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## ABSTRACT

This report presents the findings of a project undertaken for the New South Wales (NSW) State Emergency Service (SES) on people's behaviour in and around floodwater. Key objectives of the project were to:

- A) Review and analyse studies that have been conducted on why people drive, ride, walk or play in flooded areas;
- B) Review and analyse current strategies employed in Australia and internationally to:
  - i. Provide advice for people driving in floodwater;
  - ii. Deter people from driving through and playing in flood water (i.e. public education strategies and other strategies currently in place); and
- C) From the findings of B) analyse the strategies that exist, suggest strategies that may be suitable to be implemented in NSW, and suggest new potential strategies that could be tested.

Findings from the literature review in Part A (Chapter 2) show that people are often unaware of the risks posed by floods despite living in flood prone areas. Those who are aware often significantly underestimate the potential impacts, are not concerned about the risk, or believe that a flood event will not personally affect them. The most common behaviours or activities that people choose to undertake in or around floodwater are driving, walking or recreational pursuits. Males and younger people (<30 years old) are more likely to undertake such activities. Most people who enter floodwater typically do so in order to reach a specific destination in their daily routines. The literature review revealed that a number of flood studies show that people may ignore warnings in order to maintain their daily routines such as travelling to and from work or dropping off their children at school. Only a small minority of people actually move into floodwater during evacuation. The most significant consequence of these various behaviours in and around floodwater is loss of life. Figures on flood fatalities have consistently highlighted the substantial proportion of vehicle, pedestrian, and recreation-related deaths and the overrepresentation of males and those belonging to the <30 and >60 age groups in these statistics. Other consequences of behaviours in and around floodwater include both short and long-term physical effects (e.g., broken bones, amputations and paralysis) and mental health outcomes (e.g., post traumatic stress, anxiety and depression). Overall, the findings of this literature review suggest that a significant number of flood-related deaths, injuries and other health effects could be prevented as they are the result of unnecessary risk-taking behaviour.

The review of potential strategies currently in use to address behaviour in and around floodwater (Part B - Chapter 3) revealed that only limited information exists for Australia and other countries. Aside from the US-based "Turn around, don't drown" campaign, most advice about floodwater behaviour is included in general flood material available to the public alongside hazard, flood management, and evacuation and recovery information. The dearth of literature available on flood behaviour programmes themselves, the success of these programmes, and their cost-effectiveness makes comparing the effectiveness of various strategies problematic. From the literature it is evident that providing information via one-way methods is not an effective use of resources or likely to bring about desired changes in behaviours. Research has shown that strategies with a strong community engagement based component are more effective in eliciting behaviour change, as a community will take

ownership of understanding and solving a problem. In terms of signage and barriers the literature review found that road signage used for flooding may not be effective for a number of reasons. However, despite its limitations, the use of carefully considered signage should not be discounted altogether, as it does provide some benefit in terms of educating the public about flood hazards and providing a warning of flood level or extent. No systematic program of evaluation has been carried out to test the effectiveness of signage campaigns, and should be considered as part of future research. Limited research on messaging shows that some messages may be more effective than others, and message construction should be a consideration as part of a strategy. One study also found that law enforcement and physical mitigation works, did provide some support to current educational/community approaches, and could also be considered as part of the mix of measures used in a strategy.

In terms of recommending future strategies (Part C - Chapter 3, Section 3.4.1), future efforts should focus on a community-based approach supported by a variety of other activities, including partnerships (e.g. with schools, media, community groups, businesses, etc), information dissemination (during quiescence and for warnings), messaging, and use of barriers and signage. Specific elements of behaviour and risk taking in and around floodwater could be identified in the strategy and specifically targeted as part of focussed campaigns. The framing of messages should be given consideration (e.g. using messages that build a community's capacity to respond and elicit an appropriate response from people), and consistency of these messages should be maintained. Finally the evaluation of strategies and programmes must take place to ensure pedestrian and motorist behaviour around floodwater is addressed effectively.

## **KEYWORDS**

Flood, floodwater, behaviour, pedestrian, motorist, drive, ride, walk, play, avoid, strategies, community, education, signage, New South Wales, Australia.

## 1.0 INTRODUCTION

This report presents the findings of a project undertaken for the New South Wales (NSW) State Emergency Service (SES) on people's behaviour in and around floodwater ("Pedestrian and Motorist Flood Scoping Study"). Key objectives of the project were to:

- A) Review and analyse current studies that have been conducted on why people drive, ride, walk or play in flooded areas;
- B) Review and analyse current strategies employed in Australia and internationally to:
  - i. Provide advice for people driving in flood water;
  - ii. Deter people from driving through and playing in, flood water (i.e. public education strategies and other strategies currently in place); and
- C) From the findings of B) analyse the strategies that exist, suggest strategies that may be suitable to be implemented in NSW and suggest new potential strategies that could be tested.

## 1.1 Methodology

The project primarily comprised a literature review of the reasons why people drive, ride, walk or play on or in flooded areas and strategies for addressing these behaviours. To undertake the literature review information was collated from a variety of sources including:

- national and international published papers;
- book chapters;
- reports;
- theses;
- unpublished material where available (e.g. agency websites, public education campaign material);
- discussions with experts (e.g. international flood researchers).

Following the collation of relevant material, the material was reviewed, an analysis of the review was conducted, and recommendations for the testing and implementation of future strategies were made.

## 1.2 Report outline

The report first reviews available literature to determine the reasons why people enter floodwater (Chapter 2). It also details public campaigns that currently exist to deter or guide people contemplating driving, riding or walking through, or playing in flood water (Chapter 3). Finally it makes some recommendations on future strategies (Chapter 3, Section 3.4.1) and provides a summary of the main points discussed (Chapter 4).

## **2.0 PEOPLE'S BEHAVIOUR IN AND AROUND FLOODWATER**

### **2.1 Chapter outline**

The first part of this report consists of a literature review focusing on people's behaviour in and around floodwater. The review is divided up into five main sections. It commences with a general discussion pertaining to the physical risk posed by a flood hazard, people's perceptions and knowledge of flood hazards, and the influence of warning systems on behaviour. People are often unaware of the risks posed by floods despite living in flood prone areas and even those who are aware, significantly underestimate the potential impacts, are not concerned about the risk, or believe that a flood event will not personally affect them (e.g. Becker et al., 2007a; Becker et al., 2008a; Micromex Research, 2005). Such perceptions and other social and warning system factors can all have significant implications for how people behave in and around floodwater. Second, the various ways that people behave in and around floodwater, the activities they undertake including driving, recreation, evacuation and rescue, and the characteristics of those who undertake these behaviours are examined. Third, the reasons why people enter floodwater are explored. The fourth section provides an overview of the consequences of people's behaviours in and around floodwater in terms of fatalities, injuries and health issues. The chapter concludes with a summary which draws together the previous sections.

### **2.2 People's perception of flood hazards**

#### **2.2.1 Risk perception studies**

Studies of risk perception examine the judgements people make when they are asked to identify and assess hazardous processes, activities and technologies (i.e., earthquakes, floods, chemicals and nuclear power plants) (Slovic, 1987; Wildavsky & Dake, 1990). These studies seek to examine what people mean when they say that something is, or is not, 'risky' and to establish which factors influence those perceptions (Slovic, 1987). The study of risk perception has emerged mainly as result of the observation that there are significant differences between experts' 'objective' assessments of risk, and lay persons' intuitive judgements of risk (Ho et al., 2008; Slovic, 1987).

Risk perception research has highlighted that a person's view of the risk posed by any hazard including flooding is shaped by a variety of different personal, social, cultural, and political factors (Sjoberg, 2000; Slovic, 1987; Wildavsky & Dake, 1990). At the individual level these include a person's knowledge, experience of, and perception of the immediacy of the hazard threat (Brilly & Polic, 2005; Burningham et al., 2008), as well as by people's values, attitudes, and biases (McClure, 1998, 2006; Renn et al., 1992). For example, an individual's perception of risk can be influenced more by personally salient issues (i.e., perceptions of the risk posed to their own health and safety or their property) than by the actual level of risk associated with any given hazard (Paton et al., 2006). On a broader scale, people's views can be shaped by the views of their friends, family and colleagues, how the hazard is portrayed by experts, the mass media and government agencies, and the degree of trust they place in these people and institutions (Burningham et al., 2008; Drobot et al., 2007; Slovic, 1987; Wildavsky & Dake, 1990). The following section provides a brief overview of some of the factors which contribute to the presence of a flood hazard. This is followed by an examination of the research that has been undertaken on people's flood perceptions.

## 2.2.2 The physical risk posed by a flood hazard

The danger floods pose to an individual's health and safety vary in time and space across a floodplain. Floodwater can be deep and swift at some locations and shallow and slow in others. There are a variety of factors which determine the flood hazard including (see Green et al., 2000; Jonkman et al., 2002; Lind et al., 2004; NSW Government, 2005):

1. velocity of floodwater;
2. depth at a flood site;
3. size of flood;
4. effective warning time;
5. flood readiness;
6. rate of rise of floodwater;
7. duration of flooding;
8. evacuation problems;
9. effective flood access; and
10. type of development.

For instance, the risks of death associated with a flood event are expected to be greatest when flow velocities are high, the onset of the event is sudden (i.e., flash floods), floodwater is deep, natural or artificial protective structures fail due to overtopping or collapse, and where extensive low lying densely populated areas are affected (see Green et al., 2000; Jonkman et al., 2002; NSW Government, 2005). As the focus of this first chapter is on people's behaviour the following sections elaborate on the risks faced by individuals who enter into floodwater either in a vehicle or on foot.

### 2.2.2.1 Vehicle stability in floodwater

The stability of a vehicle is influenced by the velocity and depth of floodwater at any given location (see Figure 1; Jonkman et al., 2002; Keller & Mitsch, 1992, 1993; NSW Government, 2005; USBR, 1988). For instance, when crossing a rapidly-flowing causeway small, light, low motor vehicles can become unstable when the depth of water is greater than 0.3 metres (CSIRO, 2000; EMA, 1999). Similarly, it is usually only feasible and safe for larger, higher sedans to proceed when water depths are less than 0.4 metres (CSIRO, 2000; EMA, 1999). Research has considered the influence vehicle mass and dimensions (height, length and width), buoyancy and drag forces have on the velocity of water needed to make a vehicle unstable at low depths, and also the depth at which a "water-tight vehicle" would float (Keller & Mitsch, 1992, 1993; Mens et al., 2008; Walsh et al., 1998). This research shows that as the depth increases the velocity required to make a vehicle unstable decreases (see Figure 1; Keller & Mitsch, 1993; Mens et al., 2008). This is because "the downward force of the vehicle is countered by increased buoyancy" (Mens et al., 2008, p. 46). It also illustrates that the stability of a vehicle is influenced by the vehicle mass and dimensions (height, length and width), buoyancy and drag forces. For example, vans, ambulances and fire engines remain stable in deeper and higher velocity floodwater than cars (Figure 2; Mens et al., 2008).

