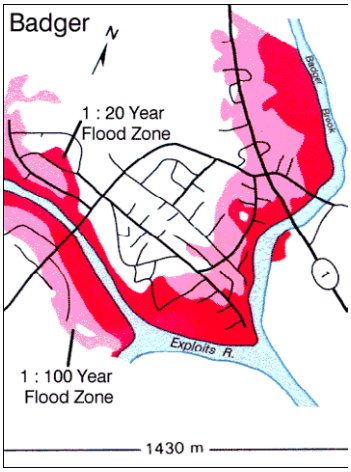
The use of legislation to control development can apply to both flood risk areas, and areas where flood generation occurs and therefore reduce the prevalence and impacts of floods. Legislation for water management and control is usually provided through a statutory instrument, for example a Water Resources Act. This provides the broad framework for control, but implementation may be through regulations or provisions under planning laws. Examination of how legislation can control development is a complex task, to be carried out at high levels in government. It should include:

- Identify legislative tools which provide powers for development control;

- Propose means whereby these may be strengthened and updated;
- Are there bureaucratic barriers to the degree of co-operation and co-ordination required for more effective development control in respect of flood risk;
- What regulations need to be in place;
- Examine the effectiveness of implementing legislation.

It is important that the legislation includes public representation, and for public participation in meetings and enquiries. This in turn requires education and guidance, and is where NGOs have an important role.

4.17.4 Community level implementation of zoning policy



Flood zone map used for the town of Badger in California in the USA.

The zoning policy needs to be carefully explained and demonstrated at the community level, in order that it can be acceptable. Implementing any policy at community level requires that the community understands and can take ownership of the concept. Communities may then co-operate with the implementation of zoning plans, which may involve removing parts of settlements with high flood risk, strategic relocation of key facilities, and radical rethinking of development plans. The community may be able to, and should be encouraged to build capability to adopt its own approach to zoning and controlling occupation of flood risk areas.

Key issues must be addressed including:

- Identifying major issues for people in each proposed zone in past floods. These should include post flood issues such as security of tenure (particularly in relation to buildings and use of agricultural land) and post flood employment;
- Establishing criteria to identify the groups of people facing the highest levels of risk;
- Identifying people or institutions with the best links to the communities at risk;
- Raising flood-awareness with these people and institutions;
- Checking consistency between zoning proposals and local government or traditional authority policy;
- Identifying best practice in extending the flood-awareness and zoning at community level;
- Identify and generate relevant information for specific communities;
- Assess community potential to accept/act on information;
- Identifying additional resources required to promote:
  - Thorough investigation of the impacts of zoning;
  - Acceptance of zoning as a flood mitigation strategy;
- Source and deploy the necessary additional resources;
- Develop widespread acceptance of community approved zoning strategy.

Participatory techniques can be used to stimulate discussion and further understanding of issues for all the participants. The Participatory Learning for Action (PLA) approach aims to ensure that action ensues, in this case, generating and distributing information on zoning as a strategy to help ameliorate problems during the next flood event. This

aspect may be a particular problem in squatter areas where additional resources will be needed such as government assistance in the form of grants and re-housing policies.

5. RESPONSE TO FLOODING

5.1 INITIATE RESPONSE ACTIONS THROUGH APPOINTED INDIVIDUALS

This action involves informing all those involved in flood response that a flood is about to occur (or is occurring) and the agreed response actions must be carried out. This action is essential to minimise the impact of floods. The responses to be carried out will generally be agreed in advance. Good communication will be needed to ensure that all those who have particular response actions are informed. These will include people in a range of organisations and local communities. Some actions are carried out by groups and others by individuals.

People evacuated from flooded areas of Mozambique arriving at Maputo airport.

Typical actions for individuals might include basic actions such as securing houses, putting goods, etc. in safe places, bringing together of livestock ready to move to safe havens, or full evacuation. Families should also follow pre-agreed actions. It is particularly important to keep families together as far as possible during emergencies, particularly where evacuation is needed. The community will be involved in the response actions. These should be agreed in the community emergency plan where this exists.

5.2 PROVISION OF HELP TO VULNERABLE PEOPLE

Women with children, particularly pregnant women and nursing mothers, the elderly and the infirm need to be specially attended to in an emergency. This is because they are less able to respond to flood emergencies. Part of the community preparation activities should include knowledge of vulnerable people in the community. Individuals should be identified to help these people during floods. The way in which this is done will depend on local culture and customs. In many cases it is likely that the immediate families will be responsible for their own family members.

Special arrangements may be necessary to ensure that they are moved early to a safe place. The elderly and infirm who are not linked with families should be taken into other groups for evacuation. The responsibility for looking after vulnerable people normally lies entirely with the community.

Box 5.1 Example of assisting vulnerable people

With local floods predicted in the riverside town of Antioch in the state of California in the USA in 1997 there was concern about evacuating wheelchair bound residents. A group of community based organisations identified the residents who needed assistance and supplied them with transport to get them to safety.

5.3 PREPARE FOR EVACUATION OPERATIONS

Evacuation requires moving people from their settlement to a safe place. The community generally has to take the lead in this action but, when the need to evacuate is announced, will require a certain level of interaction with authorities. The exact division of responsibilities will

depend on how the evacuation is organised and how closely different groups of people work together closely. The following general statements should be observed:

- Communities must accept the authority of evacuation organisers;
- Arrangements for storage of food and placing animals in refuges should be carried out;
- Arrangements for emergency water supply and sanitation need to be activated;
- Evacuees to bring only emergency supplies and documents.

Search and rescue of people stranded during floods in New Zealand.

If the appropriate community level actions have been set up in planning and preparedness activities, then the implementation should proceed according to the agreed plan. The following are important:

- If it appears that evacuation might be necessary, activate plans and evacuate early. Also it is safer to move in the daytime rather than at night;
- Collect the goods that you wish to carry with you in bundles that are easy to carry;
- Secure all valuables, and make arrangements for guarding property against looters, if this is possible. This might include, for example, tying ploughs and other large items to trees;
- Pay special attention to the difficulties of children, the old, and the disabled in evacuations;
- Individuals to collect together personal items they wish to take in the event of evacuation;
- Other belongings to be placed in sealed containers. These could be buried in a place where they can be found on return to the settlement;
- Arrange a search and rescue team, to assist members of the community who are in danger or stranded;
- Establish a means of observing the flood and letting people know when they can return.

Figure 5.1 illustrates methods by which valuable goods may be stored.

(Source: Reference 9)

Figure 5.1 Storing important goods in preparation for floods

5.4 FLOOD FIGHTING

5.4.1 Mobilise emergency workforce and equipment

The purpose of this action is to provide the resources to undertake emergency work during a flood including repairing and maintaining flood protection structures and assisting with the evacuation of people. A core emergency work force and equipment needs to be established as part of the flood preparedness arrangements.

- The emergency workforce should be organised on a rota basis of preparedness
- The emergency workforce should be prepared through progressive stages of alert, culminating in mobilisation
- Plant, equipment, supplies and fuel stocks should be checked, serviced and replenished, in readiness for the flood season.

Other arrangements that need to be considered are:

- The work force should be contactable at short notice. In the case of a community based force, they could be called together by siren or loud-hailer. If the work force is in a number of separate locations, they should have telephone or radio contact.
- In the case of a prolonged or severe emergency, the workforce may need to be organised into camps.
- Emergency services should have the necessary powers to commandeer equipment and manpower.

The community can be involved by identifying and providing people for the emergency workforce or providing the complete team of community workers. It must however be remembered that the first

priority of people in flood risk areas during a flood will be to look after their own families, animals and homes.

Box 5.2 Example of community work force in China

Figure 5.2 Emergency work force in action in China

The Ministry of Civil Affairs, the State Development Planning Commission, the People's Bank of China and the ministries of finance, water resources, agriculture, communications, public health and education have recently united in China to form a powerful disaster relief force. Their team-up constitutes China's most dynamic "emergency squad" whose task is to minimise the losses inflicted upon victims.

