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# Sustainable flood risk management strategies to reduce rural communities' vulnerability to flooding in Mozambique

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## Key words

Mozambique; sustainable flood risk  
management strategies; vulnerability.

## Abstract

In 2000, Mozambique was hit by widespread flooding that affected some 4.5 million people and cost approximately 20% of the country's gross domestic product. In a large, sparsely populated country such as Mozambique, a structural approach to flood risk management cannot be justified on environmental and economic grounds. As a consequence, flood mitigation measures need to focus on nonstructural solutions, such as reducing vulnerability to flooding and improving preparedness. This paper details the development of sustainable flood risk management strategies and the production of educational tools to reduce rural communities' vulnerability to flooding. The tools, which were developed in partnership with local stakeholders, included a Source Book on sustainable flood risk management strategies, a series of posters, a manual and a card game aimed at improving schoolchildren's flood preparedness. These tools were piloted in partnership with three rural communities in the Limpopo River basin in order to develop sustainable flood risk management strategies.

## Introduction

### Background to flooding in Mozambique

Mozambique is one of the poorest countries in the world. In the United Nations Human Development Index, it is ranked 172 out of 177 countries (UNDP, 2007). Mozambique, which is located at the downstream end of nine major international river basins, is also one of the most cyclone- and flood-prone countries in southern Africa.

Over the past century, Mozambique has been subject to a number of large flood events. Table 1 provides details of the major flood events that have affected the country in the past 30 years. The floods that occurred in 2000 were the worst for over 150 years and resulted in the deaths of some 800 people, and serious damage to crops, livestock, rural housing, communication infrastructure and business assets (Christie & Hanlon, 2001). These floods affected 4.5 million people, which is one quarter of Mozambique's population. In the Limpopo River basin alone, an area nearly the size of Belgium and the Netherlands combined was submerged (Christie & Hanlon, 2001). Figure 1 shows the area that was inundated by a series of floods that occurred between January and March 2000.

Floods regularly affect the livelihoods of millions of people in Mozambique. The negative impact of these natural

events is not solely a result of their magnitude but also a result of the high level of vulnerability of the people. In a large, sparsely populated country such as Mozambique, a structural approach to flood risk management cannot be justified on environmental and economic grounds (Christie & Hanlon, 2001; Hussein & Husain, 2004). Although the cost of the 2000 floods was approximately 20% of Mozambique's annual gross domestic product, any form of future disaster protection measures must compete against other development expenditure (e.g. education, agriculture) in one of the world's poorest countries (Christie & Hanlon, 2001). As a consequence, flood mitigation measures need to focus on nonstructural solutions, such as reducing communities' vulnerability, raising awareness and improving preparedness. One of the lessons learnt from the 2000 floods was the need to promote education programmes on flooding, at all levels, so that in the future the loss of life and damage caused by large floods can be minimised (Christie & Hanlon, 2001).

This paper details the work undertaken by projects funded by the UK Government's Department for International Development (DFID) and the United Nations Human Settlements Programme (UN-HABITAT) to produce educational material to raise communities' awareness of flooding and to develop sustainable flood risk management strategies relevant to rural communities in southern Africa.

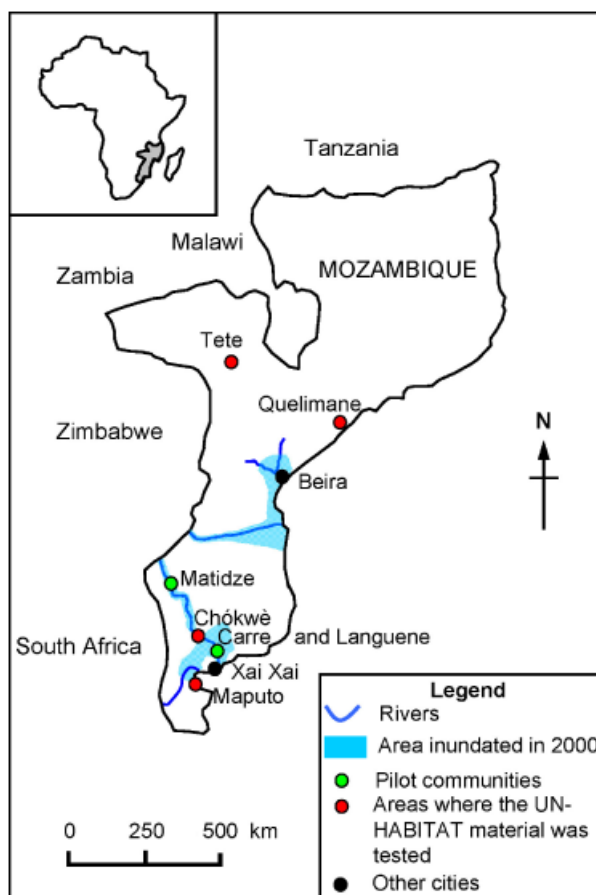
**Table 1** A recent history of flooding in Mozambique

