

**THE EFFECTIVENESS OF EARLY WARNING SYSTEMS FOR THE
REDUCTION OF FLOOD DISASTERS: SOME EXPERIENCES FROM
CYCLONE INDUCED FLOODS IN ZIMBABWE**

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Abstract

The aim of any early warning systems is to provide warning to people of an impending natural hazard so that those vulnerable are aware of the potential impact of the natural processes in order to respond appropriately and minimise damage. This paper looks at variables affecting the implementation of flood hazard early warning systems in a flood prone area of Zimbabwe. Documenting the experiences of the local communities, the Civil Protection Unit responsible for managing disasters, the meteorological services department responsible for weather forecasts, non nongovernmental organisations operating in the area and local authorities, the study provides an important insight for future non structural flood mitigation strategies. The current early warning communication is a one-way process, with those issuing warnings not fully aware of the needs and priorities of vulnerable communities, and therefore not responsive to their needs. Warning information is poorly disseminated to poor communities with limited capacity to respond. The absence of preparedness plans for evacuation, and overdependence on rain fed agriculture by locals hamper the implementation of early warning systems. As a recommendation, there is need for those issuing warning information to acquire more information themselves about how communities perceive risk, and the reasons that underlie their behaviour when floods threaten them. There is also a need to strengthen local communities' capacity to play a key role in information dissemination before the onset of flood disasters.

Introduction

Climatic variability is a major problem for southern African societies and economies, where the majority of the population is still largely rural and directly and indirectly dependent on rain-fed agriculture. A casing example is the wide spread flooding due to Cyclone Eline in 2000 over Mozambique, South Africa, Zimbabwe, Malawi, Botswana and Namibia (Vaz,

2000). The Cyclone Eline induced floods of February 2000 in the Zambezi Basin alone for example, left 700 people dead, over 500 000 people homeless and over US\$1billion of infrastructural damage (Wamukonya et al, 2001). In Zimbabwe the floods were the worst in many years and highlighted the significance of disaster management at community level. The flood was declared a national disaster, breaking all records and killing several people. The death toll was increased by survivors who were left to suffer lack of food and clean water and malaria outbreak stemming from mosquitoes swarming and breeding in the floodwaters (Shumba, 2000).

Asking the questions what went wrong, and what lessons can be learnt from the disaster, put early warnings and other disaster mitigation measures under scrutiny. The effectiveness of these forms of flood mitigation measures was tested in terms of how they persuaded vulnerable communities to adopt self protective behaviours before the onset of floods. While analyses of the risks and vulnerabilities of communities hit by floods have been conducted elsewhere, many questions have been raised in terms of what could have been done to minimize the high flood impact on communities' livelihoods. For example, how early were the warning systems? Were the early warning systems the same as forecasts? What information was encompassed in the early warning systems information? Were the early warning systems accepted or ignored by the local communities and if ignored what were the reasons?

The overall framework of this study was the effectiveness of early warning for flood risk reduction on vulnerable communities. Within this framework the focus was on four areas, adjudged by Handmer (2000) as integrating the concept of a total flood warning system, namely:

- knowledge of the risks faced;
- technical monitoring and warning service;
- the dissemination of warnings to those at risk; and
- public awareness and preparedness to act.

Handmer (2000), citing the Emergency Management Australia (1995: 5), noted that: “A total flood warning system integrates flood prediction, the assessment of likely flood effects, the dissemination of warning information, the response of agencies and the public in the threatened community, and review and improvement. The components must operate together for sound flood warning performance to be achieved”.

This view is echoed by the United Nations (2006) which has emphasized that early warning systems must be community-centred. To achieve all the four elements, there is need for cooperation, shared responsibility and thinking about the problem as well as involvement of the communities at risk among all stakeholders concerned (Handmer, 2000; Mileti, 1999). Failure in any one of these elements can mean failure of the whole early warning system. The warnings must be ‘early’ and ‘warn’ so that if alerted to an upcoming crisis situation, the chances of preventing the situation from escalating into a serious crisis are highly increased (Alusa, 2006; Handmer, 2000).

This paper assesses the role of early warning systems in Zimbabwe’s flood prone areas and highlights the challenges in making these systems effective.