Recently the Chinese army formally added disaster relief training to its set of compulsory courses. To strengthen the nation's capability to handle emergencies, various disaster-relief schemes are currently being mapped out across the country, especially in those regions vulnerable to natural calamities. These include mobilising communities to make sure major flood defences do not breach as shown in Figure 5.2.
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5.4.2 Distribute sandbags locally

Use of sandbags to prevent water entering a shop in Prague in the Czech Republic.

Sandbags are bags filled with sand or other soil, that can be used to provide protection from flooding. Sandbags are still the most effective means of emergency repair and providing local and domestic protection. It must be clear which agency is responsible for providing and distributing sandbags. Depending on local organisation, it may not be the river basin authority. It is most likely that the local authority will distribute materials for sandbags, to be filled by local communities. However filling of sandbags is an arduous activity that might best be carried out by the emergency workforce.

- Preparatory stock-piling of sandbags can be carried out, both at a central location and at households/premises which are known to be susceptible to flooding, for example coastal flood-risk areas, locations at risk of flash-floods
- Transport, for example trucks or boats, must be available to move stockpiled bags to key locations
- In addition to stocks of prepared bags, arrangements should also be made for empty bags to be distributed for filling by communities
- Communities should be trained in filling of sandbags: this can be practised as part of a preparedness drill
- Communities will also be involved in decisions as to where to place sandbags

The effectiveness of sandbags should not be overestimated. They can be very effective at filling gaps in existing defences or blocking entrances to buildings, but a very substantial effort would be needed to build even a small sandbag wall. Figures 5.3 and 5.4 show methods by which buildings can be protected using sandbags.

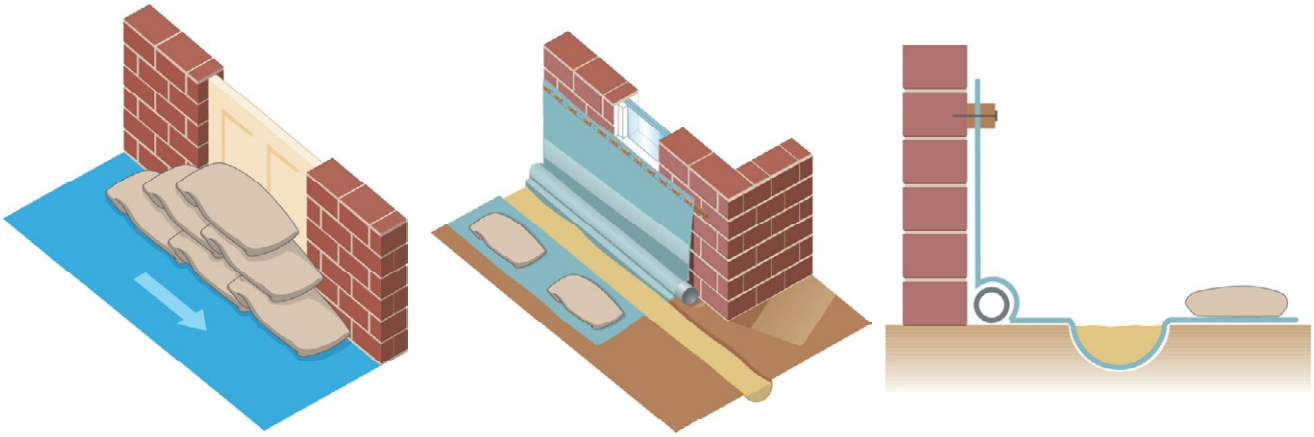


Figure 5.3 Method of protecting brick buildings against flooding

Figure 5.4 Use of sand bags in Dresden, Germany during the 2002 floods

5.4.3 Co-ordinate local workforce and community volunteers

The action involves the co-ordination of community volunteers into a local workforce for flood emergency work. It requires that communities are alerted and prepared to be involved in the co-ordination of the emergency work force. This activity should be planned and implemented over a long period to be effective.

Activities to be carried out by the emergency workforce may include:

- Filling sandbags;
- Moving sandbags and other items to where they are needed;
- Watch for overtopping of river banks and defences during the flood and warn people;

- Repair breaches and other openings in embankments
- Assist people who live outside flood banks
- Protect houses wherever possible. For example, walls could be removed to reduce the resistance to flowing water.

Disaster relief arriving in Mozambique in 2000.

The emergency workforce is likely to require periodic review to ensure new social and economic factors are incorporated. Review of arrangements and procedures may be required at three to five year intervals, depending on the local frequency of flooding. The organisation and review of the workforce should be part of the responsibilities of a specific agency, or group of agencies, whose activities relate to flood response and voluntary efforts. A committee with responsibilities for the workforce could be established. Matters to consider when establishing and maintaining the workforce include the following:

- The workforce should be co-ordinated by people in authority from the local administration, river management agency or emergency co-ordinators
- The workforce will be dependent on other considerations in the community and the ability of different communities to contribute, for example the availability of manpower, skills and equipment for relief activities.
- Priority should be given to one of the alternatives of evacuation or protection
- Food, shelter and security for the workforce will be required
- Establishing links with the authority responsible for the workforce through Community leaders and others with direct involvement, for example wardens or individuals with community status such as teachers, doctors and religious leaders.
- Monitoring of performance for incorporation into review activities

Any emergency workforce will be required to meet regularly and be trained in flood fighting. This could be linked with practising community emergency plans.

5.5 RESPONSES TO SERIOUS EMERGENCIES

5.5.1 Prepare and open shelters

Evacuation of people in Bangladesh.

This action involves opening shelters to receive evacuees when a flood emergency occurs, and is the implementation of the shelter management plan. It is clearly important that this is co-ordinated with evacuation activities during flood emergencies.

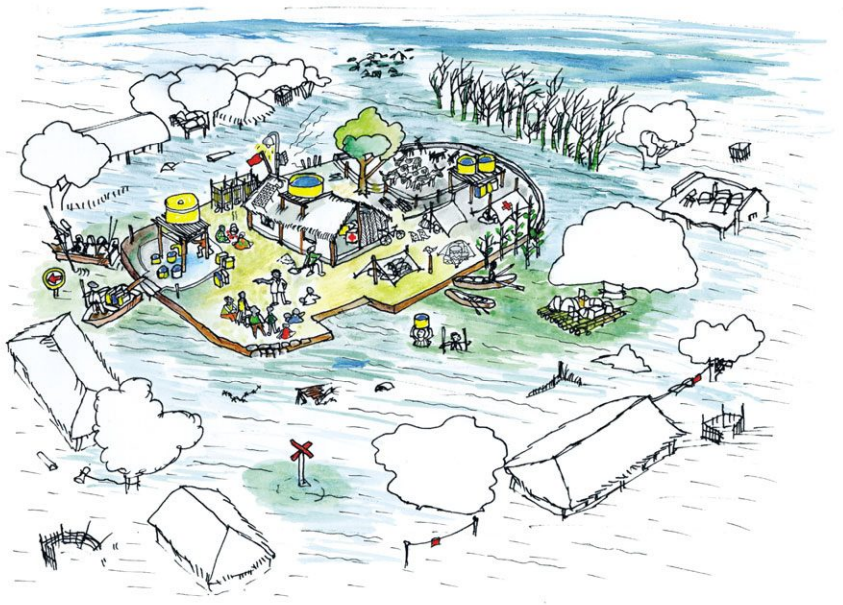
The opening of shelters should be carried out according to a pre-agreed plan, including staffing of the shelter, provision of water, sanitation and supplies. Those responsible for running the shelters should be mobilised as soon as the risk that evacuation could occur becomes apparent. It is expected that members of communities affected by flooding will become involved in managing the shelter. However the immediate need will be to ensure that all those evacuated can be accommodated and looked after.

