UPGRADING PRACTICES IN THE FIELD OF FLOOD WARNINGS

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1 SUMMARY

This paper traces the development of flood warning systems in New South Wales from their nineteenth century origins to the present day. It suggests that in the modern era there is a widespread but mistaken belief that flood warnings are synonymous with flood height predictions. Such predictions are, of course, vital to effective warning systems, but equally vital are local appreciations of the consequences of flooding at the predicted heights, advice on how people should cope with the coming flood, and means of ensuring that the warnings are actually received by those who need them. Unfortunately, these elements of the optimal flood warning system are not equally well developed in New South Wales. Flood intelligence systems exist in only a rudimentary state in many flood prone areas, and warning messages do not always assist people in their responses to flooding. Moreover, warnings often fail to reach those who could benefit from them. Recent initiatives designed to rectify these problems are outlined.

2 INTRODUCTION

A generation ago, flood warnings constituted only a relatively minor part of our efforts to mitigate the effects of flooding. Flood mitigation was largely about engineering works - levees, river diversions, dams, retarding basins and the like - and significant sums of money were spent on structures designed to keep flood waters away from locations in which investment was concentrated. Non-structural approaches - those intended to adjust people and their activities to the inevitability of flooding as distinct from modifying water behaviour - were by comparison ignored or left in a partially-developed state. As a result the vast bulk of the $375 million (measured in 1991 terms) that were spent on flood mitigation in New South Wales between the 1950s and the early 1990s went to structural works of one kind or another (Clarke, 1991).

But in recent times there has been a steady shift away from a concentration on physical or engineering works towards a **balance** of structural and non-structural approaches. Flood mitigation, nowadays, is based on a wide range of measures and on the principal of **managing** floods rather than controlling them (see Crabb, 1982; Smith and Handmer, 1984). Thus land acquisition measures, zoning and building regulations, forecasting systems and flood planning are increasingly being utilised in the fight to contain the high costs which flooding incurs.

So non-structural measures are becoming more important. In addition, the **mix** of these measures is undergoing change as individual devices are developed and fine-tuned with experience and new knowledge. One area in which particularly rapid change can be foreseen relates to **flood warning systems**. Over the past two years, considerable effort has been expended in Australia to redefine the purposes and techniques of warning about floods and to develop better ways of transmitting warnings to communities which are about to be affected by flooding. The way ahead is becoming increasingly clear, and we may expect considerable change in practices relating to flood warnings over the next few years.

3 THE DEVELOPMENT OF FLOOD WARNINGS IN NEW SOUTH WALES

To all intents and purposes, flood warning activity in New South Wales began during the late nineteenth century on the Murray and Darling rivers. So-called 'flood signals' - daily river height bulletins - were passed by telegraph, newspapers and eventually radio to the masters of steamers plying the waterways. The height data they provided was of great value in determining river navigability and in working out loading regimes for ships, as well as in indicating to river-side communities when floods were on their way.

On non-navigable rivers, too, warning systems evolved to alert people to the likelihood of flooding problems. The Mandagery Creek, in the state's central west, was a case in point. There, a system developed during the 1930s in which upstream flood heights were telephoned to a post office at Murga where they were used to form predictions of the likely height downstream at Eugowra (a town situated on the floodplain of the creek near its confluence with the Lachlan River). These predictions were transmitted by car or telephone to shopkeepers and the local police, and when particularly serious floods were imminent the police organised doorknocks in the streets which were expected to experience inundation. In other areas, local flood warden systems (which grew out of the air-raid warden systems of World War II) were set up to pass the message.

Such informal local community systems, organised by and for local valley residents, developed in various parts of the state. Their characteristics reflected local needs, local resourcefulness and local expertise, but invariably the key people involved in them were farmers (the usual gauge readers), postmasters (who controlled the telephones) and policemen. In the Hunter Valley, for example, flood warnings were passed downstream from police station to police station - from Scone to Muswellbrook to Denman to Singleton and eventually to Maitland. In time, some of the people involved in these warning systems became highly knowledgeable about their rivers and developed considerable expertise in predicting river heights and flow times despite their lack of formal training in hydrology.