Background and overview of the flood early warnings in Zimbabwe

Flood disasters in Zimbabwe are caused by two different phenomena: localized heavy seasonal rainfall and run-off which often result in rivers overflowing, and the cyclone induced floods. The first and most frequent type of floods is the seasonal flood. This occurs

in most years normally in January or February at the peak of the rainfall season. The second and more frequent in recent years is the cyclone-induced flood. In February 2000 cyclone Eline hit the country bringing with it intense storms. The cyclone affected the eastern and southern parts of the country. The cyclone happened when some parts of the country, particularly the main river basins were experiencing life threatening floods due to heavy rains. These areas were in Zambezi basin in Mashonaland Central, Save River basin in Manicaland, the Limpopo River basin in the southern provinces of Matabeleland South and Masvingo (United Nations, 2002). In March 2003 cyclone Japhet also caused flooding in the country with Guruve and Mzarabani districts in the Zambezi Basin the worst affected. Diseases outbreaks such as malaria and cholera have were quite common during this period. The impact of the 2000 floods was the worst in people's living memory (Shumba, 2000). The floods caught people unaware and farmers used to battling against drought were the worst affected. Reports by Shumba (2000) show that the floods claimed more than 100 lives and left more than 300 000 homeless. More than 70 000 hectares of agricultural land and thousands of tonnes of stored food were destroyed. The available data on flood impact raise the question of who really was at fault for the high impact. These and other questions remain a challenge for researchers in the field of disasters.

In the aftermath of the 2000 floods, several views have emerged on what could have exacerbated the problem (Christie and Hanlon, 2001; Davies, 200; Tumbare, 2001). While it is acknowledged that the rains were the worst on record to date and so were the subsequent floods, it has still been argued elsewhere (Davies, 2001; Pearce 2001) that damages could have been reduced. The extensive and damaging floods put warning systems under scrutiny. A review of literature for example shows that while flood prediction requirements were

mostly met, lack of maximum effort by the Civil Protection department and local communities in planning their responses to weather forecasts worsened the flood impact on the vulnerable communities (Madamombe, 2004; Tumbare, 2001). Similar experiences elsewhere have shown that to be effective, early warning systems must be both technically systematic and people-centred (EWC II, 2004). In the Caribbean, during 2004's hurricane season, most countries successfully alerted their populations of approaching storms and saved many lives as a result (World Disasters Report, 2005). The key to their success was putting people at the centre of their warning systems. In Cuba, disaster awareness is taught as part of the school curriculum and evacuation drills are held every year before the hurricane season (Niskala, 2005). In Jamaica, Red Cross volunteers go from street to street issuing warnings by megaphone, 48 hours before hurricanes are due to hit. The Hurricane Katrina disaster is also a case in point where the meteorological warnings of wind speed, storm surge and rainfall were accurate and frequently communicated many hours in advance but the public and official engagement and responses to the warnings were inadequate (EWC II, 2004).

When the 2000 floods hit southern Africa, information exchange, communication and coordination under the Zimbabwe-Zambia Joint Operational Technical Committee was reportedly hindered by limited government participation from both Zambia and Zimbabwe. While the Zambezi River Authority provided information to two national governments, which in turn issued downstream warnings as required many people were still negatively affected by the floods (Gwimbi, 2004; Madamombe 2004). The Hidroeléctrica de Cahora Bassa also issued warnings through telephone, radio and facsimile to communicate information on the opening and closing of the flood gates at Cahora Bassa to downstream

administrative centres and users of the river (The SADC Regional Remote Sensing Unit, 2002).

One often-overlooked aspect in disaster management is that of public reaction to the warning message (Mileti and Sorensen 1990). The human factor in early warning systems is very significant (Twigg 2002). This was also true of Hurricane Katrina which affected New Orleans in late August 2005, though in this case there was the additional failure in respect to risk knowledge, namely a lack of full public appreciation of the vulnerability of the inadequate levees and the consequences of their structural failure. In the case of the December 2004 Indian Ocean tsunami, there were major failures in all four elements.

Methodology

The analysis of timeous access to forecast information by the communities in flood prone areas, as well the role played by the meteorological services department, disaster management institutions such as the civil protection department and Zambezi River Authority that provided some form of forecasts and disaster management responses were considered crucial in this study.

The targeted respondents in the flood prone areas were randomly selected communities. Mostly the heads of the household were approached as they had a better memory of the past floods and were actively involved in daily farming activities.

In developing the tool to assess early warning information access, flow and local communities' preparedness to act on it, many other studies were reviewed to determine the effectiveness of the tools and approaches (Handmer 2000; Carsell, and Plush, 2002; Mileti, Dennis and Sorensen 1990). Data was gathered using questionnaire and complimented with interviews with civil protection department, non governmental organisations (NGOs),

meteorological services and local communities and authorities officials. Focus groups were held in 3 case study locations across the country. The focus groups included communities who were at risk of flooding.