The way in which supplies of water and food are obtained will depend on the shelter management plan. Where no plan exists, these matters must be dealt with as effectively as possible. Issues of sanitation, hygiene and prevention of disease will be of particular importance.

This activity can be community led although assistance is likely to be needed with the initial opening and running of the camp, when evacuees will be pre-occupied with the flood. An example of preparing a shelter is shown in Figures 5.5 and 5.6.

(Source: Reference 9)

Figure 5.5 Preparation of a local safe haven



(Source: Reference 9)

Figure 5.6 Local safe haven during a flood

5.5.2 Implement evacuation plans

Implementation of the evacuation plan involves implementing previously agreed plans. Preparation for evacuation is described in Section 4.6.4. Where no evacuation plan exists, evacuation should be carried out as effectively as possible. The priorities will be to move people to a safe place and then provide (or help the people to provide) water, sanitation, food and shelter.

It is important to appreciate that evacuation can be dangerous, particularly if it takes place just before the flood occurs. Evacuees may be exposed to hazards such as flooding of evacuation routes, exposure to bad weather, getting lost or being separated from other family members. The need for evacuation must be considered very seriously, and should be practised at regular intervals. An example of an evacuation is shown in Figure 5.7.

Figure 5.7 Evacuation during floods

5.5.3 Operate shelter and emergency relief actions

The main actions focus around the implementation of shelter management requirements, in the provision of basic needs, for example shelter, water, food and sanitation, and include:

Distribution of relief in Mozambique in 2000.

- Provision of temporary shelter, water, food and sanitation:
  - Selection of accessible secure site;
  - Provision and erecting of suitable shelter;
  - Facilitating access to the site for users and suppliers;
  - Establishing communications with regional and other co-ordinators;
- Provision of security and privacy for vulnerable groups such as pregnant women and nursing mothers, young children or old people separated from their support family;
- Provision for families to be reunited where they have been separated, and to stay together;
- Facilitation of searches for, and links between, family members separated by floods.

It is also important that search and rescue arrangements are put into place to locate and rescue other flood victims, and carried out as required. The community has a particular role here, both on their own initiative and by aiding emergency services personnel. This covers:

Flooding in a rural area of Mozambique.

- Making agreements with family members, neighbours and friends that everyone will check on each other and provide help as needed;
- Helping to put into practice the actions already planned by the Search and Rescue volunteers. Make sure that boats are available, and a place to take the rescued people has been decided on;
- The village search and rescue team will try to ensure that every corner of the village is searched and every stranded person is rescued;
- Rescued people can be taken to friends, relatives, high ground of their choosing, or evacuation centres;
- Make sure that the results of the search and rescue activity is made known as widely as possible, so that people do not worry unnecessarily that friends, relatives, neighbours are still missing.

All assistance should be channelled through community leaders and institutions. This could equally be in a tightly knit urban community, or a remote rural location. The community is fully involved in this operation, and may have to provide a lead where resources are available. There is a particular risk that relief supplies may be hijacked and stolen, often re-appearing shortly afterwards for sale in local markets. The protection of relief supplies is an important aspect of any relief operation.

5.6 RESPONDING TO FLOODS THAT OCCUR WITHOUT WARNING

5.6.1. Designated individuals to implement pre-agreed community actions

Implementing actions at a community level can have a number of advantages including:

- Strengthening the resilience capacity of the community to deal with the risk of living in flood prone areas;
- Reducing the risks from potential disasters;
- Taking the initiative to prioritise actions;
- To develop projects for capacity building on community resiliency.

There will always be a risk that floods could occur without warning. This could be the result of freak weather or hydrological conditions, failure of flood warning systems, or through unexpected failure of flood defence or other structures, for example abandoned mines or dams.

Another cause of floods that occur without warning are flash floods on relatively small, steep watercourses or intense runoff on hillsides. Ideally communities should be aware that such a risk exists although this is not always the case.

Response to unforeseen floods will require that the community must respond to a situation where authorities with wider ranging responsibilities may not have taken any action. Flood wardens in the communities and local observers need to be trained to respond to unexpected floods.

This action involves designating responsibility for responses to individuals and groups, and needs to cover:

- Rapid deployment of community work-force for emergency repairs, sandbag filling;

- Evacuation of people to safe locations or flood shelters, if needed;
- Informing authorities, for example the river basin agency and local government, of the situation
- Informing emergency services of the situation;
- Setting up search and rescue activities.

The effectiveness of the response to floods that occur without warning will be affected by the way in which people respond. Some may be too shocked and pre-occupied to do their duties. The more practice of flood response that is carried out, and the greater the awareness of the flood risk in the community, the better the response is likely to be.

5.6.2 Information on local situation passed to responsible organisations

It is highly important that the threatened community makes others aware of its plight. Such information greatly aids the implementation of emergency plans, and may help to anticipate the way a situation will develop. The key community representatives, for example village heads and flood wardens, should be trained and kept aware of their contacts and duties. Information to be passed on includes:

- The nature of the emergency, for example unexpected flood, rapidly worsening local situation, failure of structures
- Time and location of report
- An assessment of assistance needed
- Continued reporting to explain how situation is changing
- Advice to services on how community can be reached, in case of loss of bridges, road access, etc.

For example, during the 1991 cyclone in Bangladesh, the flood forecasting and warning observers were able to report on local conditions in flooded areas, through their two-way radio sets, when other communications had been lost. They were also able to be contacted by the national broadcasting service, and BBC World Service, and give vital information as to impacts.

6. POST-FLOOD RECOVERY STRATEGIES

6.1 RESTORE ACCESS, COMMUNICATION AND ESSENTIAL SERVICES

6.1.1 Emergency repair of damaged roads and bridges

Flood damaged road in Mozambique.

Rapid restoration of roads and bridges is needed to permit transport to reach the areas affected by the flood, in order to deliver such items as relief supplies, repair equipment and materials. The first step is to undertake a rapid survey of damaged roads and bridges and identify the work and materials needed. The work should be prioritised. For example, a community may have several access tracks but only one might be needed immediately after a flood, for example which provides a link to the nearest administrative centre.

Once the work needed has been identified, the repair work should be planned taking into account the availability of all resources, including labour, from the affected communities. It may be possible to provide temporary diversions around damaged parts of a road, to keep access open while more substantial repairs are carried out. Local Government, the military, external organisations (for example, NGOs), local contractors, or a combination of these depending on the nature of the event could provide resources for this work.

Investing in the repair of damaged roads and bridges helps to improve access to markets and services, and to improve access to vulnerable

Communities can assist with the identification of the work to be carried out and prioritisation. Communities could also provide other assistance, including labour and local knowledge, and organise self-help groups to repair bridges or roads so that supplies can come in from outside. Following the immediate repairs, the continuing primary reconstruction efforts require fast-track letting of contracts and procurement for road and bridge reconstruction, as far as possible using local contractors and labour. Figure 6.1 shows a damaged railway line in Mozambique

Figure 6.1 Damaged railway line embankment in Mozambique

6.1.2 Restore water supply and other services

Collecting water in a rural area of Zimbabwe.

Restoring a supply of clean water and sanitation is the most important priority. Sanitation facilities will reduce the risk of pollution and disease. Restoration of power (including transport of gas bottles where relevant) is less important although a source of fuel will be needed for cooking and possibly heating.

Specific actions that could directly involve the community in restoring services include the following:

- Continue to provide emergency water supply and water treatment facilities until normal sources are restored;
- Implement short-term water supply and sanitation facilities, if required;
- Repair and reinstate pre-flood facilities, by cleaning of drinking water sources and repairing tubewells and latrines;
- Provide improved long term water supply and sanitation arrangements. These should be flood-proofed as far as possible taking into account experience from the floods, for example by raising hand pumps.

