Australian Government
Attorney-General's Department

Flood Preparedness

MANUAL 20

AUSTRALIAN EMERGENCY MANUALS SERIES

Flood Preparedness

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Australian Emergency Manual Series

The first publication in the original Australian Emergency Manual (AEM) Series of mainly skills reference manuals was produced in 1989. In August 1996, on advice from the National Emergency Management Principles and Practice Advisory Group the AEM Series was expanded to include a more comprehensive range of emergency management principles and practice reference publications.

The AEM Series has been developed to assist in the management and delivery of support services in a disaster context. It comprises principles, strategies and actions compiled by practitioners with management and service delivery experience in a range of disaster events.

The series has been developed by a national consultative committee representing a range of State and Territory agencies involved in the delivery of support services and is sponsored by the Commonwealth Attorney-General's Department.

Details of the AEM Series are available on at www.ema.gov.au

Australian Emergency Manual Series structure and content

Principles and reference manuals

Manual 2   Australian Emergency Management Arrangements

Manual 3   Australian Emergency Management Glossary

Manual 4   Australian Emergency Management Terms Thesaurus

Manual 18 Community and Personal Support Services

Manual 29 Community Development in Recovery from Disaster

Manual 15 Community Emergency Planning

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Foreword

This Guide is the result of a review of the original Australian Emergency Manual **Flood Preparedness** which was prepared in 1998-99 by a team of experienced flood planners from around Australia led by Chas Keys, then of the New South Wales State Emergency Service. The review was conducted by Andrew Gissing (Victoria State Emergency Service) and Chas Keys, with input from Allison Godber and Nicola Moore (Emergency Management Queensland), Bob Stevenson (South Australia State Emergency Service), Belinda Davies, David Webber, Catherine Moyle and Helen Halpin (New South Wales State Emergency Service), Fiona Dunk, Myles O'Reilly and Justin Murray (Victoria State Emergency Service), Mike Edwards (Victoria Department of Sustainability and Environment), Andrew Lea and Elke Browne (Tasmania State Emergency Service), Miriam Middelmann (Geoscience Australia), Neil Dufty (Molino Stewart) and Michael Cawood (Michael Cawood & Associates). All these people have considerable experience and expertise in various facets of flood preparedness.

The Guide is one of a series of manuals on flood management whose review was instigated and managed by the National Flood Risk Advisory Group, a sub-group of the Australian Emergency Management Committee. The project was coordinated by Major General Hori Howard of the Australian Council of State Emergency Services and made possible by the financial contributions of the Commonwealth Attorney-General's Department and the Australasian Fire and Emergency Service Authorities Council.

The Guide is designed for use by all those who have roles to play in preparing communities for floods, whether in lead or supporting agencies. These people will include emergency management practitioners and members of agencies and organisations that will be involved in flood response operations, including staff and volunteers in the State/Territory Emergency Service (S/TES) organisations which in most jurisdictions in Australia have a lead role in the management of floods.

The document is intended to provide broad guidance on all the important aspects of flood preparedness. It reflects considerable expertise developed over many years of flood planning and other facets of flood preparedness in the Australian states and territories.

Like the other documents in the Australian Emergency Manual Series (**Managing the Floodplain**, **Flood Warning**, **Flood Response** and **Emergency Management Planning for Floods Affected by Dams**), the Guide focuses on defining 'best practice' as this is presently understood in Australia. It does not seek to define or describe current practices, which may vary considerably between jurisdictions. Users will find it valuable to refer to the companion documents and to other documents in the Australian Emergency Manuals series.

Every attempt has been made to use neutral terminology. As a result the Guide does not use the specific terminology (for example in relation to officers, programs and management structures) or refer to the particular arrangements for flood management in the various states and territories.

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The Need for Flood Emergency Planning

In a Nutshell…

Floodplains have been developed by rivers and accordingly will be inundated by floodwaters from time to time. Flooding often has deleterious impacts on human activities and assets, but the damage that floods cause can be reduced by careful planning and management of floodplain use. The 'manageability' of flooding is enhanced by effective preparation for floods.

This preparation should be undertaken for all areas in which there is an interaction between flooding and human activities. It should involve purposeful planning for floods and the engagement and education of the members of flood-liable communities about flood risks and their management.

Flood emergency plans for particular areas should deal with the full range of types and severities of flooding which could be experienced. This includes noting the potential impacts of climate change and sea level rise.

It is necessary to determine in advance, as far as possible, what needs to be done when floods are developing and occurring. Flood-liable communities should plan now so effective actions are taken in the lead-up to, during and after the next flood.

Good flood emergency planning allows operations controllers to identify likely flood problems and proactively manage them. Without good flood emergency plans, operations controllers may be unable to identify flood problems clearly and they will be forced to react to problems as they develop without an appreciation of the most effective means of their management.

Flood preparedness also involves the engagement of the members of flood-prone communities. This engagement is necessary so that individuals understand the need to make their own preparations for flooding and have the tools to do so.

The Flood Problem in Australia

Every year, despite the beneficial environmental impacts they create, floods impose substantial economic, social and environmental costs on Australian communities through:

- direct damage to residential, commercial, educational, recreational, cultural and industrial buildings,

- damage to infrastructure,

- damage to stock, equipment and facilities (for example farm animals, machinery, commercial stock and records and other contents of buildings),

- indirect losses due to disruption of economic activity, both in areas which are inundated and in areas which are isolated,

- stress and anxiety in those affected by flooding,

- injury and death,

- polluted water supplies, and

- damage to wildlife habitats.

In terms of economic costs to the community, flooding is Australia's most damaging natural hazard. Expressing in 2009 terms the costs estimated by the Bureau of Transport Economics (2001, p35) for flooding in Australia between 1967 and 1999, floods cost approximately $420 million per annum on average. Other sources put the average annual damage at rather higher levels when estimates are expressed in current dollar terms (see, for example, Standing Committee on Agriculture and Resource Management, 2000, p xi).

In most years, a small number of deaths occur as a consequence of flooding in Australia and there have been many cases of multiple deaths in a single flood episode. Between 1788 and 1996 at least 2213 people were killed by floods in Australia. Particularly lethal floods occurred in Gundagai (New South Wales) in 1852 (89 deaths), in the Claremont area in Queensland in 1916 (65 deaths) and in Brisbane and Ipswich in 1893 (47 deaths), but several other locations or regions have recorded more than 20 deaths in a single episode of flooding (Coates, 1996).

Large numbers of people in Australia live in flood-prone areas. Approximately 170,000 residential properties are susceptible to flooding in the 100-year ARI (Average Recurrence Interval) flood (Leigh and Gissing, 2006). The number of commercial and industrial properties liable to flooding within the extent of the 100-year flood is not accurately known but would likely be measured in the tens of thousands, and the value of the agricultural, industrial, commercial, residential and public assets that are at risk is very large as is the cost of repairing or replacing infrastructure damaged or destroyed by flooding.

Of course, many more properties, sources of productive activity and critical items of infrastructure would be affected in floods bigger than the 100-year flood. It is probable that the total value of the assets at risk in Australia in Probable Maximum Flood (PMF) events – the biggest floods possible – considerably exceeds $100 billion.

The 'Manageability' of Flooding

Flooding is a highly manageable hazard where the flood risk can be defined and appropriate emergency preparedness and mitigation strategies developed. Floods happen often in Australia and, in some areas, according to a regular seasonal rhythm. Their location is predictable and there is usually some warning of their occurrence. Often it is possible to determine who will be affected and what problems will be encountered as far as warning, evacuation, property protection, rescue, resupply and other functions are concerned. Much can therefore be known about a flood and its likely consequences before it occurs. Because of this, the opportunity exists to work out in advance (ie to plan) how a flood can be best managed in the interests of maximising public safety and minimising property and other damage. This allows for the investment of money and effort in the management of flooding.

To reduce the negative impacts of flooding, many measures have been devised to help communities adjust to and live with the flood hazard. These measures have included:

- constructing levees, flood bypasses, channel improvements, detention basins and flood mitigation dams,

- instituting land use controls (such as zoning and the removal of existing buildings) and building restrictions (such as establishing minimum floor levels and raising buildings) in relation to development on flood-prone land,

- developing warning systems,

- developing response and recovery capabilities, and

- encouraging community understanding of both the flood threat and the means by which people can manage it.

While these measures rarely remove the flood risk entirely, they can modify the characteristics of flooding, alter communities in ways that reduce the impact of floodwaters and provide mechanisms that enable communities to cope better with flooding. For more detail on these measures, see Annex B of the Australian Emergency Manual **Managing the Floodplain**.

Preparing for floods through flood emergency planning, exercising and community engagement enables a proactive response to flooding to be developed. Without preparation, flood response would become primarily reactive, reducing the opportunities to respond in the optimal time frames and with maximum efficiency through warning, evacuation, rescue, property protection and other activities. The most effective flood responses are likely to be those which have been thought about and planned for in advance. Preparing properly for floods, therefore, is likely to result in increased public safety, reduced property damage and faster community recovery.

Setting the Scene

The central purpose of flood preparedness is the building of community resilience against the flood risk. This involves the agencies and organisations charged with the management of flooding, but also the people who live, work or have other interests in flood-prone areas. For flood preparatory initiatives to be effective, agencies, organisations and people must be engaged. Procedures must be developed to address the actions which will be carried out by specified agencies and organisations, but they should also deal with building the readiness and ability of people in flood-prone communities to manage their own interests when flooding occurs.

Much of the work of flood preparedness involves the development of flood emergency plans, often at different jurisdictional levels (eg local, regional and state). A flood emergency plan is often defined as a statement of intent containing an agreed set of arrangements which define the framework for the control and coordination of a flood emergency. In essence a flood emergency plan is a script detailing the progression of emergency management functions and identifying the parts each actor must play. In short, it is a 'record of intended proceedings'.

But flood emergency planning should go beyond the development of arrangements for dealing with actual episodes of flooding. It should also incorporate the activities which will be need to be developed to raise the consciousness of members of the community as far as the flood risk is concerned and to build people's ability to respond effectively in their own interests to floods.

Flood emergency planning seeks to define the roles and responsibilities of the agencies that are involved in flood management. It also outlines appropriate strategies for the carrying out of key flood management functions. Flood emergency plans consolidate working partnerships between key management agencies by ensuring that each agency listed within a plan understands and agrees to its responsibilities. Flood emergency plans should also consolidate partnerships between agencies and the members of flood-prone communities.

The scope of flood emergency plans must be holistic, by ensuring arrangements exist for coordination across the management elements of prevention, preparedness, response and recovery. Considering all these elements ensures the minimisation of the effects of flooding on the community and enhances the ability of the community to recovery from floods. Plans should also address the full range of possible flood **types** and the full range of possible **severities**, from minor or nuisance floods to events of PMF proportions where these have been established.

The interaction between a flood emergency plan and any floodplain risk management plan for an area is important and it is vital that the two documents are consistent in content. This will help ensure management of the flood risk is carried out in a holistic fashion and without confusion.

Assessments about the level and focus of the planning should be made using an emergency risk management approach incorporating formal hazard and community analyses to establish elements at risk and their associated vulnerability. These analyses will need to consider the physical characteristics of flooding in the area and the nature of the community and its assets. By adopting an emergency risk management approach, strategies can be determined as to how flood-affected communities can identify, analyse and treat their flood problems to provide solutions.

Flood emergency planning in Australia needs to note the likelihood that climate change will alter the nature of flood risk. It is becoming accepted that rises in sea level, which have already occurred and which are ongoing, will alter the flood regime in coastal and estuarine areas, making flooding both more frequent there and more severe in its impacts. Changes in rainfall intensity over much of Australia may also have the effect of making severe flooding a more frequent occurrence (Intergovernmental Panel on Climate Change, 2007).

This Guide

This Guide is not intended to be totally prescriptive and all parts of it will not be appropriate to every situation. However, it does outline a range of procedures from which individuals or organisations charged with developing flood emergency plans can select. The application of the Guide will ensure the best available management techniques have been considered in developing a flood emergency plan that will help those responsible for the operational management of floods.

The Guide sets out the means by which flood emergency planning should proceed and is thus intended to facilitate the development of such plans. The planning itself will help the community come to grips with the problems floods will create before they are actually encountered. It will do this by ensuring that management arrangements and solutions can be devised methodically and with appropriate consultation in an atmosphere free of the stresses which actual events create. The planning will also help, along with programs to educate people about their flood risk, to build the commitment of the members of flood-prone communities to managing 'their' floods when they occur. Flood preparedness includes providing people with the tools they need to stay safe and protect their interests.

Planning to handle threats is part of making sure community preparedness for those threats is developed and maintained so that community resilience is augmented. It is a fundamental principle of emergency management that communities which have thought about a problem and planned for it beforehand will be able to cope better than those which have ignored it and hoped it will never occur.

Understanding the Risk

In a Nutshell…

To plan for floods in an area requires a comprehensive understanding of the flood threat, the community and the nature of the interaction between them. Understanding the risk involves developing a knowledge of the flood hazard and its impacts.

There is a wide range of sources and types of information which should be examined. Flood intelligence, which summarises the impacts of flooding of different severities, is a critical input to the planning process.

Flood intelligence should be continually reassessed and kept up to date. This includes collecting intelligence during actual floods and recognising that the characteristics of floodplains and communities are subject to change, affecting the impacts of flooding and the nature of the required emergency responses.

Introduction

To plan for and respond to floods in an area requires a thorough understanding of the flood risk, the community and the nature of the interaction between them. Information about flood behaviour and its effects on a community is critical to effective flood management because it provides a basis for determining how response operations should be conducted.

This chapter focuses on how an appreciation of the flood risk can be achieved, using flood intelligence (sometimes referred to as flood information) about that risk.

Flood intelligence is the product of a process of gathering and assessing information to assist in the determination of the likely effects of a flood upon a community. These effects vary with the scale of flooding, and flood intelligence is typically presented in terms of the relationship between flood severity and flood consequences.

Understanding the Flood Risk

The process of flood emergency plan preparation begins with an analysis of the area's flood risk. This appraisal must extend to full consideration of the:

• sources of flood risk,

• potential elements at risk of flooding, and

• the vulnerability of the threatened community to flooding.

Typically the appraisal will involve identifying the **sources** of risk, their **likelihood** and the evaluation of **potential consequences** in terms of impacts on the community.

The first step in defining the flood threat to a community is to establish, from a range of sources, the nature and extent of flooding in the area. The collection, assessment and collation of material associated with past and potential future floods is essential to the development of an effective flood emergency plan. Information about flood behaviour and the consequences of flooding must be built into the planning process if operational decisions are to be soundly based and warnings targeted effectively.

Some agency must take responsibility for the development of flood intelligence.

Sources of Information

The development of a flood emergency plan should be based on information from a wide range of sources that can provide material on the temporal and spatial development of floods and their consequences. Both quantitative and qualitative information should be sought although it is desirable that plans be based on as much 'hard' data as possible. This is especially so for areas with a high incidence of flooding or an unusually severe flood problem, and for rare, large events.

Food-liable communities are repositories of information about floods and their impacts, and an effort should be made to tap into their experience and knowledge of the flood hazard. A record of community experience will improve the documentation of flood history in the area and can be used to make the prospect of flooding more 'real' to people. By itself, however, community knowledge will not be sufficient even if it has been built up over a long period. This is partly because people who have lived with and responded to floods over many years are likely to be constrained by their own experiences and may be unable to contend effectively with floods which differ from or are more severe than those they have witnessed. Larger floods than these people have witnessed will inevitably occur from time to time.

Other perspectives must be included. Engineers and hydrologists will be able to bring a scientific appreciation to the definition of the hazard and to the estimation of the potential consequences of flooding of different magnitudes. If the potential flood threat includes spills or releases from dams, or the failure of dams, the expertise of dam owners and/or dam safety regulatory authorities should be sought.

