# TOWARDS BETTER FLOOD WARNINGS

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## 1 INTRODUCTION

This paper reports on current initiatives designed to improve the quality of the flood warning process in New South Wales. Flood warning practice has evolved, Topsy-like and not always with clear direction, over a period of several decades, and various aspects of it are clearly in need of discipline. A manual of 'best practice' with regard to flood warnings is being prepared and is intended to guide the future development of the flood warning process in Australia in the future.

The earliest flood warning 'systems' in NSW grew out of local community needs, information on rising creek and river levels simply being passed down river valleys from person to person and town to town. Over time, these local efforts were augmented in various ways. The most important elaborations were the addition of scientific inputs (notably hydrologic modelling introduced by the Bureau of Meteorology), and the implementation of formal procedures to ensure that river-height predictions were disseminated to the community via radio stations. Other means of dissemination, including doorknocking and the use of telephones and two-way radios, were used on occasions at the local level to ensure that the warnings actually got to those who were about to be affected by flood waters.

Modern flood warning practice is complex and multi-faceted. It involves the prediction of flood heights (which requires considerable investment in the mechanical, technological and computing realms) as well as determining where the flood waters will go at the heights anticipated. Getting the warnings disseminated in ways that are understood in the community and can be acted upon appropriately requires considerable expertise in message construction and the effective use of a range of methods of message delivery.

## 2 MULTIPLE AGENCY INVOLVEMENT IN THE FLOOD WARNING PROCESS

Given the multi-faceted nature of flood warning systems, it is not surprising that numerous organisations are involved at one level or another in their design and operation. In NSW the Bureau of Meteorology is responsible for the prediction of flood heights at specified locations on the state's rivers, the data which the Bureau uses in carrying out this task being generated from a rainfall-reader network organised by the Bureau itself and from numerous stream gauges owned by the Department of Water Resources, NSW Public Works and various water boards, councils and other organisations. Some of these agencies provide other inputs as well, including ratings tables and data-transmission systems.

Getting warnings to radio stations for broadcast is the responsibility of the Bureau of Meteorology and the State Emergency Service. The latter, as the state's 'combat agency' for flooding, also has the running for organising additional means of dissemination and often co-ordinates council and other

community-based resources in carrying out the task. For many years, this 'local' dissemination was done by the SES by custom only, since the organisation in NSW had no legislated role in the flood warning process. The State Emergency Service Act 1989, however, specified for the first time its responsibility for the development of flood warning systems, and efforts are now being made to meet the task by injecting more discipline into the dissemination process.

## 3 SOME DEFICIENCIES IN WARNING PRACTICE

Some aspects of the warning process, it is clear, are much more formalised and disciplined than others. Those aspects which relate to river-height prediction and to the passage of warning messages to media organisations are quite highly formalised and generally operate efficiently, but this is not always the case for other aspects of the process and particularly those related to the handling of warnings at the local level. Over time, wide variations have emerged in the nature and effectiveness of flood warning practice within the state.

One problem here is that there have been few guidelines laid down as to how warnings should be handled at the local level. The result has been that in some cases local warning practice has amounted to no more than a 'postboxing' of Bureau predictions to the local police or the media, whereas in others there has been considerable effort expended in making sure that additional information is supplied and that the warnings actually reach the individuals and institutions expected to be affected by flooding. Even when there have been attempts to ensure that warnings do get to such people, however, the messages themselves have sometimes not been optimally designed for effective communication. The result has been that they have not been understood or acted upon, and some flood losses have been incurred. Frequently, after a flood, the cry is heard in the community that 'we were not warned'. Sometimes the truth is that warnings were given, but that they were not effective because they were not heeded - perhaps because they were not couched in ways that made them easily understood by or credible to those who were intended to benefit from them.