Year	Location	Consequences
1975	Southern Mozambique (Limpopo and Incomati Rivers)	75 000 people affected
1977	Southern Mozambique (Limpopo River)	300 casualties, 40 000 people displaced, 400 000 people affected
1978	Central Mozambique (Zambeze River)	50 casualties, 220 000 people affected
1981	No region given	500 000 people affected
1985	Southern Mozambique (Maputo Province)	500 000 people affected
1988	Central and southern Mozambique (Sofala, Zambezia and Maputo Provinces)	12 000 people displaced
1996	Central and southern Mozambique (Zambeze, Incomati, Umbeluzi, Limpopo, Pungue and Buzi Rivers)	11 deaths and 200 000 people affected
1997	Central and northern Mozambique (Sofala, Tete, Zambezia, Manica and Nampula Provinces)	87 deaths and 300 000 to 400 000 people affected
1998/1999	Central and southern Mozambique (Sofala, Ingambane, Gaza, Nampula, Zambezia Provinces)	15 deaths and 400 000 people affected
2000	Central and southern Mozambique	800 deaths, 650 000 people displaced, 4.5 million people affected
2001	Central Mozambique (Sofala, Manica and Zambezia provinces)	200 deaths, 220 000 people displaced and 550 000 people affected
2003	Central and northern Mozambique (Nampula and Zambezia Provinces)	15 deaths and 200 000 people displaced
2004	Central Mozambique (Sofala)	1000 displaced
2005/2006	Central and southern Mozambique (Nampula, Sofala, Zambezia and Gaza Provinces)	22 dead and 9000 people left homeless
2007	Central and northern Mozambique (Tete, Zambezia, Manica and Nampula Provinces)	46 dead and 165 000 people displaced
2008	Central Mozambique (Zambezia, and Nampula Provinces)	Approximately 100 000 people affected as of January 2008

Source: Gall (2004) and Dartmouth Flood Observatory (2008).

### Introduction to the project approach

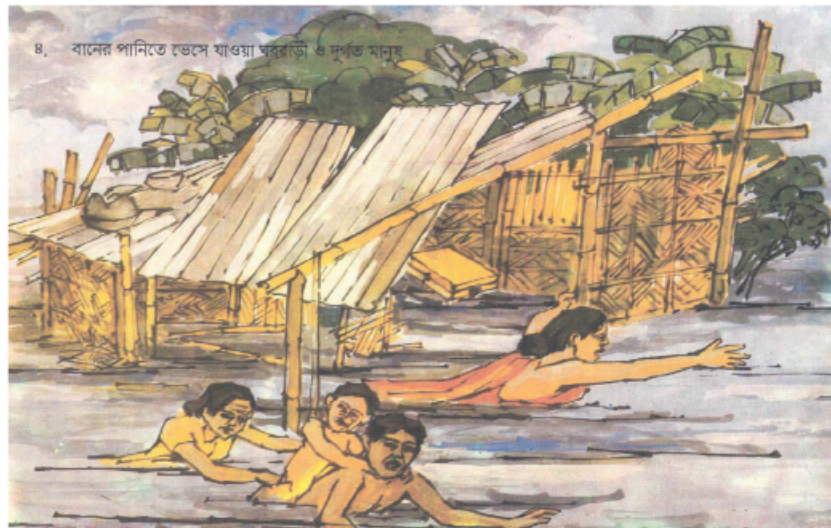
The approach adopted by the projects was to determine effective flood risk management strategies in partnership



