

Flood warning reviews in North America and Europe: statements and silence

John Handmer examines recent reviews of the flood warning systems in North America and Europe overviewing some of their issues, themes and gaps.

By John Handmer, Centre for Risk and Community Safety, Geospatial Science, RMIT University, Melbourne

This paper examines the many recent reviews of flood warning systems in North America and Europe. My purpose is to set out the main themes and issues contained in these reviews. It is also interesting and important to establish areas and issues not covered by the reviews, and I try to identify these areas of silence. A serious omission of the US and European material is the failure to explicitly conceptualise the warning task as being about enabling the communities, enterprises and individuals at risk to take action to reduce their risk and property losses. Processes are needed to ensure that the needs of those at risk drive warning system design.

Flood warning systems need continual improvement just to maintain current levels of service. Warnings are increasingly expected by those at risk and they are expected to be timely and accurate. There appears to be less tolerance for what are viewed as mistakes – even though we may regard errors as inevitable given the complexities and inherent uncertainties surrounding the warning task. This is in effect a steadily rising standard.

It would be difficult enough by itself, but there are more and more people potentially at risk demanding warnings. Many are at risk for what we might call traditional reasons; that is living, working and traveling in flood prone areas. But an increasing number are at risk because they use such areas for recreation. This group is probably not reached by warnings today with occasional disastrous consequences. Separately, there is an emerging consensus that the natural phenomenon of flooding is likely to worsen with global warming (Handmer, Penning-Rowse and Tapsell 1999).

This paper examines the many recent reviews of flood warning systems in North America and Europe. The purpose is not to compare these reports with the situation in Australia – although some comparisons are made – but to set out the main themes and issues contained in these reviews. It is also interesting and important to establish areas and issues not covered by the reviews, and I try to identify these areas of silence.

Are reports from other countries relevant to Australia?

Examining overseas experience raises an obvious issue which is far too often ignored – that is the question concerning the applicability of lessons and experience from elsewhere. This is quite distinct from the concerns raised when the information from elsewhere would be embarrassing or show the inadequacy of local thinking and practice. It is also

distinct from concerns about the limits of generalisability of case study research.

If the national – let alone regional or local – contexts of the research are very different to where it is being applied, then research results may not be automatically transferable. A large question mark hangs over the applicability to Australia of research results from the US in particular (where most of the English language literature originates). Yet such research is usually quoted as if it was perfectly transferable to Australia or elsewhere. A similar comment may be made about the uncritical transfer of results within countries to rather different contexts, for example, the results of research conducted in rural towns in the US and Australia have typically been applied to metropolitan areas without consideration of the differences. There has been and still is an assumption of universal applicability – with the exceptions of indigenous communities and easily identifiable neighbourhoods which appear to be distinctly different, such as the ‘Chinatowns’ of many major cities. Results from long ago are even more problematic. Few would disagree that in addition to all the other changes in our societies over the last few decades our approach as individuals and societies to risks and hazards has changed dramatically, most famously as set out by Ulrich Beck in *Risk society* (1992).

This is not the place to examine these problems – I simply want to

indicate the need for caution, and to suggest that the area is worth further investigation.

Reports and other sources

For North America the paper draws on recent reports from the US Federal Government's National Science and Technology Council *Effective disaster warnings* (2000); Sorensen's (2000) review of 'Hazard warning systems' completed as part of the US second assessment of natural hazard research and policy; Kendall Post's (2001) review of "Barriers to effective US alert and notification system"; *Coping with flash floods* (2001) the results of a NATO workshop on the subject (Gruntfest and Handmer 2001), and Dennis Mileti's summary volume on the reassessment of natural hazards in the US, *Disasters by design* (1999).

For Europe there are numerous national reports and some Pan European studies. The recent evolution of warnings in the UK and establishment of the National Flood Warning Centre following the 1998 English floods and subsequent enquiry (Bye and Horner, 1998) has been well covered elsewhere (Haggett 2002; Handmer et. al. 2000; Handmer 2001). The enquiry is mentioned in the text. There have since been a number of further investigations following the floods of Autumn 2000 (Environment Agency 2001). Most of my comments on Europe will come from a recent review 'Improving flood warnings in Europe' which examined many European reports (Handmer 2001), the NATO volume mentioned above (Gruntfest and Handmer 2001), the results of a major European funded study into climatic hazards (SIRCH or Social and Institutional Responses to Climate Change and Climatic Hazards: floods and droughts.) and a workshop last September in London which examined current issues in European flood policy (www.gs.rmit.edu.au/research/risk.htm). Rosenthal and t'Hart (1998)

provide a useful analysis of emergency response to the European floods during the 1990s.