## 4 TOWARDS A SOLUTION

These various deficiencies of flood warning services were noted at a workshop on Flood Warnings conducted at the Australian Counter Disaster College (now the Australian Emergency Management Institute) late in 1991. After considerable discussion of the various facets of flood warning systems and services, the workshop resolved that a manual of 'best practice' be written to guide the delivery of flood warning services in the future. This manual, it was envisaged, would outline current thinking about the purpose and methods of flood warnings. In doing so, it would serve to educate the members of the various agencies involved in the process about where their roles fitted within the overall system, how their tasks and those of other agencies could best be carried out and how the different parts of the system itself should be integrated. In sum, the purpose of the manual was to create a 'state-of-the-art' picture of how Australian flood warning services should operate.

The manual itself is now in the final stages of preparation. It has been written by a panel of four individuals, all of them experienced in the design and/or delivery of flood or other types of warnings. The authors came from the Bureau of Meteorology, the NSW State Emergency Service, the Centre for Resource and Environmental Studies at the Australian National University, and the Australian Emergency Management Institute.

The manual is about to be sent to the members of the various state Flood Warning Consultative Committees, most of whom were attendees at the original workshop, for comment. It is envisaged that once this review process is completed, the manual will be published as an Australian Emergency Manual (AEM) and distributed to agencies involved in the creation and dissemination of flood warnings - that is, to Bureau of Meteorology regional offices, water management agencies, councils, SES units and others. The process should be completed by September of this year and the manual will then be available to users.

## 5 THE CONTENTS OF THE MANUAL

The manual attempts, then, to define the purpose of flood warnings and to define 'best practice' as it applies to the development and delivery of flood warning services. It begins by identifying the place of flood warnings in the wider field of flood mitigation, and goes on to define a flood warning system, its components and its products. Then, it considers the elements of the system individually, examining flood prediction, the interpretation of flood predictions, how warning messages should be designed, how they should be communicated to those at risk, and how the system should be reviewed to ensure that its effectiveness is maintained and augmented. We deal with each of these elements in turn.

**Prediction**

Flood prediction relates to the forecasting of river levels at specific gauge locations for particular times, and this chapter defines flood predictions, explains the need for them and describes how they are made. The catchment monitoring which underlies prediction is outlined, as are the elements of the prediction system itself (the data collection network, data communication systems, meteorological forecasting and hydrologic and hydraulic modelling). The importance of clearly-defined user requirements is spelled out, along with the need for operational co-ordination and communication between the forecasting authority and key response agencies during flood events.

One aspect which might be singled out for special attention in NSW relates to the definition of user requirements - that is, the amount of warning time which users need before a flood reaches particular, identified heights. Such requirements are spelled out in the State Flood Plan but have not been reviewed, in most instances, for several years. In the second half of 1994 the SES intends to review this plan, including these requirements, to ensure that they are based on consistent and disciplined applications of appropriate principles. At present, some of the requirements seem not to be based on any particular operational needs which apply during times of flooding. Concurrently

with this review, the Bureau of Meteorology is conducting an evaluation of the impact of recent funding increases on the effectiveness of its flood warning service nationwide.

**Interpretation**

Flood height predictions by themselves do not constitute 'complete' warnings, and the predictions made by forecasting authorities need to be interpreted in the local context if they are to be fully understood in the community. In essence, such interpretations involve 'adding value' to the forecast flood height by incorporating an appreciation of the coming flood's horizontal dimension - that is, by identifying where the water will go as the flood rises to its predicted level and what its effects will be. In NSW, the SES has for some time been creating 'flood intelligence cards' which identify the impacts of flooding in the area around a gauge. These cards describe the 'reach' of flooding at a range of heights. In some areas, records of this sort have existed for some time, but in others they are rudimentary or non-existent and accordingly a detailed appreciation of the likely reach or impact of rising flood waters has not been possible.

This deficiency has meant that response agencies have not been able to determine with any real clarity the likely extent of their task in a particular event. Moreover, high-quality warnings specifying what a coming flood will do (and therefore what people should do to mitigate its effects) have not been able to be developed. In practice, where flood predictions are made by a forecasting agency which is distant from the community at risk of flooding, this interpretative addition of value is best done locally - that is, from sources within the at-risk community itself. Council and SES records from past floods usually form the basis of flood intelligence cards, which can be built up by noting the impacts of flooding at different gauge heights in later events.