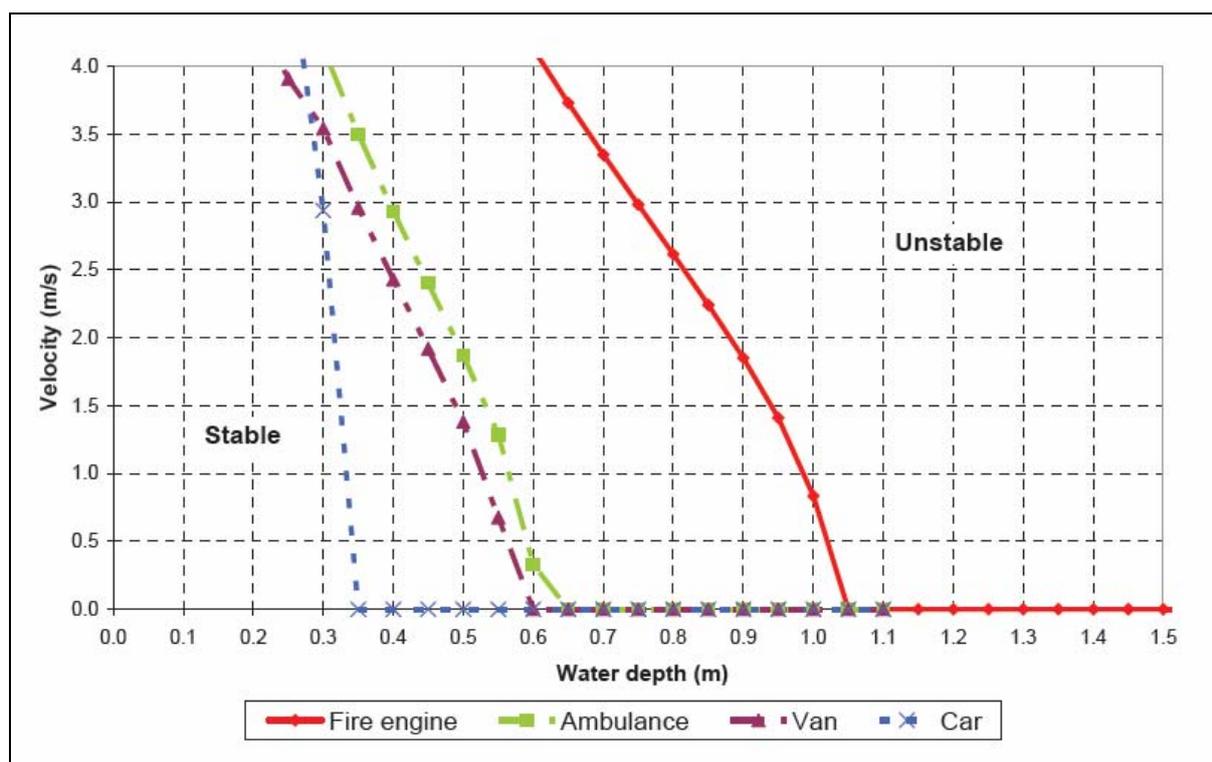


Figure 1 Vehicle stability curves for a car, van, ambulance and fire engine as a function of water depth and velocity. Source: Mens et al. (2008)

### 2.2.2.2 Pedestrian stability in floodwater

The velocity and depth of floodwater at any given location also influence the stability of pedestrians (Figure 1; EMA, 1999; Jonkman et al., 2002; Keller & Mitsch, 1992, 1993; NSW Government, 2005; USBR, 1988). Two hydrodynamic mechanisms are commonly identified as the cause of human instability. First, toppling (moment instability) happens in instances when “the force of the oncoming flow exceeds the moment due to the resultant weight of the body” (Jonkman, 2007, p. 177; Lind et al., 2004). Second, sliding (friction instability) occurs “if the drag force is larger than the frictional resistance between the person’s feet and the substrate surface” (Jonkman, 2007, p. 177; Keller & Mitsch, 1993). Further, floating is a hydrostatic mechanism, which usually occurs if the water depth exceeds a person’s height, as the density of the human body is similar to the density of water (Jonkman, 2007).

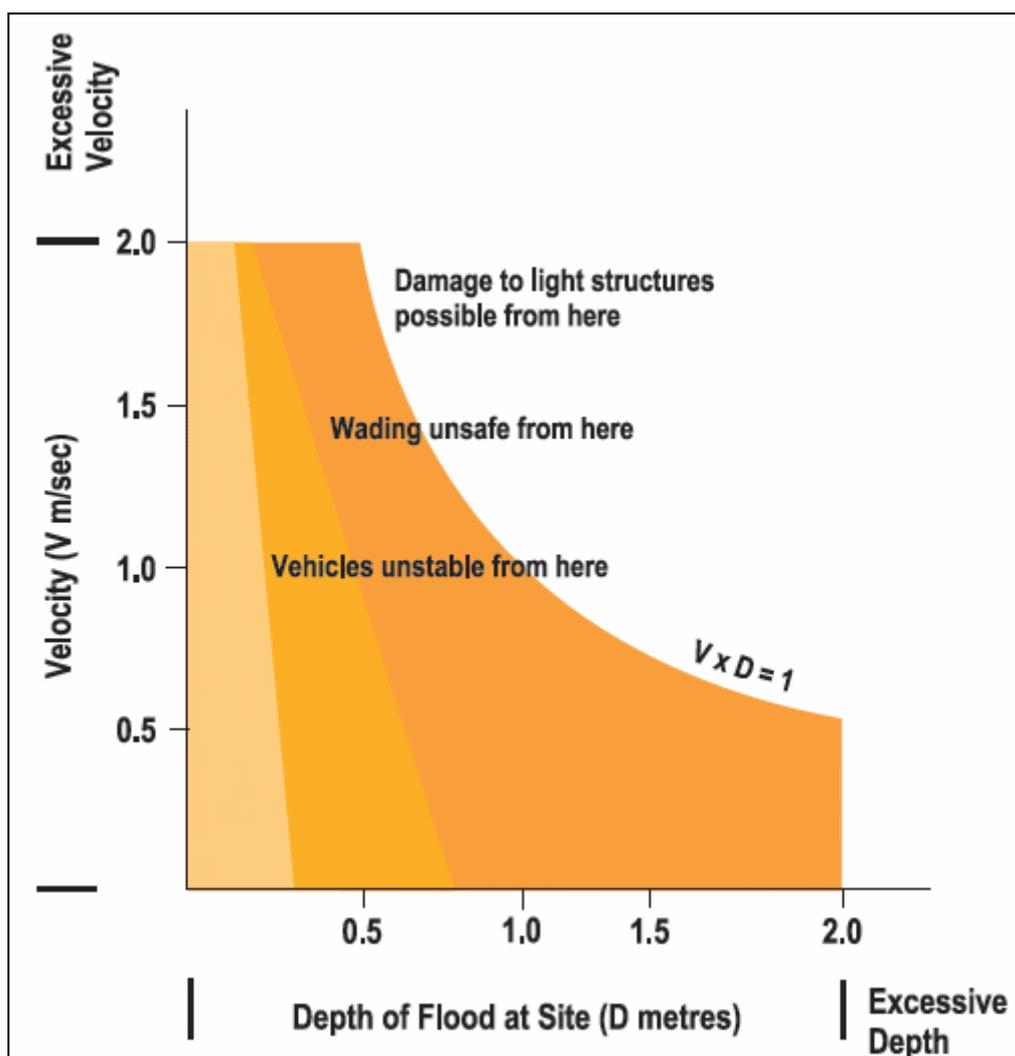


Figure 2 The influence of the relationship between the depth (metres) and velocity (metres/speed) of floodwater on the stability of vehicles and pedestrians, and the possibility of damage caused to light structures. The data presented in the figure is derived from laboratory testing and flood conditions which caused damage. Source: NSW Government (2005).

Emergency Management Australia (1999, p. 74) observe that it becomes difficult and dangerous for able-bodied adults to wade “when the depth of still water exceeds 1.2m, when the velocity of shallow water exceeds 0.8 meters per second, and for various combinations of depth and velocity between these limits”. Combinations of depth and velocity are referred to as depth-velocity products. Experimental studies have found people become unstable (topple or slide) in waters when the depth-velocity products range from  $0.6\text{m}^2/\text{s}$  to about  $2.0\text{m}^2/\text{s}$  (see Figure 1; Abt et al., 1989; Jonkman, 2007; Karovonen et al., 2000; Lind et al., 2004). On an individual basis a person’s ability to stay on their feet is influenced by their gender, age, weight, height, physical condition, duration of exposure and clothing (Abt et al., 1989; Jonkman, 2007; Karovonen et al., 2000; Lind et al., 2004). Typically, individuals who are males, middle-aged, heavy, tall, in good physical condition, and lightly clad are able to, on average, remain standing in higher depth-velocity products (Abt et al., 1989; Karovonen et al., 2000; Lind et al., 2004). The type of surface (concrete, gravel, turf and steel) and the slope of the ground can also be important but to a lesser extent (Abt et al., 1989; Karovonen et al., 2000; Lind et al., 2004). Overall, it is generally suggested that a depth-velocity product of 1.0 is the safe limit for pedestrians (Abt et al., 1989; NSW Government, 2005; Reiter,

2000). A more recent study has amalgamated the findings of Australian and International pedestrian buoyancy research and created a summary (Cox et al., 2010). The findings of this research are shown in Figure 3.

DV ( $\text{m}^2\text{s}^{-1}$ )	Infants, small children (H.M $\leq$ 25) and frail/older persons	Children (H.M = 25 to 50)	Adults (H.M > 50)
0	Safe	Safe	Safe
0 – 0.4	Extreme Hazard; Dangerous to all	Low Hazard <sup>1</sup>	Low Hazard <sup>1</sup>
0.4 – 0.6		Significant Hazard; Dangerous to most	
0.6 – 0.8		Extreme Hazard; Dangerous to all	Moderate Hazard; Dangerous to some <sup>2</sup>
0.8 – 1.2			Significant Hazard; Dangerous to most <sup>3</sup>
> 1.2			Extreme Hazard; Dangerous to all

<sup>1</sup> Stability uncompromised for persons within laboratory testing program at these flows (to maximum flow depth of 0.5 m for children and 1.2 m for adults and a maximum velocity of  $3.0 \text{ m s}^{-1}$  at shallow depths).  
<sup>2</sup> Working limit for trained safety workers or experienced and well equipped persons ( $D.V < 0.8 \text{ m}^2\text{s}^{-1}$ )  
<sup>3</sup> Upper limit of stability observed during most investigations ( $D.V > 1.2 \text{ m}^2\text{s}^{-1}$ )

Figure 3 Summary of pedestrian stability in floodwater research from Australian and International sources (Cox et al, 2010).

There are numerous additional risks other than depth and velocity that need to be considered in assessing the safety of walking or wading in floodwater. These include whether the ground surface is even or whether it includes depressions, potholes, ditches, fences or major stormwater drains, and the likelihood of being injured by stationary or moving objects (i.e., branches, materials from collapsed buildings) (EMA, 1999; Green et al., 2000). Whether vehicle or pedestrian stability research is useful for individuals making decision is unknown. The key issues are:

- How well does an individual judge depth and velocity, particularly when floodwater is muddy/opaque?;
- Do people faced with floodwater, when in vehicles or on foot, know what the safe stability thresholds are anyway?;
- Do people know their own weight/height ratio to compare against safety thresholds?; and
- Is this research implying greater levels of safety than are experienced in real situations due to the omission of debris, contaminants and hidden washouts/potholes in the studies?

To date, research has primarily focussed on the physical aspects of vehicle and pedestrian stability in floodwater, with no research into how humans interact with such information. While current research may be useful to those who are faced with deep or fast flowing water on a regular basis in a professional technical capacity, it is questionable as to whether this information is helpful to the general public faced with an unfamiliar floodwater situation. Further research is needed to investigate people's understanding of, and decision-making around, information related to stability in floodwater before this aspect can be considered for inclusion in any strategies. It is not recommended that strategies try and promote safe depth limits for entering floodwater; this approach would be contrary to the

overall aim of community safety, given the uncertainty involved in behavioural understanding and the other safety factors not related to stability.

### 2.2.3 Flood perceptions in Australia

In Australia, a few studies have examined people's awareness and perceptions of flood risk, and their level of flood preparedness and the information and warnings that they have received prior, during and/or after a flood event (Becker et al., 2007a; 2007b; 2008a; 2008b; Colmar Brunton Social Research, 1999; Micromex Research, 2005). All of this research has been undertaken in towns and rural areas in New South Wales which are susceptible to flooding, including Richmond, Windsor, Woronara, Lismore, Grafton, Narrabri, Albury, Maitland, McGraths Hill and Penrith.

In general, this research suggests that communities in New South Wales are reasonably aware and knowledgeable about flooding and a relatively large proportion of respondents (~45%) have been affected by flooding. Despite this, it appears that most people in these communities are only moderately concerned about future flood events. For example, a study of flood prone communities in Richmond, Windsor, Woronora and Lismore found that respondents were aware of the risk of flooding but were only moderately concerned about the risk of flooding (Colmar Brunton Social Research, 1999). Similarly, a study of residents living within the district administered by the Hunter-Central River Catchment Authority found most respondents believed that floods are threatening to low-lying communities (78%) but were not concerned about the prospect of their home or property being flooded (71%) (Micromex Research, 2005). Respondents attributed their lack of concern for their own home and property to the fact that they believed they lived on high ground, outside of flood prone areas or that they would be protected by levee banks (Micromex Research, 2005).

Becker et al. (2007a; 2007b; 2008a; 2008b) surveyed eight communities in New South Wales. They found most respondents felt that flooding was the most likely natural disaster that would affect their community (~85%) and an event would most probably occur either within a 5 or 20 year timeframe. The likelihood that individuals had experienced a previous flood event was dependent on the community they lived in. For example, 82% of Narrabri respondents had experienced a flood event compared to 71% in Grafton, 45% in Maitland and 35% in Albury (Becker et al., 2007b). In most instances people reported only being moderately affected by flooding in regards to property damage, injuries or financial loss. It is likely that such experiences add to people's perceptions that future floods will not pose a significant threat to their personal safety or property and, as a consequence, the moderate level of concern people hold about flooding in these communities. That some respondents believe they are not living in a flood risk area because they are living on high ground, or they have not experienced flooding in the past, or in some instances they overestimate the flood protection afforded by levee systems are also likely to be contributing factors (Becker et al., 2007a; 2007b; 2008a; 2008b). King (2000) observing trends in Northern Australia notes that many people underestimate floods. He suggests that many are unaware of the risk of flooding, and even those who are aware do not always appreciate the damage that can be caused by significant floods. As a result, people who have suffered a major loss are generally in a state of shock and disbelief as, backed up by community and personal knowledge, they have never seen the river rise so high or the floodwater cover such extensive areas in the region previously (King, 2000).