6.1.3 Restore telecommunications

Good communication is essential to co-ordinate relief activities and restore normal activity after a flood. An important priority is therefore the repair of telephone lines and other telecommunications that have been damaged by the flood. This work would normally be carried out by the national or regional telecommunications organisations. However, they may require assistance with resources and access, and this could be provided by other Government organisations. Particular activities that should be carried out include:

- Set up emergency telecommunications, through radio, mobile phones and emergency service networks
- Repair lines and local exchanges
- Quickly re-establish essential lines, for example to community leaders, local authority offices, NGO representatives.

Whilst the community forms an important part of the communication network, there is little a community can do to contribute to this activity. Figure 6.2 shows an example of a disaster proof telecommunication centre in Japan.

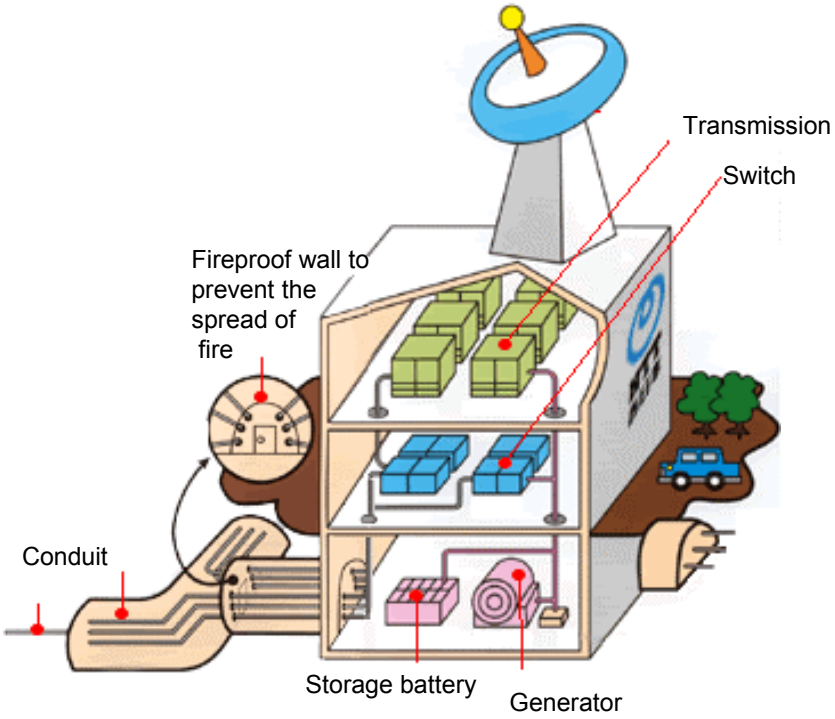


Figure 6.2 Example of a disaster proof telecommunication centre in Japan

In Japan the latest telecommunication centres are constructed to withstand typhoons with wind speeds up to 60 m/s. Waterproof board and waterproof walls are installed to prevent inundation of the machine room. The building itself is constructed on a raised site.

6.2 ENSURE PROVISION OF ENHANCED HEALTH SERVICES

6.2.1 Establish disease prevention programmes

A general environmental health programme can be implemented by a single agency working with the affected community or by a public health co-ordinating committee representing several agencies, government departments and the affected community. It should include the following.

- Identify the needs and establish priorities by carrying out a rapid assessment;
- Identify the resources needed to deal with these needs (staff, time, skills, equipment, materials, funds);
- Establish a small team for field work;
- Prioritise actions, starting by establishing a minimum level of service necessary to sustain basic levels of health. Improve the level of service later as time and resources allow;
- Prioritise and revise control measures by regularly monitoring disease incidence and severity.
- Set up an effective reporting system and ensure it is used. Monitor progress, using appropriate indicators. The programme should be evaluated and revised as necessary.

For example specific action is required to control cholera which, if left unchecked, can kill many people in a short time. Standard measures used in controlling cholera include:

- Monitor the supply of food, especially at markets, and its preparation;
- Provide safe excreta-disposal facilities, ensure they are used and prevent indiscriminate defecation;
- Control excessive numbers of flies, especially around latrines/defecation areas: families should spread adequate amounts of bleaching powder around the house;
- Ensure a safe and adequate supply of drinking and washing water;
- Prevent the use of contaminated water sources;
- Implement a public cholera information campaign, telling people the measures they can personally take to control transmission;
- Establish emergency isolation centres. Isolate and treat severe cases under conditions which treat all wastes before disposal;
- Establish oral rehydration therapy centres to rehydrate moderate cases;
- Train personnel to recognise cholera symptoms early and to give oral rehydration salt solution;
- Use patient records to plot outbreaks on a map of the settlement.
- Follow up cases to determine where the patients came from and their living conditions. Contact people who had been in contact with patients and introduce preventive measures as necessary.

6.2.2 Re-stock and equip medical facilities

This activity is primarily concerned with the population's vulnerability to water-borne disease and links to strategies to ameliorate disease resulting from pollution of floodwater by faecal coliforms and other pollutants such as agricultural chemicals and fuel oils. It is also concerned with physical risk to flooded communities such as injury and starvation. Actions include the following:

- Map existing facilities involving community leaders/health workers, indicating the numbers of patients normally associated with each facility;
- Map potential pollutant focii such as fertiliser stores, fuel depots and densely populated areas;
- Establishing suitable re-stocking sites that take account of potential supply constraints, proximity and accessibility to communities;
- Ensure publicity about the location of such re-stocking facilities is disseminated regularly;
- Re-instate and/or upgrade medical facilities, for example clinics, pharmacies;
- Develop procedures to facilitate rapid release of supplies in a post flood emergency;
- Provide local centres with medicines and other supplies lost or damaged during the flood;
- Re-establish and improve systems for maintaining emergency stocks.

This activity will be undertaken by Regional or Local Government health services, possibly with the assistance of NGOs. Communities can however assist by providing information on regular needs and specific needs following the flood. Storage of supplies is shown in Figure 6.3.

(Source: Reference 9)

Figure 6.3 Storing emergency supplies

6.2.3 Monitor community health and take actions if needed

A monitoring campaign is needed because it will take some time for the community to return to normal. The effects of poor water supplies and sanitation, and loss of resilience of the flood-affected community can take weeks or months to disappear. During this time the population may have a high vulnerability to disease. Specific steps to monitor community health include the following:

- Establish health monitoring programmes based on community health centres and clinics;
- Use monitoring results to inform and improve management of clinics and future flood emergency plans;
- Establish a register of trained individuals within the community who are willing to assume some responsibility for the duration of emergency activity;
- Establish a review period that relates to both needs and resources, and delegate responsibility for review, reporting, and action, to appropriate institutions. An appropriate institution would be one which holds responsibility for developing long-term policy in relation to flood and other emergency situations.

The community can contribute to this activity by being vigilant about health issues, and reporting problems as they arise.

6.3 RECONSTRUCT DAMAGED COMMUNITIES

6.3.1 Train and employ affected communities in immediate rebuilding programmes

It is important that those affected by flooding are provided with employment, and this action will assist meeting the need for adequate labour to be available for rebuilding work. In order to involve affected communities in rebuilding programmes, it is necessary to identify what work is needed and where, what materials and skills are needed, and how payment will be made. Building materials should be provided directly or through credit arrangements. Some building materials may be available locally, for example earth and wood for buildings. A local labour pool will need to be identified, which can be organised as a resource where needed. Training may be needed in particular skills, and this could be organised through individuals in the labour pool. External assistance, most probably from NGOs, may be needed to provide people who are able to give specific training. In addition to payment, labour from the affected communities will require food and shelter if working away from their families. It may be possible for communities to take over rebuilding activities (for example, their own houses) with assistance in the provision of materials and training.

6.3.2 Re-build houses and key community buildings, for example health centres, schools

Reconstruction of houses in El Salvador after hurricane Mitch.

An important part of the restoration of the community is the restoration of key buildings to their pre-flood condition. To reconstruct buildings it is first necessary to identify the work needed and plan the reconstruction work. Any lessons arising from the flood should be taken into account. For example, it may be possible to move buildings to parts of the floodplain where the risk is lower, or re-design the buildings so that they are more resistant to flooding including such features as raised floor levels, safe power supplies and stronger construction.