Science, too, played a role, although initially the performance of that role was quite separate from the local community systems. From its earliest days in the first decade of this century the Office of the Commonwealth Meteorologist was responsible for displaying 'flood signals', and before long it was issuing generalised flood warnings with its daily weather forecasts. After the great floods of the mid-fifties, the system was greatly refined as a result of a government decision to establish a specialist Hydrometeorological Service capable of providing systematic flood forecasts. This service, set up in New South Wales in 1957, led to the development of height-predicting warning systems based on hydrologic modelling - initially for coastal rivers but spreading gradually to encompass all the state's rivers and many of their larger tributaries. Networks of rain-gauge and river-gauge readers were set up and telephone telemetry was progressively incorporated. By the late 1980s, radio-telemetered ALERT gauging systems were being established on some of the faster-responding coastal rivers. By this time, too, the Bureau of Meteorology flood warning service had been linked to or had absorbed the local community-based systems developed in earlier times (Brown, 1986).

Meanwhile, co-operative arrangements were developed between government agencies to facilitate the exchange of hydrological data and expertise and the transmission of height predictions to communities in the path of flood waters. The Public Works Department and the Water Resources Commission (later Department) owned gauges and some of their personnel had been trained in hydrology, and the State Emergency Services and the Police became involved in the promulgation of warnings. By the middle of the 1960s, the Bureau's predictions were being sent by telegram and telex on a regular basis to SES regional offices and to the leaders of volunteer SES units as well as to radio stations broadcasting to areas expected to be flooded. This arrangement was formalised in the early seventies by the signing of the New South Wales Flood Warning Plan which laid down the procedures to be followed by the Bureau of Meteorology and the SES. Broadly speaking, this Plan in its various editions guided the development and promulgation of flood warnings for the next two decades before it was refined and updated in the New South Wales Flood Plan in 1991.

4 A CRITIQUE OF FLOOD WARNING PRACTICE

The flood warning systems which have developed in New South Wales focus, in general, on two elements - the heights which rivers will reach at specified locations and the dissemination of those heights to the communities which will be affected by the flooding. Of these elements, height prediction has received by far the bulk of the attention and investment to the extent, in fact, that the forecasting of flood heights is sometimes considered to be the **whole** concern of flood warning systems. The systems themselves, accordingly, are conceptualised as belonging solely in the mechanical, technological and computing realms and comprised entirely of gauges, models and computer software. Given this mindset it is hardly surprising that solutions to the problems of flood warning systems are usually seen in terms of the installation of improved gauging systems (for example, ALERT systems to replace telephone-telemetered and manually read gauges) or the development of improved height-predicting models.

Progress in the realm of height prediction is, of course, important. But there are other facets of existing flood warning systems to which attention must also be paid. In some of these, current practice remains relatively primitive and in need of considerable rethinking. Fortunately, reforms are possible, and generally without massive investment being necessary.

A first prerequisite for an upgraded flood warning system is a recognition that it involves more than height predictions and their transmission. A flood warning system is best thought of holistically as including a large number of elements - meteorological forecasting, rain and river gauges, gauge readers, the transmission of data to a modelling point, the production of height predictions from hydrologic modelling, appreciations of the community consequences of flooding at particular heights and means of ensuring that flood forecasts, information and advice are effectively transmitted to communities about to experience flooding and properly understood there. Viewed this way, flood warning is a matter not only of machinery and science but also of flood interpretation, communications and community education.

Present-day warning systems are quite sophisticated in terms of the science and technology used to produce height predictions. Errors will occur, of course, but evidence from a recent Flood Warning Consultative Committee survey of the responder organisations which receive predictions from the Bureau of Meteorology suggests a considerable degree of satisfaction with their quality. Most SES and Council organisations rate them as being very important both as alerting mechanisms when a flood is on the way and as determinants of response actions.

Our warning systems are less sophisticated, though, in the ways in which they use the predictions to inform the public about coming floods and what can be done to mitigate their effects. In large measure this is because the organisations empowered to add to the Bureau's predictions are highly response oriented and have traditionally accorded preparedness and communications issues a lower priority than matters more directly related to flood response. Developing appropriate methods of informing the community about what the forecast heights will actually **mean** to people is a key task to which more attention will have to be given.

The real purpose of flood warnings, after all, is not the passing of predictions of river heights but to help people to cope more effectively with flooding. That being so, it is important that warnings are communicated in ways that are readily understood and which can therefore elicit appropriate hazard-mitigating behaviours. To this point in their development, most flood warnings fall short of the ideal because they fail to transmit the real meaning of an oncoming flood to the communities in its path and because they provide little by way of suggestions as to what should be done to reduce the costs and damage which will be incurred. The focus on the prediction of river heights has not been extended to a full consideration of the **effects** on the community of flooding to these heights or to the provision of **advice** on how to cope with it. Nor can it be said that sufficient emphasis has been given to the problem of ensuring that warning messages actually **reach** the people who are likely to be affected by flooding. It is to these facets of the more user-friendly flood warning systems of the future that we now turn.