Specific sources of information on flood problems could include those listed in Table 1.

Table 1: Information Sources and Availability

Information Source	Available From
Flood studies	Councils, catchment management authorities, State Emergency Service, state/territory governments, libraries
Floodplain management studies	Councils, catchment management authorities, State Emergency Service, state/territory governments, libraries
Coastal zone management studies	Councils, State Emergency Service, state/territory governments, libraries
Dam-break studies	Dam owners
Levee studies	Councils, state water and floodplain management agencies, State Emergency Service, libraries
Historical records	Councils, catchment management authorities, State Emergency Service, media, historical societies, museums, community members
Flood mitigation design studies	Councils, operators of flood mitigation schemes
Road and infrastructure design studies	Road owners
Buildings, infrastructure and people, including census information	Councils, catchment management authorities, Australian government
Community experiences	Personal histories, newspaper archives

The online Australian Flood Studies Database (www.ga.gov.au), instigated and managed by the Australian Government, provides information on flood studies undertaken nationally.

Emergency planners should be consulted when flood risk and floodplain management studies are prepared to ensure that their information requirements are met.

Information on Flooding and its Impacts

Much of the information which can be tapped will relate to past flood events, but some sources will provide estimates for floods of severities not experienced in the usually relatively short period since record-taking began. The information sought should include:

- the **types of flooding** which could occur (eg riverine, dam failure, coastal storm surge, flash flooding and, if not defined as a separate hazard, tsunami),

- **physical and geographical characteristics** of the area, including:

- the shape and extent of the floodplain (ie whether it is wide, narrow, steep, flat, well defined with identifiable benches and escarpments, etc),

  - stream characteristics (whether the watercourses are single-channelled, braided, convergent or divergent, with steep or mild bed-slopes and escarpments, etc),

  - distance from, and relative elevation of, towns or other settled areas with respect to the river, creek, lake or sea,

  - any **bridges**, **embankments or other flow-restricting structures**,

  - the location and nature of any **flood mitigation or control works**, and

  - the location of any **dams**, their size, details of control structures and operating rules for releases, and any known physical or structural deficiencies or potential for failure under severe flood conditions,

- **land use**, ie whether the flood-liable areas are under rural, urban, industrial, commercial, service or infrastructure uses, and the changes that are occurring with time,

- typical **pre-flood conditions**, ie weather or synoptic conditions that usually precede or lead to a flood; and times (in terms of season or month) of greatest vulnerability to or likelihood of flooding,

- **impact and severity of flooding** as indicated by areal extent at particular heights at key or referable locations and in terms of velocity of flow,

- **impacts on the community**, including the extent of community disruption as defined by:

  - number and location of properties actually flooded in historic events (and to what depths), and whether the residents were surrounded by water or experienced access difficulties at various gauge heights,

  - number of casualties or deaths recorded in past events,

  - extent to which individuals and/or communities see themselves as vulnerable to flooding,

  - access difficulties and/or isolation including road, rail and airport closures and the length of time these extend, together with estimates of likely needs for resupply,

  - duration of flooding in particular areas, including the incidence of storm water back-up and/or entrapment and drain blockages,

  - extent of preparation (or lack thereof) in past events,

  - warning (or lack thereof) in the past,

- number and location of potential evacuees in floods of different magnitudes, and

- the extent to which lifelines (eg service delivery and infrastructure support) are vulnerable to flooding,

- the **frequency of flooding of different severities**, including how often rivers or creeks breaks their banks, cause roads/bridges to be closed, flood houses and necessitate evacuations,

- **output from specialist hydraulic/hydrologic analyses** of available data to define hydrologic characteristics such as:

  - the rate of rise of floods (eg rapid rise of the order of x metres per hour initially, then slow rise to peak) and their progress (eg areas first affected, incidence and location of 'shrinking islands', identification of low points on escape routes, etc),

  - the influence (and contribution) of stormwater on the speed of rise and progress of floods,

  - the significance (if any) of backwater effects,

  - water velocities and depths (including identification of areas where velocities and/or depths are likely to be high) and their impacts,

  - timing characteristics such as the time between rain starting/stopping and the river rising for the first areas being flooded, and the time taken for floods to travel between significant and easily-referable locations,

  - the duration of floods (eg the length of time the river stayed at its peak and/or above critical levels and the time it took to drain away),

  - sources of floodwaters (sub-catchment contributions), and where relevant,

  - tidal conditions at the time of the onset and peak of the flood and the impact of tidal fluctuations on river flood conditions,

  - analysis of available data to identify **causes of floods**, in terms of:

    - rainfall characteristics (eg depth, intensity, incidence of thunderstorms),

    - seasonal characteristics (eg unusually wet/dry, winter/spring), and

    - antecedent conditions (eg flood one week earlier, rain for preceding week).

- the **thought processes which people go through** and **the tasks community members will need to perform** when floods are approaching and occurring, together with estimates of the time needed to carry the tasks out. Such tasks may include:

- relocating livestock, equipment and records,

- raising or relocating furniture, memorabilia, documents and other belongings,

- stocking up on essentials before normal access to locations of supply is lost; and/or

- evacuating to safety.

This information on the nature of flooding in an area provides the basis for developing flood intelligence records and an increased understanding of the nature and effects of flooding.

Understanding the Community

The second step in defining the flood threat is to undertake an analysis of the threatened community. This involves establishing a community profile, identifying the elements at risk and their vulnerability. The profile should be regularly reviewed to capture demographic and other community changes.

Identification of Elements at Risk

After identifying the likely extent of flooding, it will be possible to identify the elements potentially exposed and any interdependencies between elements. During this process it is important to identify any flood-prone infrastructure and to analyse any indirect consequences upon the community and other infrastructure assets as a consequence of interruption to identified elements. Each element will have an associated vulnerability which will need to be identified.

Vulnerability of People and Institutions

Some members of the community are especially susceptible to flooding because of:

- **where they live** (eg on a floodplain close to a river, creek, lake or the sea; in low-lying areas that are easily inundated; or in floodways and flow paths where water velocities may be high), and/or

- **in-built personal characteristics** which affect their ability to protect themselves appropriately from or respond to flood situations (eg age, disability, or personal beliefs about flooding). Because of such characteristics, some people require special consideration in the planning process and special assistance when a flood threatens. Others are likely to be more resilient and able to cope with less external assistance.

Some communities, or parts of them, develop effective strategies to cope with flooding because of periodic or regular exposure to it. For example, many farmers are used to and adept at handling floods because of the problems which result from occupying highly flood-prone land. The frequency of inundation of rural land alongside rivers, combined with the losses which result if stock and equipment are not moved before floodwaters arrive, give farmers an expertise generated by learning from exposure to the hazard.

Not all people who live in flood-liable locations, however, are able to develop experientially-based strategies to ensure costs are minimised. Some are only occasionally threatened by flooding and, in a highly mobile society such as Australia, many people have been in their present locations for only short periods of time. As a result they are unlikely to have experienced flooding in their current environment and may be unaware of the potential for flood events. Equally, extended periods of time between floods can lessen the risks perceived by long-term residents, particularly when urbanisation obscures the appearance of floodplains.

It is possible, using population census data and other information held by councils and state agencies, to identify the potential number and location of people in an area (or the proportion of the community's population) with special needs or requiring additional support during floods.

In general, people who belong to the following groups may be considered especially susceptible to the hazards floods pose:

- **The elderly**, especially those living alone and/or frail, who are often unable to respond quickly or without assistance,

- **The poor** (ie those with low incomes, including the unemployed and others on pensions), who tend to lack resources which would give them independence of decision making and action,

- **Single-parent families**, **large families** or **families with very young children**: these may be characterised by unfavourable adult:child ratios making evacuation difficult,

- **Those lacking access to a motor vehicle** frequently need special transport provision to facilitate escape from threatening floodwaters,

- **Newcomers** (ie those resident in their communities for only short periods), who are unlikely to appreciate the flood threat and may have difficulty understanding advice about flooding. They may need special attention in terms of threat education and communication of warnings and other information,

- **Members of Culturally and Linguistically Diverse (CALD) communities**, who need special consideration with respect to the development of preparedness strategies as well as warnings and communications during flood events. Special attention may also be needed if actions which become necessary during floods offend cultural sensitivities,

- **The ill** or **infirm** who need special consideration with respect to mobility, special needs, medications, support and 'management' to ensure they continue to receive appropriate care and information, and

- **Those whose homes are isolated by floods**, creating a potential need for medical evacuation or resupply of essential items.

Knowing where the most vulnerable people are is important when allocating appropriate resources before, during and after flood events. It will make it easier to plan effectively for floods, particularly in the contexts of hazard education, the delivery of warnings and the management of evacuation.

Vulnerability also has a **psychological** dimension. Some people are prone to deny the flood risk or to be complacent about it, some are more likely to act purposefully when floods approach than are others, and some may react irrationally during floods. Aspects of this dimension can be identified in the process of gathering flood information from the community, and it can be explored in the process of educating community members about flooding and their management of it.

This could include information on:

• the level of apathy or complacency about flooding,

• the degree of uptake of advice on property-damage mitigation and evacuation,

• the reliance on local knowledge, and

• the level of participation in flood emergency planning activities (including community education initiatives).

While an understanding of the needs of individuals and households can be sought via demographic analyses, it is also necessary to take note of the needs of **critical facilities** and **institutions**. Schools, nursing homes, senior citizens' centres, hospitals, child care centres, caravan parks, hostels, libraries, art galleries, museums, gaols, sporting facilities, business districts and industrial areas located in flood-liable areas may require attention with regard to education about the flood threat and the provision of flood warnings. They may also need help with evacuation during floods. In all cases the potential impact of flooding should be made known to the relevant managers.

Identifying Vulnerabilities of Physical Structures

The vulnerability of physical structures potentially exposed to flooding must also be assessed. The following characteristics of structures can contribute to their vulnerability:

• **Construction type**: some building materials are more susceptible to flood damage than others. Some structures on floodplains may also be raised, reducing their susceptibility to direct flood damage. Raised buildings may, however, encourage occupants to shelter within them during floods, creating a risk that they may become trapped and require resupply or rescue,

• **Age**: older structures if not well maintained may be more susceptible to direct flood damage. There may also be heritage considerations with these structures and a need to identify them as requiring property protection measures,

- **Maintenance**: poorly maintained structures are more susceptible to direct flood damage, including structural failures, and

- **Degree of flood-proofing of structures**: some structures have specific flood-proofing measures (eg flood barriers) available to them. These may help to reduce direct flood damage to the structure and its contents.

Assembling Information During Flood Time

While most of the information and data referred to above comes from studies and reports and is extracted outside flood time, it is also necessary to collect information while floods are **actually occurring**. For example, information on the impacts of flooding at different gauge heights must be collected as a flood rises; if it is not, post-flood appraisals will have to rely on potentially inconsistent and inaccurate reports to build the store of data for use during later events.

It is also useful to record how people **acted** during a flood, for example in reacting to flood warnings, in property damage mitigation activity and in evacuation behaviour. Doorknockers providing warnings in the field will often be able to provide insights on these issues.

Flood consequence information can be gathered by recording observed impacts at particular locations at specified times. A hydrograph for the appropriate flood warning gauge will then allow the matching of consequences to flood heights. A flood intelligence collection sheet can be used to assist with this process: see Annex A for an example.

When collecting flood observations, it is useful to consider:

- video footage, photographs and remote sensing as useful ways of recording observations. Note that the time and location of the imagery must be recorded,

- the recording of effects that are **not** occurring (for example, low points on roads which are not yet covered with water) as well as effects that **are** occurring,

- means of ensuring that all operational information is captured. Often valuable information is collected on whiteboards, but is lost when boards are cleaned. Photographs should be taken of the relevant boards or the relevant information scribed,

- having observers look, after floods, for debris marks which will provide an indication of flood depths and extent. Surveys of depth marks and flood extents can assist in the future calibration of flood models.

Flood intelligence collection during and after floods needs to be carefully planned **before** flooding occurs so that the observers can be trained and necessary equipment and resources assigned. If this is not done, it is likely that the information required will not be obtained, or unusable information will be collected.

Key equipment that observers require may include vehicles, personal protective equipment for flood conditions, flood intelligence collection sheets, pens, notebooks, cameras, watches, measuring tapes, maps, charts and Global Positioning Systems (GPSs).

For flood intelligence to be generated effectively, the collection of data to establish height/consequence relationships must be given a high priority. Appropriate resources must be allocated to the task and capabilities developed. Requirements will include the following:

- field personnel specifically allocated to data gathering,

- operations centre staff to record such data, and

- a capacity to debrief data collectors and operations staff (including doorknockers where applicable) immediately after a flood.

Presenting the Information

Having gathered information about the flood hazard and the community at risk, there are several ways to overlay it in order to maximise its value to planners. Potential vehicles of presentation include maps, flood intelligence records and Geographic Information Systems (GIS).

Maps and Geographic Information Systems

Most flood and floodplain risk management studies already include maps showing the extent of one or more historical events along with a range of design floods. As a first step the design flood contours could be equivalenced to levels at the reference gauge. This information is generally included in flood study reports. It is relatively straightforward to digitise flood extent information and overlay it with appropriate census and other community data, on topographic or cadastral maps.

Using GIS, the characteristics of flooding (in terms of such things as spatial extent and depth) can be depicted for specified design floods or to record historic events. An especially valuable application involves the creation of dynamic simulations of developing floods, illustrating the sequence by which areas are inundated (see Crowe et al, 2003) and allowing manipulations of time frames to illustrate the varying conditions under which decisions might have to be made during different flood scenarios.

Community information (eg the locations of vulnerable groups or individuals, evacuation routes etc) can then be added to maps as overlays. Coupled with a reasonable flood height prediction and other flood intelligence, such maps can greatly assist planning and response activities through identifying areas and community groups likely to be affected in various ways and to particular extents by floods of differing magnitudes. The information can be used to develop warning systems and procedures and to generate decisions relating to evacuation, resupply and other response tasks.

Further information on the use of GIS in flood management can be found in Chapter 4 of the Australian Emergency Manual **Flood Warning** and Chapter 3 of the Australian Emergency Manual **Flood Response**.

Because electronically-stored data is vulnerable to loss of power supply during emergencies, hard copies (ie paper maps) should also be kept.

Flood Intelligence Records

Flood intelligence records can be developed for the **reference area** around a stream gauge, both upstream and downstream. This is the area for which heights at the gauge have meaning in terms of riverine flooding, independent of local flooding or flooding from tributary creeks (for further detail, see Chapter 4 of the Australian Emergency Manual **Flood Warning**). The entries themselves should consist of the known or estimated heights at which phenomena such as the following occur:

- floodwaters encroach on specified farmlands, caravan parks, residential and business properties, community facilities, institutions (eg nursing homes and schools) and utilities (eg sewerage and water supply systems) Impacts at different locations can be indicated by map grid references,

- buildings are flooded over their floorboards,

- roads are cut, causing individual houses or communities to become isolated and traffic movements to be disrupted,

- railway lines are cut,

- airfields are inundated,

- other significant effects (including the overtopping of levees) occur or can be expected, and

- significant historic floods peaked, or particular design floods such as the 1% Annual Exceedence Probability (AEP) event or PMF would peak.

In compiling these records, care should be taken to:

- ensure that effects are correctly ascertained in a causative sense relative to gauge heights (ie things which happened, but which did not relate directly to specified heights being reached during a particular event, must **not** be recorded against those heights),

- note where an impact at a particular height at a gauge will occur only if some other effect, unrelated to that gauge, also occurs (eg a road being cut at a certain height, necessitating a longer journey on an alternative route between two places but with the possibility of all access being lost when this route closes as a consequence of flooding on another stream),

- ensure that effects are explicitly noted in terms of locations of impacts, roads closed to different classes of vehicles and properties affected in different ways (eg by inconvenience, if additional distance is added to journeys, or by complete isolation which may necessitate resupply, or by inundation), and

- keep detailed lists of affected properties, by type (residential, farm, retail, industrial, caravan park, etc).