Co-ordination is required between Central Government, Local Government, NGOs and the community in order to provide the necessary resources. Where a large amount of reconstruction is needed, it is likely that prioritisation of reconstruction tasks will be necessary to make best use of the available resources. The community should be involved in the planning and design of the reconstructed buildings so that the buildings best serve their needs.

Any assistance that the community can provide for the reconstruction work should be used where appropriate, for example the provision of labour and facilities to encourage local contractors. The restoration of damage to houses, roads, culverts, embankments and bridges should be carried out by villagers themselves, wherever possible, to increase potential employment opportunities.

6.3.3 Improve flood proofing of domestic and key community buildings

The flood proofing of domestic and key community buildings should be improved to reduce the impact of flooding on buildings in future events. Design criteria should be based on knowledge of the effects of a recent flood. Information on how to improve floodproofing is needed. This should include both 'international' experience and local ideas and experience, which will be particularly suited to local conditions, for example how to strengthen the structure of a house, the need to protect important basic food supplies and personal items.

Example of a flood proof buildings in the Lempa River basin in Central America.

Specific measures for floodproofing individual buildings should be identified. These could include new structures (for example, platforms to store things during a flood) or changes in the finishes or detailing of buildings (for example, removal of raised doorsteps to facilitate drainage). The work could either be carried out using contractors or local tradesmen, depending on the complexity of the work and availability of skills.

The community could be involved by providing ideas on how best to floodproof buildings. This could include incorporating features that assist the community during flood events, for example demountable flood defences or house-door flood boards and strong lockable storage facilities for the storage of valuables during a flood. The community could also be involved in undertaking the floodproofing work.

6.3.4 Repair flood protection structures

It is important that structures that provide flood alleviation and protection (for example embankments, floodwalls, culverts and drainage channels) are repaired before the next flood. Experience from a recent flood can also be used to improve the design of flood protection structures and raise awareness of the need to maintain the structures. A list of flood protection structures should be prepared together with an assessment of the repairs needed to each item. There will also be a need for materials, labour and plant appropriate to the nature of repairs needed. Flood protection structures need to be robust and well constructed, and it is likely that contractors will be needed for significant and permanent repairs.

The repair of flood protection structures needs an assessment of the extent and nature of the damage, and designs for the repairs. These designs should include improvements to overcome weaknesses in a structure exposed by the flood or to facilitate operation and maintenance. For example, if an embankment failed because of scour at a certain location, protection should be provided at that location to prevent or reduce scour. In extreme cases, it may be advisable to reconstruct the structure at a different location. The work could either be carried out using contractors or local tradesmen, depending on its complexity and the availability of skills. Flood protection works often require specialist skills including specific experience of flood protection work.

The community can provide advice on the effectiveness of the flood protection structures and other protection work that might be needed, and also assist with planning the repair work. The community should also be involved in the operation and maintenance of protection structures, including for example clearing culverts and minor repairs. The community could also be involved in undertaking the repair work or providing facilities for contractors/public agencies undertaking the work.

6.4 RELOCATE COMMUNITIES AND HOUSING AS REQUIRED

6.4.1 Identify and acquire suitable sites

Relocation involves the finding of suitable sites, either as a result of total loss of buildings in a community or a planned relocation. Before a community is relocated a suitable site should be identified which is outside the area at risk from flooding. It should also be confirmed that the site is available and the conditions for acquisition are acceptable.

The site must be satisfactory in terms of access and services, particularly transport and water supply. Once an acceptable site is identified, it should be acquired using appropriate local land acquisition and ownership procedures. The community has a major role in this action, as it must firstly agree to being relocated and secondly agree to the new site. The community should be involved in site selection and, if possible, choose the site themselves.

6.4.2 Train and employ work force from affected communities

It is important to employ those who have been relocated both to keep them occupied during the difficult transition to a new site following a flood, and provide a source of work and income. To employ the work force from a relocated community, it is first necessary to agree the type of buildings to be constructed and the skills required. Buildings could range from traditional construction using mud and straw to brick buildings with wooden roof frames. The community should be consulted on the type of buildings bearing in mind the limitations on resources, for example the availability of bricks and other materials.

Once the type of buildings has been decided and a plan prepared for the community, the amount of labour and skills available within the community should be assessed by the agency responsible for the new buildings (usually local government). Training requirements should be agreed with the community in terms of the individuals to be trained and the skills required. The way in which work is carried out and paid for should also be agreed.

6.4.3 Build new houses and community infrastructure

It is important to ensure that the new buildings and infrastructure suit the requirements of the community and are constructed in a reasonable period of time so that the community is able to stay together. To construct the buildings and infrastructure it is first necessary to plan the

work including designing the houses and other facilities, providing the necessary materials, and deciding who will do the construction work. As far as possible labour from the community should be used, possibly under the supervision of a local Government Agency, an NGO competent in building work, or a contractor.

A plan for the construction work should be agreed with the community, agreeing the order in which things are built. Priority should be given to the construction of suitable access for vehicles, water supply, and suitable shelter for families during the construction period. Construction should then be undertaken using traditional methods and work organisation, as far as is appropriate for any new arrangements, with community labour receiving appropriate payment for their work.

This activity will involve many members of the community and have a major impact on the community. Thus the community should be involved in all decision making. In some cases it may be possible for the community to undertake the complete construction work with external specialist assistance and guidance for local government or NGOs. Figure 6.4 shows a drawing of new houses being constructed in Bangladesh.

Figure 6.4 Re-construction of houses in Bangladesh after a flood

6.5 RESTORE LIVELIHOODS OF AFFECTED COMMUNITIES

6.5.1 Expedite arrangements for cash and in-kind compensation

Flood victims have often lost many of their possessions and livelihoods including, for example, crops and businesses. In such cases there may

be a need to provide money so that they can purchase the things they need to re-establish their livelihoods. This activity relates to the immediate post-flood period and should be carefully co-ordinated within the overall planning framework.

It is unlikely that significant funds will be immediately available for distribution. It is therefore necessary to devise financial strategies by which funds can be released early in post-flood periods to assist small producers and small businesses to resume activity, despite the loss of assets that have afflicted them. Main actions are as follows:

- Develop, approve and publicise criteria on which compensation and credit can be disbursed;
- Develop, establish and publicise the terms on which credit can be extended in relation to flood events;
- Delegate assessment of applicants in relation to established criteria to institutions at provincial, district and community levels;
- Ensure the flow of funds on the recommendation of the approved institutions. It will be important in the long-term to support the credibility of such institutions.

Compensation and recovery financing can be cumbersome procedures, and open to malpractice. Government arrangements need to be thoroughly implemented and closely monitored. NGOs who are already established and working with the communities can have a significant role to act as brokers and intermediaries between communities and authorities.

Local communities can take steps to ensure that financial support and compensation is effective. Actions should include:

- Try to hold on to assets through taking loans rather than selling goods and possessions;
- Try to get loans on good terms from NGOs, or NGO organised groups;
- Seek whatever food-for-work or cash-for-work opportunities exist during and, after a flood,
- Try to avoid either going into debt or selling property;
- Instead of going to moneylenders for loans, a local emergency committee can be used to lend money on a soft-term basis.

Wherever possible, communities should develop their own contingency plans for providing funds after an emergency. One possibility would be for members of the community to contribute to an emergency fund.

6.5.2 Avoid panic selling

In the aftermath of a flood, people are often desperate for money and supplies. As a result they may sell valuable possessions at low prices in order to survive. It could even involve family members being sold as servants. This can have a very damaging impact on their longer-term livelihoods, and create a situation from which they never recover. It has the greatest impact on the poorest, and should be avoided wherever possible.

The best way to prevent panic selling is to restore livelihoods as quickly as possible, and provide relief supplies in the meantime. This places a heavy and important burden on central and local government organisations. In particular, financial resources should be made available to flood victims as described above.