The research on flood perceptions in Australia also provides some insight into who people might contact for information during a flood. Becker et al. (2007a; 2007b; 2008a; 2008b) found the main organisations people suggested they would contact during a flood were the SES, the Police, the Road and Traffic Authority (RTA) and the local council. For instance, in Grafton, Narrabri, Albury and Maitland approximately 52% of respondents said they would contact the SES, 48% the Police, 44% the RTA and 28% the local council (Becker et al., 2007a). Furthermore, another study undertaken by Colmar Brunton Social Research (1999) found respondents indicated they would most likely contact the SES (~89%<sup>1</sup>), the Police (~71%) and the local council (~62%) for information about what to do in a flood. As the questions for each piece of research were worded slightly differently, percentages should not be compared directly. However it still appears that the SES, Police, local council and RTA are all considered key points of contact for information about both the nature of flooding, and what people should do in response.

#### **2.2.4 International studies of flood perceptions**

Internationally numerous studies have examined public perceptions and awareness of flooding, in particular, people living in areas that are most at risk from flooding (Brilly & Polic, 2005; Burningham et al., 2008; Drobot et al., 2007; Frazier et al., 1983; Ho et al., 2008; Krasovskaia et al., 2007). A number of the general findings that have emerged from these studies correspond at least in part to research conducted in Australia. These studies suggest that people are aware of the general risk of flooding but often underestimate the danger such events can pose, and more importantly, they frequently are either unaware or believe that their property and own lives are not at risk or, in some instances, even deny the danger exists (Brilly & Polic, 2005; Burningham et al., 2008; Clark County Regional Flood Control District, 1999-2009; Krasovskaia et al., 2007). In discussing their research in at-risk flood areas in the United Kingdom, Burningham et al. (2008), suggest such findings were the “most striking” as very few interviewees had “considered their property to be at risk of flooding and many had not been aware of any local risk” (p. 225). They suggest that some of their participants perceived “their locality to be completely risk-free as far as flooding was concerned, and almost all of them appeared to view their own home as invulnerable, apparently believing that ‘it won’t happen to us’” (Burningham et al., 2008, p. 225).

The international literature also highlights that individuals who tend to be more concerned about, and aware of flooding are those who have experienced a previous flood event and have resided on their property for a number of years (Brilly & Polic, 2005; Burningham et al., 2008; Ho et al., 2008; Lindell & Hwang, 2008; Siegrist & Gutscher, 2006; Wagner, 2007). Such findings should be approached with some caution, however, as people’s flood experience and the time they have lived in an area can have additional implications (Burningham et al., 2008; Krasovskaia et al., 2007; Kundzewicz, 1999; Siegrist & Gutscher, 2006). A study involving 4000 respondents living in flood prone areas in Germany, the Netherlands, Norway, Sweden and the United Kingdom found less than half of the respondents were aware they were located in an area at risk of flooding (Krasovskaia et al., 2007). The more significant finding in that study was that many felt nothing would happen to them personally and were reassured by the fact they had not experienced any flooding, and held an exaggerated belief in the protection offered by flood walls, levees and other forms of flood defences (Krasovskaia et al., 2007). Similarly, other studies have highlighted that

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<sup>1</sup> Note all of the percentages presented here are not taken directly from the Colmar Brunton Social Research (1999) report. Instead they have been calculated by averaging the results presented in the report for each of these responses.

people can be lulled into a false sense of security by a history of very minor flooding within their neighbourhood, the long period of time that has elapsed since the last devastating flood, and following the construction of flood protection measures such as levee systems (Burningham et al., 2008; Kundzewicz, 1999).

Some studies have compared people's risk perceptions in relation to a number of hazards (e.g., floods and landslides; see Ho et al., 2008; Lindell & Hwang, 2008; Wagner, 2007). But to date it appears no studies have examined how people's experiences of different types of flooding (i.e., flash flooding and riverine flooding) influence their risk perceptions or behaviour during different types of flood events. Overall, the literature on flood and other hazard risk perceptions, however, highlight the need to develop flood strategies that are tailored to meet the needs of various individuals and groups within communities. People's perceptions and awareness of the threat posed by floods can have significant implications for how they behave in and around floodwater. Warning systems can also play a significant role in influencing people's behaviour. The following section briefly discusses how warning systems and social factors influence behaviour prior to examining how people behave in and around floodwater.

### **2.2.5 The influence of warning systems on behaviour**

There is considerable body of literature that has examined people's perceptions of, and responses to, warning systems (i.e., warning messages, information, alarms, sirens, and evacuation orders) for various hazards including flooding (see Aguirre, 1991; Balluz et al., 2000; Bateman & Edwards, 2002; Benight et al., 2007; Brown & Damery, 2002; Dow & Cutter, 1998; Drabek, 1999; Handmer, 2000; King, 2007; Mileti, 1995; Mileti & Sorenson, 1990; Parker et al., 2009; Sorenson, 1991; 2000). Overall this literature highlights that "context is everything" and that it is insufficient, therefore, to focus only upon warning systems to understand how the public responds to these systems (Drabek, 1999; Mileti & Sorenson, 1990; Parker et al., 2009, p. 104). Parker et al. (2009) observe, for example, that "both the physical characteristics of flooding (e.g., the severity of the flood threat; the time available between a flood warning being received and the onset of flooding) and the social circumstances of those to whom the flood warning information is issued, are absolutely crucial to understanding and interpreting how people respond to flooding and flood warning" (p. 104). In other words, people do not generally take protective action upon hearing a warning (Mileti, 1995; Mileti & Sorenson, 1990; Parker et al., 2009). Rather, those who receive warnings go through a social psychological process to form their own impression of the risks they face and ideas about what to do before they respond (Mileti, 1995; Parker et al., 2009). As Mileti (1995, p. 1) argues, this process can be divided into several phases:

1. hearing a warning;
2. forming a personal understanding of what was meant by the warning;
3. developing a level of belief in the risk information conveyed in the warning;
4. personalising the risk or perceiving it to be someone else's problem;
5. deciding what, if anything, to do and responding in ways thought to be appropriate to the risk personally faced.

Warning systems that take this process into consideration can be very successful in assisting at-risk members of the public to find safety before disasters strike (Mileti, 1995; Mileti & Sorenson, 1990; Parker et al., 2009). Prior to discussing the social factors outlined above in more detail, we briefly consider warning factors that influence public response.

### 2.2.5.1 **Warning system ('sender') factors that influence public response**

Research on warning systems has revealed that there are number of factors related to the hazard warning communication process which can influence public response (Drabek, 1999; Handmer, 2000; Mileti, 1995; Mileti & Sorenson, 1990; Parker et al., 2009). While the following is focused on warnings, much of this content is equally relevant to approaches that seek to raise flood awareness including the provision of information about flood risk, education programmes, and other forms of community engagement (see Chapter 3 for further details). Factors which can influence public response to warning systems and these other approaches include (for further details see Brown & Damery, 2002; Mileti, 1995; Mileti & Sorenson, 1990; Parker et al., 2009):

1. *Warning source*: the credibility and reliability of the individual or organisation providing a warning is critical. Warnings are most convincing if they come from a broad range of persons, as people have different opinions about who is credible and who is not. As a result of this and other factors there have been increasing calls for integrating both official and unofficial warning systems (see Brown & Damery, 2002; Parker & Handmer, 1998).
2. *Warning message consistency*: a warning message is best if the information it provides and the tone in which it is provides it is consistent.
3. *Message accuracy*: a warning message needs to contain accurate, timely, and complete data. The degree to which the contents of a message about risk, location, and what to do is or is not fully factual determines the accuracy of a message.
4. *Warning clarity*: a warning message must be worded clearly and in simple language that can be understood so that people know what is happening and what they should do about it as a lack of clarity can result in misunderstanding of the message.
5. *Certainty of the message*: a message needs to communicate a high level of certainty about the events taking place. A message should be stated with certainty even in instances where there is a low probability or an uncertain situation.
6. *Sufficient information*: not knowing, or feeling that one has insufficient information creates confusion, uncertainty and anxiety. Sufficient information should therefore be given so the public know exactly what is happening.
7. *Guidance*: a warning message, perhaps most importantly, should communicate a clear statement of guidance, and specifics about what people should do in relation to the event reported, and the length of time in which they have to act.
8. *Warning frequency*: the number of times or the frequency at which the warning message is delivered affects hearing, understanding, believing, and deciding, and as a result is essential at most stages of response.
9. *Risk location information*: identifying a location is essential in establishing belief and personalizing a warning. People need to be told if they are the intended recipients of the message and it should, therefore, plainly outline the areas affected or potentially impacted by the event.
10. *Channel of communication*: the channel of information plays an important role in warning response. The use of multiple channels including printed, electronic media, personal delivery and unofficial channels have been shown to increase the likelihood of the public hearing, understanding, believing, and responding to risk information. For example, a number of studies have shown that official warnings often rarely reach over 40% of the people they are intended for (e.g., Parker et al., 2007; Thielen et al., 2005).

### 2.2.5.2 **Social ('receiver') factors that influence public response to warning systems**

The ways that people interpret and respond to various warning systems are influenced by a number of social factors some of which have already been discussed in relation to flood perceptions (see Sections 2.2.3 and 2.2.4). These findings show that people are often unaware or underestimate the risks associated with flooding, and in some cases, even deny that the danger exists (Brilly & Polic, 2005; Burningham et al., 2008; Krasovskaia et al., 2007; Parker et al., 2009). Such perceptions and a number of other factors can influence how people respond to warning systems, and in this context, how people behave in and around floodwater. Other factors can include the following (for further details see Drabek, 1999; 2000; Mileti, 1995; Mileti & Sorenson, 1990; Parker et al., 2009):

1. *Experience*: an individual's experience of flooding and their experience of previous flood warnings can have an important effect on their warning response. People's experiences of a flood hazard can contribute to them being better prepared and responding more appropriately during a hazard event (Parker et al., 2009). Such experiences can also however lull people into a false sense of security (see Section 2.2.4) and result in them learning to underestimate the risks associated with flooding and respond inappropriately, if at all, to flood warning systems (Burningham et al., 2008; Kundzewicz, 1999). In addition, people's experiences of previous false alarms and the perception that those issuing the flood warnings do not know the local conditions, and therefore are not giving appropriate advice, can also contribute to people ignoring warnings (Parker & Handmer, 1998).
2. *Socio-demographic*: An individual's socio-demographic characteristics including whether they own their home, age, gender and socio-economic status can influence whether they hear, understand, believe and respond to warning systems. For instance, it has been highlighted that those renting often take fewer actions to reduce flood damage than home and business owners (Parker et al., 2009). Elderly people (>60 years) can be less likely to hear a flood warning, and if they do, may be less capable to respond due to lack of mobility or because of difficulties understanding warning messages (Handmer & Ord, 1986; Mileti, 1995).
3. *Social setting*: the social context in which a warning message is received can influence people's beliefs, decisions and response. Factors such as whether or not a family is together when the warning is delivered, the activities being undertaken and what others are doing to respond can play a role in dictating what people do. Socio-psychological research highlights that people receiving warnings before deciding how to respond will generally talk about this warning with members of their family, or friends and neighbours (Drabek, 2000). Similarly, whether neighbours and friends are evacuating can be a major influence in others' decision to evacuate (Mileti, 1995). A number of flood studies have also highlighted that increasingly, people are ignoring warnings in order to maintain their daily routines such as travelling to and from work or dropping off their children at school (Coates, 1999; League, 2009; Ruin et al., 2009).
4. *Confirmation*: following a flood warning people commonly seek further confirmation through various channels such as the emergency services, the flood management agency, local council, the media, or family, friends, and neighbours (Drabek, 2000; Parker et al., 2009). Research from Australia supports this assertion (see Becker et al., 2007a; 2007b; 2008a; 2008b). Becker et al. found people living in Penrith, McGraths Hill, Windsor and Richmond upon hearing a flood warning indicated they would undertake a variety actions including contacting the local council (~75%), the SES (~56%), or their neighbours (~28%), evacuate at once (~43%) and listen to the radio (~32%).