It should be noted that virtually all flood intelligence records are **approximations**. This is because no two flood events at a location, even if they peak at the same height, will have identical impacts. The gradients of the floods may differ, the floods may be near their peaks for different durations, and the channel and floodplain environments in which they occur are unlikely to remain static.

The fact that height/consequence links are approximations (and in some cases may be **estimates** of likely occurrences) should not be of concern, however. Absolute precision in these matters is not necessary for effective planning to be undertaken. The alternative to imperfect information would be to have no recorded information at all on which to base operational decisions and construct warning messages. Where substantial known variability exists in the heights at which particular effects can occur, this can be noted by listing a **range of heights**.

Apart from recording height/effect relationships, the records may indicate specific actions which may need to be:

- **undertaken before specific heights are reached** (eg barricading a road which will be dangerous to travel on or closing drainage valves to prevent backwater flooding), or

- **completed in advance of floodwaters reaching particular levels** (eg moving farm animals before paddocks are inundated, evacuating people to safety before escape routes are cut, or removing electric motors from sewerage pumping stations to prevent submergence).

In such circumstances, indications of the **amount of time required** to carry out the required actions are particularly useful.

Recording heights against consequences and actions helps develop a forward planning tool for flood managers which allows them to look ahead to ensure responses occur at appropriate times. In turn, this will mean that actions which need to be undertaken are carried out when they can be done rather than when they are most needed to be done – which is often later than is preferable. Estimating the amounts of time needed to carry out these tasks will facilitate their successful completion.

An example of a flood intelligence card is shown in Annex B.

Developing the Plan

In a Nutshell…

The authority to plan, the scope of a plan and the integration of the plan with other documentation must all be defined and a clear planning process established.

Planning must be inclusive of the full range of agencies and organisations with flood management roles to play and of the community at risk. Broadly-based participation is essential.

Planning should cover the tasks expected to be carried out and should identify the agencies which will manage them.

Planning should identify solutions to the problems which will be experienced in carrying out warning, evacuation, resupply, property protection, rescue and other tasks. These solutions should be developed in relation to the full range of possible flood types and severities in the area and in relation to any special environments (eg flash flood environments, communities with levees and communities downstream of dams with identified deficiencies.)

The process of developing a flood emergency plan consists of the following phases: establishment of a project plan, establishment of a flood emergency planning committee, understanding the risk, developing strategies and arrangements, documenting the plan, implementing the plan and reviewing the plan. In most cases, Standing Operational Procedures (SOPs) will also be required to guide intended actions.

The planning process must go beyond developing actual planning documents. It must include agencies and the community accepting and endorsing the plans.

Introduction

The goal of flood emergency preparation is to lead, guide and build the community's response to flooding so as to maximise the safety of individuals, minimise property and infrastructural damage and ensure the community's effective functioning is maintained as far as possible and, where impaired, is restored speedily. To achieve this goal an ordered planning process must be followed. Planning must incorporate input from a wide range of interests drawn from the agencies which have roles to play before, during and after floods and from the flood-liable community itself. The most effective flood planning is shared with and engages the members of flood-liable communities.

The authority for the development of a formal flood emergency plan should be established and the document itself properly integrated with the emergency management arrangements which apply in the area for which it is written. A clear content and structure are required, together with a set of actions and procedures to ensure the document is kept alive, relevant to its task and accessible to and understood in the community.

As for any plan, there should be a vetting process whereby quality assurance can be achieved. Annex C incorporates a checklist to guide this process in relation to flood emergency planning.

Authority

For a flood emergency plan to be developed, some agency must have the authority or responsibility to undertake the process which will produce it. Authority will usually be established in legislation, where a 'lead', 'combat' or 'control' agency for the management of flooding may be identified, or in local emergency management arrangements which may allocate the planning task to a particular agency.

Authority is best vested in a single agency with access to expert advice, other stakeholders being required to assist. Ideally, the agency with the authority to plan should also be the agency with control responsibility when flooding actually occurs, and the agency charged with developing and maintaining flood intelligence. Such a clustering of responsibilities under a single key agency encourages the development of flood management expertise within that agency and maximises its ability to exercise leadership in flood management.

The agency identified has responsibility for leading and driving the process. This responsibility includes the requirement to develop an appropriate level of expertise in flood management itself and in planning to facilitate effective management.

Scope

No flood emergency plan can be effective without clear identification of its scope. This is best defined in terms of threat and reference area.

The scope of flood emergency planning will vary from area to area depending on the severity and complexity of the threat. Where the problem is serious and multi-faceted, the plan will need to address a wide range of preparedness, response and recovery issues and may need to include a long list of agencies with tasks to fulfil. The result, in such a case, may be a lengthy document.

Other areas, less severely affected, may require less detail in their flood emergency plans. In some areas where the flood problem is minor a free-standing flood emergency plan may not be necessary. In such cases flood management responsibilities could be discharged by recording general flood management arrangements in an annex of the relevant local emergency or disaster plan.

The Risk

The plan must make clear the **types** and **severities** of flood hazards addressed. Potentially, flooding may occur from:

- rainfall overwhelming the capacity of natural and artificial drainage channels (riverine and flash flooding),

- coastal storm surge,

- dam failure, and (if defined as flooding rather than as a separate hazard)

- tsunami.

This means the nature of the problem of flooding must be established along with the magnitudes of flooding which are to be addressed. Ideally the plan should deal with all types of flooding which could occur in the area and with magnitudes ranging from small to extreme events.

The Area

Flood emergency plans should be written for defined communities (for example local government areas, or combinations or parts of them). It may be desirable to divide the area to which the plan refers into sectors: this may be appropriate in situations where different parts of a community become cut off from each other when flooding occurs or to facilitate operational management in floods which have impacts over large areas or on large numbers of people.

Integration

Flood emergency plans should not exist as isolated documents. There may be flood emergency plans written for local areas, regions and states, and all flood emergency plans of whatever level or type need to be integrated within the appropriate emergency management structure for their individual areas of reference.

Some flood emergency plans will also need to be cross-referenced to other planning documents. Examples might be dam safety emergency plans or levee operation plans.

The Planning Process

The process of developing a flood emergency plan aims to produce a shared understanding of agreed arrangements between agencies. It is essential that all key agencies, local government and the community are involved in the planning process.

The process does not just produce a flood emergency plan. It forms an important learning exercise where participants become familiar with:

- the nature of the flood hazard(s) in the area,

- the nature of the community in relation to flood awareness, knowledge and expected flood responses,

- the roles and responsibilities of agencies and organisations within the area covered by the plan, and

- key strategies for prevention, preparation, response and recovery.

The planning process is continuous. The key steps in the planning process are shown below, with each step explained in the following paragraphs.
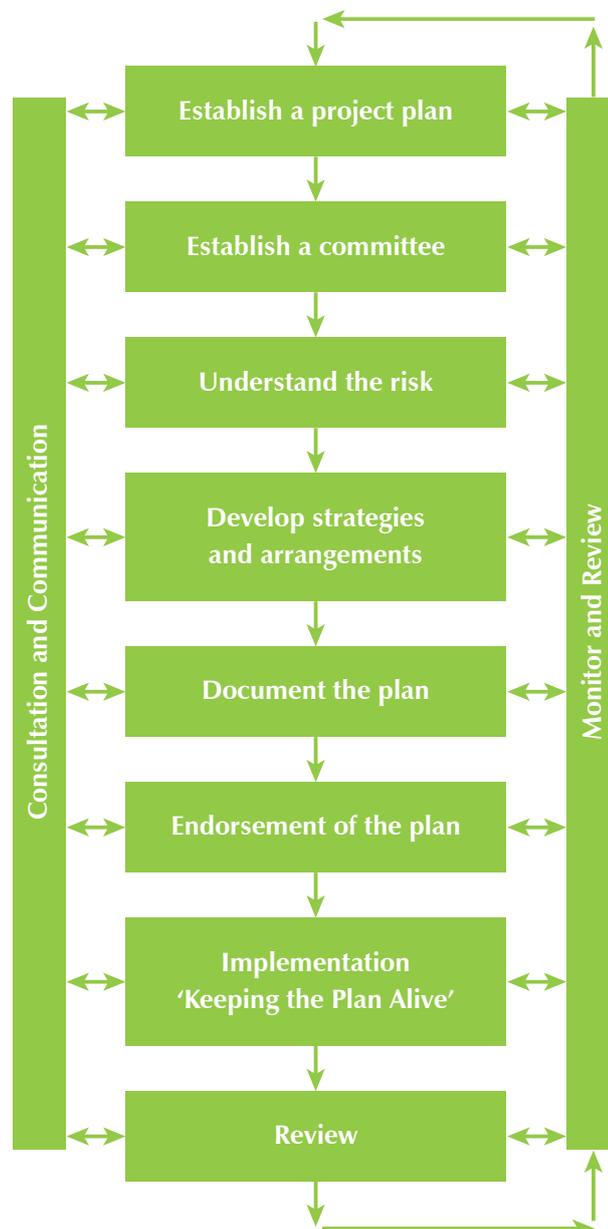
Figure 1: The Planning Process

Establishing a Project Plan

Developing an emergency plan is a project and a project plan should be established to guide the planning process. Project planning allows planners to scope the entire process, so they have an understanding of what key stages are involved. It has been the experience of emergency planners that without proper project scoping, emergency planning projects often stumble or stagnate, as planners consider what step to take next or become sidetracked by other priorities.

Establishing a Flood Emergency Planning Committee

People who are involved in the planning process are more likely to understand, accept and use an emergency plan than those who did not participate. Therefore, it is important that key stakeholders are involved in the planning process.

In most jurisdictions the planning process will require consultation with a range of technical specialists who can supply information on the nature of the problem and with agencies which will be able to assume responsibility for managing particular tasks before, during and after flooding. At the minimum, agency personnel must be involved in planning for the management of those tasks for which they will be responsible.

Consultation with flood-prone communities themselves is also vital. In other words, opportunities should be provided for members of the community to actually participate in the planning process. There are many stakeholder groups and individuals, and planning should not be carried out in isolation from them. Consultation and active participation build community ownership of the flood emergency plan.

There are several possible strategies for preparing a flood emergency plan. An ideal strategy would include the creation of a broadly-based flood emergency planning committee made up of technical experts, community representatives and agency personnel. The flood emergency planning committee is likely to have a core membership which takes responsibility for the actual preparation of the plan. However, it should be possible to co-opt outside expertise as necessary and to set up meetings with particular interest groups including people who live, work or otherwise have interests in flood-liable areas. As the plan is written, drafts should be distributed to members of the interest groups that have been brought into the process and appropriate revisions and amendments undertaken in the light of any additional input.

A Planning Committee would typically be a sub-group of the relevant Emergency Management, Disaster Management or Counter Disaster Committee and led by the lead agency for flood management. It is essential that committee members are sufficiently senior and knowledgeable to contribute to the committee. In cases where a plan covers more than one community it may be necessary to establish separate committees for each community.

Local Government participation in the Flood Emergency Planning Committee is essential as councils can provide large amounts of information regarding flood risk and relevant council policies. Involvement also ensures that council officers are aware of the flood emergency management arrangements within their Local Government Area and can incorporate these within the wider floodplain risk management process.

Terms of reference may be established for the committee to outline the aim and scope of the planning committee's functions. In combination with the agreed project plan the terms of reference provide guidance to the committee in undertaking the planning process.

Understanding the Risk

Flood risk is generated by the potential for flooding to interact with elements of the community and/or the physical environment. The flood risk must be thoroughly understood before any strategies can be developed. It is essential to develop an understanding of the risk posed by all magnitudes of flooding, including that generated as a result of dam failure where that is possible.

To understand the flood risk, planners should conduct a risk analysis. A risk analysis is a systematic process of identifying sources of risk, estimating their likelihood and evaluating potential consequences in terms of how the flood hazard interacts with the community. The three primary sources of risk in the context of flooding are inundation, isolation and indirect affects as a consequence of infrastructure damage or interruption. The emergency risk management process is used to conduct risk analysis (Standards Australia, 2004).

To be properly understood and planned for, risk needs to be appreciated in the context of specific types of environment. In the flood context, special environments for which planning will be required include:

• flash flood environments,

• communities with levees, and

• areas downstream of dams with identified deficiencies.

Further information about developing an understanding of the risk is contained in Chapter 2. Planning for special environments is covered in Chapter 5.

Developing Strategies and Arrangements

For each source of risk identified, emergency management functions should be determined. Functions that need to be dealt with for the various sources of flood risk are listed in Table 2.

Table 2: Emergency Management Functions and Sources of Flood Risk

Functions	Source of Risk		
	Inundation	**Isolation**	**Indirect Effects**
Community Education	✓	✓	✓
Warning	✓	✓	✓
Property Protection	✓		
Evacuation	✓	✓	✓
Rescue	✓		
Resupply		✓	✓
Restoration of Infrastructure			✓

For each identified emergency management function it is necessary to develop strategies and arrangements. Once these have been developed, responsibilities should be identified and assigned for functions, including tasks which allow functions to be undertaken. It is important to ensure that allocated responsibilities are consistent with the overall emergency management arrangements.

There are numerous key considerations in developing strategies and arrangements for key functions, and these are discussed in later sections. Exercises and questionnaires can be used to facilitate the development of strategies and arrangements.

It is essential that strategies and arrangements are based upon valid assumptions regarding how the community is likely to behave during a flood. This is an important reason for consulting with the community regarding a plan and encouraging community involvement in the planning process.

Documentation of the Plan

Plans should be documented so that they are clear to their audience. Standard templates will assist in this process and ensure consistency in format and arrangements across plans. It is important to ensure such templates are flexible in content so that users can adapt them to the circumstances of individual plans.

Endorsement of the Plan

Plans should be endorsed by Emergency Management, Disaster Management or Counter Disaster Committees. Prior to a plan being tabled for endorsement, consultation must be completed and a quality assurance process conducted. Examples of some quality assurance considerations are presented in Annex C. Once endorsed, copies of the plan must be distributed to all stakeholders. This can be done either by hard copy or electronically.

Keeping Plans Alive

Unless a plan is implemented regularly, either during floods or by other means, it is likely that it will be ineffective. Any plan needs to be kept alive to ensure it remains 'fit for purpose'. This can be done through exercising, review, training and community engagement and education.

Exercises provide opportunities to ensure that plans are workable and effective. They can be used as tools in plan revision, by identifying required strategies and responsibilities and inadequacies in procedures and communication flows, and they help to educate emergency services' personnel and community members about emergency management arrangements.

Exercising should be conducted regularly and be varied in its content and extent since no single test can adequately simulate all aspects of a flood response. All agencies need to be involved in the process, practising their designated roles and responsibilities as specified in the plan. However, not all agencies will need to be involved in every exercise.

Training helps emergency personnel to become familiar with their responsibilities and to acquire the skills necessary to undertake them. A simple way of ensuring emergency personnel are familiar with their responsibilities is to run briefings detailing arrangements contained within a plan.

Community education programs can also be used to promote flood emergency planning and the plans themselves. Programs should educate the community about the contents of the plans especially regarding the actions community members should take that are consistent with strategies outlined in the plans. It is desirable that emergency plans are completed prior to the establishment of community education programs to ensure the educational activities are consistent with strategies outlined within the plans. A plan can also be used as an instrument to educate communities through providing it in public libraries and on websites.

Arrangements for the conduct of exercises and community education should be contained within plans.

