Are Warnings Working? Achievements and Challenges in Getting Communities to Respond

Steven Molino, Neil Dufty, Geoff Crapper and Alison Karwaj

Molino Stewart Pty Ltd, PO Box 614 Parramatta CBD BC Parramatta NSW 2124

ABSTRACT: Events over the past three years have provided the opportunity to examine the effectiveness of warnings issued for natural hazards, including floods, and identify the strengths and weaknesses in our warning systems. This paper considers the findings from recent evaluations of community warnings: how communities responded and why. It also considers the recommendations of the Victorian Bushfire Royal Commission and their relevance to flood warning, and the results from recent use of the national Emergency Alert System and the Shepparton Telephone Flood Alert. Using these sources, it identifies what currently works well in our warning systems and what improvements need to be made to make warnings more effective.

Introduction

Following recent major flood events particularly in eastern Australia, much focus has been placed on the delivery of warning messages and their effectiveness. The Flood Warning Manual in the Australian Emergency Manuals Series (Attorney-General's Department, 2009) states that the purpose of warning about impending floods is to enable and persuade people and organisations to take action to increase safety and reduce the costs of flooding. Technological advances in the field of flood warning should be increasing the ability of warning systems to process and disseminate warnings to achieve this goal of appropriate reaction from the target audience. Yet, it is recognised that technology can only do so much, and eventually the success of warnings will ultimately depend on the performance of a number of interrelated components in the total warning system.

The Total Warning System

At its simplest, the Flood Warning Manual recommends that a flood warning system should have six integrated parts. These are:

1. Prediction - Detecting changes in the environment that lead to flooding, and predicting river levels during the flood.
2. Interpretation - Identifying in advance the impacts of the predicted flood levels on communities at risk.
3. Message Construction - Devising the content of the message which will warn people of impending flooding.
4. Communication - Disseminating warning information in a timely fashion to people and organisations likely to be affected by the flood.
5. Response - Generating appropriate and timely actions from the threatened community and from the agencies involved.
6. Review - Examining the various aspects of the system with a view to improving its performance.

Other research splits 'prediction' into two parts: data collection; and prediction. In either case, diagrammatic representations tend to show the total flood warning system as a linear process (e.g. Victorian Flood Warning Consultative Committee, 2001).

These representations include the concept of consultation and review with agencies and the community at all points within the total flood warning system. The EMA Flood Warning Manual states that it is vital that people in flood-prone locations understand flooding and its potential consequence for them. Yet, appropriate adjustments of community behaviour will only be generated when they are preceded by soundly-based public consultation and education programs. Additionally, the dissemination of the warning message should trigger a

response which had been premeditated i.e. preparations are vital that allow the community to undertake the desired actions when a warning is issued.

The premeditation or preparation for action could be a comprehensive, documented flood response plan or a simple mental check list. In either case, unless some thought is given to appropriate actions beforehand, there is a high risk that the response actions will not be appropriate when a warning is issued. This applies to public and private sector organisations as well as individuals.

Furthermore, it can be argued that flood response planning should actually drive flood warning system design. For people to be able to take appropriate actions they need to be given useful information in a timely manner via reliable communication channels. Consultation with stakeholders is therefore an important part of flood warning system design so that the warning system meets the needs of those who have to respond. The system design as well as the flood response planning must be based on an understanding of flood behaviour, hazards and risks.

A suggested outline of a suitable warning system is provided in Figure 1. This diagram attempts to show the inter-relationship between flood warning system components, stakeholder consultation, stakeholder education, flood studies and flood response plans.

Each of these warning system parts can work well or can work poorly or at worst, not work at all. The overall effectiveness of the warning can only be as strong as the weakest link in the chain and, unlike a real chain, errors or weaknesses can accumulate as they are passed along the chain e.g. poor data plus poor interpretation can be worse than either poor data or poor interpretation.

It is important to realise that the diagram is imperfect and does not reflect the significant amount of iteration which is required for each of the components to be done well and properly aligned with the others. Recent research suggests that community-centred warning systems will be more effective than institutionally-driven systems (Basher, 2006). In fact, this research suggests that a linear model of flood warning is unhelpful.

Despite these shortcomings, reference will be made to this diagram to provide some insight into what needs to be considered when designing and maintaining a total flood warning system and, as recent studies and examples of flood warnings are examined, in terms of what has worked well and where improvements can be made.