In addition, there are of course many projects, reports, web sites and commentaries of relevance, for example see the Boulder site for the US (www.colorado.edu/hazards) and for Europe, www.MITCH.ec.net, or www.hrwallingford.co.uk/projects/RIBAMOD/.

Some key themes

Examining many reports and papers from many places unavoidably means that any summary will be general. Here some major themes have been selected that emerge from the material as well as some distinctive omissions.

Material on flood warnings can be divided loosely into micro and macro issues. There is much in most reports on what can be termed the micro issues of warning – message design, psychometric and demographic factors which affect warning response and so on. As micro issues are very well covered by the literature and show relatively little change over time, the emphasis here is on macro issues. These concern broader policy and system design issues and the sharing of best practice. Areas of continuing concern within the micro category include the need for: effective processes for community engagement; determining and delivering appropriate advice on what action to take on receipt of a warning; and the identification of high risk groups and ensuring that they get the warnings they need.

Warnings are very much part of flood risk management, but are no substitute for effective risk management. The emphasis should be on the development of national (or continental) approaches to risk management. Effective approaches in one area are often at present offset by ineffective or non-existent action elsewhere. This is inequitable for those at risk, probably economically inefficient, likely to be

environmentally damaging where development proceeds in floodplain areas, and unlikely to produce resilient communities.

Enforcement problems raise questions over sole reliance on a regulatory approach – an issue raised in reviews and interviews in Canada (Emergency Preparedness Canada and Environment Canada 2001), UK, USA, France and Poland. These problems suggest that approaches relying less on enforcement and more on cooperation, as employed in New South Wales, may be more workable (May et. al. 1996).

The emphasis on technology

The government warning reports reviewed for this paper generally emphasised the potential of modern technology and the need to apply it with more fervour. Most of this effort has been directed at improvements to monitoring, modelling and prediction systems (for example see www.MITCH.ec.net) – this is hardly surprising given that most warning reports are authored by technical specialists. Apart from this area much effort is going into large scale applications such as GDIN (Global Disaster Information Network) and it is not always clear how this would actually help local warnings or response – given that effective management of rapid onset flooding depends initially on local warnings and response. All the current EU funded warning related research projects are essentially about the application of information and communication technology – although they may have other dimensions as well. This is important when we appreciate that some agencies with warning responsibilities claimed to be unable to share key data between their own offices, let alone across national borders. Apart from the use of the internet, large scale fully operational examples of the successful application of modern technology in local

The warning task has become harder because of our expanding use of flood-prone areas for recreation





Early warnings enable communities to reduce risk and property loss.

warning and response are rather scarce. The NATO volume mentioned above contains one example from Oklahoma which is likely to be applied across the US (Crawford, 2001). This combines the communication and access potential of the web with traditional weather monitoring and relies on a sound hydro-meteorological network – something which is under threat in many jurisdictions (e.g. the Canadian review). I know of no other large scale examples proven to be both cost-effective and performance enhancing. There are some more local cases, such as the Denver metropolitan district which uses a range of technology for storm detection and warnings, and the Danish Hydraulic Institute's FLOODWATCH system.

How does the emphasis on modern information technology match up against the problems being faced by warning systems? I would assert that it matches poorly. The main problems and complaints relate to human and institutional failures.

They relate to the failure to properly identify and address the residual risk, they touch on issues of determining acceptable risk – a social and political process, and the difficulty in achieving improved outcomes. In his review of warnings in the US, Sorensen (2000) states that: "Better local management and decision making about the warning process are more critical than promoting more advanced technologies, although both would help."

It may be that a real pessimist would see that the concentration on information and communication technologies may make things worse by directing effort and resources away from the real problems and issues. We can see that we have better and better ability to monitor, detect and predict hazards while using similar procedures to warn those at risk as were used thirty years ago. Why do we wonder why warning response and effectiveness as measured by outcomes has improved little?