Review

To ensure that flood emergency plans remain relevant and accurate it is essential that they are regularly reviewed. The arrangements in plans should be reviewed:

- after each flood operation,

- when significant changes in land use or community characteristics occur,

- when new information from studies regarding flooding becomes available,

- when flood warnings systems are established or altered,

- when flood control or mitigation works are implemented or altered,

- when there are changes which alter agreed plan arrangements, and

- when there are significant changes in the personnel who will have to manage a flood.

There is no 'right' time frame within which reviews should be undertaken, but as a general guide it is wise to conduct full reviews at least every three years. Partial reviews covering specific elements may need to be undertaken more often than complete reviews.

Consultation and Communication

Communication and consultation are important considerations in each step of the planning process. Communication and consultation with the community and other emergency services and government agencies builds ownership of the provisions of flood emergency plan, creating commitment and enhancing the effectiveness of the plan. It is essential that project planning includes effective strategies for communication and consultation between agencies and stakeholder groups in the community.

An important time for community consultation is immediately **after** a significant flood. Public meetings at such times may provide an outlet for community anger (eg about warning quality or the nature of agency responses), but for flood managers they also create opportunities to better understand the community's needs and to gather information about flood consequences, planning arrangements and other matters.

Structure and Content

There is no single structure or table of contents that can be prescribed for all flood emergency plans. This is partly because of differences in the nature of flood threats from area to area and partly because plans operating at the local, regional and state levels are likely to address somewhat different concerns. 'Higher level' plans will often direct planning processes at lower levels and address coordination functions, while local plans will deal with managing particular tasks at the community level.

The following generic Community Flood Emergency Plan identifies the principal topics or themes that should be addressed (Table 3). The degree of detail on particular themes will be dictated by individual cases.

Table 3: A Structure of Headings for a Community Flood Emergency Plan

Contents
Distribution list
Amendment certificate (to indicate agreed modifications after initial publication)
Abbreviations
Glossary
Introduction
Purpose (objective)
Authority (in legislation or as a result of endorsement by other appropriate means)
Area covered (council area or other)
Description of flooding and its effects
Responsibilities (of participating agencies, organisations and officers
Cross-border assistance arrangements
Preparedness
Maintaining the plan (exercises, briefings, re-writes; sunset clause on life of document before revision)
Floodplain risk management (participation of agency personnel, benefits in terms of developing flood information)
Community consultation and participation (methods)
Developing and maintaining flood intelligence (content of systems, collection and collation of data)
Developing and operating warning systems (description, client identification, identification of impacts at different heights, required actions, means of disseminating warnings)
Public education (knowledge required, strategies to employ)
Training (of agencies with tasks to perform)
Resources (maintaining the readiness of operations centres, contact lists and resource lists)
Response
Control (control responsibility, decentralised or other special control arrangements)
Operations centres (locations)
Liaison (provision when required by operations centre)
Communications (systems and back-ups)
Activation of plan (conditions, communicating activation to agencies)

Flood intelligence (sources, types)

Preliminary deployments (eg actions to be taken before isolation occurs)

Warnings (arrangements, types, methods of dissemination)

Information provision (flood bulletins, arrangements for phone-in services, inter-agency information transmission)

Road control (arrangements for closures and re-openings)

Flood rescue (control, tasking, resources)

Evacuation (areas possibly needing evacuation, agencies involved in doorknocking and providing assistance to evacuees, evacuation routes and centres, transport provision)

Registration (evacuees)

Managing animals (setting up and operating animal shelter compounds, eg for pets)

Logistics (eg sandbag availability, aircraft tasking)

Resupply (areas affected, arrangements for delivery of essential items)

Stranded travellers (accommodation)

All clear (transmitting message)

Recovery

Welfare (long-term responsibility)

Recovery coordination (outline of plan)

Debriefing arrangements (details and recording of needed actions)

Annexes

Nature of the flood threat (flood types and environments, seasonality, weather systems, flood history, potential for extreme flooding)

Effects of flooding on community (land uses affected, demographics, specific facilities needing attention, eg schools, hospitals, nursing homes, gaols, neighbourhood centres, utilities)

Gauges monitored (list of gauges referred to)

Arrangements for disseminating flood Information (media and other agencies)

Guide to the content of evacuation warning messages (checklist of categories of information to be provided to people before evacuation)

Details of response operation arrangements for particular areas (area definition and description; institutions possibly requiring help; control arrangements eg location of forward control points; evacuation centres; evacuation routes including option sequences; traffic control points; helicopter landing points; arrangements for transporting evacuees; doorknocker requirements and agencies involved; time factors). Such annexes as these should be able to be used in the field as stand-alone plans for evacuations

Guide to assessing needs for large-scale evacuation operations (doorknockers, transport needs, time)
Arrangements for flood-liable caravan parks (description of caravan parks, including heights at which inundation begins and floods whole parks; numbers of sites affected; advising procedures, arrangements for evacuation and van relocation; arrangements for return of occupants and vans)
Resupply requirements and operations (areas affected, scale of tasks, agencies involved)
Maps
Reference area of plan (eg local government area)
River systems
Areas inundated (eg in floods of different scales)
Operational sectors (evacuation routes, evacuation centres, operations centres marked)

Scenario-Based Planning

The best flood plans are those which 'inform' flood responses, making the response task of flood managers simpler. They do this by being easy to follow, by performing the function of the 'aide memoire', and by providing well-considered solutions to problems in advance. A useful approach is to develop specific flood **scenarios** for which managerial solutions are devised and incorporated in the plan.

This can be done by identifying what responses would be required in an area in the case of floods of different severities (eg minor, moderate, major and extreme). Sub-plans can be developed, within the body of the plan or in annexes, for each function (eg warning, resupply, property protection, evacuation etc) at each severity level. Doing this leads to a conceptualisation of the flood response which recognises that different measures will normally be appropriate under different flood scenarios. In the case of flood warning, for example, the need for different warning modes (and therefore different suites of resources) for floods of differing severity will be made explicit.

This approach also makes simple the development of action checklists which can be referred to when a flood operation is imminent.

Matching Managers to Tasks

Management-task linkages need to be defined comprehensively. The goal in all cases must be to ensure all foreseeable tasks will be managed by the most appropriate 'actors' available. Appropriateness must be defined in terms of the relevant skills, resources or authority held by the individual (officer) position, group or agency charged with carrying out a particular task.

In some cases, the personnel nominated to carry out tasks will not be members of emergency agencies. They may be members, instead, of service, sporting or other special-interest clubs or community groups.

Typically, generic responsibilities will be found in general Emergency Management or Disaster Plans. These responsibilities can be expanded upon within the flood context in flood emergency plans.

Supporting Information

Flood emergency plans should not be regarded, in themselves, as complete descriptions of all aspects of the management arrangements relating to flooding. Other documentation will be necessary. Most agencies with responsibilities listed in flood emergency plans will need to develop detailed Standing Operating (or Operational) Procedures (SOPs) to guide their intended actions in fulfilling their responsibilities.

SOPs will, in turn, guide the training done to ensure operational readiness is maintained. In addition, contact and resource lists will need to be developed and maintained. These should be separate from the plan itself since they are so prone to change they can quickly render a plan obsolete.

CHAPTER 4

Planning for Specific Functions

In a Nutshell...

Planning needs to be carried out on a function-by-function basis.

The key functions for which detailed planning should be undertaken are warning, evacuation, resupply, property protection and rescue.

Introduction

The tasks to be identified and managed during floods are, in most areas with significant flood problems, numerous and it is not possible to deal with them all in this manual. Some guidance can be provided, though, in terms of coverage in a plan of particular key functions, identification of appropriate agencies to carry out particular tasks and development of solutions to problems relating to warning provision, evacuation, resupply, rescue and property protection.

Planning Considerations for Warning and the Provision of Advice

The creation and maintenance of flood warning systems are critical to unlocking the manageability of the flood threat. More detail on the matters covered in this section can be found in the Australian Emergency Manual **Flood Warning**.

The components of a flood warning system are the:

•   prediction of severity and time of onset of flooding,

•   interpretation of the prediction using flood intelligence to determine flood impacts on the community,

•   construction of warning messages describing what is happening, what the flood prediction is, what the expected impacts of the predicted flood levels will be, what actions the public should take and who to contact for further information and emergency assistance,

•   communication of warning messages to the public,

•   response to the warnings by agencies involved and the community, and

•   reviews of the warning system after a flood event.

Prediction

Predictions of flooding are provided by the Bureau of Meteorology for many river gauges and catchments across Australia. Types of Bureau of Meteorology Flood Warning products are described on the Bureau of Meteorology website (www.bom.gov.au). Planning considerations include the identification of:

• the responsibilities for flood warning prediction,

• existing flood prediction systems for flood warning,

• Bureau of Meteorology flood warning products which could apply,

• other possible warning products, for example those from local flash flood warning systems, and

• warning time frames.

Interpretation

Flood predictions are of little value unless they are interpreted to assess the likely impacts of the predicted flooding. Flood predictions contained in flood warnings are interpreted by reference to the relevant flood intelligence for the warning gauge and its reference area. Planning considerations include identification of:

• the responsibilities for warning interpretation,

• flood intelligence available, and

• sources of real-time flood intelligence.

Message Construction

For the community to be given the best chance of undertaking appropriate action in response to flooding, its members must receive a flood warning message.

As far as possible, all messages should be pre-written to ensure that high quality messages can be released in a timely manner. Note, however, that pre-written messages need to be checked in the real time of a developing flood to ensure their relevance to the circumstances and to allow incorporation of information which was not known before the flood operation. Pre-written warning messages should also be reviewed when flood intelligence is updated, when the flood emergency plan is reviewed or after a flood event.

Planning considerations include the identification of:

• the responsibilities for message construction,

• the appropriate advice (call to action) that should be provided, and

- pre-written flood bulletins available and responsibilities for their maintenance.

Communication

Communication in a flood warning context involves communicating messages to those identified as being at risk. Planning considerations include:

- identification of the responsibilities for warning communication,

- identification of the clients of warnings for varying magnitudes of flooding, including the number of properties and people requiring warning,

- identification of any special-needs groups,

- identification of resources available to conduct warning,

- establishment of warning priorities,

- identification of arrangements for warning communication including identifying potential methods of communication,

- identification of arrangements for use of the Standard Emergency Warning Signal (SEWS), and

- establishment of warning sectors for the communication of warnings. These are likely to be based on evacuation sectors.

Review

After each significant flood event, the performance and effectiveness of flood warning systems should be evaluated. Arrangements for the review of flood warning performance and effectiveness should be incorporated within plans.

Planning Considerations for Evacuation

The purpose of evacuation is to relocate people temporarily from areas at risk of the consequences of flooding to places of safety. Evacuation of people may not always be the most appropriate response to flooding, though, and it is essential to assess the risks involved in undertaking an evacuation. This will ensure that people are not exposed to more hazardous environments as a consequence of their evacuation.

Note too that a degree of 'spontaneous evacuation' is likely to occur when there is sufficient warning, without evacuation having been called for by an emergency service.

In some situations, evacuation planning is relatively simple and the relevant flood emergency plan will need only a brief section on the topic to note the potential (small) scale of the task, the areas which could be affected and the evacuation centres that would be used. In other circumstances, however, the evacuation section may need to be considerably more detailed.

An evacuation operation is conducted as a sequential process, ideally consisting of the following five phases:

- **Decision**, which involves the assessment of considerations in making a decision to evacuate people,

- **Warning**, involving the development and communication of an evacuation warning,

- **Withdrawal**, involving the movement of people from a dangerous or potentially dangerous area to a safer area where adequate shelter is available,

- **Shelter**, involving the provision of the basic needs of affected people away from the immediate or the potential effects of flooding, and

- **Return**, which involves the assessment of the safety of an affected area and the return of evacuees to their places of residence.

Prior to the development of evacuation arrangements, the following matters should be considered:

- identification of areas likely to require evacuation,

- establishment of evacuation sectors,

- classification of floodplains using floodplain classification descriptions (see Annex D),

- identification of the number of people needing evacuation,

- identification of any special-needs groups, and

- identification of when evacuations will be required.

Decision

Planning considerations include the:

- identification of the authority to evacuate and the existence of any powers in relation to 'mandating' evacuation,

- identification of evacuation triggers and completion restrictions (eg the closure of evacuation routes by floodwaters),

- identification of evacuation priorities,

- identification of evacuation risks to determine whether evacuation is the best option,

- estimation of time available to conduct the evacuation, and

- estimation of time likely to be needed to complete the evacuation.

Warning

Planning considerations include the identification of:

- available pre-written warning messages,

- warning responsibilities,

- warning communication methods, and

- arrangements for warning special-needs groups.

Withdrawal

Planning considerations include the identification of:

- transport strategies,

- responsibilities and arrangements for traffic control,

- suitable evacuation routes,

- responsibilities and arrangements for security of evacuated areas,

- transport provision and arrangements for special-needs groups and people without transport (this may include a need to arrange for the movement of wheelchairs and life-support equipment),

- responsibilities and arrangements for the movement of the companion animals and pets of evacuees, and of livestock, and

- deployment of engineering resources to 'shore up' low sections of roads.

Shelter

Planning considerations include identification of:

- suitable evacuation shelters, including sufficient capacity to accommodate all evacuees in flood-free areas above PMF levels, and accessible from areas likely to be flooded. Note that this does not mean that **all** evacuation shelters must be above PMF levels,

- responsibilities and arrangements for the registration of evacuees,

- responsibilities and arrangements for the provision of welfare and security for evacuees, and

- suitable shelters for the pets of evacuees.

Return

Planning considerations include the identification of:

- damage assessment strategies and arrangements,

- criteria for the return of evacuees, and

- transport arrangements.

Agencies and Organisations Potentially Involved

Most large-scale evacuations require coordination of the efforts of numerous agencies and organisations (sometimes including businesses and community groups). Amongst them could be:

- **the Police**, to ensure people do evacuate when necessary, maintain traffic flow along evacuation routes, maintain the security of evacuated premises and areas and ensure evacuees are registered,

- **other emergency service agencies**, to conduct doorknocks and to assess the special needs some evacuees are likely to have,

- **councils** or **road-managing agencies**, to close routes which may be flooded and dangerous to use,

- **transport agencies or companies**, to provide appropriate modes of transport (eg buses, trains, taxis, boats and/or aircraft) for evacuees,

- **organisations to care for the livestock, pets and companion animals** of evacuees, including establishing animal shelter compounds or arranging to move farm animals out of flood reach,

- **organisations or groups to help with evacuation-related tasks**, such as raising or moving furniture and commercial stock and removing or securing caravans, and

- **welfare agencies**, to operate reception centres outside flood affected areas so the accommodation, clothing, food and personal requirements of evacuees can be met.

Time Considerations in Planning for Evacuation

A particular concern in planning evacuation operations relates to the **effective use of time**. Particular matters of concern arise if there are few access roads into and out of an area, if evacuation routes could be cut by floodwaters before an evacuation is completed, or if islands which contain people could be submerged before escapes can be made good.

In such circumstances, where there are strict limitations on the amount of time available, the elements of an evacuation operation can be conceptualised using a timeline (see Figure 2). In this figure, the trigger for evacuation is taken to be the **prediction of the height at which inundation occurs**; in some real cases, other motivating factors (including the loss of escape routes or the need to move elderly people at an early stage) may be more critical.

Figure 2 illustrates the various phases into which an evacuation can be divided and forces planners to come to grips with the scale of the evacuation task in relation to the amount of time available. Using it, in conjunction with assessments of when evacuation routes will be cut and assumptions about vehicular flows along escape routes, will help in the calculation of numbers of doorknockers needed, the time by which specific groups of evacuees will need to begin their evacuation, and the phasing of the evacuation (area by area) to prevent bottlenecking. A figure of this type can be used to determine how to manage an evacuation operation so that everyone is moved to safety before critical moments, such as loss of routes or onset of nightfall, are reached.