If communities are able to implement flood impact mitigation activities such as storing food, the risk of panic selling will be reduced. Local authorities and communities must work together to ensure that they are aware of the dangers of panic selling, and the things they can do to prevent it. Box 6.1 provides an example of food prices during a flood and how they are related to market access.

Box 6.1 Example of food prices and market access in Mozambique

When transportation routes are cut, existing supplies of food become more expensive. Demand for food rises at the same time as supplies are diminishing. Figure 6.5 shows what happened to maize prices in the town of Xai Xai in Mozambique before and after the 2000 floods.

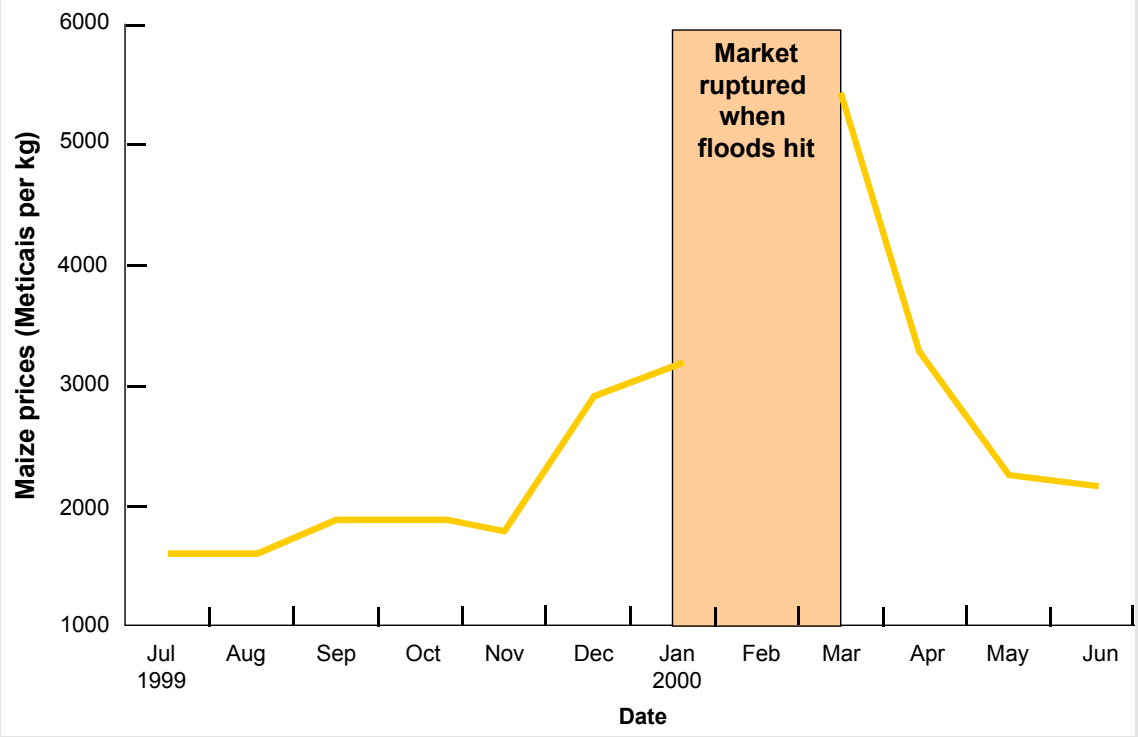


Figure 6.5 Maize prices before and after the 2000 floods in Xai Xai Mozambique

The pattern of change in market prices following the 2000 floods provides a useful guide to likely changes in future floods. Perhaps surprisingly, market activity resumed relatively quickly once flood waters receded and prices returned to near normal levels within two to three months. A number of factors will contribute to the rapid normalisation of prices after a flood, including the availability of crop production in neighbouring areas, the amount of food assistance provided and the ingenuity of traders that seek out alternative transport routes often long before road repairs are fully completed.

(Source: Reference 1).

6.5.3 Restore agriculture

This activity involves the restoration of agricultural activity including growing crops, looking after animals and restoration of fisheries. It is a

very important component of community recovery in rural and peri-urban areas. Support may be necessary for one or two seasons depending on the severity of the flood and impact on the community. Support requires:

- Extended credit on low interest terms;
- Provision of equipment, seed and fertiliser. In the case of fisheries, replacement of boats and equipment may be needed and support for aquaculture;
- Establishment/introduction of improved levels of agricultural extension, particularly for pest control and marketing.

Recognised community channels should be used to implement the above actions. In addition, the community needs to implement its own planned activities. Seed saved for emergency use should be planted directly after the flood, to allow cultivation to start as soon as possible. Vaccination of livestock or poultry should be carried out to prevent spread of diseases.

The impact on agriculture and the need for restoration will be reduced if communities have been able to save their animals, fisheries and even some of their crops. This emphasises the vital need to minimise the impact of floods on agriculture. Immediate actions to restore agriculture include:

- Drying wet grain and seed;
- Transplanting seeds quickly after the flood to grow a new crop as quickly as possible, and benefit from residual moisture;
- Being aware that crop diseases and crop pests are a high risk after a flood. These should be identified and dealt with;
- Recognise and treat illnesses in animals;
- Isolate animals with contagious diseases.

6.5.4 Restore shops and other economic activities

This action relates to activities that aim to restore the flows of expenditure and income normally found in the communities during flood free periods. They are likely to involve backward and forward economic links and it may be necessary to involve the commercial private sector in this activity. It may be necessary for the public, or government, sector to establish a framework of rules within which these restoration activities can function. These include:

- Extending credit for specific periods, with rules that are specified for the duration of post-flood activities;
- Providing start-up stocks of food and basic materials for which specific credit arrangements are established;
- Improving and developing marketing facilities for produce that is generated locally in the immediate post-flood period;
- Providing better communications both in terms of information exchange and access between communities and markets.

These actions should be established through recognised community channels. In the event of the community channels being disrupted, assistance should be sought from local or international NGOs. This

activity will be affected by other disruption caused by floods, for example loss of access routes to market. Box 6.2 provides details of a method used to improve the economy in Mozambique.

Box 6.2 Example of post-flood recovery strategy in Mozambique – money or material aid?

After the 2000 floods in Mozambique some people were given roofing sheets or other materials as they left accommodation centres. However, the executive director of the Mozambican NGO Association for Children stated that "*All post-flood distributions tend to be sold because they don't match their needs. Agencies think that they are meeting needs, but they don't. People sell the roofing sheets and buy clothing or school books, for example*".

In the event of a flood in the USA the US Federal Emergency Management Agency (FEMA) gives family grants of US$14,000 plus subsidised loans. In Mozambique after the floods USAID decided to give US$100 per family, roughly the same percentage of GDP per capita as in the USA to the 85,000 families outside Maputo and Matola that were affected by the flood. Local accounting firms were hired to go to flood affected areas and draw up lists of affected families, relying heavily on local consultation to see who was really affected. Then, soon after, a cheque was issued for US$100. If local businesses were not prepared to cash the cheque, then the accountancy firms that had been hired would have to go and cash the cheques on the spot. Local leaders were told that USAID preferred to have cheques made out in the name of the senior woman in the household. Most communities accepted this.

Putting US$8.5 million into the economy over a short space of time can have an inflationary impact on the economy with the cost of staple goods rapidly escalating. Although this might happen in more remote areas most of the recipients will live in more densely populated areas with commercial competition. In addition USAID also set up a US$7 million low interest credit line for wholesalers; if they took up the credit they were supposed to improve their own suppliers credits, allowing retailers 60 days instead of the normal 14 days to repay. Retailers and wholesalers were also told where cheques were to be distributed, so that they could step up supplies in those areas.