5 FROM FLOOD HEIGHTS TO FLOOD INTELLIGENCE AND HELPFUL ADVICE

The flood warnings issued by the Bureau of Meteorology may be either qualitative or quantitive in nature: that is, they indicate the anticipated severity of the flood at a location by referring to a **broad class** of flooding (minor, moderate or major) or a **gauge height** (measured in metres and centimetres) which the water is expected to reach. How useful these predictions are to response organisations like local councils and SES units, or to the wider community, varies widely from area to area. In some cases they are well understood by these clients and assist them to develop appropriate responses to the oncoming flood. In others, the predictions have little meaning to potential client groups and as a result their utility is relatively small.

When a flood prediction is received from the Bureau, the initial task of the responder organisation should be to give **meaning** to it. To do this effectively, responders must bring local knowledge to bear so that the likely **consequences** of the anticipated flooding can be understood in the community. Absolute precision is virtually impossible to obtain in these matters, but in most cases the development of local intelligence systems has the potential to improve significantly our knowledge of the impact of floods.

Determining what will happen before the predicted flood arrives amounts to 'adding value' to the Bureau's prediction. Prior understanding of the probable consequences of flooding to a particular level will be helpful in assisting response agencies to develop effective strategies in combating the effects of the flood, and in constructing messages likely to promote appropriate responses by individuals and households. For people about to be affected, the message might be as follows: "At the predicted height A, B and C are likely to happen and accordingly residents should do X, Y and Z." The advice might be to avoid particular roads, stock up on food and other essentials, lift furniture or prepare to evacuate.

Present practice in developing locally-relevant interpretations is highly variable. In some areas, especially those with a history of frequent and severe flooding, an impressive bank of information has been developed to describe what has happened in past flood events and both the responder groups and the public at large are well educated about floods. In many other communities, though, response agencies and the public have only limited understandings of what has happened in floods reaching particular heights in the past and therefore of what would be likely to happen if such heights were attained again. At best, in some cases, knowledge is held in the minds of a small number of responders who have seen many floods but who have never appreciated the need to record their knowledge systematically. Questions about where flood waters go at particular heights and what happens as a result (which houses experience over-floor inundation, which properties become isolated, which special needs groups are placed at risk, which roads are closed, which public utilities are affected and to what degree) are, it seems, dealt with on a rather haphazard basis.

The survey of responder organisations carried out by the state's Flood Warning Consultative Committee revealed that many councils and SES organisations collect data on such things as road closures, peak heights recorded, hydrographs and the like, but that the collection is generally unsystematic. Certainly it does not appear to be directed towards sharpening future response efforts or providing improved information to people on what is likely to happen at their particular location when a flood is approaching. In other words, information is assembled during flood episodes but is not effectively **used** to upgrade responses to later floods or communication with the community during them.

To rectify this problem, the State Emergency Service has embarked upon a project to develop information systems for the state's flood prone communities. These systems will be designed to collect data during floods and to convert it to intelligence which will be of value in upgrading flood warnings and improving operational decision making in future events. Many sorts of information could be incorporated in such systems. For a particular reference gauge in a community, the following would be of value:

- A map showing the boundary of the area to which the gauge refers - that is, the area for which gauge heights have meaning in terms of riverine flooding independent of flooding from tributary creeks, surcharging drains or other local sources.

- Gauge heights at which flood waters begin to encroach, within this area, on:
  Farmlands and other rural properties
  Low points on roads and railway lines
  Caravan parks
  Houses
  Business and industrial premises, and
  Utility systems (water, power, gas, electricity, telephone and sewerage).

- The depth of water at specified locations (for example, low points on roads) when particular gauge heights are reached.

- Descriptions of the severity of community impact at particular gauge heights so that 'critical levels' can be determined at which responses of particular types and intensities will become necessary. This would include information on particular institutions (schools, hospitals, homes for the aged, and the like) and on the number of people who would need to be evacuated.