Planning Considerations for Resupply

Resupply is a frequently-required function in rural areas. It can be difficult to manage because of the **geographic dispersal** of those who are cut off by flooding from normal means of supply. More rarely, resupply is necessary to whole towns, in which case the **scale of the task** is likely to be a problem especially if isolation, as a result of road closures, is likely to last for a considerable length of time and create many logistical challenges.

Resupply requirements differ depending upon the likely duration of flooding and the likelihood of infrastructure damage.

Where prolonged isolation is identified as a possible consequence of flooding, planning for the resupply of properties and/or communities should be undertaken. The purpose of this planning should be to ensure that arrangements are developed to provide supplies of essential items to properties and/ or communities when they are isolated.

The initial task in developing a plan to conduct resupply is to identify areas which are likely to lose road and/or rail access and the flood events that will result in the isolation of properties and/or communities. For each area the following information should be identified and included in the plan:

• location of the area,

• key access routes to the isolated community or properties,

Figure 2: An Evacuation Timeline
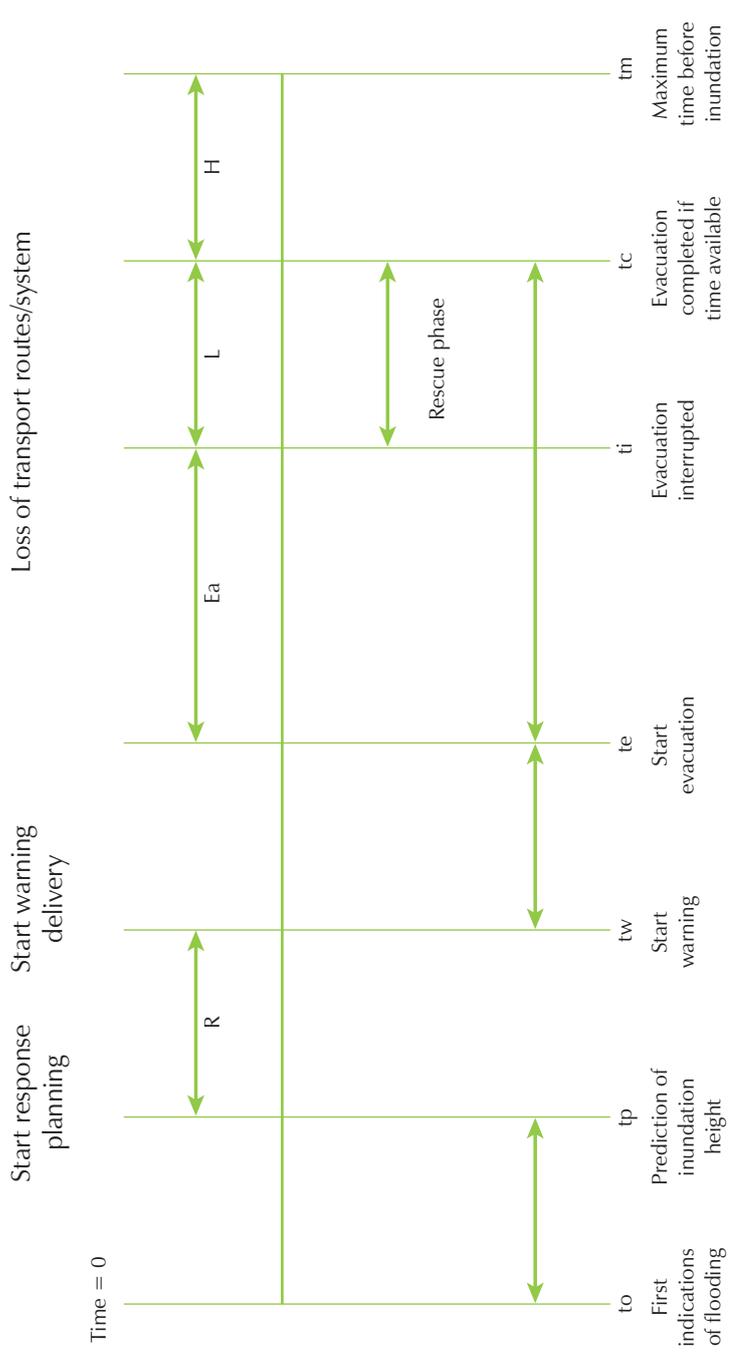
P = prediction calculation, R = response initiation, W = warning delivery, En = time needed to evacuate, Ea = time available to evacuate
L = time lost due to failure of evacuation routes/system, H = headroom for error. Note: H can be negative if tm is earlier than tc.

Time segments are not drawn to scale

Time = 0	to	tp	tw	te	ti	tc	tm
	First indications of flooding	Prediction of inundation height	Start warning	Start evacuation	Evacuation interrupted	Evacuation completed if time available	Maximum time before inundation

Start response planning

Start warning delivery

Loss of transport routes/system

Rescue phase

R   Ea   L   H

- location and heights (relative to the relevant flood warning gauge) at which key access routes may be closed by flooding,

- the likely duration of isolation,

- the size of communities and/or the number of properties requiring resupply,

- locations where the community and/or properties normally purchase supplies,

- whether or not a community has businesses to meet its needs or resupply the community,

- whether or not any special-needs risk groups (eg families with young children) or institutions (eg hospitals, clinics and nursing homes) are likely to become isolated, and

- specific resupply needs of people and animals (including farm livestock and domestic pets and companion animals).

Once the isolation problem is understood, arrangements and strategies for resupply can be developed. Sectors should be established for areas requiring resupply. Generally each isolated area should form a separate sector. For each sector the following should be identified and included in the plan:

- control and coordination arrangements,

- locations suitable as distribution points to which resupply items are to be delivered for distribution to isolated property owners or businesses if whole communities are isolated,

- the most appropriate method(s) of transport to deliver resupply items, potentially including aircraft, train, flood rescue boat or high clearance vehicle, and

- resupply responsibilities.

Locations from which resupply occurs are referred to as loading points. Resupply goods will be delivered to such points by suppliers and then transported to isolated communities and/or properties. Sites for loading points should be identified and detailed in the plan. They should be established in communities close to isolated areas, but also close enough for normal suppliers to deliver easily to them. The choice of loading point location will also depend upon the chosen methods of resupply delivery.

Priorities for resupply must be determined and detailed in the plan. Generally essential services should be given the highest priority.

Planning Considerations for Property Protection

The aim of property protection is to prevent or minimise property damage through temporary means. Two types of property require planning to prevent flood damage: public infrastructure, and business and household contents. Methods of protection include barriers and the removal or lifting of the contents of buildings.

The use of barriers may require the application of cost-benefit analyses to determine whether they are economically appropriate. Such analyses, because of time constraints, are rarely possible during responses to floods. To apply such analyses during the planning phase requires the early identification of the locations and circumstances of potential barrier use.

Barriers

Temporary barriers constructed by sandbagging, earthworks or commercial 'wall' barrier products can be used to prevent water entering buildings or yards (containing, for example, essential infrastructure) or business premises or dwellings. These methods of protection are often ineffective against large floods, during which they may be overtopped. Sandbags must be positioned correctly to be effective. For further information on the deployment of sandbags, see Chapter 7 of the Australian Emergency Manual **Flood Response**.

Temporary barriers are suitable only for the protection of infrastructural assets and property. Such barriers should **not** be used as an alternative to evacuating a community.

Removal or Lifting of Contents

Damage to building contents, essential infrastructure and equipment can be reduced or eliminated by either lifting items or removing them to higher areas.

Key Considerations

The following are key considerations to identify when developing plans for property protection:

- the property requiring protection, including the critical infrastructure which needs to be protected,

- triggers for property protection (eg forecast flood heights),

- resources available to conduct property protection,

- time frames available for conducting property protection,

- strategies for conducting property protection (barrier eg sandbagging, and/or lifting or removal of goods),

- logistical support for property protection (for barriers: sources of sandbags, sandbagging machines and sand; for removal: transport, storage facilities, management of storage facilities and security of storage facilities), and

- responsibilities for property protection.

Planning Considerations for Flood Rescue

The aim of flood rescue operations is to move people from immediate or potential harm to safety. Failed evacuation operations (eg evacuation operations which have been initiated too late and have not been completed before egress routes are lost) can result in the need for large-scale coordinated rescue operations to take place to rescue people and animals from flood islands or inundated areas. Where the potential need for large-scale coordinated rescue operations is identified, arrangements should be contained within flood emergency plans. Since flood rescue is often related to evacuation arrangements, planning for these functions should be conducted concurrently.

An understanding of the likely flood rescue problem should be established through the consideration of the following:

- areas likely to require rescue, noting that high risk will apply to low flood islands, and

- the potential number of people likely to require rescue, including any special-needs groups.

Flood rescue operations can be separated into the following phases as dealt with below.

Identification and Deployment of Rescue Resources

This stage identifies available resources and mechanisms for their deployment.

Key planning considerations include the identification of:

- accredited rescue units available,

- other rescue resources (including material resources) available,

- identification of arrangements for the management of aircraft,

- triggers for the pre-deployment of resources. These triggers should be based upon evacuation triggers. Hence, when ordering the evacuation of a large area, an operations controller should also consider the pre-deployment of flood rescue resources. Therefore knowledge of evacuation triggers is required,

- areas suitable as staging areas, including areas suitable for the landing of aircraft.

Activation of Rescue Resources

Planning considerations involve the identification of activation methods. Activation can occur either through a member of the public contacting the emergency services (for example by calling 000), through reconnaissance reports or through active searching of an area.

Rescue Execution

The rescue execution stage encompasses the conduct of the rescue itself. Planning considerations include the identification of:

*   the most suitable methods (flood rescue boat, aircraft or high-clearance vehicle),

*   rescue sectors (these are likely to be aligned with evacuation sectors),

*   rescue priorities, and

*   shelters of last resort where people may assemble and from which they can be rescued.

Shelter of Flood Victims

Once people have been rescued, shelter and welfare need to be provided. Planning considerations include the identification of:

*   likely drop-off points where rescued persons can be transferred to evacuation centres or hospitals. These may be the same location as staging areas, but need to be located in areas where flood-free road access is available to medical facilities and evacuation centres,

*   likely resources required at drop-off points eg transportation, registration and ambulatory care,

*   logistics support requirements for rescue resources,

*   arrangements for the registration of rescued persons, and

*   appropriate shelters. These are likely to be identified in evacuation planning.

Return of Flood Victims

Once an 'All Clear' is issued, people can return to their properties. Plans should identify arrangements for the issue of 'All Clear' advice. These arrangements will be common across the evacuation and rescue functions.

CHAPTER 5

Planning for Special Environments

In a Nutshell…

Planning is often necessary for 'special' environments in which unique or additional considerations have to be built in to the planning process. Amongst these are:

•   *areas which are liable to flash flooding,*

•   *communities with levee protection, and*

•   *areas downstream of dams which may fail or from which water may be released through gates.*

Planning for Flash Flood Environments

Flash floods are often sudden and unexpected and are characterised by their short warning time frames, short duration, and often dangerous floodwaters which can cause severe damage. Flash flooding, which is often defined as flooding which peaks within six hours of the rain which causes it, typically results from relatively short, intense bursts of rainfall, often from thunderstorms. Generally, such flooding is of short duration.

The ability to provide warning to people likely to be affected by flash flooding is limited. Bureau of Meteorology warning products providing advice about potential flash flooding include Severe Weather Warnings, Severe Thunderstorm Warnings and Flood Watches. When developing warning arrangements for areas which are prone to flash flooding, an assessment to identify existing warning systems should be undertaken.

Due to the limited warning time available, it is unlikely that large-scale evacuations of the floodplain will be successful since the time required to complete evacuations in most cases will be greater than the time available. As a consequence of the limited ability to evacuate people, there can be an increased demand for flood rescue in flash flood areas. Limited lead times also restrict the ability for evacuation centres to be established in a timely manner.

For the same reason, the ability to protect property in areas susceptible to flash flooding is likely to be limited. At-risk homes, businesses and essential services at risk should be encouraged through community education programs to be flood resilient and to develop their own means to minimise flood damage potential.

There will be limited time to pre-deploy resources to maintain essential emergency functions. However, unless flash flooding causes damage to roads and bridges it is unlikely that isolation requiring resupply will be necessary.

In cases where damage to property and infrastructure has been severe it may be necessary to conduct evacuations once floodwaters have receded.

Flash flooding can affect more than one watercourse in an area at a time. Hence a separate sector for each watercourse may need to be established, especially if transport difficulties are likely between affected areas.

Evacuation v Sheltering in Place

Evacuation is a suitable strategy only when, by evacuating, people are not exposed to greater risks than they would face by remaining where they are. Due to the limited warning time available and the dangerous nature of flash flooding, in most flash flood catchments it may be more dangerous for people to evacuate than to shelter in place (ie stay inside their building and move to the highest place). Hazards that evacuees may be exposed to whilst evacuating are:

• flooding of evacuation routes,

• severe weather including strong winds, heavy rainfall, hail and lightning,

• debris, and

• fallen electricity lines.

However, where buildings are located in floodways, it is likely that people will be exposed to high hazard conditions in which it will be more dangerous to shelter in place than to evacuate. In these circumstances an evacuation strategy should be adopted.

It may be appropriate for a mixed strategy to be developed, with a shelter in place strategy adopted for buildings where evacuation is likely to be more dangerous than sheltering in place and an evacuation strategy where evacuation is less dangerous than sheltering in place. Areas where these strategies apply should be detailed in plans.

Planning for Flood-Prone Communities with Levee Systems

Levees are flood mitigation structures which aim to reduce flood frequency by creating a barrier between floodwaters and community elements at risk. Levees have been used in an attempt to reduce flood damages and enhance public safety. All levees, however, unless designed for PMF events, will ultimately be overtopped by events larger then their design events, and in addition they may fail (despite not being overtopped) through lack of maintenance, inadequate construction or unforeseen circumstances.

The potential for overtopping or failure means that flood emergency plans must be maintained for all communities protected by levees, and must detail evacuation arrangements to be undertaken when floodwaters threaten to overtop levees or cause levee failure. Communities protected by levees should also receive ongoing community education to maintain their awareness of the flood risk, dispel any complacency which the presence of levees has generated and promote the actions which people should

take in preparing for and responding to flooding.

Planning Considerations

Where levee systems are identified the following information should be contained within plans, if available:

- description of each levee, detailing location, construction type, and the communities protected,

- the name, identification number and gauge zero for the flood warning gauge relevant to each levee,

- the following heights relative to the relevant flood warning gauge, and the likelihood of the respective heights being reached:

    - levee design height

    - overtopping heights of levee low points

    - levee spillway heights

    - imminent failure height,

- likely locations of levee overtopping and the sequence of overtopping and flooding (these outputs may be presented in a spatial format, accompanied by a description),

- size of the population, the number of residential and commercial properties, and critical infrastructure affected by levee over-topping or failure. This output should be expressed in relation to a variety of flood magnitudes, including a worst-case scenario,

- the height (relative to the relevant flood warning gauge) at which any backwater flooding commences affecting urban areas behind each levee, and the pattern of inundation,

- once overtopped the length of time taken to fill the basin area behind each levee and the pattern (evolution) and behaviour of inundation,

- details of ground profile (topography) inside each levee and the height of potential high points of land (relative to the relevant flood warning gauge),

- location of any parts of a levee which need to be closed and the height (relative to the relevant flood warning gauge) at which that action must be completed by,

- knowledge of any critical issues including structural integrity affecting each levee, and

- means of dispelling inappropriate community attitudes (eg false senses of security created by the existence of levee protection).