5. *Environmental cues*: environmental cues or the physical characteristics (i.e., the visibility of the hazard) of a setting can interact with warning factors to convey information to the public receiving a warning. For instance, people may not believe a flood warning on a sunny day (Mileti, 1995).
6. *Perceptions of responsibility*: expectations and beliefs people hold in regards to the allocation of responsibility for “responding to flooding and flood warnings, for saving damage and for compensating for flood damages” can have a substantial influence on the way they view and behave in floods (Parker et al., 2009, p. 104). In Germany and France where compensation schemes for flood victims exist, there is concern that such schemes may discourage a sense of self-responsibility for, and personal ownership of, damage reduction (Parker et al., 2008). Research from Australia highlights that people generally believe that more of the responsibility for protecting them from flooding lies with the local council or the SES rather than themselves (Becker et al., 2007a; 2007b; 2008a; 2008b). Furthermore, another Australian study found respondents felt the SES (~69%), the Bush Fire Brigade (~42%), the Police (30%) and the ambulance (~12%) would help if there was a serious flood in their area (Colmar Brunton Social Research, 1999).

### 2.3 Flood risk behaviour

A substantial number of flood-related deaths are believed to be linked to avoidable risk-taking behaviour (Ashley & Ashley, 2008; Coates & Haynes, 2008; Drobot et al., 2007; Grunfest, 1977; Jonkman & Kelman, 2005; WHO, 2002). The World Health Organisation (WHO), for instance, estimates that risk-taking behaviour accounts for 40% of all health impacts in European floods (WHO, 2002). When people are confronted by floodwater they often underestimate the risks and dangers and as a consequence do not always act accordingly. In this section we examine the ways that people behave in and around floodwater, the activities they undertake including driving, recreation, evacuation and rescue, the characteristics of those who undertake these behaviours and activities and their underlying reasons for doing so. Before examining these matters we briefly discuss the extent to which people’s behaviour in and around floodwater and their likelihood of evacuating may be influenced by the instructions and warning messages they receive.

To date there have been only a small number of studies that have examined people’s behaviour in and around floodwater. These studies can be divided into two types. First, a number of studies have presented participants in their studies with a hypothetical situation and have then asked how they would behave under the circumstances (Becker et al., 2007a; 2007b; 2008a; 2008b; Coles, 2008; Colmar Brunton Social Research, 1999; Drobot et al., 2006; 2007). The major limitation of such studies is that they do not observe actual behaviour (only ‘imagined’ behaviour) and as a result may not reflect how people actually behave in a hazardous situation. Second, recognising the inherent weakness in the first approach, a few studies have sought to observe and understand people’s actual behaviour during a flood event (Grunfest, 1977; League, 2009; Ruin et al., 2008; Vazquez et al., 1997). There is a need for more research into people’s behaviour around floodwater in order to understand how best to counter poor decision-making. This section will elaborate on both types of studies where research is available. As there have been a limited number of studies conducted on this topic we will also draw on the literature regarding flood injuries and fatalities to provide some indication of the extent to which people undertake these behaviours. As this literature does not make a distinction between injuries and fatalities associated with different types of flooding (e.g., flash floods and riverine floods), when statistics are presented they refer to the total number of deaths from all types of flooding. The

only exception is a study which focused specifically on flash flood injuries and fatalities (Coates & Haynes, 2008), and when statistics are presented from this study reference is made to flash floods. The literature specifically regarding injuries and fatalities that have occurred during flood events is examined in greater detail in Section 2.4.

### **2.3.1 Driving**

A considerable number of flood fatalities are vehicle-related. In Australia, of 169 flash flood fatalities between 1950-2008, for which the mode of transport is known, 31% were inside a vehicle at the time of death (Coates & Haynes, 2008). It appears the number of fatalities associated with vehicles may have increased recently with figures for the period 1997-2008 showing the use of a vehicle was involved in 49% of all flood-related deaths (FitzGerald et al., 2010). Similarly, 37% of reported near misses and injuries, which occurred in flash floods in Australia between 1988-2008, were vehicle-related (Coates & Haynes, 2008). These figures correspond with studies undertaken in the United States and Europe. Earlier studies in the United States reported vehicle-related deaths accounted for 42% (French et al., 1983) and 49% (Mooney, 1983) of all flood fatalities with a more recent study suggesting vehicles are related to 63% of all flood deaths (Ashley & Ashley, 2008). In France, 40% of all flood fatalities in the last fifty years have been vehicle related (Ruin et al., 2009). Overall, the majority of these vehicle-related deaths have occurred when people have attempted to drive across flooded bridges, roads or streams and have drowned in the vehicle, or by escaping only to perish in the open water (Coates & Haynes, 2008; Drobot et al., 2007; FitzGerald et al., 2010; Jonkman & Kelman, 2005; Ruin et al., 2009). For example, in Australia 40% of flood fatalities for the period of 1997-2008 were the result of individuals attempting to cross a waterway (FitzGerald et al., 2010). These fatality and injury statistics illustrate that it is common for people to drive into floodwater. We will now look at studies that have examined people's driving behaviours in more detail before examining who undertakes these actions.

#### **2.3.1.1 Driving behaviour in and around floodwater in Australia**

Only a few studies have examined driving behaviour in and around floodwater in Australia. One study conducted in Richmond, Windsor, Woronora and Lismore asked respondents if it is safe to walk or drive through six inches of flood water (Colmar Brunton Social Research, 1999). They found that 50% of respondents considered such an undertaking to be safe. Research undertaken by Becker et al. (2007a; 2007b; 2008a; 2008b) which surveyed eight communities in New South Wales asked respondents what they would do in two hypothetical situations. Respondents were then asked whether they agreed or disagreed with a number of statements about how they would act in order to determine if they would drive through the floodwater. In the first, they were asked what they would do if they encountered a flooded area of road not marked with a road closed sign. Around half of respondents (~49%) suggested they would turn around and 'go back' with around a fifth (22%) indicating they would 'continue on with care'. A small proportion (<10%) suggested they would wait for assistance, while ~15% said they would take some other action (not specified). In the second scenario they were asked to indicate what they would do in the same situation but in this instance they are confronted with a road closed sign. The vast majority of people contended that they would 'go back' (>90%).

The research above regarding what people would do when encountering floodwater, is focussed on people's 'imagined' behaviour, rather than actual behaviour. There is some support in the literature that a person's 'imagined' intentions will often indicate their future

behaviour. For example, research in the US by Kang et al. (2007) showed that hurricane evacuation expectations corresponded well with actual behaviours during Hurricane Lili. This was attributed to the fact that people had experienced previous events, they relied on hurricane information sources they had used previously, and that people's responses were based on a limited number of evacuation alternatives. Discrepancies in predicted and actual behaviour may exist where people have limited experience of an event, as people may lack critical information about what they are responding to and how they should respond (Kang et al., 2007).

A series of focus groups held in four New South Wales communities in May and June 2009 (Grafton, Narrabri, Albury and Maitland) (Becker et al., 2010) sought to examine details that could not be captured by earlier surveys of residents' perceptions and understanding of flood risk and preparedness (see Becker et al., 2007a; 2007b). A particular focus of these sessions was to understand why people do or do not undertake certain actions around flood preparedness and warnings. During these sessions issues related to walking and driving through floodwater were explicitly explored. This study found that in general the majority of people were profoundly aware that they should not drive into floodwater. People knew that the flows could be very powerful and should not be underestimated. They understood that they could quickly and very easily get caught out. As a consequence, a few participants suggested that they would never drive through floodwater at all.

A number of participants did admit, however, that they had driven on flooded roads even though they were aware of the dangers. People described a variety of experiences with some recounting how they subsequently considered it to be a bad decision, others recalled feeling lucky they had got through, some turned around and in one case someone had to be rescued. As a result of these experiences some suggest they would never do it again while others admitted they did not mind driving through floodwater. Some participants also expressed concern for family or friends who they knew had driven through floodwater in the past, and may do so in the future.

Several participants suggested that they would drive across flooded areas of road if they deemed them to be manageable. People had developed their own methods and criteria for determining driving feasibility. For instance, some felt that they would never drive across the water if they consider it to be 'rushing' or fast flowing. Others would get out of their vehicles and test the depth and speed of the water by walking into it. One person suggested having water up to your calf was safe while another participant felt water up to the height of his knee was appropriate. Other criteria and measures used to determine if the waters were safe to cross were to test the depth of the water with a stick, establish if it was possible to see the bottom and if the water was still, or estimate the risk using the flood markers on the road. One participant said if they knew the road they might judge whether to enter by the levels of the flood markers, and if they did not know the road they might not drive in.

In some instances participants reported that they had contacted the police to check if it was okay to proceed before driving into floodwater. One woman recalled people attempting to enter floodwater after having been advised it was fine to proceed by the police. In this instance one vehicle had successfully driven through and another car had just entered the waters before seeing a "wall of water" and deciding to turn back. Some participants said they would ask the opinion of long-time locals about the level of risk involved and whether they could suggest any alternative routes that would avoid floodwater. Other participants

suggested that they would often follow other people or drive through floodwater if they had seen the person in front of them successfully cross.

Participants in Grafton had experienced a flood just before the focus group was held. They highlighted that signage was sometimes an issue. On a number of occasions “Road Closed” signs were left on roads that were clear of water. This resulted in people distrusting the signs and in some instances thinking the road might not be flooded and, therefore, driving around the sign and using the road. Some participants said they would not drive around a “Road Closed” sign while others would. Having accurate and updated information was noted as important in allowing people to know and trust that a road was really flooded.

### **2.3.1.2 International studies of driving behaviour in and around floodwater**

Given the high proportion of flood fatalities related to vehicles a few studies have begun to attempt to understand actual driver behaviour (Coles, 2008; Coles et al., 2009; Drobot et al., 2006; 2007; League, 2009; Ruin et al., 2007; 2009). A survey sent to homes in Denver and Austin in the United States presented respondents with a driving scenario that placed them in a mid-size car after a severe thunderstorm, with approximately 18 inches (45.7 cm) of water covering the road and vehicles ahead were stopping or had stopped (Drobot et al., 2006; 2007). Respondents were then asked whether they agreed or disagreed with a number of statements about how they would act in order to determine if they would drive through the floodwater. They found 40% of the Denver respondents would drive through the flooded roads compared with 8% in Austin. The authors suggest this difference could potentially be explained by the relative occurrence of floods and flash floods between the two cities, with Denver experiencing fewer flood events than Austin (Drobot et al., 2007).

Benight et al. (2007) looked at the effects of previous and current trauma on people’s behaviour in and around floodwater. They found that extreme or elevated trauma had an impact on people’s perceptions and behaviour in flash flood situations. In particular they were more likely to undertake a response at home, such as confirming the hazard, evacuating or calling 911 for help. However, when it came to risky behaviour (e.g. driving through floodwater) they found no substantial difference in the actions of traumatised people versus non-traumatised people. They suggest that “when environmental conditions are this salient it may override the emergence of individual differences”, such as a trauma experience (Benight et al., 2007, p. 225).

The Clark County Regional Flood Control District (CCRFD) in Texas, USA conducts research into flood awareness perceptions and behaviours, as well as conducting public education and flood mitigation activities. The surveys find consistently that males aged between 45 and 64 are the most likely to enter floodwater of all demographic groups. The CCRFD research highlights that over 50% of those who enter floodwater in vehicles during flash floods do so because they do not think it is unsafe to do so. Other reasons given are “had to drive through, no choice”, “in a hurry” or “didn’t think about it” or “for fun” This figure for those underestimating the risk remains relatively constant while there is a steady decrease in the overall percentage of people who chose to continue driving when faced with flooded roadways. Between 2000 and 2009 the percentage of respondents who chose to enter flooded roadways dropped from 43% to 30% (Clark County Regional Flood Control District, 2009). Discussion of flood education campaigns conducted by CCRFCD is found in Section 3.3.3.

Ruin et al. (2007) used cognitive mapping and GIS data processing to assess motorists' risk perceptions of flash floods on their daily itineraries in France. They found that drivers typically tend to underestimate rather than overestimate the risks associated with flooding on their daily travel routes. In particular, those individuals who were either under 25 or over 45 years of age, unemployed, without previous experience of flooding and had longer travel itineraries were more likely to underestimate such risks. In contrast, respondents who were middle or upper class and with previous flood experience were more likely to overestimate the risk of flooding on their travel route. Other studies while not specifically related to flooding have highlighted that road accident risk is elevated during adverse weather and road conditions (e.g., Kilpeläinen & Summala, 2007). Such studies support Ruin et al.'s. (2007) findings, suggesting drivers tend to make poor estimates of accident risk and do not always adjust their driving behaviour (Kilpeläinen & Summala, 2007).