A comprehensive questionnaire was designed to cover issues such as community knowledge of flood and the risks it posed, monitoring and warning services and their dissemination to communities; public awareness and preparedness programs by disaster management agencies.

Analysis of data ranged from descriptive to inferential with multiple correlation analysis being done using the SPSS statistical package. The significance of the relationship between flood impact variables and early warning variables deemed to influence flood impact were sought using the Spearman rho correlation coefficient tests. The statistical significance of the correlation coefficients values were compared to absolute values of the correlation coefficients.

Results

The results of this study revealed the need to increase the lead time between the warning information availability to the vulnerable communities and the occurrence of a flood event. Households who did not receive warnings on time or not at all were most closely associated with high flood risk

Gaps and Challenges in Dissemination of early warning information

The flood management process in Zimbabwe is multi-functional involving a number of different sectors. The Central Government initiates disaster preparedness programmes through the Civil Protection Unit, with local administration taking the responsibility for implementing and maintaining its effectiveness. It is the coordinating body at the government

level and is empowered by an Act. The Act spells out the legal instruments for disaster management and the powers vested in individuals as well as organizations in the case of disasters such as floods. The Civil Protection department can call on any government department or private sector to assist wherever such assistance may be required.

The desire to strengthen disaster management structures came immediately after Cyclone Eline induced floods to try and address the weaknesses identified in the management of the 2000 flood events (Gumbo, 2006, Madamombe, 2004). Largely, some of the weaknesses included the fragmented approach to flood management, highly centralized decision making in flood management, and the lack of local community involvement especially in the decision making process of the disaster management. Some of the victims of Cyclone Eline did not cooperate during evacuation due suspicion and lack of knowledge of the effect of flooding. To compound matters further some of the rescue teams had little knowledge of the area and became a danger to the victims as well as themselves. The new decentralized structures are now incorporated in the proposed bill now soon to be renamed *Emergency Preparedness and Disaster Management Act*. The bill's main thrust is to address structural and organizational gaps that are in the current Act by placing emphasis on localized decision making with the local authorities being expected to take a leading role in preparedness and response with the support of the provincial level thus strengthening the decentralization policy(Madamombe, 2004; Gumbo, 2006). The draft also seeks to decentralize critical services to make sure that most of the disaster management activities are done locally as opposed to the current centralized systems.

The current flow of information can best be summarized by Figure1. The National Civil Protection Coordination Committee (NCPCC) is responsible for civil protection functions,

and is comprised of senior officers selected from government departments, parastatals, and NGOs. Similar multi-sectoral representation is maintained at the Provincial and District levels. Dissemination of information is normally through the newspapers, radios, televisions, telephones, and awareness programs by government and non-governmental organizations (Madamombe, 2004). In the 2000 floods, disaster management was largely reactive, with events being handled as floods were in progress.

One of the major challenges with the Cyclone Eline floods was the lead-time between the time flood warning information got to the victims and the flood event. This could not allow enough time for flood victims to evacuate the flood prone areas and minimize destruction. For example, the survey in Muzarabani district (Table1), respondents did not receive early warnings on time (66%). A significant percentage of the respondents who did not receive warnings of the pending floods experienced substantial losses in livestock, household goods and grain. The assistance to households came mostly during and after the floods.

Table 1. Time households received flood warnings in Muzarabani district in the 2000 floods (n = 78)

Time warning received	percentage
Before floods	6.4
During floods only	14.1
After floods only	16.7
During and after floods	53.8
Before, during and after floods	5.2
Others	3.8

Results analysis of this study also showed that flood impact and early warning systems were statistically and significantly correlated (Table 2). There was a negative correlation between deaths from flooding and respondents preparedness for the flood. Warnings coming from village leadership were more effective and accepted as authentic in reducing negative effects among the respondents. This, however, depended on the time the warning was received vis a vi the occurrence of the flood event.