(Source: Reference 30)

6.6 CARRY OUT A DETAILED ANALYSIS AND REVIEW OF THE FLOOD EVENT

6.6.1. Analyse physical nature of event (meteorology, hydrology), highlighting any exceptional conditions

Improving the understanding of flood events is important to develop monitoring and management needs for the future. Knowledge of the storm and flood characteristics helps to identify types of situations that are the most critical. On meteorological aspects, this should cover long-term as well as event based forecast information, for example:

- Comparison with the seasonal forecasts, where there is a strong seasonal pattern to flooding;
- Review the behaviour of the causative meteorological events, and add to the understanding of the main meteorological situations which cause flooding;
- Relate the detailed behaviour of rainfall in major events to the relevant forecast;
- Quantitative assessment of forecast performance, where forecasts have given rainfall amounts.

In relation to flooding, it is important to collect data and information quickly after an event, so that the numerical records can be related to on-the-ground experience. Principal actions are as follows:

- Carry out a post-flood inspection with community leaders to identify maximum extent of flooding and particular damage sites;
- Obtain eye-witness accounts from local people on extent and timing of floods;
- Examine local record from monitoring networks, especially to check if equipment was functioning properly;
- Obtain reports from local staff of meteorological and hydrological agencies.

Eye witness accounts from affected communities are important, but have to be carefully assessed against prevalent "myths" regarding external activities, for example mismanagement of control structure upstream and the severity of phenomena.

6.6.2 Analyse the performance of flood management measures

Removable floodwall in the USA.

It is essential that experience gained in flood management is properly documented, so that both the successful and less successful aspects are understood, and acted upon. Does the flood management agency have a regular system for monitoring performance? If not, a process should be introduced which provides monitoring of routine operations and specific events. These include:

- An annual report on all aspects of the flood management process;
- A post event report, which covers all parts of the event from forecasting, through to response, involvement of emergency services and clean-up operations;
- Internal and community post-flood meetings.

The internal review process has to be backed up with information from the affected communities. This provides feedback for awareness programmes, forecasting and warning arrangements. Information obtained from affected communities should include:

- How warnings were received, and if the information was useful and understandable;
- The performance of local structures, (for example embankments, drainage channels).

In addition, information should be obtained from the local authority on maintenance and flood fighting.

6.6.3 Review the performance of emergency plans and organisation

A review of emergency plans and their organisation need to be driven from a high level, and be approached through meetings between flood and catchment management agencies and emergency services. It should be established as normal good practice that post-event reviews are held quickly after each event. The catchment management agency, as

providers of the flood warning service should concentrate on evaluating outcomes as follows:

- Consult with communities on their perceptions of emergency management;
- Consult with local authorities on their perceptions of emergency management;
- Organise post event review meetings with main government agency and emergency services, at which representation of local experience can be presented.

Public meetings including question and answer sessions with flood management staff at community level are important. They should be organised in collaboration with NGOs and community leaders to avoid the development of antagonism between "official" and "target" parties. The outcome of these meetings and reviews should appear in the written reports, described in the following section. The community should undertake its own review of their emergency plan through community discussion, and redesign it if necessary. Questions to be raised in such a discussion should focus on:

- Who provided help and guidance in the last flood?
- What were the causes of death and other serious losses during the flood? Could these be prevented in future?
- Has any committee been organised in the village to help plan for future disasters?
- If not, do you think that such a committee would be useful?
- Who do you think should be members of such a committee? Who showed themselves a leader in the last floods?
- What should the committee do when there is no disaster?

This activity can also be used to identify things that reduced the impacts of flooding, for example modifications to houses to improve their flood resistance. A particular problem with flood emergency planning and response is the rare nature of floods, and the risk that the people or facilities needed will not be available at the time the flood occurs.

6.6.4 Prepare reports for appropriate levels and users

Post-event reporting will present the findings from actions described above. There should be separate reports for specific areas, for example a catchment or local government unit, for the detailed presentation of flood information. The reports should include the following information:

- The meteorological and hydrological features of the flood;
- A summary of damages, loss of life, property and infrastructure disruption;
- The actions of authorities and emergency services, during and after the event;
- Lessons learned and recommendations for future improvement.

The findings of the "local" reports need to be collated into shorter reports for presentation to higher levels, so that information and recommendations are provided at policy and strategy levels within the

government. These may in turn lead to special investigations being instigated from high levels, or onward reporting to international agencies for funding and assistance. A typical reporting process, which develops high level activity, could be as follows.

- Local sections of river basin agency prepare the required post-event reporting;
- The senior administration of the river basin agency prepares an overall performance report to its supporting ministries
- Ministry/central government establish high level reviews or detailed reporting on specific activities;
- Multi-department/agency meetings and conferences examine issues. This is the point when extensive consultation with communities, usually through NGOs, is most effective to influence future developments;
- In the case of a major catastrophe, reviews by international agencies.

There is also a need to provide feedback to communities on lessons learnt to improve flood preparation and response next time. The use of suitable dissemination material, for example posters, can reinforce the lessons learnt.

7. CHECKLISTS

Checklists have been produced that give the elements of the particular strategy, which are further broken down into particular actions. The relative costs and effort involved are qualitatively indicated, as are the levels of involvement in their implementation by various sectors or agencies, including the communities who are at risk of flooding. It is assumed that one "agency" (or at most two) will have a leading role to play in implementation (▲), and other agencies which have a linked involvement (Δ).

The indication of cost, effort and level of involvement are given. These are broadly indicative only, and not to scale, for example the level of the resources needed is identified as follows:

Resources needed: ●●● Large ●● Medium ● Small

CHECKLISTS FOR DEVELOPING FLOOD MITIGATION AND PREPAREDNESS STRATEGIES

Strategy	Action	Cost	Effort	Level					
				Community	Local Authority	Water management organisation	Non-Governmental Organisations	Regional Government	National Government
Raising flood awareness	Prepare flood maps	●●●	●●●	Δ	Δ	▲			Δ
	Dissemination of flood risk information	●●	●●●	Δ	▲	▲		Δ	
	Prepare seasonal calendar	●	●	Δ		▲	Δ		
	Historic flood marks	●●	●●	Δ	Δ	▲			
	Disseminate flood mitigation information to regional communities	●	●●		▲	▲	Δ	Δ	
	Disseminate flood mitigation information to local communities	●	●●	Δ	▲	▲	Δ		
Flood forecasting	Develop and maintain a national flood forecasting system	●●●	●●●			▲		Δ	Δ
	Involve communities in data collection	●	●●●	Δ	Δ	▲	▲		
	Method for providing flood forecast	●●	●●	Δ		▲			Δ
	Prepare national or regional flood forecast	●●	●●			▲		Δ	Δ
	Prepare a short lead-time regional and local forecast	●●	●●		Δ	▲		Δ	Δ
Provide flood warnings	Prepare standard warning messages for different purposes	●	●●	Δ	Δ	▲	Δ	Δ	Δ
	Procedure for disseminating warnings	●	●●	Δ	▲	▲		Δ	Δ
	Procedure for disseminating warnings to remote areas	●●	●●●	Δ	▲	Δ	Δ		
	Prepare and issue progressive flood warning messages	●	●		Δ	▲			
	Disseminate flood warning to communities and remote areas	●●	●●●	Δ	Δ	▲		Δ	Δ
	Disseminate flood warning within communities	●	●●	▲	Δ	Δ	Δ		