The types of warnings issued also plays a vital role in their dissemination and level of effectiveness. In order to understand data on flood warning response, it is necessary to distinguish between responses to each of these flood warning types (Parker et al, 2009).

As identified by Parker et al (2009), most research into flood warnings focuses on the “official” or “formal” warning systems, that is, those designed and operated by agents of government to warn the public, and other agencies, of flooding. Official flood warning systems also often have several levels or types of warning which should be taken into account when interpreting public response, such as the flood alert, minor, moderate and major flood warnings hierarchy used by the Australian Bureau of Meteorology (BoM) and the NSW and Victorian State Emergency Services (SES). However, this is just one way that people find out about the possibility of flooding.

Self-warning is a method which has been widely used by flood affected populations in the past and has attracted considerable research. This is a self-diagnosis of the flood situation and predictions made by people based on personal observations of environmental cues such as rainfall and river levels, but also using a historical context or “past experience”. However, the sharing of this flood information through “unofficial” community warning channels such as community observation and networks is something that has not received much research attention to date.

Regardless of the methods and warning source, Parker et al (2009) also identify that warnings may also be categorised as timely, untimely (or late), or false. Timely warnings are those that are delivered to the affected population before the flood onset and provide sufficient time to respond. Likewise, untimely warnings are those delivered after the flood onset and provide little to no time to respond. False warnings are defined by circumstances when flood warnings are issued, but not followed by a flood.