It is likely that in many cases, outputs relating to overtopping and backwater flooding will vary between floods. In these cases a description of potential flood scenarios and details of associated

consequences will be required.

When new levee systems are proposed or under construction, planning authorities should encourage the levee owner to provide the required information.

Levee Heights

The following terms are often referred to in relation to levee heights, measured relative to a relevant flood warning gauge:

- **Imminent Failure Level**: This is a level lower than the crest height of the levee and considered to be the potential failure level of the levee.

- **Design Height**: The height to which a levee was designed to provide protection. Where there is a spillway the design height should relate to the spillway level less freeboard; elsewhere it should relate to the height of levee low points less freeboard.

- **Crest Height**: The crest height of a levee is equal to the design height plus freeboard.

- **Spillway Height**: The height of a levee's spillway (if any).

Freeboard and Levee Design

Freeboard is the additional height added above a levee's design height to ensure that the levee performs at its design height. Freeboard is generally required to allow for:

- wave action due to wind, boats and trucks, often occurring well after rain has subsided,

- localised hydraulic affects, which may result in higher than design flood levels, and

- inherent inaccuracies in modelling or historic flood information.

Freeboard also provides a safeguard for variation between flood predictions and actual flood levels in events.

In addition to the above considerations for freeboard, the long term condition and performance of earthen levees needs to be considered. The relevant issues are:

- post-construction settlement, which effectively reduces the crest level of the levee,

- traffic crossing or driving along the levee and resulting in surface erosion reducing its height,

- the prevalence of deep surface cracking which is made worse by drying out and lack of vegetation cover, and

- the performance of earthen levees when they overtop. Overtopping can be characterised by relatively quick vertical erosion resulting in a breach which can allow more water in quickly. This can result in flooding occurring rapidly and causing difficulties for evacuation.

Since the performance of a levee cannot be assured after its design height or design specifications are exceeded, the design height or design specifications should be used as the trigger for evacuation. For example, if a flood prediction indicating flooding to or above the design height of a levee is received from the Bureau of Meteorology or another credible source, evacuation would be advisable.

Note that this also means that freeboard should **not** be relied upon to provide community safety or be a consideration in the decision to evacuate or not to do so. This point has been confirmed in court proceedings in Australia, and many cases have been noted in which the freeboard originally provided has been reduced by consolidation of levee materials or has disappeared since the levee was constructed.

Planning For Areas Downstream of Dams

Flooding downstream of dams may occur as the result of the release of impounded water, either deliberately to provide irrigation or environmental flows or unintentionally as a result of errors in gate operation, or from dam failure or fuse plug activation. Of these, dam failure is uncommon but can be catastrophic in its consequences.

Understanding the Dam-Failure Risk

The failure of dams results in the uncontrollable release of water, flooding downstream areas. Dam failure can be caused by:

- flooding overtopping a dam wall or spillways, resulting in the erosion of the dam,

- earthquakes that cause damage to dams, resulting in their failure,

- piping and seepage of water through the dam structure that causes erosion of the dam, and

- humanly-induced actions such as terrorism or errors relating to the operation or design of a dam.

Dam-failure floods are typically **much** larger than any previous historical floods and can occur in a very short period of time. Downstream communities located close to dams typically have short warning times, though in the case of dam failures caused by extreme floods passing through the dam some downstream evacuations may have already occurred as a consequence of anticipated flooding of rivers or creeks. However, not all the community may have been evacuated, and some people may have become isolated as a consequence of the flooding of evacuation routes, complicating any evacuations in anticipation of dam failure. In these cases evacuation will have to occur early before evacuation routes are flooded.

The dam owner should supply information to the planning authority regarding the downstream consequences of dam failure. Types of information available should include dam-break analysis

reports, inundation maps and Dam Safety Emergency Plans. Information to be provided should include:

- the nature of the dam's deficiency with respect to potential flood failure or sunny-day failure,

- (for dams with a flood deficiency only): the AEP of the Dam Crest Flood (DCF),

- (for dams with a flood deficiency only): a description of the hydro-meteorological conditions which might lead to the development of a DCF or greater flood,

- the period over which dam failure might occur,

- a description of DCF conditions downstream of the dam, including the impact of inflows from downstream tributaries (inundation map),

- descriptions of 'sunny day failure', 'DCF without dambreak', 'DCF plus dambreak' and PMF conditions (inundation maps),

- travel times for the flood wave to reach critical downstream locations (indicating both the front of the wave and its crest where possible),

- likely flood inundation durations, and

- flow velocities and depths.

Floods that need to be considered in planning may include the following:

- **Sunny Day Failure** (floods caused by the unexpected failure of the dam). Such floods may happen at any time and may not involve a rainfall event,

- **Dam Crest Flood** or **Imminent Failure Flood** (floods which raise the storage to its maximum safe level),

- **Probable Maximum Flood** (the extreme flood for the catchment). Information regarding this level of flooding is typically presented as with and without dam failure.

Planning Considerations

General planning requirements will include:

- description of the dam,

- description of dam-failure scenarios and description of likely downstream consequences and timings,

- description of any special dam-failure alerting or warning systems, for example sirens or automatic-dialling telephone systems.

- arrangements for the establishment and review of intelligence regarding the downstream consequences of dam failure (to identify/verify risk areas, action triggers, time frames and priorities),

- arrangements and responsibilities for the conduct of community education regarding dam failure, and

- arrangements and responsibilities for the establishment and maintenance of dam failure warning systems.

Considerations for response will include arrangements and responsibilities for:

- the warning of at-risk communities,

- the evacuation of at-risk affected communities; including the identification of suitable evacuation routes and shelters,

- the restriction of access and security of evacuated areas,

- reconnaissance of potentially affected areas,

- the rescue of trapped and injured people, and

- the resupply of potentially isolated communities.

Considerations for recovery will include arrangements and responsibilities for the:

- initiation of recovery, and

- conduct of debriefs.

Other Dam-Related Flooding

In addition it will sometimes be necessary to plan for 'operational floods' which do not involve dam failure. Such floods may be caused or exacerbated by the deliberate or unintended release of water through dam gates. They do not endanger the dam but may result in downstream flooding for which special warning and/or response measures may be necessary (eg for movement of livestock or barricading of roads).

Further detail on planning for floods caused or exacerbated by dams can be found in the Australian Emergency Manual **Emergency Management Planning for Floods Affected by Dams**.

Using Education to Increase Community Resilience to Flooding

In a Nutshell…

To minimise the risks to their safety and property, it is critical that people in flood-liable areas learn how to prepare for, respond to and recover from flood events. 'Flood preparedness' must include ensuring that the people who will be affected by flooding are given the opportunity and the tools to manage it in their own interests.

Flood education can build resilience by helping people learn about the need to be prepared for flooding, how to prepare for floods and how to improve their ability to cope with flooding. Because floods can occur at any time, flood education should be on-going.

Local flood education strategies are best developed, implemented, evaluated and maintained by collectives incorporating local community representatives, local councils and emergency management agencies. The strategies should incorporate local knowledge through consultation with local stakeholders, as well as expertise from appropriate organisations, to deliver programs, products and resources which are truly local in their focus.

Flood emergency plans constitute important source documents for educating communities about floods and their management.

To maintain high levels of community readiness for flooding, a range of appropriate local delivery and engagement methods, which target appropriate behaviour change, need to be utilised. These should support broader social marketing projects and deliberate information-based campaigns.

The key elements of an effective community education strategy are:

- *knowledge of the local target populations,*

- *knowledge of the local flood history and current risks,*

- *development of appropriate community education materials,*

- *development of a local community education strategy which involves the community and identifies local needs and means of delivering education to meet these needs,*

- *over-arching social marketing branding, message and product concepts which frame local delivery programs, and*

- *periodic review and evaluation of program elements to ensure continued reach, relevance and effectiveness.*

Introduction

It cannot be expected or assumed that all people in a flood-liable community will understand the nature of their exposure to the flood threat or know what they should do to protect their belongings and maintain their safety in the face of flooding. Some will be more experienced than others in dealing with floods in their present environments, but some will have had no exposure at all. In most areas very few people will have experienced genuinely severe floods.

Everybody, even those who have experienced several floods during their lives, will be prone to forget what they have learned about flooding and what they can do to mitigate its effects. People will also vary in regard to their acceptance of the risk, the degree to which their behaviour will involve the taking of risks, their ability to respond to floods, and their knowledge, attitudes and beliefs in relation to the flood hazard.

Even when people do have experience and/or understanding of the flood risk in their area, they may respond inappropriately when flooding occurs. In most cases, this is manifested by **under**-responding to the threat or initiating and carrying out responses **later** than is ideal. Often, this reflects a high degree of **complacency** about the flood risk and can be associated with **denial** of it.

Improving Community Flood Resilience through Education

In terms of flooding, 'resilience' involves the ability of the members of a community not only to protect their interests during a flood and to recover from it afterwards, but also to learn and improve responses as a result of the experience that a flood will provide. The aim of flood education is to increase resilience to the flood risk by helping people and their communities to learn from, adapt to and manage flood events.

Principles

Flood-ready communities must be purposefully created through:

- **engagement**, to create an awareness and understanding locally of the flood risk and an understanding of the need for individuals to prepare for, respond to and recover appropriately from floods,

- **empowerment**, so that people can take responsibility for and adopt appropriate actions to help protect their own property and personal safety,

- **delivery to community members of information** about the tools from which appropriate actions can be developed,

- the **collaborative involvement** of local community representatives, services and organisations so as to build local ownership of flood management solutions and actions, and

- the promotion of the **flexibility** of services and organisations to adjust to and incorporate the diverse and changing educational needs of the community through continual reflection on the internal processes and structures that define why, how and when community flood education is carried out.

Educating the members of flood-prone communities takes several forms. It can involve:

- providing information, sometimes characterised as 'one-way learning' (eg via brochures, displays, web pages, DVDs and the media),

- providing learning opportunities by 'two-way learning' (eg by training, school curriculum lessons and on-line learning programs),

- building educational capacity (by mentoring educational leaders and developing partnerships for flood-educational purposes), and

- supporting community participation (eg in designing and implementing educational programs about flooding and its management).

Flood education initiatives seek to increase community resilience to the flood risk by augmenting the ability of community members to adapt to and manage flooding. Resilience incorporates the 'preparedness' of a community for flooding, but also the community's competencies and systems for adapting to a flood and its ability to learn from flood events. 'Community' in this sense is inclusive of the organisations and services responsible for flood mitigation (both infrastructure and social) and of the individual members of the community.

Community flood education can help people and their communities build resilience to flooding in the following ways (Dufty, 2008):

- by learning about the need to **prepare** for flooding,

- by learning what to do **before**, **during** and **after** a flood,

- by learning how to **improve systems and competencies** to cope with a flood, and

- by learning, after a flood, ways to **further improve preparedness levels, competencies and systems**.

An important first step in designing a flood education program is to understand the community's level of resilience, the local flood risk and the emergency planning which has been conducted. An understanding of community resilience in relation to flooding (eg vulnerable groups, levels of preparedness, understanding of risk and attitudes to flooding) can be obtained through different forms of social research (eg interviews, surveys, focus groups) and from intelligence gained from previous flood responses (including informal and anecdotal references). Understanding of flood risk and emergency plans can be obtained from floodplain management plans and flood emergency plans respectively.

Put together, this information should help focus community flood education programs, whether they are aimed at the community in general or at specific at-risk sectors such as businesses, caravan parks, or the residents of a particular street.

Above all, community education initiatives must seek to **persuade** people that preparing for floods, and responding to them effectively, is possible and in their own interests. They must also recognise that people in flood-prone areas are often **complacent** about the risk, in **denial** of it or have come to believe in **myths** about flooding. Such attitudes constitute barriers to learning which the designers of educational programs should recognise and seek to overcome (see Keys, 2008, pp56-68). Ironically, denial may be most prevalent where mitigation devices such as levees have been built. Such areas often experience very severe flood consequences when the levees are overtopped or breached, but the levees have given people the impression that the flood problem has been solved.

Methods

The four types of flood education identified on p53 (Dufty, 2008) can be used to guide the design of programs (including targeting the areas of greatest need). In some communities (especially in those parts that are particularly vulnerable to flooding), learning about the need to prepare for flooding will be the main type of education.

Note that increasing people's 'awareness' of a flood problem is not the only way to encourage them to prepare for flooding. Other factors in determining people's willingness to prepare include their understanding of flood risks and the limitations of local mitigation measures, their level of concern about flooding, what impact they think a flood will have on them, and their perceived ability to cope with flooding. Activities that help people learn about the need to prepare for flooding include, but need not be limited to:

- commemorative events, activities and promotions (displays, stalls, media – both editorial and advertorial – presentations, etc),

- the development of locally specific information products (brochures, inserts, hand-outs, fact sheets, etc),

- targeted displays and engagement activities (eg doorknocks and demonstrations),

- schools-based kits which include fact sheets and flood activities and are competency-based on current curriculum learning objectives,

- reminders of past flood events (flood markers, comparative photographs, etc), and

- the preparation of individual flood plans through the use of toolkits (eg for households, businesses and institutions.

Other educational activities that could help people and their communities improve their flood competencies and systems include:

- training SES volunteers in community education. Such training enables volunteers to help educate their local communities in formal settings (eg events). It also produces educators on the ground to help communities immediately before, during and after a flood,

- identifying and training community leaders in flood education so that they can help educate others in their networks,

- developing and maintaining ongoing community discourse about flooding and coping with different local flooding scenarios,

- using public meetings, working groups or focus groups to conduct community and agency reviews of preventative measures (eg floodplain management 'devices' such as levees) and coping systems (eg warning systems, recovery systems),

- providing vulnerable community sectors (eg businesses), organisations (eg caravan parks) and groups (eg the aged, people of non-English speaking backgrounds, people who have no idea of what they should do or do know what to do but are unable to do it at the appropriate time) with specifically tailored educational activities to develop their competencies to cope with a flood event, and

- conducting meetings to discuss flood effects and how people should respond to coming floods. Ideally, individual meetings should involve only small numbers of people.

The measures which are adopted should be recorded in flood emergency plans.

To be resilient, communities need to learn from flood events to increase their preparedness levels and improve their capabilities. Apart from further refining the types of flood education described above, post-flood education activities could include or make use of:

- social research (eg surveys and focus group discussions) to find out how effective the warning, evacuation management and recovery support systems were, how effective the past flood education initiatives were and how these things can be improved,

- agency debriefs, the learning from which should be used to improve management systems and agency competencies,

- oral histories, which allow people to recount their stories about the flood event and to identify further opportunities to learn how to better prepare and cope with future floods, and

- community debrief meetings to identify problems in preparation, response and recovery and to identify possible sources of improvements.

This list is not prescriptive or necessarily complete. Community education needs to be adaptive to the needs of local communities and to explore educational options in a search for the approaches and methods that offer sound fits.

Traditional approaches to flood education focused largely on raising 'flood awareness' within the community. But **awareness by itself is not sufficient** to guarantee that people will act appropriately to save belongings and maintain personal safety. Neither is the institutional belief that as 'experts', the emergency services can direct people on what to do in these situations with any certainty that they will automatically do it.

Flood education must seek a **progression to a state of preparedness to act**. When people have a real sense of their exposure to the flood risk, have developed a personal understanding of what they can do to mitigate the threat and feel supported by the emergency services, they will be more capable of responding to warnings with appropriate actions (whether these involve avoiding particular routes on the journey to work, stocking up on food and other essentials, lifting or relocating belongings or evacuating their dwellings).

It also must be remembered that no matter how aware, knowledgeable and prepared people may be for flooding, and how engaged they feel with any response process, their behaviour cannot be guaranteed when they are placed in an actual flood situation. This is the nature of dealing with behaviour in a risk context.