**Figure 1** Map of Mozambique showing the main areas that were affected during the 2000 flood. Source: Adapted from Christie and Hanlon (2001).

with floodplain populations, taking cultural, social and physical constraints into account and to enable floodplain populations to be aware of flood risks, thus reducing their vulnerability to flooding. Following a literature review, it became apparent that there was very little practical information available aimed specifically at rural communities in sub-Saharan Africa to assist them with improving their preparedness to flooding and other natural hazards. For example, there is plenty of technical information available relating to flood forecasting and warning systems (e.g. Lumbroso *et al.*, 2006) but there is little practically based community-level information on how to utilise locally available resources to reduce vulnerability to and to mitigate against the impacts of flooding.

Of the literature reviewed, the most relevant and useful material related to reducing the vulnerability of rural communities to floods came from Bangladesh. In Bangladesh, community-based material, such as that shown in Figure 2, has been used successfully to raise awareness of flooding in rural communities over the past 30 years (Sayeed, 2007;



**Figure 2** Material used at a community level in Bangladesh to raise awareness of flooding. *Source:* Nishat (2004).

Wahlström, 2007). This has helped to lower the number of fatalities, and agricultural losses from major flood events and cyclones (Mirza *et al.*, 2003; Sayeed, 2007; Wahlström, 2007). The material developed in Bangladesh was used as an example of 'best practice' by the project. The project team included a member of the World Conservation Union (IUCN) who had experience of producing and implementing such material in partnership with rural communities in Bangladesh.

### Development of tools for reducing rural communities' vulnerability to flooding

The simple solution to flood mitigation in a country like Mozambique is that people should live on higher ground. After the 2000 and 2001 floods, this was the main policy pursued by the Mozambican Government, who constructed new homes for flood victims outside floodplains (Mozambique News Agency, 2001). However, floodplains provide fertile farmland and most rural communities want to work on and live near them (Eduardo Mondlane University Department of Geography and Famine Early Warning Network, 2003). People do not want to move to less productive land just to avoid another flood that may not happen in their lifetime (Christie & Hanlon, 2001). This means communities need the ability to live with floods and implement sustainable flood risk management strategies.

Sustainable flood mitigation strategies are ones that can be implemented by communities to reduce the impact of floods on their livelihoods with a minimal requirement for a reliance on continued external support in the future. A strategy for an individual community may consist of a number of measures. Examples of measures include

strengthening of houses in areas prone to flooding to reduce the probability that houses will be destroyed and providing safe water supplies during flood emergencies.

A number of educational tools aimed at reducing communities' vulnerability to flooding were developed as part of two DFID and UN-HABITAT projects on sustainable flood risk management. These included:

- (i) A Source Book containing information on sustainable flood risk management strategies appropriate to southern Africa aimed at technical staff in water management and emergency planning organisations.
- (ii) Six colour posters on flood-related issues and an accompanying black and white pamphlet.
- (iii) A 52-pack card game aimed at schoolchildren to educate them about flooding and sustainable flood mitigation measures.
- (iv) A 77-page illustrated colour manual entitled 'Living with floods'.

These tools, which were developed over a 2-year period in partnership with a number of government and non-governmental organisations (NGOs), are briefly described below. All the material was produced in English and Portuguese so that they can be used throughout the Southern African Development Community (SADC) region.