- Information on the features of particular floods (including rate of rise, flood gradient, speed of flow, the contributions of individual upstream tributaries, weather conditions, tidal states and correlations with upstream gauge heights). Over time, as intelligence systems are built up, such data will allow responders to develop pictures of the range of flood behaviours and impacts which can occur and of the ways in which individual flood episodes may vary from one another and from any general norm.

The development of flood intelligence systems will involve considerable work for SES personnel, and in many instances council assistance will be needed in the surveying of floor levels and the production of inundation maps for floods to different gauge heights. Some SES units have already made significant progress in the creation of such systems and have developed their own manuals and flood intelligence cards (see Table 1). Others will soon be capable of using Geographic Information Systems and computers to assist them in the interpretation of height predictions. With presently available software such as MAPINFO it is possible to build maps on a computer to show the locations of creeks, streets, utilities, property boundaries and contour and flood lines. Once critical levels are surveyed - for example low points on roads or floor heights of buildings - it will be a simple matter using such a system to feed in a Bureau of Meteorology prediction and obtain a picture of the likely extent and consequences of an impending flood which reaches the forecast height or indeed any other level.

In the 1990s, the development of flood intelligence systems using computer technology is likely to become more common. However, because there are likely to be problems related to resources and to the availability of appropriately skilled personnel in response agencies, it will be necessary to begin the task of system development using manually-based tools such as flood information cards.

Most SES units have some of the basic data to carry out this task, but particularly in the small towns of non-metropolitan New South Wales there remains some way to go before such systems are capable of providing real assistance to flood response and flood warning efforts by pinpointing, in detail and in advance, the likely locations and degrees of flood impact.

6 TOWARDS IMPROVED COMMUNICATION OF WARNINGS

Improved flood intelligence provides a means of translating height predictions, which by themselves may mean little in the community, to statements about effects which will generally be easily understood. This information can be added to warnings or flood bulletins in whatever detail is appropriate. To be useful, however, it must get to those people who need it. Generally this will not be a problem for responder organisations, which are formally integrated into flood warning systems, but there are real difficulties in ensuring that the warnings get to the public in general.

The minimalist approach is the one that forms the basis of current flood warning practice: flood warnings and bulletins are transmitted by the Bureau of Meteorology and/or the SES to radio stations which then broadcast the messages to their transmission areas. In some cases - those involving only minor or localised flooding, for example - this may be sufficient. But in others, particularly when the coming flood is likely to have serious consequences or affect a large number of people, such a limited approach is likely to be inappropriate. Radio is now highly fragmented as to markets so that individual stations, commanding only small proportions of community listenerships, may not be capable of bringing the warning messages to many who need to hear it.

The solution is not to ignore radio as a dissemination tool, but to seek depth and flexibility by developing **other** means of communication as well. Precisely what these are will depend on the nature of the impending flood - in particular its likely severity and the lead time available before it begins to have an impact on communities in its path - and the nature of the communities themselves. But there is a wide range of possibilities, including some which are relatively **remote** from those who need the warning and some which offer the opportunity to target the warning **directly** to individuals or families likely to be at risk.

A rarely used ‘remote’ medium which might nevertheless be more useful than has generally been believed in the past is television. During February, a middle-of-the-night flood episode on the Moruya River prompted an experiment in which the SES sought to transmit flood warnings by means of messages pulled across television screens. Channels WIN, Prime and Capital, all of which are seen in the town of Moruya, were contacted late at night, without prior notification, and asked to run ‘crawlers’ or ‘pull-throughs’ to inform the people of Moruya about the coming flood which appeared likely to have a serious impact on the town’s main business district. All three stations were supportive and helpful, and hurriedly constructed messages were put to air. Despite the lateness of the hour (after midnight) it appears that the messages were seen by many -

largely, probably, because the Winter Olympics were in progress at the time. Numerous people phoned the Emergency Operations Centre seeking further information and advice. Outstanding co-operation was received from station executives, the messages were free and the evidence was that they were seen, understood and acted upon - despite the unfavourable time of night.

As a result of this experiment, SES divisional personnel are being encouraged to make contact with TV stations serving their areas to reach agreement on the carriage of warning messages in future flood events. Such agreements, reached before flooding occurs, will obviate the need to negotiate with management during the development of a flood. They will also allow the general formatting and content of messages to be spelled out beforehand and permit discussions on the desired length of messages, the optimal frequency of carriage, the duration of carriage and the like. Preferably, the messages should be short - probably of the order of fifty words at most. As far as possible within this severe limit, they should mention the expected peak height (if it is known) and the timing of the peak, identify the areas likely to be inundated, compare the event with a recent flood of comparable severity and note the kinds of responses which would be appropriate. Not all of these were included in the Moruya case which was, of course, put together in great haste.