An exception to this rather negative assessment is the use of the web as part of the interface between the science of prediction and those at risk. Even here many of the web displays do not inform people of their own risk of flooding, and do not follow good practice in warning message design. In particular, they do not tell people what to do in the event of a warning. An outstanding exception to this picture is the website of the UK Environment Agency (www.environment-agency.gov.uk). Locally, the Traralgon flood warning system has been designed to maximise community access to warning information including via the Bureau of Meteorology's Victorian flood warning services web site (Kazazic at al. 2001).

An urgent policy need may be to agree on the technical specifications for warnings via various new media such as mobile phones, as suggested by the US report on *Effective disaster warnings* (NSTC 2000).

Key groups at risk

Some attention in the reports reviewed has been devoted to groups seen as particularly vulnerable in the warning context. These are usually seen as people who would have trouble responding to warnings. However, these groups are relatively visible and include the housebound, immobile, mentally ill, and those who cannot hear or read warning messages.

Far less attention is given to less visible but nevertheless at-risk groups. These include people who may not be reached easily by the normal warning communication mechanisms, such as:

- All those mobile at the critical warning time.
- Tourists.
- Business travelers (US reports).
- Seasonal workers (US reports).
- Those who are socially isolated such as the homeless and those trying to remain out of sight including undocumented people (those without permission to be in the country).

Nevertheless, these groups can usually be identified and located even if only by police patrols, with the possible exception of the last listed. In practice, during a major flood event the emergency services may not have time for this task.

Another group is more problematic. This group consists of those who occupy high risk locations on a casual basis such as bushwalkers, cross-country skiers and adventure recreationists. If we considered recent well publicised flash flood deaths in Europe we would add campers. This group can be subdivided into those using official camp grounds, commercial or other organised groups, and independent adventure recreationists.

The largest numbers at risk at any one time are campers and organised groups of recreationists. These two groups have contributed significantly to flash flood death

tolls in Europe. France in particular has tried to implement warning systems at camping grounds, although there is a conflict between raising awareness of the hazard and the economic imperative of having people stay at a flood prone camp ground. Organised groups appear to be generally aware of flood warnings although their risk related decision-making processes may be poor. Like camp-grounds, they can be regulated, targeted and warned and most would already carry communication equipment. One risk here is that a withdrawal of insurance cover or heavy-handed regulation may lead to these groups becoming more informal, less visible and further outside formal warning arrangements.

When considering warning priorities we should focus on where they are likely to have the most impact. There are two major areas here: where substantial property losses can be avoided with warnings and appropriate response; and where the risk of large death tolls is high. To concentrate on the second area – the groups most at risk appear to be organised groups of adventure recreationists, campers and vehicle occupants. About half of all flash flood related deaths in the US are people in vehicles (Gruntfest and Handmer, 2001). Failure to warn organised recreational groups leads to inquiries, lawsuits and in Europe criminal charges. At present, the main group missed altogether by warnings appears to be independent recreationists. To confirm this a gap analysis may be useful.

Handling uncertainty

Although not generally set out explicitly in reviews and reports, uncertainty plagues most aspects of flood warning. There are several interrelated dimensions to this, a few are discussed below.

Many parts of Europe and the US are subject to severe flash flooding presenting testing challenges for

warnings and response. *Uncertainty over the timing and occurrence of the flooding as well as the modelling of water spread*, makes flood prediction difficult. Although there are often complaints about the accuracy of prediction – especially if it is around critical heights for road closures or levee failure – the real issue is failure to predict flooding altogether, or to communicate warning messages to those at risk before flooding commences.

Largely inseparable from this point is *uncertainty over the precise location of the areas likely to be affected*, particularly when dealing with rare events and unexpected phenomena and pathways. Floods may affect groups and areas that are not seen as hazardous. Even the best hazard identification process will contain uncertainties and assumptions, for example about what degree and type of flooding to include.

Frequently, areas thought to be low or no-hazard may still be flooded in severe events. Warnings systems need to be designed to cover such areas even when they are not identified in advance. Usually however, areas can be identified as of very low, but nevertheless real, hazard. The question then is how to ensure their inclusion in warning system coverage.