### Source Book on sustainable flood risk management strategies

The purpose of the Source Book was to act as a reference document for methods by which the impacts 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 SADC

region. However, much of the information contained in the book is relevant worldwide. The Source Book contains the following chapters:

- *Introduction to flooding* that provides a background to the different sources of flooding;
- *Raising flood awareness* detailing methods by which the awareness of flood risks can be raised such as community-produced flood maps and historical flood marks;
- *Flood forecasting and warning* including examples of community-based flood-warning systems implemented in South Africa;
- *Flood preparedness measures* that includes examples of flood proof housing constructed in rural areas of Africa and methods of maintaining a safe supply of drinking water during a flood;
- *Flood response* detailing how people can respond to floods including the implementation of evacuation plans; and
- *Postflood recovery*, which includes examples from the 2000 flood that had been successful, such as the use of family grants and low interest credit, rather than the distribution of construction material that often did not meet people's needs (Christie & Hanlon, 2001).

The Source Book incorporated a number of regionally produced illustrations that form a strong link with the material developed by UN-HABITAT. The contents of the draft Source Book were reviewed at a workshop held in Maputo at an early stage of the project. This was attended by national and local government institutions with an interest in water and disaster management, and a number of NGOs.

A series of checklists were also developed and incorporated within the Source Book. These cover:

- Raising flood awareness and preparedness;
- Flood forecasting;
- Flood warning;

- Structural flood measures;
- Evacuation and shelter management;
- Control of development in flood risk areas;
- Emergency response;
- Recovery; and
- Postflood reviews.

An example of a checklist is shown in Table 2. The relative costs and effort involved for each action 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. These are broadly indicative only, and not to scale; for example the level of the resources needed is identified as follows:

- (i) Large ●●●
- (ii) Medium ●●
- (iii) Small ●

The organisation that is expected to take the lead in implementing a specific action is denoted with a red triangle (▲). Other organisations that are also expected to be involved in implementing an action are denoted by a white triangle (△).

A document entitled 'Guidance on national flood risk assessments' was also produced as part of the project. The objective of this brief document was to provide guidance on how to carry out national flood risk assessments for water management organisations in southern Africa.

### Posters and pamphlet

A series of six colour posters, together with a black and white pamphlet, were produced to raise awareness of flooding at a community level. The six posters covered:

- Raising and maintaining flood awareness through the use of flood marks;

**Table 2** Example of part of one of the checklists included in the Source Book

Strategy	Action	Cost	Effort	Community	Level				
					Local authority	Water management organisation	Nongovernmental organisations	Regional government	National Government
Raising flood awareness	Prepare flood maps	●●●	●●●	△	△	▲			△
	Dissemination of flood risk information	●●	●●●	△	▲	▲		△	
	Prepare seasonal calendar	●	●	△		▲	△		
	Historic flood marks	●●	●●	△	△	▲			
	Disseminate flood mitigation information to regional communities	●	●●		▲	▲	△	△	
	Disseminate flood mitigation information to local communities	●	●●	△	▲	▲	△		

- Methods for accessing potable water during floods;
- Flood warnings;
- Issues related to flooding from urban drainage systems in high-density settlements;
- Safe havens for communities during flood events; and
- Improvements in urban planning and its effects on flooding.

Figure 3 shows a poster illustrating the use of flood marks to maintain flood awareness. The number of words on the posters was deliberately kept to a minimum. This was done to facilitate their understanding by the majority of the community. A 16-page pamphlet was produced to accompany the posters. This A5 size pamphlet explains the concepts behind the posters in more detail and was produced in black and white so that it is relatively inexpensive to reproduce.

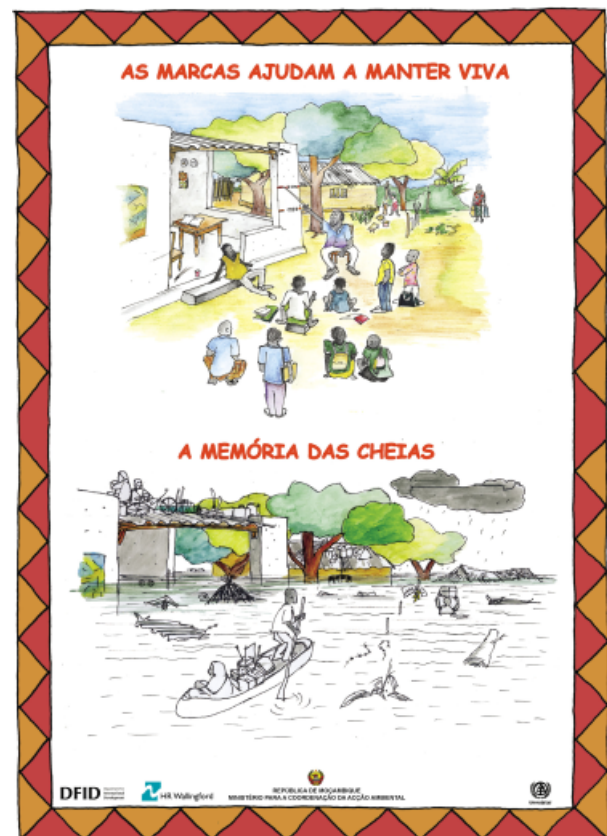
### 'Living with floods' manual and card game