Another, less remote method of delivering flood warnings is to use a police vehicle equipped with a public address system and moving through streets or along rural roads broadcasting an emergency message. This approach will soon be able to be complemented by the inclusion of the Standard Emergency Warning Signal - a custom-designed oscillating wail with beeps embedded in it - which has been devised to alert people to the message which will follow its playing.

Less remote again is the use of 'telephone trees' in which a message is communicated to an individual or a small number of people who contract to pass it on to others. This method is especially valuable if a relevant organisation can be found to give it carriage. At Moruya, because the principal effect of the flooding was expected to be the inundation of parts of the business district, the secretary of the Chamber of Commerce was used as the principal disseminator. Again, the strategy proved effective, with several businessmen leaving their homes to lift stock above the reach of flood waters. But one difficulty with the use of warden-type systems such as these relates to the problem of maintaining message accuracy and credibility: in the Moruya case, the expected flood height became exaggerated in transmission and unnecessary responses were generated.

The use of telephones to pass warnings is not uncommon in this state. At Bomaderry, the Shoalhaven City SES provides a service of this kind to a small number of industrial firms located on the floodplain of the Shoalhaven River. A similar procedure is followed at Inverell, where the SES maintains a list of phone numbers of premises in the main business district. These are grouped by elevation and when a flood is approaching, the managers or owners are called (at work or at home, depending on the time of day or week) and warned as appropriate according to the height prediction. Agreements such as these are relatively common but could be more widespread yet.

Care must be taken in these situations, of course, to avoid overloading the SES unit. A requirement for the unit to telephone a large number of people could occupy telephone lines which may be needed for operational purposes and divert trained volunteers from their primary task. Council or other community assistance in the delivery of warnings may be necessary.

The most direct method of delivering warnings, of course, is by doorknocking. In most cases of flooding in urban areas the number of dwellings or businesses affected is not large and doorknocking should therefore not become prohibitively difficult in terms of labour demands. Moreover it is difficult to find a superior method simply because it targets so effectively and because it generates other information of value in developing responses (for example, information about those who might need help from emergency service volunteers). Ideally, doorknocking should occur in any situation in which evacuation might be necessary, and it can be justified in other circumstances as well.

What is being suggested here is the conscious building of a **range** of communication strategies to ensure that the warnings get through and are understood. The electronic media will still need to be used, but making greater use of telephones and doorknocks will allow a more personalised and direct provision of warnings and reduce the current over-reliance on radio. In essence we need to re-create the old warden-based systems and utilise the electronic media as adjuncts to them. What has happened in recent decades is that radio has been relied upon more and more, with the consequence that the old-style but effective warden systems have fallen into disuse. The recent evolution of the Neighbourhood Watch organisation indicates what is possible here.

One of the uses of doorknocking is in bringing relevant information to residents, business people and others. At present the SES is designing a flood action card suitable for delivery in the usually short period between the issuing of the initial warning and the arrival of flood waters: the actual delivery could be carried out using service club members, scouts, Neighbourhood Watch co-ordinators, emergency service workers or whoever else might be considered appropriate by the Local Emergency Management Committee. The card itself will provide advice on how to respond to warnings and what to do if inundation appears likely or evacuation becomes necessary. In essence, this card will seek to take advantage of the fact that warnings can arouse awareness and weaken psychological defences such as denial of the existence of a flooding problem (Handmer, 1990). The time between the issuing of a warning and the arrival of a flood constitutes a 'teachable moment' (Filderman, 1990) which a combat agency would be unwise to ignore.

7 CONCLUSION

The optimal flood warning provides an accurate and timely prediction of the height the water will reach and does so in a way which will be readily understood by those who will be affected by the flood. Moreover it ensures that the message will get through and that people are given appropriate advice as to the coping strategies they should follow. In New South Wales, flood warning practice tends to fall short of this high standard. While the prediction service provided by the Bureau of Meteorology is more than adequate, the need to develop other elements of the system in tandem with the predictions appears not to have been fully understood. As a result, the development of flood intelligence records has been retarded, appropriate measures to ensure the warning gets through are not always followed and the warning messages do not always provide appropriate advice on mitigating the effects of the coming flood.