### **2.3.1.3 Who drives into floodwater?**

The various studies of driver behaviour provide some general insights into the characteristics of people who drive into floodwater. Age seems to be an important determinant with younger people being more likely to self-report (Becker et al., 2008b; Drobot et al., 2006) or be observed driving into floodwater (League, 2009). Studies in both Australia (Becker et al., 2008b) and the United States (Drobot et al., 2006; League, 2009) found that drivers 18-35 years of age were more likely to enter floodwater in motor vehicles. Research that has examined the relationship between driving behaviour and age in general has found that young drivers (<25 years) have a propensity to take risks while driving (Jonah, 1986) and tend to be over confident in regards to their actual driving ability (Matthews & Moran, 1986). In contrast, older drivers (>60 years) tend to avoid driving in difficult conditions as they have less confidence in their cognitive ability to deal with such situations (Ball et al., 1998; Kilpeläinen & Summala, 2007).

Gender has been shown to play a role to some extent. Studies in Australia show that more males (~30%) than females (~20%) self-reported that they would 'continue with care' if they encountered a flooded area of road not marked with a road closed sign (Becker et al., 2007a; 2008a). Similarly in the United States it was found most people driving into floodwater were more likely to be male (League, 2009). Studies of driving behaviour studies have shown that young males (<25 years) relative to their female counterparts possess an exaggerated sense of their own driving ability and perceive less risk in a variety of dangerous driving behaviours (DeJoy, 1992; Matthews & Moran, 1986). For instance, DeJoy (1992) found that young males (18-24 years) rated risky behaviours as less serious and less likely to result in an accident.

Research conducted in Australia (Coates & Haynes, 2008), France (Ruin et al., 2009) and the United States (League, 2009) has highlighted the number of people who deliberately enter floodwater in an effort to maintain their normal everyday activities. This is particularly the case when people are confronted with the need to travel to and from work and drop off and pick up children from school. Recent research in the United States has found that individuals who drive SUVs and trucks are more likely to self-report (Coles, 2008) or be observed driving into floodwater (League, 2009). Other factors which may also contribute to the likelihood that an individual will drive into floodwater include whether they have done so in the past and if they do not take flood warnings seriously (Becker et al., 2010; Drobot et al., 2006; 2007).

### **2.3.2 Walking, wading and swimming**

Data related to fatalities and injuries that occur during flood events shows that a relatively large number of people enter floodwater on foot. In Australia, between 1950-2008, of the fatalities for which mode of transport is known, 17% of victims were on foot and 15% were swimming or wading (Coates & Haynes, 2008). Seven percent of the near misses and injuries in Australia between 1988-2008 were attributed to pedestrians, and 14% to individuals swimming or wading (Coates & Haynes, 2008). These figures correspond with studies undertaken in the United States and Europe. In the United States, 9% of the flood fatalities during the period 1959-2005 were linked to people walking close by or into floodwater (Ashley & Ashley, 2008). Another study which examined flood deaths in the United States and Europe reported that pedestrians accounted for 27% of the total number of flood deaths (Jonkman & Kelman, 2005). Much like vehicle-related deaths, most of these fatalities have occurred when people have drowned attempting to cross flooded bridges, roads or streams (Ashley & Ashley, 2008; Coates, 1999; Haynes et al., 2009; Jonkman & Kelman, 2005).

#### **2.3.2.1 Studies of pedestrian behaviour in and around floodwater**

Only a few studies have examined pedestrian behaviour in and around floodwater in Australia. Research undertaken in Richmond, Windsor, Woronora and Lismore reported that 50% of respondents considered it safe to walk or drive through six inches of water (Colmar Brunton Social Research, 1999).

Focus group research undertaken in New South Wales provides some additional insights into why people walk into floodwater (Becker et al., 2010). Participants in these sessions suggested that they would walk through water to check on property or save various items of property (e.g., household items and equipment worth \$200,000 in the Rowing Club in Grafton) and farm animals and stock. One participant described how her husband would routinely go back to check their property through floodwater after the “crisis is pretty much over [when the waters are] receding”. She said that her husband’s general rule was that he would “walk across if the water is up to around the top of his calf”. Another participant admitted walking through water to go to the shops because she was out of supplies for baking a cake as because of the weather there was nothing else to do. She felt it was safe to walk through the water in her street because it was “not rushing” when she decided to go out. Unfortunately the water levels rose while she was out and it was coming up rapidly on her return, so that water was up to her waist. She decided to continue walking through the water so she could return to her house.

There appear to be very few studies that have examined the behaviour of pedestrians outside of Australia. As outlined above, a number of studies detail flood deaths where people have entered floodwater on foot but do not focus on their actual behaviours (Ashley & Ashley, 2008; Jonkman & Kelman, 2005). It appears that only one study in the United States has examined people’s behaviour. Grunfest (1977) outlined what people did during the Big Thompson flash flood in Colorado and reports that people attempted to move to higher ground rather than walking into the waters.

### 2.3.2.2 *Who walks, wades or swims in floodwater?*

There is only limited information available on the demographics of people and whether or not they walk into floodwater. While there are no detailed studies of behaviour and walking in floodwater it is possible that such individuals have the same profile as those who drive in floodwater, with a propensity for males and younger individuals (<30 years) to take risks and underestimate danger (Ashley & Ashley, 2008; Coates, 1999; Coates & Haynes, 2008; FitzGerald et al., 2010). In the United States, it was found that all of the victims who died as a consequence of walking into floodwater were over the age of 12 (Ashley & Ashley, 2008).

### 2.3.3 Recreation

A reasonable number of flood fatalities and injuries are a consequence of people undertaking recreational activities in floodwater. During the period 1980-2008 in Australia 16% of people were swimming<sup>2</sup>, playing<sup>3</sup>, paddling or bathing, 4.5% were boating, making a wager or joyriding, and 3.6% were on a boat or a makeshift boat at the time of their death (Coates & Haynes, 2008). More recently (1997-2008), Australian fatality figures show 27% of victims were swimming or surfing, and 4% were on a boat in floodwater when they died (FitzGerald et al., 2010). These recreational activities and others such as sightseeing also account for 47% of the flash flood near misses and injuries (Coates & Haynes, 2008). Aside from deaths associated with recreational boating it is difficult to find similar data for the United States and Europe. French et al. (1983) report 2% of deaths in the United States were linked to rafting and sailing. Another study suggests that 3.6% of flood fatalities in the United States and Europe were the result of people undertaking recreational boating (Jonkman & Kelman, 2005). Various instances of what has been termed “flood tourism” have also been documented during the relatively recent European floods including significant crowds congregating on riverbanks and bridges, and people undertaking recreational boating activities on flooded streams (Jonkman & Kelman, 2005, p. 88). During the 2002 flash floods in Southern France, some campers lost their lives while trying to get a closer view of the flood (Ruin et al., 2009). In New Zealand on 15 April 2008 seven people were killed by a flash flood while on a school trip in the Mangatepopo Gorge/Stream. The trip was organised by the Sir Edmund Hillary Outdoor Pursuits Centre (OPC) and led by an instructor working at the facility. The coroner’s summary states that “lack of environmental awareness, lack of instructional use of historical information, instructor inexperience, lack of proper assessment before the gorge was entered to ensure there was no significant chance of water levels rising above a safe level during the trip, lack of or inadequate communication when in the gorge between the instructor and the Field Manager or OPC Tongariro base staff, failure to implement a crisis plan and dispatch response teams in a timely manner, under-estimate of risks, and complacency contributed to the deaths” (Devonport, 2010). In the subsequent court case, a number of recommendations were made with respect to running high-risk recreational activities in future (Kiernan, 2009; Devonport, 2010):

1. Ensure good access to up-to-date weather reports;
2. Require adequate training, exercising and supervision of staff (including new staff);
3. Promote a safety of culture in an organisation;
4. Have no less than 2 staff leading groups in ‘risky zones’; and
5. Ensure there is unbroken radio / phone contact.

<sup>2</sup> Two Australian studies which report on flood fatality statistics make a distinction between individuals who were recreating and those who were crossing a waterway by swimming or wading (see Coates & Haynes, 2008; FitzGerald et al., 2010)

<sup>3</sup> These figures were pooled and as a consequence it is not possible to determine precisely how many deaths were the result of individuals playing in flood water

### **2.3.3.1 Who recreates in floodwater?**

To date it appears that no study has specifically examined why people recreate in and around floodwater but it is likely they are similar to people's motivations for general water-based recreation which include testing one's skill and ability, curiosity, fun and enjoyment (Schneider, 2009). It is likely that a number of people also undertake these activities to reach certain destinations (Ashley & Ashley, 2008; Coates, 1999; Coates & Haynes, 2008). While there is no direct evidence as to who undertakes these activities, it is likely they reflect trends in flash flood fatalities and injuries which suggest that males and younger people (<30 years) are more likely to die in flood events (Ashley & Ashley, 2008; Coates, 1999; Coates & Haynes, 2008; FitzGerald et al., 2010; French & Holt, 1989; Jonkman & Kelman, 2005). The susceptibility of these groups reflects the increased propensity of these groups to take risks and to underestimate the dangers associated with flooding (Ashley & Ashley, 2008; Coates, 1999; Coates & Haynes, 2008). Data from the United States suggests that of the deaths for which age is known, a number of children (less than 12 years old) died after walking into or playing in floodwater (4% of all flood fatalities; 41% of 'in water' deaths) (Ashley & Ashley, 2008). At present there does not appear to be any comparable published Australian data about children who have died as a result of walking into or playing in floodwater.

### **2.3.4 Rescuing**

The risks involved in entering floodwater to rescue other people for both amateur and professional rescuers are evident in data pertaining to flood fatalities and injuries. Of 97 fatalities that occurred during the period 1950-2008 in Australia, 4.1% were professional rescuers, fire-fighters and police, and a further 2.1% were volunteers attempting to rescue others (Coates & Haynes, 2008). The evidence relating to injuries and near misses also highlights the risks involved with professionals and volunteer rescuers accounting for 5.8% and 3.5% of these incidents (Coates & Haynes, 2008). In the United States earlier fatality studies report rescue related deaths as accounting for 3% of deaths (French et al., 1983) while a more recent study that examined fatalities in the United States and Europe suggested that 1.2% of deaths can be attributed to rescues (Jonkman & Kelman, 2005).

Overall, this research suggests there are particular dangers related to attempted rescues, but the outcomes vary. Jonkman and Kelman (2005) reported that of the three people who lost their lives during a rescue, only one was an official rescuer. Other sources have illustrated the dangers connected with rescue. During Hurricane Floyd in 1999, five rescuer deaths were reported in a death toll of 52 in North Carolina. Two of the nine people who died during the 1988 floods in Nimes, France were rescuers who drowned in the midst of rescue operations (Duclos et al., 1991). There appears to be no measured age and gender trends relating to flood rescue deaths. However, the demographic of rescue workers in general suggests that males and younger (<34 years) and middle-aged (35-54 years) people are more likely to die in flood events due to their involvement in occupations and activities that put them at greater risk of work related deaths and injuries (Ashley & Ashley, 2008; Coates, 1999; Coates & Haynes, 2008; French & Holt, 1989; Jonkman & Kelman, 2005).

### **2.3.5 Evacuating**

The word 'evacuation' can have a variety of definitions such as "official evacuation", "self evacuation" or "escaping/fleeing". Where possible the authors have tried to make the distinction between an evacuation that occurs before getting impacted by an event (i.e.

“official evacuation” or self-evacuation”) as opposed to escaping or fleeing when the event is immediately imminent or has occurred. However, most literature does not define the word evacuation before using it, and therefore it is often impossible to make a distinction (in which case we can only use the term “evacuation”).

When considering the people who die in flood events it is particularly revealing that only a relatively small percentage of victims die during the evacuation process (Ashley & Ashley, 2008; Coates, 1999; Coates & Haynes, 2008; French et al., 1983). As discussed earlier, this suggests that a substantial number of flood-related deaths are linked to avoidable risk-taking behaviour (Ashley & Ashley, 2008; Coates & Haynes, 2008; Drobot et al., 2007; Grunfest, 1977; Jonkman & Kelman, 2005; WHO, 2002). Only 6.1% of deaths during the period 1950-2008 in Australia have occurred during the evacuation process (Coates & Haynes, 2008). Since 1980, evacuation-related deaths only account for 1.8% of the total number of Australian flood fatalities (Coates & Haynes, 2008). Similarly, evacuations only account for 1.2% of reported near misses and injuries during flood events between 1988-2008 (Coates & Haynes, 2008). These findings mirror those found in the United States. French et al. (1983) reported 2% of deaths (excluding those involving a car) were related to evacuation while Ashley and Ashley (2008) suggest only 16% of all deaths associated with walking through floodwater were the result of attempts to evacuate or rescue others. None of the studies analysing flood deaths have reported who is more vulnerable during a flood evacuation but it is more likely to be individuals who do not leave when they are first requested to evacuate (Grunfest, 1977). As research undertaken in Grafton following the 2001 floods suggest, this can be a relatively large proportion of the community as in this instance only 22% of survey respondents indicated they followed the evacuation order (Pfister, 2002).