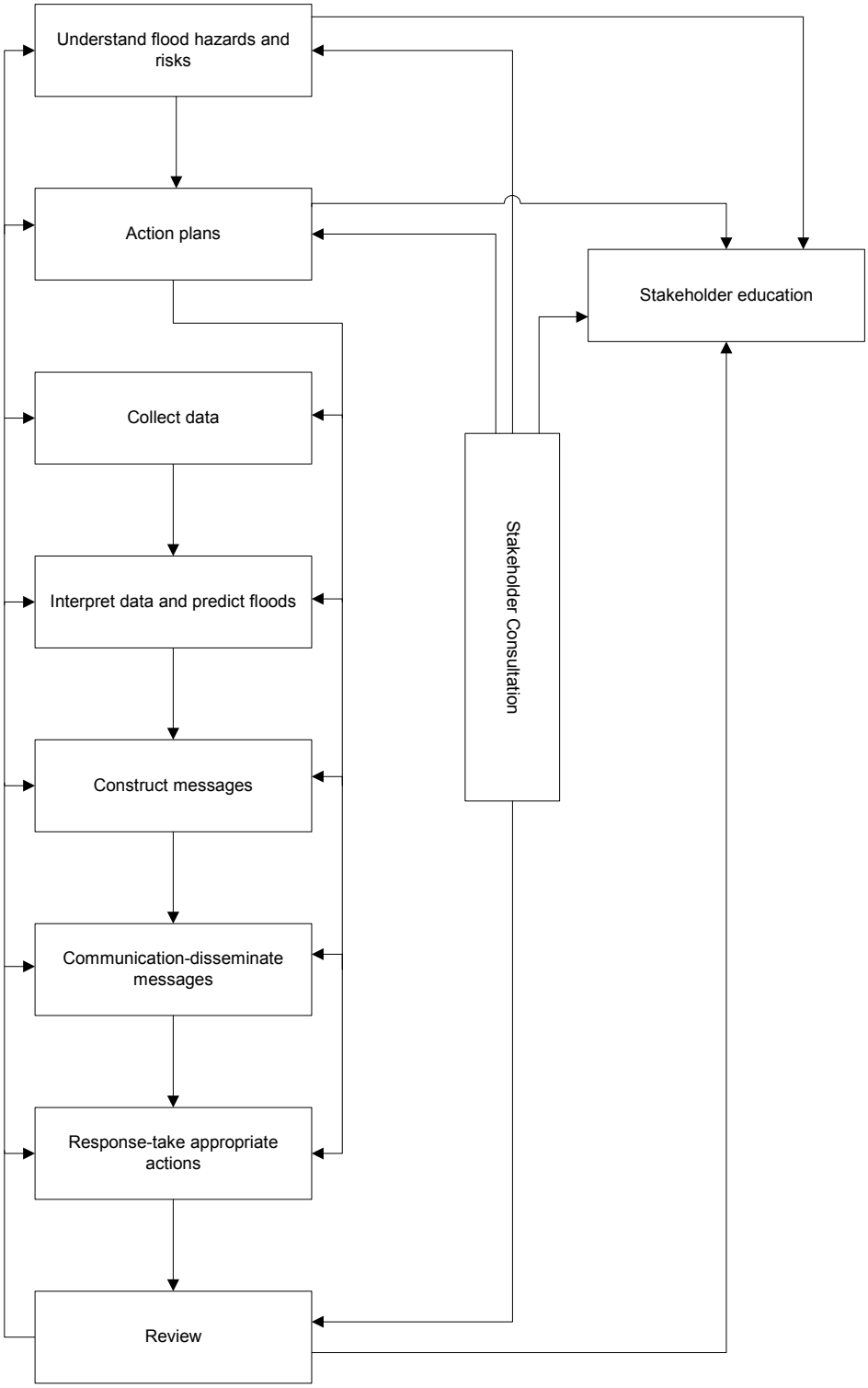

Figure 1: Flood Warning System Components in Context

Action Plans

The NSW SES has action plans which vary in detail around the State depending on what information is available about flooding and the communities impacted. The extent to which these plans have been developed in consultation with communities and the extent to which these plans have been communicated to communities vary. This has an impact on how communities respond.

Collect Data

The core of good flood warnings is dependent on good data collection. The BoM is the official national flood forecaster and as such it operates extensive real-time data collection networks which include river data supplied mainly from river gauges that are owned and maintained by others for purposes beyond that of flood warning.

It must also be acknowledged that a device that is placed by a river has a risk of being damaged by a flood and the bigger the flood the greater the risk it will be damaged. This means that the worse the flood gets and the more critical it becomes that the BoM must issue an accurate and timely forecast, the higher the chance that the data collection devices will be damaged and the forecast accuracy will diminish.

In late June, 2007 the Victorian Gippsland region experienced severe weather conditions culminating in major flooding caused by a succession of intense east coast low pressure systems. In this flood most of the rainfall occurred in the afternoon and evening but instream critical gauges were knocked out at about 4pm. Flood response officers said they were 'flying blind' from this point on (Molino Stewart, 2008).

The 2009 NSW Mid-North Coast floods also experienced problems with their gauge system. All flood heights recorded at Kempsey prior to 9am on the 23rd May were in the order of 0.34 metres higher than corrected river heights produced later by the BOM in their internal flood warning performance review. The BoM believes this was due to an instrument error in two gauges on the Macleay River. However, these problems were not noticed until part way through the flood event and after numerous flood warnings had been issued.

The September 2010 floods in Victoria showed that the computerised water monitoring system used to check river levels across the State had some serious inaccuracies in the Wimmera Catchment, with some measurements being wrong by as much as two metres. The Wimmera CMA resorted to sending out inspectors to physically confirm river levels after there were suspicions that the three year old system had malfunctioned, or had not been calibrated correctly due to low water levels when it was installed (Molino Stewart, 2010a). This type of technology is currently in place around the State. Authorities later admitted that the discrepancies in measurements had affected the City of Horsham's preparations and may have contributed to inaccurate overrepresentations of the flood risk (Molino Stewart, 2010a).

Discrepancies in flood data and its reporting contributes to the reasons why many people within flood affected communities gather their own data to make decisions in the event of a flood. However, another important factor is that many community members rely on gauge levels rather than flood warnings to determine their actions, increasing the importance of their accuracy. Twenty four per cent of Macleay catchment respondents specified that they waited until the water reached a particular level on the gauge in the 2009 Far North Coast flood event (Molino Stewart, 2009).

Interpret Data and Predict Floods

Using the data collected, BoM undertakes official flood forecasting around the country. In NSW, the SES also uses local council supplied data to interpret impacts of particular flood levels and inform their planning decisions. The challenge here is that the SES need to know in advance what possible flood levels could be reached so they, and the community, have sufficient time to undertake appropriate actions. However, it is generally the case that the further ahead the forecast is made, the less accurate it is likely to be. And the less time between the measured rainfall and river levels and the forecast, the less warning time will be available. This is a trade off which has to be made between accuracy and timeliness of warnings.