Part of the problem has been that height prediction is sometimes believed to be the **whole** purpose of flood warning. That being so, it is not surprising that solutions to the deficiencies of such warnings tend to be sought in terms of technological fixes - that is, improved gauges and better models - which may lead to more accurate and more timely estimates of river heights. But it can be argued that the real weaknesses of the flood warning system lie elsewhere, especially in the ways in which height predictions are utilised and transmitted. Currently, the State Emergency Service is seeking to reform the system so that height predictions are made more meaningful at the level of the local community and useful advice on coping strategies is provided. At the same time, efforts are in train to ensure that the warning messages are more effectively targeted and that they actually get through to those who will benefit from them. The goal must be to ensure that flood warnings are made more user-friendly and user-helpful than they have been in the past.

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TABLE 1: FLOOD INTELLIGENCE CARD

GAUGE NAME: Windsor Bridge **AWRC NO:** 212903

RIVER/STREAM: Hawkesbury **LOCATION:** Windsor Bridge

DATUM:

<u>Key Heights</u>

1. Minor: 5.8m	2. Moderate: 7.0m	3. Major: 12.2
4. Danger:	5. Critical:	6. Levee: N/A

HEIGHT	DATE	REMARKS
6.0		Gronos Point isolated. Abt 30 houses (70 people) and a permanent c'van park, population of abt 60 families, can be affected at hts between 5.8 and 12.2m. These are located at Agnes Banks, Cornwallis, Gronos Point, Freemans Reach lowlands, Pitt Town Bottoms and some river bank areas downstream of Pitt Town.
7.0		Water starts crossing bridge deck.
8.0		First evac occurs - at Cornwallis.
8.2		Decide whether to evac Windsor sector if CPL type flood predicted.
9.6		Decide whether to evac Pitt Town sector (34 people) if CPL type flood predicted.
11.0	Feb 1992	Flood peak.
11.2		Decide whether to evac McGraths Hill if flood predicted to exceed 13.0m.
12.0		Electricity supplies fail progressively up to a height of 20m. 15-20 houses evacuated in low lying areas of Riverstone (Blacktown LGA) due to backup flooding in South Creek system.
12.1		Macquarie St cut under railway line.
12.5		All gas supplies fail to Windsor area.

13.0		Windsor Rd cut at Curtis Rd. This affects evac route for McGraths Hill.
13.3	Aug 1990	Flood peak
13.5		Up to 50 houses evacuated in low lying areas of Riverstone (Blacktown LGA) due to backup flooding in South Creek system.
13.7		Richmond/Blacktown Rd cut near South Creek.
15.0		Electricity supplies cut progressively to McGraths Hill. George St cut south of Rifle Range Rd.
15.5		Telephone services begin to fail.
16.0		Current Planning Level (CPL). 860 houses (2580 people) to be evacuated from Windsor sector. McGraths Hill isolated and almost completely inundated - 520 houses (1560 people) to be evacuated before this ht reached. 195 people to be evacuated from Wilberforce sector.
17.1		Junction of George St and Richmond/Blacktown Rd cut.
19.1	1867	Flood of record. 450 people to be evacuated from Wilberforce Sector. 4650 people to be evacuated from Windsor Sector. 450 people to be evacuated from Pitt Town Sector.

AUTHOR PROFILE

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Two years ago he entered the emergency management field with the SES, taking on responsibilities in the fields of flood warning systems and flood preparedness planning. He is also interested in response management, hazard education and the identification of disaster-vulnerable groups.

ABSTRACT

Flood warning systems have a long history in this state, going back to the river-height bulletins of the nineteenth century and the formation of the early local flood warning associations. Nowadays, flood warnings are grounded in sophisticated hydrological modelling carried out by the Bureau of Meteorology to produce predictions of flood heights at key gauges. There is a tendency in some quarters to believe that these predictions themselves constitute flood warnings, but in this paper it is argued that the predictions are merely inputs and that true flood warnings also give appreciations of where the water will go at the predicted heights and what can be done to soften the impact of flooding there.

To ensure that flood warnings are more than 'mere predictions', it is important that flood intelligence systems are developed in flood prone areas and that these are used in the provision of appropriate advice as to how people should respond once notice of impending flooding has been received. The SES is currently developing projects designed to guide the development of flood warning systems and also to ensure that all of those who are likely to be affected by a coming flood are warned about it beforehand. The paper gives details of these projects.

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