Developing a Local Community Education Strategy

A community flood emergency plan contains information on the threat, the problems it will pose and the intended management of those problems. In a broad sense (though not necessarily in terms of detail), community members need to understand this information. As a principal source document on flooding, the plan should be made available to the community as well as being used to drive the preparation of a **community flood education strategy** incorporating an engagement and delivery strategy as well as a media strategy.

In developing a community flood education strategy, a number of practices should be included:

- Community flood education strategies should be developed in partnership and collaboration with communities to assist in the maintenance, sustainability and improvement of the constituent educational activities.

- Programs should be delivered through community groups, whereby communities are empowered to research, plan, implement and evaluate their own activities.

- Emergency agencies such as the SES should act as consultants to communities (eg facilitators, resource providers, change agents and coordinators) rather than directing the change process in a top-down manner.

- Opportunities for cross-hazard (and cross-agency) programs should be identified and implemented where possible.

- Flood education strategies should be incorporated in floodplain risk management and emergency planning processes.

- Flood education strategies should be linked to flood warning systems so that warnings can have the direct effect of triggering appropriate response behaviours. This relationship should be clearly communicated through education programs.

It is suggested that flood education strategies should have a life of no more than three years before they are revised. Strategies should consist of:

- a background explaining the local flood scenarios, community features and applicable warning services,

- the vision, outcomes and main strategies to achieve the outcomes,

- an implementation plan in tabular form that shows the main activities for each strategy, a time frame for rollout, and responsibilities and costing for each activity,

- an engagement strategy relevant to the local community, and

- an evaluation plan to show how the plan and its outcomes will be assessed and improved during the life of the plan and at the end of the plan's life.

Particular attention needs to be given in flood education strategies to building:

- understanding and trust in the warning services that are provided and how people can relate warning messages to their own circumstances,

- people's understanding of what they need to do to maintain their personal safety and protect items of importance.

A flood education strategy can be a valuable tool to publicise the existence of flood threats and to debunk the erroneous beliefs and myths which are common in flood-liable areas. These include:

*   the notion that the very severe floods seen in an area in the past will never be equalled in scale in the future,

*   the belief that mitigation devices such as dams, levees, diversion channels and retention basins will render future floods harmless (in this context, building a recognition that town-protecting levees will on occasions be overtopped is crucial), and

*   the idea that flood education will damage real estate values.

The strategy's prime purposes should be to remind people in flood-liable areas that the threat continues to exist and to indicate to them that there are things they can do to limit the consequences of their exposure to flooding.

The most effective flood education strategies are strongly **local** in content. They use local information (eg on flood consequences at specified flood heights) and explain how local warning services operate. They refer by name to areas which are familiar to their target audience.

The Local Flood Education Strategy Committee

To enable a robust and relevant education strategy to be developed, the community must be involved with its development and implementation. By utilising or building localised community networks and including representatives from sectors that are affected by flooding, the strategy will be more robust in nature and will be driven at the local level. Accordingly, behaviours will have a better chance of being adopted in local cultural norms.

A local flood education strategy committee could consist, as applicable to the community, of:

*   local residents,

*   rural landholders,

*   local business representatives,

*   representatives from other sectors and groups (eg schools and caravan parks),

*   local council staff,

*   Catchment Management Authority personnel,

*   emergency services personnel (volunteer and paid representatives), and

*   other agency staff.

With such a committee membership, the strategy will be seen as creating a blueprint for action for the local community to develop, using local responses defined from within the local community.

Using the Strategy

Copies of the completed community flood education strategy should be placed in council libraries and in schools, hospitals, nursing homes and council information centres. It should also be available, where appropriate, in non-paper form, eg on CD or on an internet home page. The strategy's availability should be publicised regularly in local media outlets to coincide with anniversaries of significant events and immediately preceding the flood season (if one exists).

Developed resources (eg booklets and fact sheets) could be included in council welcome packages for new residents and business owners as well as being promoted to sectors such as real estate and tourism. Equally, such items could be displayed and made available from council information offices and at council rates desks.

Potential Content Elements

It is important to recognise that not everything which is known about flooding needs to be conveyed to the at-risk community. Some selectivity is necessary so that people are not overwhelmed by the information provided. The key information relates to:

- the potential for flooding in the area,

- the consequences of flooding of different levels of severity,

- the warning services that are available in the area and how they should be utilised as a flood is developing. This element is particularly important given the evidence that many people neither understand nor trust existing warning services; in essence, they need to be educated about warnings as well as about flooding,

- how people can plan for floods, and

- what individuals can do to manage flooding as it is developing.

Delivering Flood Education: Some Pointers

There is no single flood education method which can or should be employed over all others. Community flood education needs to be diverse (as communities are) and flexible enough to incorporate a range of program, delivery and output options. There are, however, several factors which should guide the planning of such programs and be incorporated into community flood education strategies. These are:

- Community education involves delivering a range of initiatives which can be layered upon one another. Strategies need to be broad and varied in approach. To reach a lot of people, breadth and variety will give the benefit of repetition of messages as well as reaching out to different parts of the community. Along with these approaches, some delivery options need to be specific and targeted or have very specific messages tailored to different sections of a community. Different people also learn from different sources and styles of presentation, and variation will help maintain interest and allay boredom. It is important to maintain a varied and multi-levelled approach to educating all members of the community about floods.

- Events should be planned for particular times of year, preferably at or near the beginning of the community's flood season, if there is one, or at the time of the anniversary of a significant flood event. It is at these times that community attention is most likely to be obtainable. Times of drought, by contrast, are likely to be less favourable for such activities, but to avoid long periods with no flood educational activity some initiatives may need to be undertaken during periods of little rainfall. Flood education campaign planners must recognise that both success and cost-effectiveness will be maximised at those times when message receptiveness is high. It is not the convenience of agencies with responsibility for educating the community, but the likely receptiveness of the community itself, which must be the primary driver of how and when the educational task is undertaken.

- Media cooperation is important to program success. A flood commemoration, for example, could be publicised by a newspaper campaign carrying articles about the community's flood history. Newspapers can also be encouraged to record and publish interviews with people who actually experienced the event being commemorated, and to publish maps showing the areas which were inundated. This campaign could also exhibit parts of the local flood emergency plan during a council-declared 'Flood Readiness Week' and feature displays mounted by agencies with interests in flood management matters. The newspaper would, in effect, be advertising and building interest in the commemorative activity, and council support would give it further credibility. A commemoration also provides an opportunity to publicise the flood warning services which have been developed, the flood mitigation measures which have been adopted and the steps which people can take to prepare for future floods: all of these themes can be taken up in newspaper articles and in interviews on local radio stations. Extracts from the community flood education strategy should be made available to newspapers and radio stations for use in articles and interviews.

- Partnerships should be purposefully created between emergency services and other stakeholder organisations on the one hand and community representatives on the other. The organisations may include local councils, the appropriate water, catchment and emergency management/ counter disaster agencies and local or regional media organisations. Attention should be given to ensuring programs and activities are kept interesting, with appropriate variation of items and use of modern technology in the delivery. A great deal of the experience, knowledge and resources necessary to mount these campaigns will already be present within the community.

- Flood education programs should be repeated from time to time to maintain high levels of understanding of the threat and of the warning and other arrangements which have been devised. This is because community flood understanding will decline without periodic reminders, and because community composition will change over time as will the content of important documents, including the flood emergency plan. Repetition should incorporate new and updated material and, where appropriate, revised strategies. This is vital to keep the information fresh and relevant and to ensure it is presented in ways which compel attention.

- Where possible, links with other hazard education programs and processes should be sought. This is especially appropriate in rural and urban fringe areas where there may be opportunities to link with fire authority education programs. Flood education programs would also be well linked to education initiatives about catchment management. Such combinations will avoid duplication of effort and will utilise combined competencies and resources. Moreover, they recognise that the community tends to seek a 'one-stop-shop' for hazard education. Combined displays at events such as stalls and community barbeques or co-presenting at community group meetings offer opportunities.

- In all instances, campaigns should be incorporated in the local flood education strategy. This will be an effective way to design, implement and evaluate activities on an ongoing and formal basis. The strategy should be 'driven' by the local flood education committee with the purpose of creating a flood-resilient community. The key principle is to seek engagement at the local level by local people.

- Community Service Announcements (CSAs) about flooding should be played over radio and television to publicise the existence of flood problems and their management. These would highlight the need to listen to advice given over the radio or by doorknockers and to take appropriate action when floods are imminent. The CSAs should be no longer than 30 seconds each and should be used just before or during the flood season or as a flood is actually rising. Newspaper equivalents could also be devised. Stories could be developed incorporating the building of flood readiness throughout the year and triggering the actions required to maintain a level of readiness in the community.

- Public meetings could be held to launch, discuss or review the strategy and its provisions. Such meetings would normally be with people frequently or severely affected by flooding and could be held in conjunction with local flood lobby or residents' action group meetings. Engaging the community to be active participants in the planning and development of future strategies will give them ownership and will enable them to 'drive' local flood education.

- Flood markers indicating the heights reached by past floods in the area can be installed. The markers may be plates attached to power poles or other convenient, visible and permanent structures or specially constructed 'totem poles' or billboards noting the levels at which the various historical floods peaked. These should not be 'hidden' from view in parks well away from dwellings or business premises, although some business and council interests may argue against placing them near houses and business districts for fear of negative land value effects. These effects have been shown to be largely illusory (see Yeo, 2003). In addition the markers should indicate the heights reached in **actual** past floods rather than the heights which have been estimated for floods of specified annual exceedence probabilities (eg the 5% or 1% AEP floods): these lack realism and resonance in the minds of community members. An unveiling of the signs could be used to publicise the risk of flooding to the community and to 'connect' in people's minds the flood heights noted with the warning services provided.

- Height levels on key gauges for which flood warnings are provided are often located at bridges and causeways and should be clearly marked and visible from considerable distances. Such markings help people to obtain an idea of the flood levels forecast to be reached in flood warning messages and the areas which are likely to be inundated at those levels.

- Signage on evacuation routes indicating that the route is designated to specified communities during flood periods can be provided.

- Information (letterbox) drops using flood action guides, information on warning services and other printed material on floods can be valuable. These could be used for areas at high risk of flooding, such as caravan parks on river banks or residential, commercial and industrial areas located on low-lying floodplains. Equally, information could be made available in the form of kits at community shows and field days or in talks given by flood managers to schools, service clubs and other community groups. It could also be provided with council rates notices or other council communications with ratepayers. Such information should be customised to small areas and should focus on material which is specifically relevant to them (including maps showing the locations of evacuation centres and any designated evacuation routes). Local known areas that are subject to flooding should be noted. Specific information can also be translated into different languages.

- Photographic displays depicting the impact of past floods in the area provide graphic illustrations of the potential for flooding. Similarly, GIS outputs can be made available in libraries and schools to illustrate the extent and depth of inundation for floods of different severities. These need to be visually large and kept simple.

- School projects can be established on floods and flood management.

- Councils can be encouraged to strike multiple CD ROMs or videos containing flood information, including flood maps and plan extracts for issue or sale to the community. These could contain footage of recent floods and commentary linking the event to the local flood emergency plan and illustrating what people should do during future events. Videos of recent floods can help remind people of what flooding can do and how they should respond next time.

- Internet sites with information and interactive components can be developed.

- Flood commemorations to remind communities about past significant floods, especially those which occurred within the memory of the present community, can be held. Such commemorations could incorporate:

  - launches of flood plans,

  - displays of flood photographs and other memorabilia,

  - publicity being given to council flood maps and flood-related zoning of land,

  - guided tours to inspect local mitigation systems incorporating diversion channels (floodways), levees and spillways,

  - written or oral briefings about warning systems and how people can use the warnings issued, and

  - street parades featuring flood response agency personnel.

Private Flood Emergency Planning

Private flood planning should be encouraged for all individuals and families in flood-liable areas as well as for businesses, infrastructure operators and institutions (such as schools, nursing and retirement homes, libraries, art galleries, museums, jails and churches). People should be encouraged to write down the results of their planning and to store their plans in safe places. The plans should incorporate:

- information on the flood risk at the relevant dwelling, business location, infrastructural installation or institution. This information should include, where possible, estimates of the conditions (eg flood heights at the relevant flood warning gauge) in which inundation of the property and of

building floors would occur and at which local evacuation routes would be inundated,

- actions required to maintain the personal safety of the occupants of the site (including evacuation, specifying what needs to be done in preparing for evacuation and what route should be taken to reach safety);

- actions required to protect items of importance such as:

  - (in dwellings): photograph albums, other precious items of sentimental value such as family heirlooms, important papers and moveable furniture and furnishings, as well as family pets,

  - (in business premises): stock, records and computers and other equipment,

  - (for infrastructural operators): items that should be moved, raised or protected by flood barriers,

  - (in institutional premises): records, books, artworks and heritage items,

  - trigger points for action (for example, a flood warning indicating likely inundation of the property, or reaching floor levels, or being likely to close evacuation routes.

- reminder messages on the do's and don'ts of behaviour during floods (such as not entering floodwaters on foot or in vehicles).

Input for private flood plans should be obtained from community flood emergency plans, education strategies, council and emergency services information and by conducting workshops for residents, businesses, institutions and the operators of infrastructural assets. These workshops would seek to prompt people to define what needs to be protected, how the protection should be achieved and how an evacuation should be prepared for and undertaken.

Such planning can be facilitated by the provision of templates for private flood plans.

Ongoing Educational Initiatives

It is important that flood education programs, using strategies of the types outlined above, be carried out periodically to maintain and renew learning processes. They must be carefully planned to attain a critical mass of public interest, something which can be achieved by using several different initiatives in concert. Unlike many other types of community education that address everyday behaviours (eg health and road safety), flood education is 'challenged' because floods in most parts of Australia are not usually frequent and the time of occurrence of the next flood in a specified area cannot be known. To be effective, flood mitigation behaviours need to be learned and then maintained over what could be a long period of time.

In short, communities need to continually build and maintain their competencies and systems so that they are 'fit for use' when flooding occurs. Community education planning should be seen as an ongoing endeavour, not just a single campaign.

Evaluation

Evaluation should be an integral part of the local flood education plan and the campaign initiatives which flow from it. This evaluation will inform improvements for future programs and education activities. There are two categories of program evaluation (see Dufty, 2008). These are:

- **summative evaluation**, which measures the plan's success or failure by comparing outcomes with original goals, and

- **formative evaluation**, which measures the plan's progress against ongoing benchmarks and allows the Local Flood Education Committee to make 'course corrections'.

Evaluation of the plans and activities should use both types of evaluation. It should strive to gauge the appropriateness and effectiveness of the plans and the educational activities by measuring success in the following:

- delivery of the plan actions and education activities,

- levels of community preparedness,

- competencies and systems in place to adapt to a flood event,

- responses to flood events, including use of appropriate mitigation behaviours,

- recovery after a flood event, and

- learnings and improvements to preparedness, competencies and systems after a flood event.

A major tool in this evaluation should be social research to help measure these 'indicators of success'. This research can include surveying of landholders and others affected by flooding, as well as holding focus groups and debriefing meetings and recording oral histories. Anecdotal observations from landholders, community members and emergency agencies should be useful in adding to the more quantitative methods such as surveying.

Educating Decision Makers

Other people besides those with personal interests in flood-prone areas need to understand the flood threat and be encouraged to support the community education objective. Among the people who should be targeted by those who are responsible for community flood education are local government

councillors, who periodically make decisions about flood-liable areas (including decisions about flood markers and other signage or about development applications).

Some Community Flood Education Initiatives in Australia

Some particularly effective materials were developed in Victoria during the 1990s to communicate with and educate community members about flooding and flood warnings. This work involved cooperation between the Bureau of Meteorology, the State Emergency Service and local councils and produced excellent booklets which reminded people in flood-prone locations about past floods and provided tips on what to do to manage future ones (see, for example, Delatite Shire 1997 and Shire of Strathbogie 1997). Information on local flood risks and flood warning services was provided, as was encouragement to write personal (household or business) flood plans.