Uncertainty over the impact of the hazard. Impact is related to the timing and magnitude of the flood. A flash flood sweeping through a campground at night will likely result in a high death toll. Flooding mid afternoon on a week day will cause maximum disruption in a major city, and so on. Another aspect of this is that late at night few people will receive or respond to warnings with the result that the impact could be much greater in the absence of any damage reducing actions.

Perhaps more challenging is how people respond to warnings, once they have received and understood them, and how this can influence the flood impact. An important

issue here is *uncertainty over appropriate action*. Many warnings do not provide advice on appropriate action. For some hazards, the advice provided may increase the risk; for example, evacuations from relatively secure premises at the last minute for bushfires, or through deep or fast flowing flood waters.

Pre-event awareness and education

Almost all post flood-disaster reports advocate pre-event public awareness raising and education. However, this is no panacea. According to Sorensen's summary of the US experience (2000) "There is no conclusive evidence regarding whether or not a public education or information program actually makes a significant difference of increasing human response to warnings." His statement echoes much earlier findings published by the Illinois Department of Transportation in 1980. He goes on to say that the evidence for effectiveness is mixed, probably because many programs are poorly designed or executed. Other reasons for this statement are that many assessments are poorly designed or executed (see Rohrmann 1999); and in any case there is simply no guarantee of success in advertising, promotion, or in trying to change people's attitudes or behaviour.

This gloomy assessment is not a reason for giving up, however. The current British public awareness and preparedness program being developed by their National Flood Warning Centre suggests one novel approach to building awareness and behaviour change using a strategic campaign over a ten year period. The program is based on the social marketing approach well developed in the field of health promotion

Measuring success

This is an ongoing critical issue. Without a clear and agreed approach to assessing success, or failure, it is not easy to see how we

can be confident that warnings are improving. Recent papers by Rohrmann (1999) and Handmer (2000) examine this issue and the difficulties surrounding rigorous assessment. The NATO volume contains discussion of some alternative approaches (Gruntfest and Handmer 2001). Some reviews deal with the issue implicitly only. Here I simply want to highlight some different approaches:

- Outcomes in terms of lives saved and property loss avoided.
- The primary output of prediction timing and accuracy.
- Assessment of each stage of the warning process against targets such as proportion of audience reached and time taken to reach them.
- Satisfaction with warnings by those at risk.
- Warning system design and function including the quality and reliability of inputs.
- The principles and assumptions underlying design and operation, for example, is it based on the needs of those at risk assessed through processes of community engagement?

The focus here is quite properly on warnings and warning messages issued in advance of the flood, but much can also be done to reduce losses immediately after inundation through salvage and appropriate treatment of flooded items.

However, virtually no guidance is available to those wishing to do this. For businesses, continuity planning provides a proven approach to damage limitation.

Institutional design – task focused

The material reviewed rarely mentioned the real purpose of warnings: that is to assist those at risk. Where it was mentioned, it was in the context of micro issues such as message wording. The fundamental problem of designing warning systems so that they meet community needs was ignored. An exception may be the UK.

In Australia positive examples are provided by some of the regional offices of the Bureau of Meteorology, which have worked to ensure that warning system improvements are based on community needs (Songberg et. al. 1999; Kazazic et. al. 2001).

Warning system models discussed and proposed in the reports are essentially top-down or agency centred. This may be unavoidable, as the agencies generally have the ultimate responsibility for warnings, but may perpetuate warning dissemination and response problems. If user needs and priorities are overlooked or ignored completely, it is difficult to see how warning outcomes will improve, although system performance may show improvements judged by so far – while it is clear that there is much room for improvement in interagency coordination. There is an ever increasing amount of material put in front of the 'public', much of it more attractive (in the sense of being positive and entertaining) and of more immediate interest than flood warning education. Furthermore, if material does not address community needs it is unclear how it will achieve improvements. To address community needs, these needs have to be known by those responsible for warnings. Community engagement is also necessary to manage public expectations of the warning system.

At a more general level, engagement with the communities at risk is a fundamental part of the risk assessment and management process of which warning systems form part. Similar comments could be made concerning the commercial sector. Most warning systems also involve the mass media, at least, if not other private or autonomous groups, and these groups should be part of warning system design.