A manual entitled 'Living with floods' and a 52-pack colour card game have been developed as part of a UN-HABITAT project. The manual contains a number of colour illustrations to make it attractive to younger people, and accessible to less literate adults. It was developed specifically for Mozambique. It explains the nature of floods, describes their impact on the economy and recommends sustainable and affordable ways through which communities and individuals can cope with their aftermath. It also provides details of the Mozambican cyclone warning system and an introduction to the accompanying card game. Figure 4 shows a page from the manual illustrating flood-resilient construction using locally available materials.

The 52-pack card game is aimed mainly at schoolchildren. It features methods by which houses can be protected against floods; flood forecasting and warning; and ideas for a clean and safe water supply and sanitation during a flood event. Figure 5 shows cards illustrating how the flood resilience of rural housing can be increased, and Figure 6 shows the methods by which rural water supply and sanitation infrastructure can be flood proofed. UN-HABITAT developed the manual and card game over a 12-month period in partnership with a number of communities in the vicinity of Maputo, Chókwè, Quelimane and Tete (Figure 1).

### Dissemination of the tools

In order for the tools to inform policy and practice effectively, they needed to be disseminated widely. The posters, pamphlet, manual and card game were distributed to rural and urban communities throughout Mozambique. This was done via primary and secondary schools, because this is widely seen as the most effective channel for communication and mobilisation (UN-HABITAT, 2006). By educating schoolchildren about flooding, a twofold result can be



**Figure 3** A poster produced to illustrate the use of flood marks to maintain flood awareness.

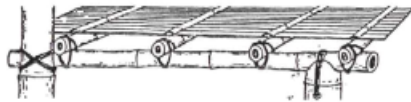
achieved. The students gain an understanding of the key issues and share what they have learnt with their parents. In this way, the knowledge is also disseminated among other community members (Affeltranger, 2001).

The Source book and community-based material developed have been adopted by organisations in Mozambique such as the Mozambican National Disaster Management organisation, Oxfam, UNICEF and the Red Cross for training purposes as part of their participatory approach to flood management. The products of the UN-HABITAT- and DFID-funded projects are also freely available from HR Wallingford on a CD ROM or downloadable from the internet in PDF format.

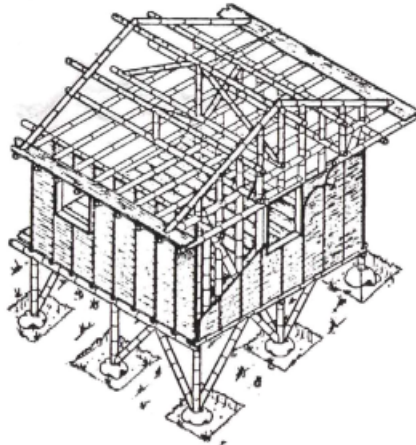
The Source Book and Guidance on national flood risk assessments have also been disseminated via WaterNet. This is a network that runs a regional masters degree in water resources management in southern Africa. There has been significant demand for the Source Book. It would appear that there is no other document readily and freely available in southern Africa that draws together the physical, social and institutional measures involved in flood management in the SADC region.

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**Figure 4** Extract from the manual showing simple methods of floodproof construction. Source: Ministry of the Environment (MICOA), Mozambique (2005).