More recent initiatives of note include the NSW State Emergency Service's **Business FloodSafe** initiative (www.ses.nsw.gov.au/floodsafe/businesstoolkit), the Hunter-Central Rivers Catchment Management Authority's and NSW State Emergency Service's community flood education strategy, **Building Community Capacity for Flood Safety in Maitland and the Hunter Valley** (2006), and the Tasmanian Flood Warning Consultative Committee's **Floods and You** (www.ses.tas.gov.au/ Publications/). In addition, the NSW State Emergency Service has produced dozens of brochures (called FloodSafe Guides) about flooding, flood warnings and flood management for individual communities across the state: these are aimed in some cases at communities of only a few scores of people. They are available from the organisation's website (www.ses.nsw.gov.au). In Queensland the Bureau of Meteorology provides flood material, including information on flood risks, flood forecasting and the interpretation of flood warnings, for individual river catchments (www.bom.gov.au/hydro/flood/qld/brochures/index.shtml). In South Australia, on-site meetings with individual householders and businesses have been conducted to discuss the flood problem at the site (Johnston et al, 2007), and a major FloodSafe Program developed by the State Emergency Service and councils has been developed (www.ses.sa.gov.au/site/community_safety/floodsafe.jsp)

Some of these sources present material in 'kit' form, some are for school projects and some are published as DVDs. They have been used to educate the members of flood-prone communities about the existence of flood problems, how to utilise flood warnings, how to plan for floods and what to do as a flood is approaching. Some of them also outline the educational strategies which have been employed in their areas.

Personnel in key governmental land use planning authorities, too, need to understand the need for community flood education and the difficulties which flood educators face. They should be appraised

of new flood risk information which should be applied to future land use planning reviews and should be made cognisant of the scale and difficulty of the flood education task.

Both these groups, if they permit excessive development in flood-liable areas, exacerbate the difficulties involved in community flood education by increasing the vulnerability of the community and ensuring that a larger educational task must be undertaken.

Flood Intelligence Collection Sheet

Date: Unit: Observer: Contact No:

Time	Location	Description

Example

Time	Location	Description
0900	Smith St, Karodan	Six houses in lower end of Smith St flooded to one metre over-floor
0900	Thomas St, Karodan	Thomas Street beginning to flood. Water coming across from Regal Park
1100	Benson Hwy	Benson Hwy not flooded at Fords Bridge

Complete sheet by recording the **time** of observation, **location** of observation and flood **effects** observed

Remember it is just as important to record the observation of effects that are **not** occurring as it is to record the effects that **are** occurring

Return completed sheet to Planning Officer. Planning section to collate sheets and forward to Region Headquarters

A Sample Flood Intelligence Record

Flood Intelligence Record

Nevagazunda Gauge – Station Number: 310065

Monday, 2 February, 2009

Accuracy:

Use this information as a guide to the possible effects of a flood. The card is based on estimates of flood behaviour and particular effects may occur at heights different from those indicated here. They may also occur at slightly different heights in different floods.

Confidentiality:

This card may contain sensitive information about the effects of flooding on private property. Specific reference to private addresses or businesses must be made directly to owners or other emergency services but **not** via broadcast or print media.

Stream: Stopper River

Gauge Zero: 0.0m

Location: Located on the Nevagazunda Bridge over the Stopper River

Datum Type: AHD

Minor: 1.5m   **Moderate:** 2.5m   **Major:** 5.0m   **Levee Height:** 5.0m

Note: The Bureau of Meteorology is generally able to predict flood heights 12 hours in advance of major flooding at Nevagazunda.

Height (m)	Consequences
1.50	Water starts to break out of the Stopper River, flooding low-lying farmland to the south of Nevagazunda. Livestock and equipment need to be relocated to higher ground.
2.50	1 in 10 year flood level.
	The town common is flooded. This is a popular spot for campers during the summer months and during the annual Knee Knockers festival held in the last week of February. At the peak of the festival, up to 1000 tent sites may be occupied.
	Deck height of the old bridge over Kneys Creek. During flooding on the Stopper River, water can back up along Kneys Creek, closing this bridge and isolating up to 20 rural acreages east of Nevagazunda. During past flood events, access from these properties into town has been lost for up to one week.
3.50	The Nevagazunda Caravan Park is flooded. The van park has a normal occupancy of 50 people, but this can rise during peak periods to over 300. The park consists of 40 van sites, 10 of which are permanent, and 70 tent sites. Note: tent sites are located close to the river bank.

5.0	Peak height, 3 October 1974. During this event, a flood runner crossed Bank Road closing it to all traffic.
	1 in 20 year flood level. This is the design height of the Old Nevagazunda levee. The overtopping or failure of this levee will result in over-floor flooding of 100 residential properties and approximately 40 businesses in Old Nevagazunda. A further 20 residences will have flooding in their yards. There is a large proportion of elderly persons living in this area.
	Widespread rural flooding occurs in the areas south of Nevagazunda and approximately 15 rural homesteads are inundated over floor level.
5.50	Crest height of the Old Nevagazunda levee. The western approach to the Nevagazunda bridge over the Stopper River (on Kings Road) is now closed.
6.50	1 in 50 year flood level.
	200 residential properties and 50 businesses flooded over-floor in Old Nevagazunda. A further 40 residences experience flooding in their yards.
	Water breaks out of the eastern bank of the Stopper River and flows into the lower south-western part of the Nevagazunda Central Business District (CBD), inundating 20 to 30 businesses premises.
	The northern approach to the Kneys Creek Bridge closes at the intersection of the Central Highway and Bank Road.
	All access roads to and from the Swampy Heights area are now closed by floodwater except the Queens Road. This road stays open until the 1% flood height (7.0 metres).
7.00	1 in 100 year flood level
	Queens Road is closed to all traffic. This is the last evacuation route from Swampy Heights. Swampy Heights becomes a flood island. Further river rises will result in the flooding of properties in Swampy Heights.
	300 residential properties and 70 businesses flooded over-floor in Old Nevagazunda. A further 20 residences experience flooding in their yards.
	Extensive rural flooding downstream of Nevagazunda with up to 30 rural homesteads inundated and many more isolated.
7.10	Floodwaters begin to enter Swampy Heights. Approximately 500 properties experience flooding of their yards.
7.60	Approximately 500 homes in the Swampy Heights area have flooding over the floor up to 0.1 metres deep.
7.80	Approximately 1000 residential properties in Swampy Heights experience over-floor flooding up to 0.3 to 1 metre deep.
	A minimum of 9 hours is required to evacuate Swampy Heights (assumes 28 doorknocking teams available).
9.50	90 businesses in the Nevagazunda CBD are flooded over floor by this height.

10.50	1 in 200 year flood level.
	400 residential properties and 90 businesses flooded over-floor in Old Nevagazunda. 1000 residential properties experience over-floor flooding (2.8 to 3.0 metres deep) in Swampy Heights. 160 businesses flooded over-floor in the Nevagazunda CBD.
11.20	Probable Maximum Flood (PMF) level.
	500 residential properties and 120 businesses flooded over-floor in Old Nevagazunda. 1000 residential properties flooded over-floor in Swampy Heights (3.5 to 3.7 metres deep). 250 businesses flooded over-floor in Nevagazunda CBD.

ANNEX C

A Checklist for Vetting for Quality

Preferably, evaluation of a plan should be carried out by people who have experience in emergency management but who were not involved in writing the plan. This will help make sure the appraisal is undertaken with appropriate detachment. The evaluation should involve an assessment of the plan's technical suitability to its purpose – that is, the likely effectiveness of its management provisions – and an examination of the level of community ownership and support it has achieved and is likely to achieve with any educational program it proposes.

Evaluating the Flood Emergency Plan

Evaluation of a flood emergency plan must be rigorous. Flaws should be detected and rectified. It must ensure the plan meets the requirement of providing 'an organised method by which things are to be done', it must have a clear statement of intent and objectives, and it must be easy to read and comprehend. In short, it must be 'fit for purpose'.

The following checklist is not exhaustive but the flood emergency plan should be assessed against the following criteria after preparation and periodically thereafter:

Authority: Does the plan clearly state the source of its authority?

Ownership: Is there evidence that the plan is owned and accepted by the community? Do the members of the community know about it and understand its elements? Is there an effective program to increase and then maintain community understanding, acceptance and ownership of the plan?

Objectives: Is the plan easy to read? Does it have a clear statement of intent and objectives?

Scope: Does the plan clearly set out its scope? Does it identify such things as any assumptions used in its preparation, any limitations imposed on it, the range of events it has been written for and the relationship between it and any other management plans?

Flexibility: Does the plan allow flexibility of approach so that it can meet unexpected operational realities? Does it allow for 'what if' questions to be asked?

Scale: Does the plan clearly define the scale (magnitude) of the flood events it covers, with different procedures for events of differing scale if appropriate?

Completeness: Is the plan complete in terms of coverage of foreseeable problems and identified solutions to those problems?

Users: Does the plan clearly describe and meet the needs of the communities which are the subject of the plan? Does it identify the user groups, those involved in the preparation and those who will have to apply it?

Agencies' Needs and Responsibilities: Does the plan meet the needs of all who will use it? Is the relationship between different response agencies clearly spelled out? Can agencies and individuals quickly and easily identify their areas of responsibility?

Physical Description: Does the plan contain sufficient information in words, maps, tables and drawings about the characteristics of the area covered for an outsider to understand both the area and the hazard without referring to other documents?

Hazard Analysis: Does the plan contain a concise statement of the results of the hazard analysis undertaken as part of its preparation?

Community Analysis: Does the plan contain a concise analysis of the community at risk from flooding of whatever relevant type?

Lifelines: Does the plan contain a concise analysis of community lifelines in relation to service delivery and infrastructure support? Does it identify any vulnerabilities and propose treatments or actions?

Activation: Does the plan clearly state the triggering processes for its activation? This should specify who can activate the plan and what notification procedures will follow.

Management: Does the plan clearly set out the responsibilities that will prevail once the plan is activated and who is in overall control? Does the plan detail the management systems to be used in various phases (eg warning, response and recovery) of an event?

Review: Is there an effective review process which includes community education and involvement and which ensures currency of the plan? Will the reviews be capable of identifying and responding to changes in the flood threat, the community at risk and the agencies and organisations with roles to play?

Standing Operating Procedures (SOPs): Do the agencies listed in the plan have detailed procedures as to how specific activities are to be undertaken or how sectors are to be managed?

Document Management: Has the plan been prepared in a practical way that allows for ease of amendment? Is it complete with a distribution list and an amendment list? Does the plan contain a glossary of terms that may not be known to users? Does it use appropriate practices with regard to numbering, tracing and updating copies?

Floodplain Classifications

Access road cut and no overland or alternative road access possible	Island below predicted flood level	N/A	**Low flood island** ('shrinking island')
	Island above PMF	May or may not have failed	**High flood island**
Access road cut and no overland or alternative road access possible	Below predicted flood level	N/A	**Low trapped perimeter**
	Above PMF	May or may not have failed	**High trapped perimeter**
Access road cut but overland escape/rescue possible on foot or AWD vehicle	Below predicted flood level	N/A	**Overland escape route**
Access uninterrupted and via all-weather rising road (usual route or alternative)	Below predicted flood level	N/A	**Rising road access**
Access uninterrupted and via all-weather rising road (usual route or alternative)	Above predicted flood level	One or more services failed	**Indirectly affected area**

Acronyms and Glossary

AEP: Annual Exceedence Probability
The chance, expressed as a percentage, of a flood equalling or exceeding a given size (usually measured as the peak height recorded at a gauge)

ARI: Average Recurrence Interval
The long-term average length of time between floods of a specified size at a given location, expressed in years.

CSA: Community Service Announcement
An announcement made over the electronic media, often about emergency matters and intended to be of community benefit.

DCF: Dam Crest Flood
A flood which reaches the crest of a dam wall.

Floodplain
The land which may be covered by water when a river overflows its banks during a flood. The extent of a floodplain will normally be greater than the area covered in the 1% AEP flood, its ultimate extent being defined by the PMF.

GIS: Geographic Information System
A computerised database for the capture, storage, analysis and display of locationally defined information. Commonly, a GIS portrays a portion of the earth's surface in the form of a map on which information is overlaid.

GPS: Global Positioning System
A satellite-based navigational system used for determining location, often expressed as a peak height at a gauge.

IFF: Imminent Failure Flood (for a dam)
A flood which, if exceeded, will cause a dam to fail.

PMF: Probable Maximum Flood
An estimation of the largest flood that could occur at a particular location.

SEWS: Standard Emergency Warning Signal
A specific siren sound, designed for playing over the electronic media, to alert people to an emergency announcement that is about to be made.

SOPs: Standing Operating Procedures.

References

Australian Emergency Manuals Series:

    Manual 19 **Managing the Floodplain**

    Manual 21 **Flood Warning**

    Manual 22 **Flood Response**

    Manual 23 **Emergency Management Planning for Floods Affected by Dams**

Bureau of Transport Economics (2001). **Economic Costs of Natural Disasters in Australia**, Report 103, Canberra, Department of Transport and Regional Services.

Coates, L (1996). An Overview of Fatalities from some Natural Hazards in Australia, **Proceedings of the NDR96 Conference on Natural Disaster Reduction** Heathcote, RL, Cuttler, C and Koertz, J, eds), Surfers Paradise, pp49-59.

Crowe, P, Cinque, P and Davies, B (2003). GIS and Spatial Data in the Service of Flood Management: a Report on an Initiative of the SES, paper presented at the 43rd annual conference of the Floodplain Management Authorities of New South Wales, Forbes.

Delatite Shire (1997). **Benalla Township and Rural Surrounds: Flood Response Guidelines**.

Dufty, N (2008). A new approach to community flood education, **The Australian Journal of Emergency Management**, 23 (2), pp4-8.

Hunter-Central Rivers Catchment Management Authority and New South Wales State Emergency Service (2006). **Building Community Capacity for Flood Safety in Maitland and the Hunter Valley**, Community Flood Education Strategy.

Intergovernmental Panel on Climate Change (2007). **Climate Change 2007: the Physical Science Basis**, IPCC Fourth Assessment Report (Working Group 1), Geneva.

Johnston, L, Wright, C and McArthur, J (2007). Developing and Implementing a Flood Awareness and Preparedness Programme, **Journal of Business Continuity and Emergency Planning**, 2 (1), pp70-81.

Keys, C (2008). **Maitland, City on the Hunter: fighting floods or living with them?** Hunter-Central Rivers Catchment Management Authority, Paterson.

Leigh, R and Gissing, A (2006). How many flood prone properties are there in Australia? paper presented at the 46th annual conference of the Floodplain Management Authorities of New South Wales, Lismore (www.floods.org.au).

Shire of Strathbogie (1997). **Euroa Township and Rural Surrounds: Flood response Guidelines for the Community**.

New South Wales State Emergency Service. **Business Floodsafe** (www.ses.nsw.gov.au/floodsafe/ businesstoolkit).

Standards Australia (2004). **AS/NZS 460: Risk Management**, SAI Global, Sydney.

Standing Committee on Agriculture and Resource Management, Agriculture and Resource Management Council of Australia and New Zealand (2000). **Floodplain Management in Australia: Best Practice Principles and Guidelines**, SCARM Report 73, CSIRO Publishing, Collingwood.

Tasmania Flood Warning Consultative Committee (2006). **Floods and You** (www.ses.tas.gov.au/ Publications/).

Yeo, S (2003). Effects of disclosure of flood-liability on residential property values, **The Australian Journal of Emergency Management**, 18 (1), pp35-44.