This chapter spells out what flood intelligence systems should contain and what resources are needed to create them. It also considers the place of computers and geographic information systems in the development of flood intelligence for warning purposes.

**Warning Message Construction**

This chapter defines warning messages and their purposes, and deals with how messages should be constructed so as to ensure that their content has meaning for the target audience and can persuade those at risk to respond. Effective warning messages must be user friendly - something which has not always been true in the past - and must be based on a clear understanding of the physical dimensions of the expected flooding and on how the communities at risk will be affected by it. They must describe flood impacts in simple, non-jargonistic terms, briefly but informatively, identifying what is happening, what is expected to happen and what the consequences are and will be. Messages should, as far as possible, be positive rather than negative (that is, suggesting what should be done rather than what should not be done) and be vivid in their descriptions.

The chapter presents a checklist of criteria for effective message design and notes that messages usually need to be constructed with a recognition of the fact that most communities are composed of different 'publics' with different information needs. Above all, messages must convert technical information on flood predictions and their interpretation into the everyday language of those at risk: this is vital if effective protective action is to be elicited from those who will be affected by the

flood.

**The Communication of Flood Warnings**

A message cannot be effective unless it is communicated appropriately, and for that reason the manual addresses the means by which flood warnings should be disseminated. Communication involves the selection of communication devices or modes, the careful identification of target audiences and making sure that there is provision for the confirmation of warning messages. Distinctions must be made between 'general' warnings designed for whole communities and 'specific' ones intended for parts of them, and the choice of modes of transmission must be based on this distinction. In general a **range** of modes should be used, the particular devices being chosen on the basis of the severity of the expected flood, the time available for warning people, community characteristics and other criteria.

In New South Wales, especially on the western plains where flood warning times are generally long, more use could be made of newspapers than has traditionally been the case. Flood intelligence cards can be published in newspapers, allowing people to gain an impression of the coming flood's likely consequences for them. Equally, 'telephone trees' can be effective in delivering personal warnings to substantial numbers of people who are about to be affected by flooding. Where evacuation is likely to be necessary, warning strategies should seek to include doorknocks of those who will need to leave their homes. Doorknocking is the most direct and personalised means of warning, and is best suited to the task of ensuring that people are advised on what they should take with them, what routes can safely be travelled and the like.

Whatever the particular primary modes of warning delivery, it is important that recipients can confirm the existence and meaning of the warning. This can be done if a confirmation service is provided, usually by means of a designated phone number which goes out with the warning message itself.

**System Review and Improvement**

No flood warning system can continue to operate effectively or be improved without ongoing maintenance and upgrading, both of its mechanical and its procedural elements. Periodic reviews are necessary to maintain and upgrade system performance and reliability, to ensure that the lessons drawn from the experience of flooding are not lost, and to make sure that account is taken of changing environmental conditions and community characteristics.

Reviews need to be held as soon as practicable after floods, and at various levels: in NSW, for example, the Flood Warning Consultative Committee needs to undertake long-term strategic planning relating to gauging networks and modelling, whereas local SES units should be involved in reviewing their intelligence-gathering functions and the effectiveness of their warning messages and dissemination procedures. Some of these issues can be dealt with on an 'in-house' basis, but others may require the involvement of people from outside the actual agencies with stakes in the design or delivery of warning services. It would be difficult and unwise, for example, to review questions such as the timeliness of warning reception or the extent to which people understood a warning message without actual reference to target audiences.

# 6 ENSURING THAT THE MANUAL IS USED

It is one thing to produce, from a workshop attended by professionals in the field of flood warnings, a manual which summarises optimal practice - but it is quite another to ensure that such a manual is widely used amongst the very large numbers of people, many of them volunteers, who will be involved in the flood warning process. Yet it will be the effective use of the manual which will lead to the development of better warning procedures.