## 2.4 Why do people enter floodwater?

As illustrated in the previous section on flood behaviours there appear to be a variety of reasons why people enter floodwater (Table 1). This section will briefly discuss seven of the main reasons that have emerged from the various studies of flood fatalities, injuries and behaviour.

First, these studies tend to suggest the predominant reason is that people are attempting to reach a particular destination in the course of their normal everyday routines such as travelling to and from work and picking up and dropping children off at school (Becker et al., 2010; Coates, 1999; Coates & Haynes, 2008; League, 2009; Ruin et al., 2009). In Australia, it is reported that attempts to reach particular destinations in an attempt to sustain “business as usual” account for 22% of fatalities and 11% of near misses and injuries (Coates & Haynes, 2008). In the United States one study has suggested that 9% of all flood-related deaths were a result of people attempting to reach a given destination (Ashley & Ashley, 2008). It is somewhat of a concern that at least in Australia, deaths associated with such activities have increased from 15% between 1950-1979 to 26% between 1980-2008 (Coates & Haynes, 2008).

Second, a number of studies have highlighted that people are increasingly entering floodwater to undertake a variety of recreational pursuits and activities, such as swimming, playing, paddling, bathing or joyriding (Coates & Haynes, 2008; FitzGerald et al., 2010; Jonkman & Kelman, 2005; League, 2009). During the period 1950-2008 deaths associated with recreational activities accounted for 16% of the total fatalities (Coates & Haynes, 2008). As Coates and Haynes suggest, alarmingly the number of people dying as a result of

undertaking these activities has increased from 5% over the 1950-1979 period to almost 25% of fatalities over the 1980-2008 period. Similarly, League (2009) who surveyed people who broadcast themselves crossing flooded roads on YouTube in an attempt to understand what they were thinking found most people had entered the waters for fun or to film the flood. This result is likely to be a reflection of her research methodology but it does add further concern about the increasing number of individuals who are increasing their risk by choosing to voluntarily enter floodwater.

Third, it is reasonably common for people to enter floodwater in an attempt to rescue or retrieve stock, property or pets, whether they are their own or belong to others (Becker et al., 2009; Coates, 1999; Coates & Haynes, 2008; Ruin et al., 2009). Figures from Australia suggest that over the period 1950-2008 such behaviour has accounted for 11% of all fatalities (Coates & Haynes, 2008). On a positive note however, it appears that the number of people undertaking such risks is declining as the number of fatalities has dropped from 23% between the years 1950-1979 to 3.5% over the period 1980-2008 (Coates & Haynes, 2008). It has been suggested that this decline is attributable to people placing less importance on rescuing stock, property and pets, and having more respect for, or a greater understanding of, the potential dangers associated with flash floods (Coates & Haynes, 2008). Fourth, a number of individuals encounter floodwater directly or indirectly in the context of their job. Data from Australia spanning the period 1788-1996 shows that 12% of flood fatalities are work-related (Coates, 1999). Particularly vulnerable groups are drivers (2.9%), miners (2.8%), rescue personnel (1.4%), and mail delivery personnel (0.9%) (Coates, 1999).

Fifth, it appears a number of people enter floodwater because they are unaware of or underestimate the risk (Coates & Haynes, 2008; Drobot et al., 2007; Jonkman & Kelman, 2005; Ruin et al., 2007; 2009). Coates and Haynes (1999) found that 10% of flood fatalities over the period 1950-2008 were attributable to people who were unaware or taken by surprise by a flash flood (see Table 1). Other studies have also shown that people often underestimate the risks associated with flooding (Ruin et al., 2007) and severe weather conditions (Kilpeläinen & Summala, 2007) on their common travel routes. Sedwick (2008) attributes people's willingness to enter floodwater (or get in the way of a flash flood) to an underestimation of the risk, an underestimation of the speed and power of moving water, and an overestimation of the ability to survive.

Sixth, (at least in terms of driving) it appears that individuals are influenced by what others around them are doing. A number of people in Australia (Becker et al., 2010) and the United States (League, 2009) report that they have driven through floodwater following others or after having seen the person in front of them successfully cross. Over 50% of people researched by League (2009) suggested that they had been influenced to drive through floodwater because the "car ahead made it".

Finally, as discussed above, a number of individuals enter floodwater to either rescue other people or to evacuate an inundated area. As already highlighted, the number who undertake such actions in Australia, the United States and Europe is small compared to those who go into floodwater in an attempt to reach a destination or even for recreational purposes (see Table 1) (Ashley & Ashley, 2008; Coates & Haynes, 2008; Jonkman & Kelman, 2005).

Table 1 Total number and percentage of Australian flash flood near misses, injuries (1988-2008) and fatalities (1950-2008) in relation to modes of transport<sup>1</sup>, and reasons for entering floodwater. Adapted from data presented in Coates and Haynes (2008)<sup>2</sup>.

Mode of transport	Near miss and injuries (1988-2008) n=191		Deaths (1950-2008) n=206	
	Count	% of total	Count	% of total
Driving/exiting vehicle	46	24%	55	27%
Walking	9	5%	28	14%
Swimming/wading	18	9%	26	13%
On a boat	unknown	unknown	13	6%
On a horse	unknown	unknown	4	2%
<b>Total known to be travelling</b>	<b>73</b>	<b>38%</b>	<b>126</b>	<b>61%</b>
<b>Not travelling or travel mode unknown<sup>3</sup></b>	<b>118</b>	<b>62%</b>	<b>44</b>	<b>39%</b>
<b>Total</b>	<b>191</b>	<b>100%</b>	<b>206</b>	<b>100%</b>
<b>Reason for entering floodwater</b>				
Undertaking everyday routine	9	5%	23	11%
Recreation	40	21%	16	8%
Rescuing stock, property, pets and crops	unknown	unknown	11	5%
Work including rescue	8	4%	12	6%
Unaware of the risk or taken by surprise	18	9%	10	5%
Escaping peril (fleeing)	5	3%	9	4%
Waiting to be or being evacuated	6	3%	7	3%
Subtotal reasons attributable	86	45%	88	43%
<b>Unknown or undefined reason<sup>3</sup></b>	<b>105</b>	<b>55%</b>	<b>118</b>	<b>57%</b>
<b>Total</b>	<b>191</b>	<b>100</b>	<b>206</b>	<b>100%</b>

<sup>1</sup> Because this study is concerned primarily with those entering floodwater on foot or in vehicles only transport-related data have been expanded.

<sup>2</sup> Our percentage calculations in this table differ from Coates and Haynes (2008) because we have included all 'unknown' near misses/injuries and fatalities in our total percentage calculations, whereas they have often calculated percentages only on 'known' near misses/injuries and fatalities, therefore using smaller "n" for analysis.

<sup>3</sup> In many cases the mode of transport, or reason for entering flood water, is unknown. This may cause a slight misrepresentation of the data (e.g. greater proportions of people may have been injured by walking into floodwaters, but is not recorded). Further research could clarify this issue.

## 2.5 Consequences of behaviours

### 2.5.1 Fatalities

One of the main consequences of entering floodwater is potential death. Numerous studies have highlighted that flooding is one of the leading causes of death of those that can be linked to natural disaster events (Ashley & Ashley, 2008; Coates, 1999; Jonkman, 2005; Jonkman & Kelman, 2005). For example, it has been reported that in the last decade of the 20<sup>th</sup> Century floods killed about 100,000 persons in both developing and developed countries (Jonkman, 2005). In Australia, records covering 1788-1996 indicate that at least 2213 persons have been killed during floods (Coates, 1999), a number that is second only to heatwaves in regard to fatalities resulting from natural disasters (Coates, 1996). More recently, 206 people have died as a result of flash floods from 1950 to March 2008 (Coates & Haynes, 2008). As highlighted previously, many of these deaths appear to be associated with avoidable risk-taking behaviour, in particular, driving into floodwater (Ashley & Ashley,

2008; Coates & Haynes, 2008; Drobot et al., 2007; Gruntfest, 1977; Jonkman & Kelman, 2005; WHO, 2002).

Drowning is the leading cause of death associated with flood events (Coates, 1999; Coates & Haynes, 2008; French et al., 1983; Jonkman & Kelman, 2005). Of the 200 fatalities where the circumstances of death were known, drowning accounted for 90% of flood deaths in Australia (Coates & Haynes, 2008). Other indirect causes of flood deaths were heart attack, overexertion and shock (1.5%), electrocution (1%) and tree/limb fall (0.5%) (Coates & Haynes, 2008). Other studies outside of Australia have also highlighted that drowning is the leading cause of flood-related death. An early study in the United States found 93% of fatalities were due to drowning (French et al., 1983). Jonkman and Kelman (2005) in their relatively recent study, however, found that drowning only accounted for 67.6% of flood fatalities in the United States and Europe. The next most common cause of death they identified was physical trauma (11.7%) followed by fire (3.6%), heart attack (5.7%) and electrocution (2.8%).

Sedwick (2008) examined flood deaths in Texas for the year 2007 and found that over two-thirds of deaths were flash flood related, while remaining deaths were related to riverine flooding or high water<sup>4</sup>. Sedwick found similar reasons as Coates and Haines (2008) did for floodwater-related deaths (see Table 2). Additionally he found that drowning in a vehicle was more likely to be related to flash flooding (91%) than from high water (6%) or a flooded river (3%). In contrast, deaths related to walking or playing in water were fairly evenly split with 46% of deaths occurring in flash floods, 46% occurring after entering high water, and only 8% entering a river in flood. Flash flood deaths in general were more common at night (80%), while high water and riverine flooding deaths were more common during daylight (80%). Vehicle related drownings were also more common at night, with 48% of deaths in vehicles occurring from 6 pm to midnight and 31% from midnight to 6 am.

Table 2 Flood-related drownings by circumstances, Texas, 2007 (Sedwick, 2008)

<b>Circumstances</b>	<b># of Deaths (where cause is known)</b>	<b>Percent</b>
Vehicle	35	56%
Walk/Play	13	21%
Mobile Home	4	6%
Boating	3	5%
Swimming	5	8%
Rafting/Tubing	2	3%
Cave	1	2%
<b>Total</b>	<b>63</b>	<b>100%</b>

A number of studies have examined the longer-term effects of floods on mortality. Bennet (1970) examined the long-term effects of the 1968 floods in Bristol, United Kingdom. In the 12 months following the flood event, he reported a 50% rise in population mortality rates in the flooded area of the city compared with no noticeable change in mortality rates for non-flooded areas (Bennet, 1970). No specific cause of death could be attributed; however Bennet did notice a conspicuous rise in cancer-related illness. Baxter et al., (2001) suggest that this could be explained in terms of psychological effects, whereby a hastening of death

<sup>4</sup> High water refers to an event that involved an individual that got into a rapid flow in a stream or river, though the stream or river was not at flood levels.

occurred in those already predisposed to die by underlying illness. Corresponding patterns in post-flood mortality were observed in Canvey Island, United Kingdom, following the 1953 flood disaster (Baxter et al., 2001) and on the Canary Islands, Spain, following the 1953 floods (French & Holt, 1989). Some studies have not documented increases in post-flood mortality such as a study conducted in the wake of the 1988 flood disaster in Nimes, France (Duclos et al., 1991), and one following the 1974 flood disaster in Brisbane, Australia (Abrahams et al., 1976). Despite such findings Jonkman and Kelman (2005) claim that in general “strong evidence persists regarding the connections between psychological health effects and mortality in flood disasters” (p. 78).

A number of studies have illustrated that a number of vulnerabilities can potentially contribute to an individual’s death in a flood. These include: “gender, age, physical and mental health history, current physical and mental condition, activity and behaviour (such as attempting a rescue, sleeping or escaping/fleeing), clothing worn, swimming ability and experience (likely only to be relevant for non-moving water)” (Ashley & Ashley, 2008; Coates & Haynes, 2008; Jonkman & Kelman, 2005, p. 80). Other vulnerability factors include, “temporary impairment (for instance, due to alcohol or drugs), lack of knowledge of the area where the flood is occurring, situation/place (for example, on foot, on a bicycle, in a vehicle or in a building), and rescue (including self-rescue) and medical response capabilities” (Ashley & Ashley, 2008; Coates & Haynes, 2008; Jonkman & Kelman, 2005, p. 80). The remainder of this section examines how flood fatalities differ in relation to such variables and demographic characteristics.