## Piloting of the developed tools

### Introduction

Three rural pilot communities were identified in the Limpopo River Basin in Mozambique. The communities were identified in conjunction with the relevant institutions including the local administration, regional disaster management committee and NGOs. The three communities were as follows:

- Carre on the Lower Limpopo near the town of Xai Xai;
- Languene on the Lower Limpopo near the town of Xai Xia; and
- Matidze on the Upper Limpopo near the town of Mabalane.

The locations of the three communities are shown in Figure 1. The three pilot communities were selected for the following reasons:

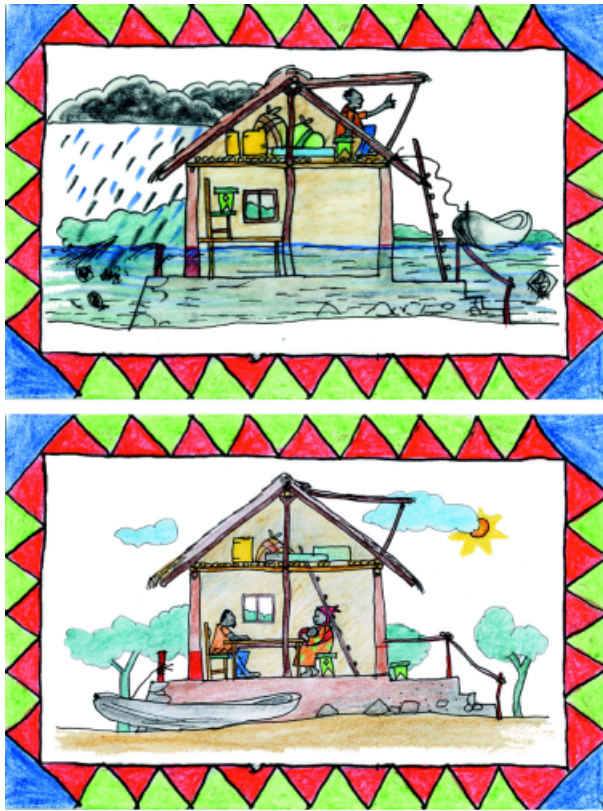
- During the 2000 floods, the Limpopo River basin was extensively affected with an area the size of the Netherlands inundated for 1 month (Christie & Hanlon, 2001);
- The villages of Carre and Languene are located in the lower part of the Limpopo where the floodplain is flat and approximately 30 km wide, making evacuation difficult; and

- The village of Matidze is located in the upper reaches of the Limpopo. Although the village itself was not inundated by the 2000 flood, the community was severely affected as a result of crops being lost and the water in the Limpopo (their main source of drinking water) being contaminated with silt, which led to a high incidence of diarrhoea.

### Use of the developed tools to identify flood mitigation measures

The primary purpose of the pilots was to develop flood risk management strategies in partnership with the communities using the tools developed as part of the project (i.e. the Source Book, pamphlet, manual, card game and posters). Over a 5-month period, a series of workshops and consultations were held with the communities and local administrations. Figure 7 shows photographs taken at some of the workshops. The Source Book and checklists were used by the facilitators of the workshops, in partnership with the communities, to develop mitigation measures that fell into the following categories:

- Things that could be done by the communities immediately.
- Measures that could be implemented by the communities with technical assistance from external



**Figure 5** Cards showing an example of a flood-resilient house.

organisations including the District Administration, local disaster management agency and NGOs.

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

The card game, posters and manual were used to illustrate various mitigation measures and raise awareness of certain solutions (e.g. rainwater harvesting). Examples of measures that communities stated that they could implement immediately included:

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

The main issues raised by the communities during the initial consultations that required funding and external technical assistance related to:

- Frequent loss of crops;
- Lack of clean drinking water during a flood;
- Food and seed storage; and
- Protection of valuables during a flood.