Estimates of future rainfall may have to be made when the forecasts of major flooding are issued 12 or more hours in advance of the forecast flood level. A lot of rain can fall in 12 hours or threatening weather systems might pass over without dropping nearly as much rain as might be expected. It is also possible that the rainfall measured at a rainfall gauge is not representative of the rainfall across the entire catchment but that is not apparent until it is measured as a streamflow some hours later. While technology is helping improve rainfall forecasts, they currently have limitations to their accuracy.

For communities which have significant flood risks such as the Macleay, Richmond and Clarence valleys, the SES has identified the amount of time which they would theoretically need to be able to evacuate everyone at risk in advance of a flood cutting off their evacuation routes. The NSW State Flood Plan sets these as target warning times for the BoM for these locations. In Grafton and Kempsey, the target warning time for levee overtopping is 24 hours but 12 and 15 hours are more realistic for reasonably accurate forecasts in these localities. In Lismore about 12 hours warning is needed and usually achievable.

The requirement to forecast early to provide sufficient warning time can also contribute to problems with false warnings. During the 2001 and 2009 flood events at Grafton, the actual flood peak was significantly lower than the BoM's predicted flood peak (by about 0.4m in 2001 and 2009). On both occasions this resulted in flood evacuation orders being given by the SES which, in the opinion of many residents surveyed, turned out to be 'unnecessary' (Molino Stewart, 2009). The SES pointed out that given the lead times required for evacuation, the flood forecasts available at the time and the chance of more rain, the SES had to make a decision and in both instances the orders were warranted.

In forecasting predictions, there is an additional factor involved – not only what level the water will reach, but what it will do at this level. This produces additional difficulties if there is a degree of uncertainty, for example as to what is a critical level for a levee overtopping or failure. Because levee failure or overtopping can cause rapid and devastating flooding of towns behind levees, it is the BoM practice to provide as much warning time of potential critical levels as is practical. This may mean including assumptions about forecast rainfall in the modelling. The level which threatens a levee's structural integrity may also be much lower than the levee crest level and it is the level that is used in making evacuation decisions while the community may look at the crest to determine if they think levee failure is a real threat.

Evacuation warnings issued by authorities following flooding in Wangaratta in September 2010 were viewed with disbelief because the Wilson Rd levee had had water against it for hours and it was holding up. Yet even though the levee had not overtopped, two weak points had been found where piping erosion was occurring and the levee was in danger of failing – a point unknown to many local residents.

Self and unofficial interpretation by community members therefore also presents a challenge, as they are often based on less or different datasets than those from the SES and BoM.

Construct and Disseminate Messages

Following the catastrophic bushfires in Victoria in February 2009, the Royal Commission recommended a revision of bushfire safety policy including enhancing the role of warnings by providing timely and informative advice about the predicted passage of a fire and the actions to be taken by people potentially in its path.

The Commission also recognised that warnings cannot contain all the detailed information on the many variables that will inform people's planning and decision making: this is the domain of education and information before the event (VBRC, 2009). But they must achieve a balance between being succinct and also resonating with people so that they take the best course of action in their circumstances.

The same holds true for flood warnings which need to support the types of actions recommended by response authorities, evacuation triggers, time frames and routes, and the reinforcement of urgency when lives are at risk.

The construction of messages can be done either beforehand or in response to an evolving event. NSW SES often employs the beforehand option which allows words to be chosen carefully and used in a template to ensure all important information is included. However, difficulties arise when there appears to be a simple response required, such as the need to evacuate, from a clear threat, such as a levee overtopping. However, there is likely to be complex contingencies involved, such as whether the flood reach a certain level, what the flood slope will be, the chance of levee failure before overtopping, the duration of flood at a particular level and the time needed and available to evacuate before premises are flooded. These can all influence the actual likelihood and consequences but may be too complex to communicate in a succinct flood warning or evacuation order.

Even when a message has been kept clear and simple, a particular challenge is ensuring that message detail does not get lost in media broadcasts. While radio has been cited in many surveys as the most popular means by which people receive flood warnings, messages can be either intentionally or unintentionally altered to fit the style, angle or duration of the news broadcast.