Table 2. Spearman correlation test results between flood impact and early warning in Zimbabwe's flood prone areas

Flood impact	Early warning source					
	None	Police	CPU	Radio	Local leadership	NGO
Home flooded	0.143	-0.195	0.121	0.137	0.099	0.026
Crops destroyed	0.263	-0.061	-0.166	0.137	0.023	-0.033
Flood related illness	0.017	-0.122	-0.096	0.04	0.285	0.099
Flood related deaths	0.268	-0.254	-0.205	-0.012	-0.294	0.068
Drop from school	-0.258	0.276	0.175	0.226	0.297	0.06
Livestock killed	-0.078	0.171	0.156	0.003	0.11	-0.049
Migrate to high ground	0.157	0.169	0.187	0.013	0.273	0.079

Note. Correlation coefficients of $r > 0.215$ or $r < -0.215$ are significant at $p < 0.05$ significance level when two tail tests are used

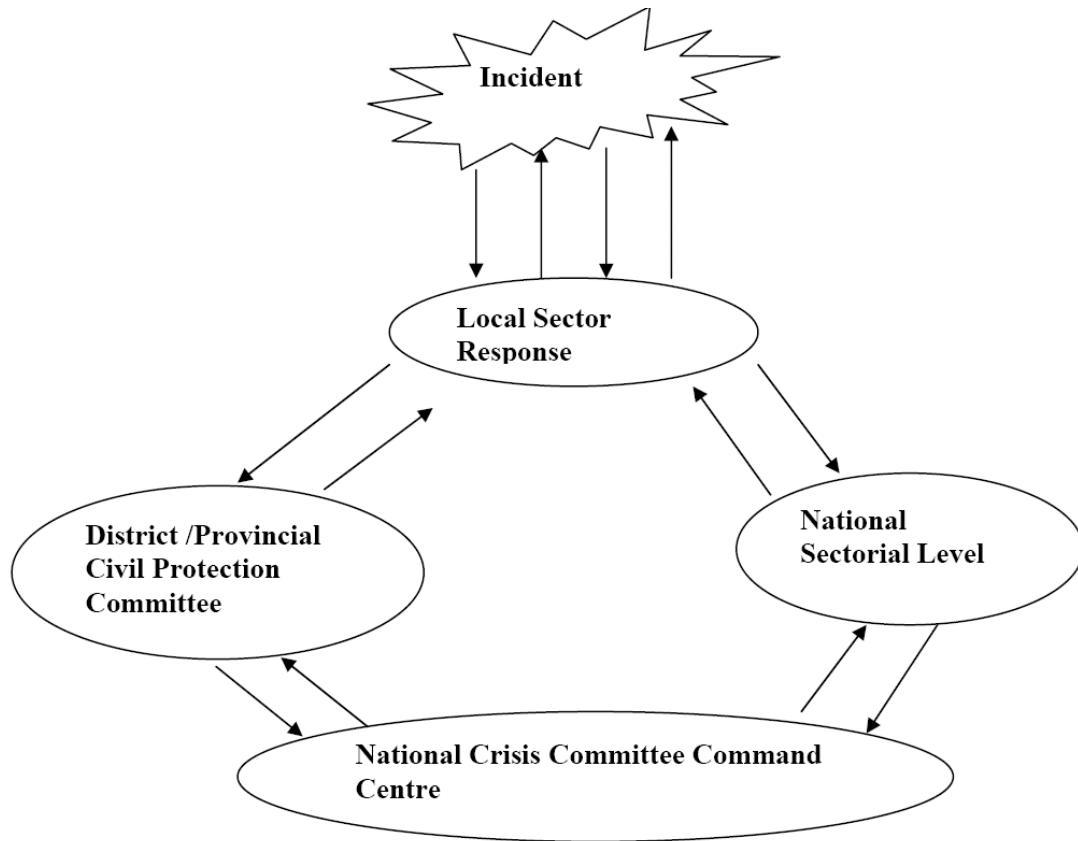


Figure1. Information flow in Management of Flood Emergencies in Zimbabwe
 (Source Civil Protection Unit Operational Manual)

Following the 2000 floods there has been some improvement in co-operation with multisectoral meetings on flood management which are coordinated by the civil protection department and well attended by stakeholders such as local authorities, communities the department of meteorology and non governmental organizations. The meteorological forecasts are now taken more seriously than before. Long term awareness programs promoting self protective behaviours in response to flood disasters have been conducted in flood prone areas of the country.

Topics which are covered during these campaigns include informing people about what floods are, where they normally occur, that people, should be aware of the normal behaviour of their rivers, areas to relocate in the event of floods, the need to work as a community when

floods occur, survival tactics and what to do during and after the floods. They are also advised on the long term planning of type of house to construct, materials to use in order to reduce the impact of floods on shelter, and where to locate their houses.

There are still disparities in the setting of standards for early warning training, primarily due to the lack of national guidelines or standards. There is also no independent monitoring structure for the evaluation of the early warning training material.

One of the weaknesses with the current flood awareness programs is that Existing informal training and community awareness programmes emphasize disaster response and recovery actions. Little attention is paid to potential hazards, faced by vulnerable communities, and what can be done to mitigate their impact.