Flood mitigation measures for each of the three communities were prioritised after the consultation process had been completed. It was not possible to fully implement all



**Figure 6** Cards illustrating examples of the flood proofing of rural water supply and sanitation infrastructure.

the measures in the strategies within the time scale of the project. However, all three communities identified that two of the most important flood mitigation measures were:

- The provision of safe drinking water during flood events and
- Safe storage of pest-resistant seeds, so that after floods they could plant new crops with minimal delay, thus reducing the impacts of floods on their livelihoods.

These two measures were, therefore, given precedence and were implemented in the three pilot communities over a 3-month period. Community members carried out much of the work with assistance from the project team.

### Implementation of the mitigation measures

The implemented mitigation measures comprised the following:

- A 3000-L water tank mounted on a concrete stand about 1 m above ground level. The tank could either be filled using river water or by rainwater from the rainwater harvesting facility referred to below;
- A rainwater harvesting facility with a catchment area of 18 m<sup>2</sup>, constructed using galvanised steel sheets on a concrete and wood frame. The facility was connected to





**Figure 7** Photographs of community consultation and workshops in Languene.

the water tank. This should yield approximately 18 000 L of potable water in an average rainfall year, which is enough to meet most of the communities' annual drinking water demands;

- Provision of a seed store with devices to prevent entry by rodents, together with seed that had been treated to prevent damage by other pests. The seed was treated in collaboration with the Ministry of Agriculture. The traditional thatched seed store was located under the rainfall harvesting facility to provide it with additional protection and located above the 2000 year flood level.

Photographs of the implemented measures in each of the three communities are shown in Figure 8. Members of the NGO PSI instructed the communities in the use of the water purification fluid. PSI specialises in performing drama to educate poor communities in Mozambique on a wide variety of health issues. This is shown in Figure 9. Training was given to communities to set up a management committee to operate and maintain the implemented measures.

The success of the implemented measures will be monitored both by the Local Administrations for each community and via Eduardo Mondlane University and UN-HABITAT. The latter two organisations continue to work in the area under the auspices of a Global Environmental Fund project on flood and environmental management. An initial evaluation of the DFID and UN-HABITAT projects proved to be instrumental in convincing both national and local authorities in Mozambique of the feasibility of adopting new approaches in response to the threat of floods and, most critically, in moving away from previous policies that were based on resettlement as the first response. It has also been recognised by NGOs and government organisations that to be sustainable in rural areas of Mozambique, flood mitigation measures need to contribute to reducing other risks such as crop failure and health issues related to contaminated drinking water (UN-HABITAT, 2006).

## Conclusions

A set of educational tools have been produced to raise the awareness of flooding and assist in the development of sustainable flood mitigation strategies for communities in the SADC region. The tools include material aimed at rural communities and schoolchildren such as posters and a card game, together with a Source Book and checklists for use by water managers and emergency planners. These tools have been piloted in three rural communities in the Limpopo River basin in Mozambique to both raise awareness of the flood risks in the communities and to assist with the identification and implementation of flood mitigation measures.

The impact of flooding on the rural floodplain communities in the three pilot areas has been reduced through the implementation of practical flood mitigation measures that were prioritised at a variety of workshops. It has been recognised that monitoring and evaluation of the effectiveness of the measures and implementation of other measures identified in the strategies will be a long-term activity and be largely dependent on occurrence of flood events against which to measure response. However, the specific measures that have been implemented are valuable to the communities not only in times of floods, but on a day-to-day basis. For flood mitigation measures in rural, vulnerable communities to be successful, they need to integrate a range of risk reduction measures that are not only related to flooding but also include issues such as grain protection, sanitation and water supply.

## Acknowledgements

The authors wish to acknowledge the assistance of the following: UN-HABITAT, Architect Eduardo Feurehake, Professor Rui Brito and his staff at Eduardo Mondlane



**Figure 8** Rainwater harvesting and seed store nearing completion in Matidze.



**Figure 9** Members of the NGO PSI staging a play at Languene illustrating how to purify drinking water.

University, Mozambican National Institute for Disaster Management, Mozambican Ministry of the Environment, Mozambican Red Cross, South African Department for Water Affairs and Forestry, Ainun Nishat of the World Conservation Union in Bangladesh and British Government Department for International Development.

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