A review of the media monitoring for the June 2007 Gippsland floods found that numerous media reports/warnings were not progressive and the terms 'flash flood' warning, 'flood warnings for Gippsland' or 'severe weather warning' were repeatedly used, even after 'major' flood warnings were issued for specific rivers and locations. This significantly under reported the threat to the audience. Many community members whom we surveyed reported that they did not hear their specific location mentioned in flood warnings subsequently causing them to be unprepared for the impending flood (Molino Stewart, 2008).

It was also noticed in this review that there was a tendency for television coverage to pay little attention to forecasts and to instead report damages. This was particularly evident in media with state-wide coverage and often meant that flood warnings for yet to be impacted locations were left out to make way of more interesting footage of damages and rescues.

While official warnings are "passed-on" by media broadcasts, they are also disseminated directly to recipients through door knocking, web sites and telephone alert systems.

The national Emergency Alert System (EAS) is an all-hazards warning system which was established after the 2009 Victorian bushfires and it sends emergency notices to landlines and mobile phones in the affected area in the form of voicemail and text messages. The technology itself is not new and many local councils around Australia and the Western Australian Government already had telephone alerting systems in place for floods and/or other emergencies. The significant advantage of the EAS over previous systems is that it has access to all phone numbers in Australia without the need for recipients to preregister to receive messages.

The EAS is not without its own limitations. It can only have 12 people logged in nationally at the same time and can only operate eight concurrent warning campaigns across Australia, with a maximum of 50,000 telephone numbers in each campaign. The system also cannot prioritise one location over another, either within a campaign (e.g. an upstream town ahead of a downstream town threatened by the same flood) or between concurrent campaigns (e.g. two different threats – a bushfire in Victoria ahead of a flood in Queensland) as the calls are made at random as telephone system capacity becomes available. This means that problems will occur if multiple disasters occur over a large geographical or population area. Area polygons which determine which numbers to call cannot be pre-loaded, saved or recalled and need to be drawn free-hand which often means it will capture properties which do not need to be warned.

The rate of warning calls actually issued will depend on network capacity and the amount of general call traffic at the time. It also cannot give its own EAS calls priority over traffic on the general telephone network which can actually increase if the warning generates a second wave of calls from warned residents to family and friends.

The system is of limited to no use for flash flooding which has short lead times. Warnings would have to be issued for severe weather or generalised flash flooding issued by the BoM. To date, the BoM is not using the system at all, despite it being the organisation responsible for generating these types of warnings in Australia.

Another problem which can occur is conflicting "official" messages being disseminated by different organisations through different communication channels. This issue recently occurred in Queensland in October, where Brisbane residents were issued with contradictory flood messages via text messages and online sources from Brisbane City Council, the BoM and South East Queensland Water (the operator of upstream dams) following a week of heavy rainfall (Molino Stewart, 2010b).

The Greater Shepparton City Council's Community Telephone Alerting System (CTAS) was used for the first time in a Major Flood in September 2010 and worked as planned. However, contradictions in warnings also occurred, when a local VIC SES controller issued to the media details about up to 100 homes being flooded when Council maintained that less than 10 were

ever under any threat from the predicted flood level (Molino Stewart, 2010a). While the river peaked at the BoM's forecast peak level, not one house was flooded, reinforcing the need to have and use accurate flood mapping and flood intelligence.

The EAS SMS messages sent out by VIC SES, contained little, if any, involvement from Council in regards to the content or timing and Council reported delays in getting VIC SES to authorise council disseminating warnings through its CTAS telephone message system .

As a result of these types of discrepancies, trust becomes a significant determinant in how people will ultimately respond to warnings. Scepticism about the official source, including low public confidence in the flood authorities, and the accuracy and reliability of warnings can often induce a passive warning response (Parker et al 2009). This occurs not only in the case of floods, but all natural hazard events. Parker et al (2009) provides examples from research where too much exposure to false warnings causes credibility to decline along with adaptive response as communities become desensitised to the warning message. It is also important to note that community attitudes vary. Parker and Neal (1990) found that on the River Severn, survey respondents living on the floodplains preferred to receive false warnings than risk being flooding without any warning at all.

Warning messages can also be disseminated through community networks. During the North Coast floods in 2009, the majority of older residents said that they received the warnings through radio announcements primarily and younger resident from the BoM website. However, family and friends were cited by all as a significant source of flood warning information particularly for verifying or confirming initial warnings as was physically inspecting the river levels themselves (Molino Stewart, 2009).