CHECKLISTS FOR DEVELOPING FLOOD MITIGATION AND PREPAREDNESS STRATEGIES

Strategy	Action	Cost	Effort	Level					
				Community	Local Authority	Water management organisation	Non-Governmental Organisations	Regional Government	National Government
Provide flood warnings	Provide warnings for high emergency conditions	●	●●		Δ	▲			
	All clear message preparation and dissemination	●	●●	Δ	Δ	▲		Δ	Δ
	Establish flood watch system, including communication	●●	●●	▲	Δ	▲		Δ	
	Establish gauges for local flood warning purpose	●	●●	▲		▲	Δ		
	Establish trigger levels for action	●	●	▲	Δ	▲			
	Main infrastructure	●●●	●●		Δ	▲		▲	Δ
	Local structural provisions	●●	●●	Δ	▲	Δ		Δ	
	Operation and maintenance of flood defence infrastructure including drainage	●●	●●●	Δ	Δ	▲		Δ	
Structural flood defences	Main infrastructure	●●	●●		Δ	▲		▲	Δ
	Local structural provision	●	●●	Δ	▲	Δ		Δ	
	Operation and maintenance of flood defence including drainage	●	●	Δ	Δ	▲		Δ	
	Examine institutional framework	●●	●●●		Δ	Δ	Δ	▲	▲
Plan for flood emergencies	Prepare community plan	●	●●	▲	Δ		Δ		
	Identify vulnerable groups	●	●	▲			Δ		
	Identify equipment and other improvements needed for implementing plan	●	●●	Δ	Δ	▲	Δ	▲	
	Prepare water and food supplies for emergency	●●	●●●	Δ	▲		Δ	▲	
	Identify individual actions in emergency	●	●	Δ	▲	Δ		▲	Δ
	Practice emergency plan	●	●●●	▲	Δ		Δ		
	Health and sanitation including disease prevention	●●	●●	Δ	▲		Δ	Δ	▲
	Provide funding for emergencies	●●●	●●			Δ		Δ	▲

CHECKLISTS FOR DEVELOPING FLOOD MITIGATION AND PREPAREDNESS STRATEGIES

Strategy	Action	Cost	Effort	Level					
				Community	Local Authority	Water management organisation	Non-Governmental Organisations	Regional Government	National Government
Evacuation and shelter management	Identify safe evacuation zones and routes	●	●●	▲	Δ				
	Provide adequate shelter and evacuation facilities	●●●	●●		Δ			Δ	▲
	Establish operational plans for evacuation and shelter management	●●	●●	Δ	▲	Δ	Δ	▲	
Minimise impact of floods on community and livelihoods	Protect essential services	●●	●●		▲	Δ	Δ	▲	
	Safe havens to delay or avoid evacuation	●●	●●●	Δ	▲		Δ		
	Modify houses to provide safe havens	●●	●●	▲	Δ		Δ		
	Establish alternative water supplies	●●	●●●	Δ		▲	Δ		
	Store food and other survival essentials in a safe place	●	●●	▲	Δ			Δ	
	Alternative energy supplies	●●	●	Δ	▲				
	Make houses and other buildings flood resilient	●●	●●●	Δ	Δ		Δ	▲	
	Relocate houses	●●●	●●●	Δ	▲		Δ	Δ	
	Protection of homes from looting	●●	●●●	Δ	▲				
Minimise impact of floods on community	Store for valuables	●	●●	▲	Δ				
	Reduce the impact of floods on infrastructure including roads and bridges	●●●	●●	▲	Δ		▲	Δ	
	Protect animals, agriculture and fisheries	●●	●●●	Δ	▲		Δ	Δ	
	Store seeds and other essentials to aid recovery	●●	●●	Δ	Δ		Δ	▲	
	Planning for initial community recovery	●●	●●	Δ	Δ		Δ	▲	▲
	Provide support for livelihoods	●●	●●	Δ	Δ		Δ	▲	Δ

CHECKLISTS FOR DEVELOPING FLOOD MITIGATION AND PREPAREDNESS STRATEGIES

Strategy	Action	Cost	Effort	Level					
				Community	Local Authority	Water management organisation	Non-Governmental Organisations	Regional Government	National Government
Control of development in flood risk areas	Flood plain zoning	●●●	●●●	Δ	Δ	Δ		▲	▲
	Prevent development within a certain level of risk	●●●	●●		▲			Δ	
	Legislative tools to control development	●●	●●●	Δ	Δ	Δ	Δ	Δ	▲
	Community level implementation of zoning policy	●●	●●	▲	▲	Δ	Δ		
Community flood response	Receive warning messages and disseminate flood warning within community	●	●●	▲	Δ	Δ	Δ		
	Initiate response actions through agreed plans and appointed individuals	●	●●	▲	Δ		Δ		
	Provision of help to vulnerable people	●	●●●	▲	Δ		Δ	Δ	
	Prepare for evacuation operations	●●	●●	▲	Δ		Δ	▲	
Responses to serious emergency	Prepare and open shelters	●	●	▲	Δ		Δ		
	Implement evacuation plans	●●	●●●	Δ	▲	Δ	Δ	▲	
	Operate shelter and emergency relief actions	●●	●●●	▲	Δ		▲	Δ	
Floods that occur without warning	Designated individuals to implement pre-agreed community actions	●	●●	▲	Δ	Δ	Δ		
	Information on local situation passed to responsible organisations	●	●	▲	Δ	Δ	Δ		

CHECKLISTS FOR DEVELOPING FLOOD MITIGATION AND PREPAREDNESS STRATEGIES

Strategy	Action	Cost	Effort	Level					
				Community	Local Authority	Water management organisation	Non-Governmental Organisations	Regional Government	National Government
Restore access, communication and essential services	Restore telecommunications	●●●	●●		Δ			▲	Δ
	Emergency repair of damaged roads and bridges	●●	●●	Δ	▲	Δ		Δ	Δ
	Restore water supply and other services	●●	●●	Δ	▲	▲	Δ	Δ	
Ensure provision of enhanced health services	Establish disease prevention programmes	●●	●●●	Δ	Δ		Δ	▲	Δ
	Re-stock and equip medical facilities	●●	●●				▲	▲	
	Monitor community health and take actions if needed	●●	●●	Δ	Δ		▲	▲	Δ
Reconstruct damaged communities	Train and employ affected communities in immediate rebuilding programmes	●●	●●●	▲	Δ		▲	Δ	Δ
	Re-build houses and key community buildings, e.g. health centres, schools	●●	●●●	▲	▲	Δ	Δ	Δ	
	Improve floodproofing of domestic and key community buildings	●●	●●	▲	Δ	▲		Δ	
	Repair flood protection structures	●●●	●●	Δ	Δ	▲		Δ	
Relocate communities and housing, as required	Identify and acquire suitable sites	●	●●	▲	▲		Δ	Δ	Δ
	Train and employ work-force from affected communities	●●	●●	Δ	Δ		▲	Δ	
	Build new houses and community infrastructure	●●●	●●●	▲	Δ		Δ	Δ	
Restore livelihoods of affected communities	Expedite arrangements for cash and kind compensation	●●●	●●●		Δ		Δ	▲	Δ
	Avoid panic selling	●●●	●●	Δ	▲		Δ	Δ	Δ
	Restore fisheries	●●	●●●	▲		Δ	▲	Δ	Δ
	Restore agriculture	●●	●●●	▲			▲	Δ	Δ
	Restore shops and other economic activities	●●	●●●	▲	Δ		▲	Δ	Δ

CHECKLIST FOR POST FLOOD RECOVERY

Strategy	Action	Cost	Effort	Level					
				Community	Local Authority	Water management organisation	Non-Governmental Organisations	Regional Government	National Government
Carry out a detailed analysis and review of the flood event	Analyse physical nature of event (meteorology, hydrology) highlighting any exceptional conditions	●●	●●	Δ	Δ	▲		Δ	Δ
	Analyse the performance of flood management measures	●●	●●●	Δ	▲	Δ	Δ	▲	Δ
	Review the performance of emergency plans and organisation	●●	●●●	Δ	▲	Δ	Δ	▲	▲
	Prepare reports for appropriate levels and users	●●	●●		Δ	▲	Δ	▲	Δ

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Contact details:

Darren Lumbroso, HR Wallingford, Howbery Park, Wallingford, Oxfordshire, OX10 8BA, UK
Tel: +44 (0)1491 822217, Fax: +44 (0)1491 826352
Email: d.lumbroso@hrwallingford.co.uk
http://www.hrwallingford.co.uk