Another and very important aspect of an agency centred approach is the way the links between the informal and the official are ignored – the



Areas thought to be low risk should be included in warning system coverage.

informal in this context being people's personal networks, information sources and their priorities. No official report discussed this issue, but European research highlights its importance and potential, both for undermining and reinforcing official efforts (Tapsell et. al. 1999; Gilbert and Gouy 1998: 24; Parker and Handmer 1997). It is an area where investigation seems urgently needed.

A cross-cutting institutional issue is the frequently mentioned weak legal position of warnings in common-law jurisdictions such as the UK, USA and Australia. But no solutions are advocated in the reviewed reports. The problem is that legal uncertainty may make some officials reluctant to provide information on flood preparedness and appropriate action on receipt of a warning. This appears to be less of an issue in the civil code countries of Europe.

Processes for implementation

For a long time it has not been difficult to find statements on what a sound warning system should achieve, what components it should contain, how messages should be designed and so on. In 1986 Handmer and Ord reviewed the literature to that date and found that such statements had been set out since the 1970s. The recent US and European material reviewed in this paper restates and adds to this literature, but does not set out processes or procedures for developing and implementing a warning system. (For an approach used in Australia see Handmer, Keys and Elliott 1999). Processes are also needed for sharing experience and ideas between the various jurisdictions and agencies involved. In Europe, European Commission funded projects are

attempting to meet this need on a continental wide basis.

Partial exceptions to this general lack of material on process include the US NSTC (2000) recommendation for a public-private sector partnership to leverage government and industry needs, capabilities, and resources to deliver effective warnings. But there is no recommendation on processes to achieve this beyond suggesting that it could be in the form of a not-for-profit corporation. Separately, the report suggested that working groups of stakeholders should be established to support warning system improvements. (See also www.partnershipforpublicwarning.org/). The inquiry following the British floods of Easter 1998 recommended some institutional changes including the formation of a national flood warning centre – which is now well established.

Conclusions and implications

For the US, Sorensen summarises progress with flood warning over the last 20 years with the words: "not much improvement", although he assesses that there is "some improvement" for the prediction/forecast component. This is a little harsh as the death toll appears to have fallen and modest improvements have occurred even as the warning task has become harder. It has become harder because of our expanding use of flood prone areas especially for recreation, and because of changes in society. People may be more difficult to warn as society becomes more atomised – and other features set out in Handmer (2000). This overall negative assessment of warning performance hides substantial progress in many local areas and in some countries such as the UK, as well as the steadily improving reliability of prediction and communication hardware. Sorensen also asserts that warning systems "have not been demonstrated to

have any significant impact on reducing damage to ... private property or ... economic disruption." However, Australian and UK research has long shown the property savings and economic benefits of successful warnings in specific areas. The challenge everywhere is to make such successes widespread and normal.

Making success normal requires, among other things, that the warning task be properly conceptualised as being about enabling communities, enterprises and individuals to take action to reduce their risk and property losses. The US and European material generally fails to make this clear. It has been said for decades that the finest monitoring and prediction systems possible are of no value if they do not serve this purpose – and they cannot serve it by themselves. There are many related issues in warning system success, such as harnessing the benefits of new information and communication technology, inclusion of the informal and private sector, resolving the uncertainty of legal liability, and the need to identify and engage those most at risk from flooding. In Australia, a group whose lives may be at risk from flooding are the increasing numbers occupying low quality housing in riverside caravan parks.

Processes are needed to engage with those at risk and to ensure that their needs drive warning system design and operation. Good practice and experience needs to be shared on a regular basis – and this requires leadership. Australia may need to devote more attention to state or national leadership and to processes for continuous improvement, through engagement of communities and other stakeholders critical to successful risk management.

Acknowledgements

An earlier version of this paper was presented at a joint RMIT University/

Emergency Management Australia Institute workshop "Flood warnings: status and trends", Mt Macedon, 9 April 2002. My thanks to those who provided comments at the workshop, and to Chas Keys of the NSW State Emergency Service and Jim Elliott of the Australian Bureau of Meteorology, for constructive criticism.