The focus groups in the same study were more concerned about the accuracy of warnings and communication 'problems' than how the warnings were relayed. They believed that there was generally good coverage by radio and television of the movement of the East Coast Low as it tracked south from South East Queensland in the week leading up to the floods in the North Coast NSW region. However, most participants felt that there was little or no local input used in the flood forecasts and warnings. This cast doubts in their minds on the accuracy of warnings issued by the BoM, especially as they believed that some gauges failed. As a result, it was generally felt the SES was overstating the risks, levees would not overtop and evacuation was unnecessary (Molino Stewart, 2009). In some locations, the flood peaks were as forecast and in others they were up to 0.4m lower. The BoM and SES maintain that the evacuation orders were warranted given the lead time needed, the possibility of further rain and uncertainty about the integrity of some levees.

The Victorian Bushfire Commission recommended that follow-up information can be used in regards to reasons why fires did not eventuate after warnings were provided in certain instances. By completing the cycle of effective public information, it reduces the risk that people become complacent and ignore future warnings or lose confidence in the authority of warnings (VBRC, 2010). The same would be beneficial following floods.

Response / Take Appropriate Actions

Regardless of how well a warning system works in delivering timely, informative warning messages, the success of the system in saving lives and preventing damage is how receivers respond to the messages. Unfortunately, as discussed previously, distrust of official agencies, scepticism about forecast levels and consequences, contradictory official warnings and alternative unofficial warnings passed through community networks can all contribute to passive response behaviour.

People commonly seek further information either as a first or subsequent behaviour when they become aware that flooding is possible (Parker et al, 2009). In relation to the 2009 North Coast floods (Molino Stewart, 2009), 23% of Clarence catchment respondents said they acted straight away after hearing the first warning, similar to the Wilsons/Richmond catchment at 24%. However, this increased to 47 per cent in the Macleay.

Sixty four percent of Clarence respondents, 52% of Wilsons/Richmond respondents and 47% of Macleay respondents, waited for another cue with an average of 26% across the region waiting until the water reached a particular level at the gauge. Across the region an average

of 9% waited until they heard the evacuation order before they acted and only three percent waited until the SES doorknocked their property (Molino Stewart, 2009).

The main reasons for not evacuating were property protection, lack of trust in the evacuation order (many thought it was premature and based on inaccurate forecasting) and belief from experience that their property would not be flooded. Several also thought that it was a voluntary evacuation. When asked what would convince them to evacuate in the future, respondents identified that accurate predictions based on river heights in the upper catchment, local knowledge that it was going to be an extreme event, demonstrated proof that the levee will overtop and being formally told by the SES or emergency services were the highest ranked answers. However, it is important to note than approximately 20% of Clarence respondents, 30% of Wilsons/Richmond respondents, and 30% of Macleay respondents said they would not evacuate under any circumstances (Molino Stewart, 2009).

The above suggests that even though human behaviour will ultimately determine the risk and impacts from a flood, a good warning system which has the confidence of local residents by being based on accurate forecasting and good communications, can assist in achieving the desired response from flood affected communities at risk.

Review

All of the warning system steps discussed above need to be regularly and thoroughly reviewed to see where problems still exists and how they can be improved. Although there is guidance for review in the Flood Warning Manual (Attorney-General's Department, 2009), this needs to be carried out regularly with forecasting agencies, emergency agencies and flood affected communities, not only after a flood but also between flood events.

Du Plessis (2002) argues that 'if systems are evaluated on a regular basis the necessary adjustments can be made, with resulting improvement of their effectiveness. For evaluation purposes, a distinction can be made between the forecasting and warning system, and the response system. A flood forecasting and warning system can be regarded as an information system. The appropriateness of the system can be evaluated by determining the potential and actual quality of the information provided. The response system, on the other hand, can be regarded as a decision-making system and can be evaluated on the basis of an optimal and actual response strategy.'

Parker and Neal (1990) identified four approaches that should be considered in the review of warning systems.

1. Extent of coverage of flood warning service. Although this approach does have strategic planning value in particular, it does not measure the quality of a warning system and therefore does not take into account any failures or shortcomings within a warning system. As du Plessis (2002) notes, 'it is therefore indeed possible when employing only the approach mentioned, to have a situation where the quality of the warning system decreases while the area covered is expanded.'