### **2.5.1.1 Gender**

In Australia, Coates (1999), Coates and Haynes (2008) and FitzGerald et al. (2010) have highlighted the disproportion of male fatalities during floods (Table 3). Males accounted for 68% of the 180 flash flood fatalities, for which gender was reported, during the period 1950-2008 (Coates & Haynes, 2008) and 71% of all 73 flood-related fatalities between 1997-2008 (FitzGerald et al., 2010). By comparison Coates (1999) found that 80.6% of flood victims between 1788-1996 were male. Coates’ (1999) findings translates into an overall male:female death and death-rate ratios of 4:1 (Coates, 1999). Studies from the United States and Europe show a similar overrepresentation of males (Ashley & Ashley, 2008; French et al., 1983; Jonkman & Kelman, 2005; Kundzewicz & Kundzewicz, 2005; Mooney, 1983; Sedwick 2008). For example, in a study that examined flood fatalities in Europe and the United States it was found that in instances where gender is reported, 70% are males (Jonkman & Kelman, 2005). In particular, males were notably overrepresented in vehicle crashes, drowning and physical trauma, and in cases of pedestrian drowning (Jonkman & Kelman, 2005). A number of factors have been identified as contributing to the high proportion of male flood fatalities. These include the large number of males who drive, the high proportion of males who work for emergency and supporting services, and the propensity of risk-taking behaviour of males (Coates, 1999; Coates & Haynes, 2008; FitzGerald et al., 2010; Jonkman & Kelman, 2005).

Table 3 Total number of Australian flash flood fatalities, gender of the victims, death rate per million of population and the ratio of male to female deaths for the period 1950-2008. Modified from Coates and Haynes (2008).

Period	No. of males	% of males	No. of females	% of females	No. gender unknown	% gender unknown	Total	Death rate	Ratio of M:F deaths
1950-59	30	65.21	11	23.91	5	10.87	46	0.50	2.73
1960-69	7	36.84	10	52.63	2	10.52	19	0.17	0.70
1970-79	29	65.91	8	18.18	7	15.91	44	0.32	3.63
1980-89	10	41.67	6	25.00	8	33.34	24	0.15	1.67
1990-99	25	67.57	8	21.62	4	10.81	37	0.21	1.57
2000-08	22	61.12	14	38.89	0	0	36	0.32	2.28
<b>Total</b>	<b>123</b>	<b>59.71</b>	<b>57</b>	<b>27.67</b>	<b>26</b>	<b>12.62</b>	<b>206</b>	<b>0.24</b>	<b>2.16</b>

### 2.5.1.2 Age

A number of studies have illustrated that certain age groups are more vulnerable during flood events (Ashley & Ashley, 2008; Coates, 1999; Coates & Haynes, 2008; FitzGerald et al., 2010; Jonkman & Kelman, 2005; Mooney, 1983). An examination of the total number of flash-flood victims relative to age shows that in Australia over the period 1950-2008 those in the age brackets 0-9, 10-19 and 20-29 years were most at risk (see Table 4, Coates & Haynes, 2008; FitzGerald et al., 2010). FitzGerald et al. (2010) highlight that individuals over the age of 70 years are also overrepresented in fatality statistics for the period 1997-2008. Research from the United States and Europe dealing with flooding provide similar findings. French et al. (1983) and Mooney (1983) found increased vulnerability in the <21 and >60 age groups. Similarly, Ashley and Ashley (2008) found an increased vulnerability in the 10-29 and >60 age groups, and Sedwick (2008) in the 20-29 and >60 age groups. Jonkman and Kelman (2005) found that one-half of those who drowned in buildings were elderly people (>60 years). These trends have been attributed to the decreased ability of the elderly (>60 years) and the very young to flee (0-4 years) (Coates, 1999; Coates & Haynes, 2008), and elevated levels of risk-taking amongst younger people (<25 years) (Jonah, 1986).

Table 4 Number and percentage of Australian flash flood fatalities, of the total known age vs. fatalities and death rate per million of population by ten-year age intervals for the time periods 1950-1979, 1980-2008 and 1950-2008. Modified from Coates and Haynes (2008).

Time Period	1950-1979			1980-2008			1950-2008		
	No. of deaths	% of deaths	Death rate	No. of deaths	% of deaths	Death rate	No. of deaths	% of deaths	Death rate
0-9	17	28.33	0.51	8	12.12	0.22	25	19.84	0.35
10-19	10	16.67	0.34	16	24.24	0.41	26	20.63	0.38
20-29	13	21.67	0.50	13	19.70	0.33	26	20.63	0.39
30-39	5	8.33	0.21	6	9.09	0.15	11	8.73	0.17
40-49	7	11.67	0.33	8	12.12	0.23	15	11.90	0.27
50-59	1	1.67	0.06	6	9.09	0.22	7	5.56	0.15
60-69	4	6.67	0.37	6	9.09	0.29	10	7.94	0.32
70 +	3	5.00	0.33	3	4.55	0.14	6	4.76	0.20
<b>Total</b>	<b>60</b>	<b>100</b>	<b>0.33</b>	<b>66</b>	<b>0.25</b>	<b>0.25</b>	<b>126</b>	<b>100</b>	<b>0.28</b>

### **2.5.1.3 Tourists**

In Australia, while there is published information on overall numbers of tourist deaths (e.g., Leggat & Wilks, 2009) and tourist deaths related to general activities such as road accidents and drowning (e.g., Mackie, 1999; Wilks et al., 1999), no published statistical data could be found on tourist deaths during flooding.

A few studies have examined whether tourists are more susceptible to flood events in particular (Gruntfest, 1977; Ruin, 2008) and many others have looked at tourism and other hazards (e.g., Drabek, 1994; Johnston et al., 2007). Due to their typical lack of knowledge and unfamiliarity with the area they are visiting it has been suggested that tourists may be more vulnerable during a flood event. Events (e.g., a tsunami, flash flooding or even riverine flooding) may catch people by 'surprise' and it can be difficult for tourists to obtain information about the nature of an event, how it will affect them and how they need to act and respond (Drabek, 1996; Johnston et al., 2002; Kelman et al., 2008).

Despite an apparent vulnerability to natural hazard events there are instances where tourists can be quite resilient. Tourists are commonly perceived to be more vulnerable during a flood event as they are in an unfamiliar environment and are often less able to undertake independent actions in response to an event (Faulkner & Vikulov, 2001). Faulkner and Vikulov (2001) observe, however, that tourists can also possess other qualities which reduce their vulnerability. For example, during the 1998 Australia Day flood at Katherine, tourists were less vulnerable than residents in the sense that they had no emotional attachment to the location being flooded, and thus experienced less trauma and had less difficulty in making decisions (Faulkner & Vikulov, 2001).

There are also a few examples of tourist and resident responses during a flood event. Of the 140 people killed during the 1976 flash flood in Big Thompson Canyon, Colorado, United States, 25% were classified as tourists (Gruntfest, 1977, 2000). The fact that a large percentage of residents were also killed indicates that residents had no clearer idea of what action to take than non-residents (Gruntfest, 1977, 2000). Ruin (2008) found that tourists are more likely to do the right thing during a flood event even though warnings hardly reach them. She suggests this is because residents tend to act according to their own environmental knowledge while tourists' behaviour is based on standard safety recommendations (Ruin, 2008).

### **2.5.1.4 Urban and rural differences**

It appears that to date none of the studies that have examined flood fatalities in Australia, the United States or Europe have examined whether there is any difference between death rates in urban areas compared to rural areas. The only mention of this matter is by Coates (1999) who, in discussing flash flood fatalities in Australia, observes that the gradual movement of the population from rural to urban areas has resulted in people having lesser involvement in occupations exposed to the flood hazard. Despite this she warns that these people still remain at risk from urban flash floods (Coates, 1999). People residing in urban areas, however, particularly those living on a floodplain, are also susceptible to the considerable impacts associated with riverine flood events, which affect various locations including urban Sydney (see NSW Government, 2005).

### 2.5.1.5 Geographic differences in Australia

In Australia, the greatest number of fatalities has been recorded in the eastern states, mainly in NSW and along the east coast (Coates, 1999; FitzGerald et al., 2010). In particular, the coastal strip from Wollongong (NSW) to Maryborough (Qld), is the most hazardous zone in relation to past flood fatalities (Coates, 1999). The most impacted state or territory in Australia with regard to total fatalities is NSW which has accounted for 49.3 percent of fatalities, followed by Queensland (33.5%) and then Victoria (8.0%) (Coates, 1999). In regards to drainage divisions and the total number of flood fatalities, the most impacted locations in Australia are the South-east Coast (36.2%) followed by the North-east Coast (28.2%) and Murray Darling (24.6%) (see Table 5; Coates, 1999). It is likely that distribution of flood deaths demonstrated by the percentages above are influenced by the concentration of population in eastern parts of Australia. For further details regarding fatalities in regards to population see Coates (1999) and Coates and Haynes (2008).

Table 5 Distribution of flood events and flood fatalities in Australia by drainage division and key drainage basins, 1788-1996. Modified from Coates (1999).

<b>Drainage division and drainage basins</b>	<b>% fatal flood events</b>	<b>% of flood fatalities</b>
North-east Coast Division	22.2	28.2
Herbert River	1.0	2.9
Fitzroy River	3.9	7.0
Brisbane River	5.6	8.6
South-east Coast Division	37.8	36.2
Richmond River	3.7	3.4
Clarence River	2.9	2.1
Hunter River	7.3	7.5
Hawkesbury River	7.5	5.6
Sydney Coast-Georges River	3.4	2.3
Shoalhaven River	1.8	2.9
Yarra River	1.4	2.7
Tasmanian Division	2.4	2.7
Murray-Darling Division	27.7	24.6
Murrumbidgee River	6.2	8.4
Namoi River	3.5	3.1
Macquarie-Bogan	5.2	3.7
South Australian Gulf Division	4.2	2.8
South-west Coast Division	0.7	0.6
Indian Ocean Division	0.1	0.2
Timor Sea Division	0.7	1.2
Gulf of Carpentaria Division	1.3	1.2
Lake Eyre Division	2.4	2.0
Bulloo-Bancannia Division	0.3	0.2
Western Plateau Division	0.2	0.2

### 2.5.2 Reported near misses and injuries

To date it appears there is only one study that has examined reported near misses and injuries. Coates and Haynes (2008) report that there were 191 near misses from 1988 to

2008 in Australia. Of these the majority were near misses (87.5%) followed by incidents that required hospital treatment (8.1%), shock and minor injuries (2.9%) and very severe injuries (1.5%). The trends described above related to fatalities also appear to be evident in the data pertaining to near misses and injuries. Most of these events were vehicle-related (36.8%) or occurred during attempts to undertake recreational pursuits (47%).

### **2.5.3 Health issues**

In addition to death there are numerous, non-lethal health effects - physical (physiological) or mental (psychological) - which survivors can experience following a flood event (Jonkman & Kelman, 2005). Physical health effects can range from minor cuts, bruises and lacerations to broken bones, amputations and paralysis (Noji, 1993). Further, high concentrations of a numbers of bacteria, viruses and vector-borne infectious diseases have been found in floodwater including coliforms, E. coli, enterovirus, hepatitis A virus, norovirus and adenovirus (Ivers & Ryan, 2006; Phanuwat et al., 2006). Survivors of, and responders to, flood-related natural disasters therefore may face increased risk of soft tissue, respiratory, diarrheal, and vector-borne infectious diseases (Ivers & Ryan, 2006).

The main psychological health effects that can continue for a number of years following flood events include post traumatic stress disorder, anxiety and depression (Kundzewicz & Kundzewicz, 2005; Price, 1978). Such psychological effects can also have significant short term impacts on survivors which can result in the loss of life. Hajat et al (2003) examined the psychological distress experienced by people involved in the 1997 flood in Poland and the Czech Republic. No suicides or attempted suicides were recorded in the Czech Republic; however in Poland, 50 suicides were attributed to the flood in the two months following the event.

## **2.6 Summary of people's behaviour in and around floodwater**

Form the review of literature, it appears that people are often unaware of the risks posed by floods despite living in flood prone areas, and even those who are aware significantly underestimate the potential impacts, are not concerned about the risk, or believe that a flood event will not personally affect them. The most common behaviours or activities that people choose to undertake in or around floodwater are driving, walking or recreational pursuits. Males and younger people (<30 years old) are more likely to undertake such activities. Most people who enter floodwater typically do so in order to reach a specific destination in their daily routines. The literature review revealed that a number of flood studies show that people may ignore warnings in order to maintain their daily routines such as travelling to and from work or dropping off their children at school. Only a small minority of people actually move into floodwater during evacuation. The most significant consequence of these various behaviours in and around floodwater is loss of life. Figures on flood fatalities have consistently highlighted the substantial proportion of vehicle, pedestrian and recreation-related deaths, and the overrepresentation of males and those belonging to the <30 and >60 age groups in these statistics. Other consequences of behaviours in and around floodwater include both short and long-term physical effects (e.g., broken bones, amputations and paralysis) and mental health outcomes (e.g., post traumatic stress, anxiety and depression). Overall, the findings of this literature review suggest that a significant number of flood-related deaths, injuries and other health effects could be prevented as they are the result of unnecessary risk-taking behaviour.