References

- Beck, U., (1992), *Risk society – towards a new modernity*. London: Sage.
- Bye P. and Horner M., (1998), *Easter 1998 floods: Report by the independent review team to the board of the Environment Agency. Volume 1*. Bristol: Environment Agency. 30 September
- Crawford, K., (2001), The Killer Tornado Outbreak of 3 May 1999: Applications of OK-First in Rural Communities. In Grunfest, E. and Handmer, J.W. (eds) *Coping with flash floods*. Kluwer.
- Drabek T.E., (1999), Understanding disaster warning response. *The Social Science Journal*. 36(3): 515–523.
- Emergency Preparedness Canada and Environment Canada., (2001), *Managing flood hazard and risk: report of an independent panel*. (Edited by Ashij Kumar, Ian Burton and David Elkin.) Emergency Preparedness Canada and Environment Canada.
- Environment Agency, (2001), *Lessons learned: Autumn 2000 floods*. UK Environment Agency: Bristol.
- Gilbert, C. and Gouy, C., (1998), Flood management in France. In Rosenthal, U. and t'Hart, P. (eds): *Flood response and crisis management in Western Europe: a comparative analysis*. Springer Verlag: 15–55.
- Grunfest, E. and Handmer, J.W. 2001), (eds) *Coping with flash floods*. Kluwer.
- Handmer, J.W., (2000), Are flood warnings futile? 2000–2. www.massey.ac.nz/~trauma/issues/2000-2/handmer.htm
- Handmer, J.W., (2001), Improving flood warnings in Europe. *Environmental Hazards*. 3:19–28.
- Handmer, J.W. and Ord, K., (1986), Flood warning and response. In Smith, D.I. and Handmer, J.W. (eds) *Flood warning in Australia*. Canberra: CRES, Australian National University: 235–257.
- Handmer, J.W., Keys, C. and Elliott, J., (1999), Achieving lasting change in a multi-organisational task: the case of flood warnings in Australia. *Applied Geography*. 19: 179–197.
- Handmer, J.W., Penning-Rowell, E.C. and Tapsell, S., (1999), Flooding in a warmer world: the view from Europe. In Downing, T.E., Olsthoorn, A.J. and Tol, S.J. (eds) *Climate, change and risk*. London: Routledge: 125–161.
- Illinois Department of Transportation., (1980), *Notifying floodplain residents*. Vol 1: An assessment of the literature. Vol 2: Annotated bibliography. Division of Water Resources. Chicago.
- Kazacic, E., Baker, A., Zimmerman, P. and Songberg, K., (2001), Traralgon's flood warning system – community access. *Proceedings Planning for the inevitable: Victorian Floodplain Management Conference Traralgon*. October 2001.
- May, P., Burby, R., Ericksen, N., Handmer, J.W., Dixon, J., Michaels, S. and D.I. Smith., (1996), *Environmental management and governance: intergovernmental approaches to hazards and sustainability*. London: Routledge.
- Mileti, D.S., (1999), *Disasters by design: A reassessment of natural hazards in the United States*. Washington DC: Joseph Henry Press.
- National Science and Technology Council (NSTC), (2000), *Effective Disaster Warnings*. Report by the Working Group on Natural Disaster Information Systems. Washington DC.
- Parker, D.J. and Handmer, J.W., (1997), The role of unofficial warning systems. *Journal of Contingencies and Crisis Management*. 6(1): 45–60.
- Post, K., (2001), Barriers to effective US alert and notification system. Presentation at the Annual Hazards Workshop, Boulder Colorado, July 2001.
- Rohrmann, B., (1999), Assessing hazard information/communication programs. *Australian Psychologist*. 33(2):105–112.
- Rosenthal, U. and t'Hart, P., (1998), *Flood response and crisis management in Western Europe: a comparative analysis*. Springer Verlag.
- Songberg, K., Baker, A., Kazacic, E. and Zimmerman, P., (1999), Tailoring improvements to your flood warning system. *Victorian Flood Management Conference Wangaratta: Floodplains – risks and rewards*.
- Sorensen, J., (2000), Hazard warning systems: review of 20 years of progress. *Natural Hazards Review*. May: 119–125.
- Tapsell, S., Tunstall, S., Penning-Rowell, E.C. and Handmer, J.W., (1999), *The health effects of the 1998 Easter flooding in Banbury and Kidlington*. For the Environment Agency, Thames Region. Flood Hazard Research Centre, Middlesex University, London.

John Handmer, Centre for Risk and Community Safety, Geospatial Science, RMIT University, Melbourne
Email: John.Handmer@rmit.edu.au