Currently, disaster management training and community awareness activities are poorly coordinated. There are no comprehensive strategies and programmes and no coherent and coordinated needs analyses have been undertaken. Constraints currently being faced include equipment, including rescue, communications and early warning literature; inadequate funding; legislative gaps; and qualified personnel.

Respondents Knowledge of flood risks and preparedness to act

The respondents' knowledge of the area as reflected by their period of stay in the area was long. More than 50% of those interviewed had stayed in the area for more than 20 years. A sizeable percentage (28%) had between 10 and 20 years in the area. The long period of stay in the area suggest that the majority of the respondents had good knowledge of the previous flood that had occurred in the flood prone areas. Farming was the most affected activity as

shown by more than 80% of the households who reported having their crops damaged by floods.

More than 70% of respondents indicated that they knew that they lived in the floodplain. When asked how much they knew about steps they could take to prepare for a flood disaster, only 27% indicated that they were knowledgeable, while 35% were somewhat knowledgeable. Knowledge of disaster preparedness was viewed in terms of not crossing flooded rivers; ensuring children did not go to school and relocating to high ground.

Despite the high crop damage (80%), flooding of homes (55%), high illnesses related to floods and high absenteeism from school during floods reported by households, many households indicated that they had no plans to migrate from the lowland areas to high ground. Generally the number of households reluctant to move from the floodplain increased with more assets owned by households' livelihoods in the area.

One of the challenges highlighted by the respondents was the accuracy of the previous warnings. Due to previous false alarms, people were not taking warning information seriously. In the case of the 2000 floods, an accurate forecast was issued by the meteorological office but was not taken seriously until reports of people dying as a result of floods in Mzarabani and Guruve were received. In the survey carried out in all the flood prone areas of the country more than 68% of the villagers indicated that they were not likely to respond to early warning systems if the previous warnings did not result in a serious disaster or if they did not experience the event of considerable magnitude in the recent past. Table 3 shows the households who still experienced flood hazards in one way or another despite receiving some early warning information from the various sources.

Table3. Percentage of households exposed to floods after receiving warnings (N=78)

Warning source	Percentage of households exposed to different flood impacts after receiving warning					
	Crops destroyed	Home flooded	Illness in family	Livestock killed	Death in family	Children stopped going to school
Civil Protection Unit	76	35	28.1	42	44.4	32
Police	75	28.9	24.6	11.1	29.9	28.8
Village leadership	67	31	28	12.3	20	79
Neighbours	74	26	34	14.3	21.5	74
NGOS	76	24	27	37.7	46.3	24

Given that much of the warning came immediately before, during or after the floods (Table2) it is most likely that the impact was high.

Community-based strategies for coping with floods

In reviewing the mitigation measures suggested by households, it was noted that households preferred to live with floods and therefore opted for measures that enabled them to sustainably live with the floods. The villagers suggested the following as their most preferred measures to minimise flood impact:

- ensure flood action plans are in each village (86%)
- form village flood management committees (83%)
- raise awareness and preparedness programs among village members of pending floods well in advance (65%).
- Provide communication equipment so that information is accessed within the shortest time before the floods strike (78%)
- Train local villagers in warnings and evacuation plans (64%).

Few households were willing to migrate from the flood plain as a solution to the flooding problems. On average, less than 15% of the respondents suggested measures such as resettlement in upland areas, avoiding activities close to the rivers and raising the foundations of buildings to above general flood depth.

The process of introducing flood mitigatory strategies such as restrictive land use regulations for flood prone areas can thus be thought of as more about persuading people to tolerate the floods.

Conclusion

In order to strengthen local capacity of communities for reducing flood impact through efficient early warning systems this study suggest the development of local management plans involving the local authorities and the local leadership within the community. There is also the need to promote local community means of communication to disseminate early warning information. This local communication has been found to be successful in Mola communal lands where it has been used to report incidences of crop raiding by wildlife (Gwimbi, 2001). The location of a communication station in the community could actually result in early dissemination of warning information.

Facilitation of disaster education programmes within local communities, to increase their knowledge of natural hazards, and especially to increase their capacity to understand uncharacteristically extreme events could also go a long way in mitigating against disasters. The Civil Protection unit has already started working with communities to inform them of the recurrence of extreme weather events, so that all warnings issued by the department are taken seriously. Perhaps what is needed in addition to this is for the Civil Protection Unit to come up with a standard training manual for disasters such as floods.

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