The manual is intended to be widely available at an agency level, but operators will still need to be encouraged to recognise its worth and to apply what it preaches. Within NSW, much of what needs to be done to improve the quality of warnings must be done at the level of the local community. It is important, then, that SES and council personnel be convinced of the manual's value and that they be trained in its use. Once the manual is produced, there will be a series of discussions at SES regional conferences designed to familiarise staff and volunteers with its contents and to help them implement its guidelines.

This educational process has already begun in advance of the actual publication of the manual. The SES, in preparing flood plans to guide preparedness for and response to floods around the state, has been educating its personnel about the range of warning devices available and has been challenging traditional attitudes and beliefs as to what has constituted appropriate warning procedure. Training has been provided on the use of alternative dissemination modes and on the construction of Flood Bulletins which go to the media for broadcast. During the floods on the Lachlan, Murrumbidgee and Murray rivers in late winter and spring 1993, considerable experimentation was carried out and an improved quality of warning performance was achieved. The manual will help solidify these gains and spread them to other areas, leaving SES volunteers better able to provide meaningful, user-friendly flood warnings than was possible in the past.

Other organisations can help, too. Effective flood management requires the involvement not just of the flood combat agency but of other agencies as well. In the flood plans which the SES is preparing at local government area level, other community organisations which can play useful roles in the warning process are being identified. To some extent this means creating links with existing local groups which have traditionally been involved in passing information about floods: the Gundagai Flood Warning Association and the Mandagery Creek Flood Warning Committee are two such groups whose warning activities the SES can both incorporate and help sustain. Even on small creeks with no formal warning systems, the SES can nurture community-based information systems by appointing wardens, providing them with gauges and ensuring that the flood-related information they generate goes rapidly to the broadcast media.

Equally it is important, in improving the quality of warning services, that new groups be enlisted where appropriate. Cases in point at Inverell are the Inverell Writers Group and Neighbourhood Watch Committees, which have agreed to assist the SES in disseminating warnings to businesses and residences which are expected to be flooded. Where town business or industrial districts are flood

prone, the presidents and secretaries of Chambers of Commerce and Industry can be used as conduits for the passage of flood warnings to individual shop or factory owners, thereby ensuring the personal delivery of warning messages to those who need them. Council staffs may also, in some circumstances, be used to disseminate the warnings, as may Police, Fire Brigades, Bush Fire Brigades, Volunteer Rescue Association and service club personnel when doorknocking is necessary. Whichever organisations or groups are involved, they and their agreed roles are being written in to the appropriate local flood plans.

Warnings, of course, work best when the community is adequately prepared **before** flooding is predicted and already understands the nature of the flood threat. The flood plans prepared by the SES are not owned by the SES itself; rather, they are written on behalf of whole communities and are being made available locally via schools, council libraries and other institutions. These plans, which describe the warning arrangements which apply to the area, can be used in public education programs designed to familiarise communities with their flood problems and the roles of various organisations in flood management. Such programs also include, in various parts of the state, periodic doorknocks by SES personnel of flood liable residences (to ensure that people are aware of the flood threat), the dissemination of flood awareness material with council rates notices, and media campaigns over local radio stations and in local and regional newspapers. These initiatives will increase the level of community preparedness for flooding - and familiarise people with the existence of warning services and their relevance.

## 7 CONCLUSION

One of the frustrations of flood management is that flooding often creates damage and hardship which appear, in retrospect, to have been at least partly avoidable. Too frequently it has seemed that better warnings and better communication of them would have increased the level of community understanding of a coming flood and therefore generated the appropriate behaviour modifications to create effective mitigation against its effects. In some areas, high quality flood warning procedures have existed for some time but in others this is not the case. A 'how-to' manual outlining best practice, properly sold to those responsible for producing and disseminating warnings, must help to discipline the process and raise standards of warning for flood liable areas throughout the state.

**Disaster Prevention for the 21st Century, Proceedings of the Australian Disaster Conference, Canberra, 111-16, 1999.**