2. Flood losses. A second approach is to determine the losses that can be prevented by a flood warning system. The larger the benefit that can be achieved, the better a flood warning system can function. According to du Plessis (2002), 'the greatest problem with this method is that it is necessary not only to determine the tangible direct flood damage, but also to identify the indirect, non-tangible losses. By not quantifying the latter impacts, a distorted picture could be obtained of the behaviour of a flood warning system.' The advantages of an improved forecasting and warning system are the differences in the impact of floods that occur with a longer warning time or the greater accuracy with which floods are forecast, rather than the difference between maximum potential damage and the total true flood damage (Smith and Handmer, 1996).

3. Community satisfaction with the service and response to warnings. Examples of this type of social research are cited previously in this paper.

4. Performance evaluation. The shortcomings of a warning system can be evaluated by identifying, categorising and documenting the shortcomings of flood warnings such as their timeliness, accuracy, reliability and efficacy in gaining appropriate community response. Du Plessis (2002) believes 'the advantage of this method is, *inter alia* that a specific division of a system could easily be improved, while on the other hand the greatest problem posed to the

approach is the gathering of suitable information after a flood, when other clearing works are enjoying priority.'

Although across Australia there is evidence of elements of these four warning system review methods in place (e.g. through post-flood de-briefs), they mainly involve the BoM and emergency agencies and, if relevant, local councils. Improvement can be made by ensuring that these processes systematically enable review both between floods and immediately after a significant flood. Furthermore, several flood affected communities have been critical of either being totally excluded from warning system reviews or having community de-briefs directed by emergency agencies/councils and not independently facilitated (Molino Stewart, 2009). Improvement could therefore be a more inclusive review approach with communities.

Discussion and conclusions

The ultimate measure of effective warning is appropriate responses which result in reduced loss of life and damages. As the preceding discussion shows, this requires all parts of the total warning system being well designed, maintained, implemented and regularly reviewed for improvement.

Despite significant improvements in flood warning systems, technologies and procedures, none are failsafe and there are many places in which a warning system may not perform to expectations on the day. While technological shortcomings or failures can be a contributor to warning ineffectiveness, human factors pose an even greater risk.

Key human factors include the need for:

- agencies, media and the community to have a good understanding of flood behaviour and consequences
- clear communication between all groups before, during and after a flood; and
- trust between all parties

It is our view that a well-structured, comprehensive and regularly implemented review process - between floods and after significant floods - will not only assist with identifying where the total warning system has and has not worked well but the review process itself can become a means of improving understanding, communication and trust.

References

Attorney-General's Department, 2009, Flood Warning, Manual 21 Australian Emergency Manuals Series, Australian Government.

Basher, R., 2006, Global Early Warning Systems for Natural Hazards: Systemic and People Centred, *Philosophical Transactions of the Royal Society* 364, 2167-2182

du Plessis, L.A., 2002, A review of effective flood forecasting, warning and response system for application in South Africa, Water SA Vol. 28 No. 2 April 2002

Molino Stewart, 2008, Gippsland Flood Warning Case Study, unpublished report for VICSES.

Molino Stewart, 2009, May 2009 East Coast Low Flood Warning Community Feedback, published on the NSW SES website at

http://www.ses.nsw.gov.au/multiversions/16561/FileName/2010%2007%20Sep%20MNC%20Community%20Survey%20Report%20with%20Cover.pdf

Molino Stewart (a), 2010, Floodplain Manager, Vol 6, No. 5 October 2010

Molino Stewart (b) 2010, Floodplain Manager, Vol 6, No 6, December 2010

Parker, D.J., Priest, S.J., and Tapsell S.M., 2009, Understanding and enhancing the public's behavioural response to flood warning information, In Meteorological Applications 16: 103–114

Parker, D.J., and Neal, J., 1990, Evaluating the performance of flood warning systems. In Hazards and the Communication of Risk, Handmer JW, Penning-Rowsell EC (eds). Gower Technical Press: Aldershot; 137–156.

Smith, D.I. and Handmer, J.W.,1996, Flood Warning in Australia, Centre for Resource and Environmental Studies, Canberra

Victorian Bushfires Royal Commission: Final Report 2010. Parliament of Victoria

Victorian Flood Warning Consultative Committee, 2001, Arrangements for Flood Warning Services in Victoria, Commonwealth of Australia