## 3.0 STRATEGIES FOR PROMOTING APPROPRIATE BEHAVIOUR AROUND FLOODWATER

### 3.1 Chapter outline

This chapter reviews existing flood safety education programs in Australia and overseas to determine what strategies (if any) have been used to trigger behavioural changes around entering floodwater. The chapter also looks at general flood safety education delivery in Australia and overseas, including methods and content. Existing and potential strategies and programs for public education are examined with regards to application for changing flood safety behaviours. The effectiveness of strategies and programs is discussed in the context of available measures and the literature available. Finally, recommendations are made on how the NSW SES can enhance behaviour change around floodwater using a range of methods and content, and through monitoring and evaluating adopted programs.

### 3.2 Floodwater safety issues and strategies; definition, purpose and evaluation methods

#### 3.2.1 Strategy versus activity

For the purpose of this report the term **strategy** is used to describe a systematic plan of action designed to achieve a specific goal, that goal being reducing deaths and injuries from people entering floodwater. A strategy seeks to target a particular issue and provide solutions or improvements to the status quo. Strategies therefore, ideally include a clear and documented plan of:

- Why – what is the issue being addressed, why does it need to be addressed;
- What - what is the goal of the strategy, what outcomes are desired;
- Who – who is responsible for delivering the actions to meet the strategy, and who is the intended audience;
- How – what processes and actions (activities) will be undertaken to meet the goals of the strategy, and how will the success of the strategy be measured;
- When – when will the strategy begin and end;
- How much – will the strategy cost and who pays; and,
- How will success be measured – what data is required, how will it be collected?

Actions that contribute to strategies (such as the provision of brochures through public stands at libraries, or flooding signs at a low point in the road) are termed **activities** in this report. As there are limited documented programs in place currently that meet the complete criteria of a *strategy* for preventing people entering floodwater (who, why, when, how etc), activities will be evaluated alongside strategies to determine potential or known (measured) effectiveness.

Because there are limited strategies specific to floodwater behaviour to draw upon, the assumption is made by the authors of this report that injuries and deaths resulting from people entering floodwater can be viewed as a public safety issue. Considerable research has been conducted on public safety initiatives in Australia and internationally, and an examination of these has found that much of the methodology and conclusions are applicable to the floodwater context. A variety of studies and references outline the essential components of effective safety strategies (Loo et al., 2010; Wong et al., 2004), and how

strategies can best be evaluated. Egger et al. (2005) outline an effective formula for developing social marketing campaigns which can be used as templates for developing campaigns for floodwater safety. The SOPIE process is one applicable example and includes five stages: Situational Analysis, Objective Setting, Planning, Implementation, and Evaluation. How the SOPIE model could be applied or used as a check-list for whether a strategy is well designed and achievable is shown in Table 5.

Table 6 The SOPIE strategic planning process (Egger et al, 2005) and adaptation for floodwater strategy

<b>SOPIE Model Process</b>	<b>Application for Floodwater behaviour strategies</b>
<b>Situational Analysis:</b> identifying the issue, specifying the problem, identifying potential target audiences and strategies, assessing resources, formative research	People are entering floodwater; which groups are most at risk? What options are available for treating the problem? Who can and will undertake activities? <i>The background to this stage has already been completed to a large degree within this report.</i>
<b>Objective Setting:</b> defining overall goals and campaign goals, specific behavioural and communication objectives to the target audience	Is the goal to reduce deaths and injuries (more easily quantified) or a continuous reduction in the overall proportion of people who enter floodwater? Should the focus be on one at-risk group e.g. children and others recreating in floodwater or target all pedestrians and motorists? Goals should be specific, time-related and measurable. Baseline data required.
<b>Planning:</b> devising message strategies, developing and pre-testing materials, selecting media, identifying supporting components.	Formulate key messages based on best practice; formulate how they will be delivered (e.g. radio, public meetings, printed materials, school program) and who will deliver. Test the messages with focus groups from target population and adjust if necessary. Document all decisions why, when, where, how, who of the project.
<b>Implementation:</b> developing detailed program procedures, involving other sectors and stakeholders, program management	Formation of partnerships with other agencies (e.g. BoM, schools, community groups) is necessary for program success. Create and follow detailed timelines and process goals for roll out.
<b>Evaluation:</b> campaign monitoring, process and outcome evaluation	Monitor process and outcome objectives. Collect data for analysis of objective success (e.g. floodwater related injuries, near misses)

The floodwater safety context could also be considered as a road safety issue. Road safety strategies include analyses of pedestrian and motorist casualties and behaviours and provide much that is transferable for floodwater safety. Loo et al., (2010) identify a similar set of steps to the SOPIE process that are recommended for inclusion in effective road safety strategies. The steps are: vision, objectives, targets, action plan, evaluation and monitoring, research and development, quantitative modelling, institutional framework and funding. The first four make up the strategy formulation stage while the last five factors are part of the implementation stage of the strategy.

A combination of the steps in the SOPIE and the Loo et al., (2010) processes that fit well with pedestrian and motorist floodwater safety is used to evaluate the various strategies and activities identified during the literature review for this report. Evaluation of various initiatives is covered in Section 3.4.

### **3.2.2 The Purpose of Pedestrian and Motorist Floodwater Safety Strategies**

NSW SES has identified that their overall goal is to reduce (ideally to zero) the casualties resulting from people entering floodwater. As discussed in Chapter 2 of the report, there are a number of reasons why people enter floodwater – the critical step needed to reduce casualties is influencing people’s decision-making process underlying the reasons why people enter floodwater. Therefore, the most sustainable way the goal can be achieved is to foster growing behavioural change and more considered decision-making with regards to floodwater hazard. The most effective strategy will need to be structured to bring about behavioural change of the target audience.

Young and O’Neill (2009) discuss adapting the *Social Marketing* model for use with changing behaviour concerning flood preparedness and safety actions. Social marketing is defined as “programmes designed to influence the voluntary behaviour of target audiences to benefit the target audience and or society as a whole” (Young & O’Neill, 2009). The process recognises that behavioural change is gradual not instantaneous, and is based on five stages that people are considered to experience when a behavioural change is occurring. The stages are:

- Pre-contemplation: people really are not thinking about the behaviour as being appropriate for them at this point in their lives;
- Contemplation: people are actually thinking about and evaluating recommended behaviours;
- Preparation: people have decided to act and are trying to put in place whatever is needed to carry out the behaviour;
- Action: people are doing the behaviour for the first time; and,
- Confirmation: people are committed to the behaviour and have no desire/intention to return to earlier behaviour.

The social marketing model focuses on the steps to behavioural change, not just raising awareness. The model looks at the “behavioural stages of flood preparedness and looks at how this can be enhanced through incentives, education, increasing ability and rewards (Figure 4).

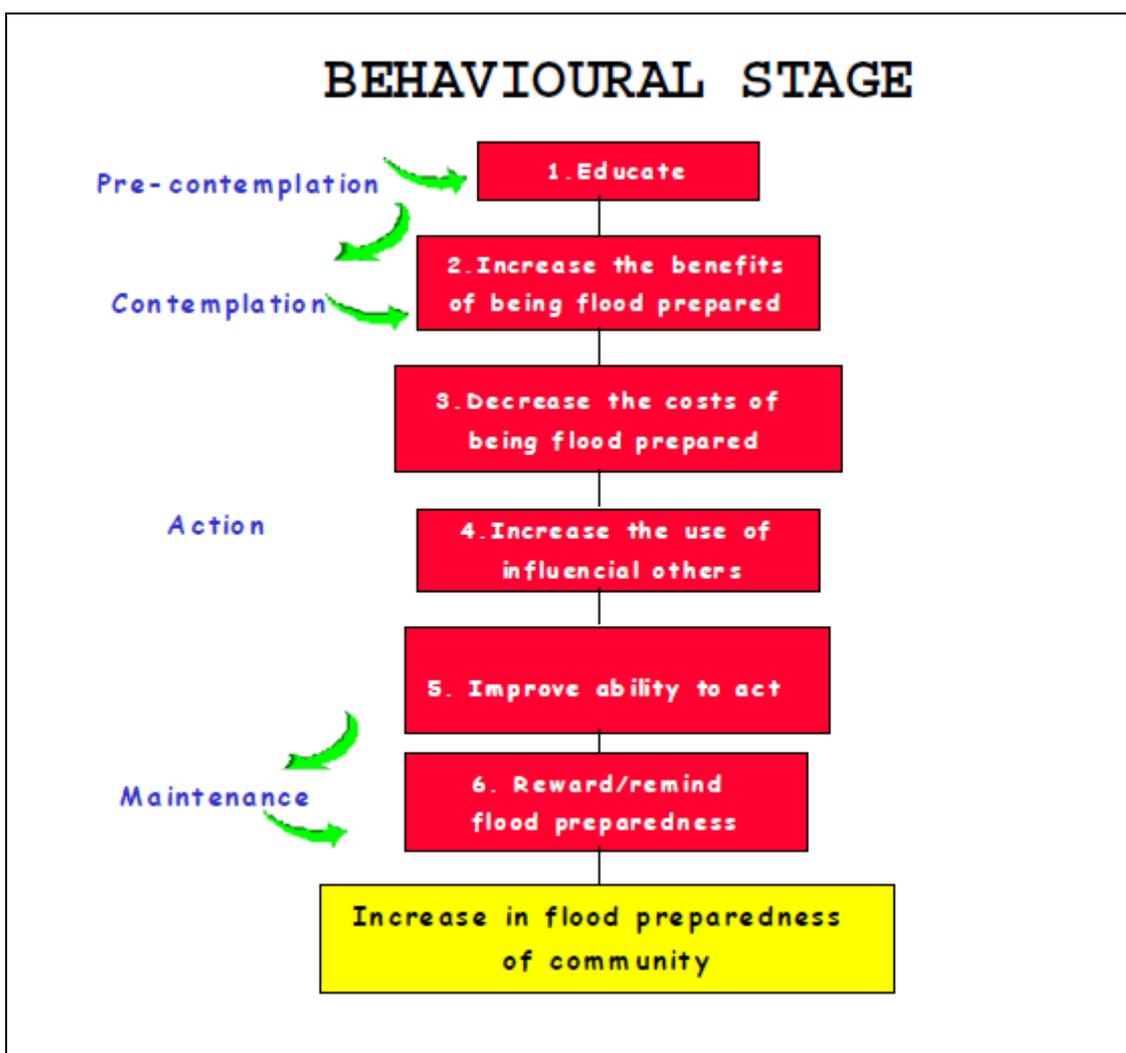


Figure 4 Behavioural stage model for changing behaviours around flood risk (Young & O'Neill, 2009)

A number of researchers have identified key attributes that need to be present for people to prepare for and respond to disasters (i.e. collate emergency items or make a plan for a disaster). These attributes have also been confirmed in a flood context in Australia (e.g. McIvor & Paton, 2007). A summary of key attributes is as follows (McClure et al., 1999; Paton et al., 2006):

- **Self-efficacy** is an individuals' appraisal of what they are capable of performing in a given situation. Relating to disasters, it may be a belief in an ability to do something about mitigating the effects of disasters
- **Critical awareness** describes the extent to which people think hazards are important enough to (a) think about and (b) conduct regular conversations about with others. Critical awareness reinforces that hazards are significant and assists with motivating people to plan in advance about what to do when faced with a hazard situation. People generally do not think or talk about hazards much, so developing critical awareness within the public is important.
- **Outcome expectancy** is the perception of whether personal action will effectively mitigate or reduce a problem or threat. There can be both positive and negative outcome expectancy. People who believe their actions will have a positive effect are

more likely to take these actions (positive), whereas people who believe an event is uncontrollable will be less likely to take appropriate actions (negative).

- **Action coping** is a form of ‘problem focused coping’, and relates to peoples’ ability to solve problems in life by confronting and resolving them.
- **Articulating problems** relates to the ability to describe community views, attitudes, needs and processes and how information is exchanged to derive common goals and meanings. It can include discussing and defining problems and determining solutions for those problems.
- **Community participation** describes the degree to which people take part in community life.
- **Empowerment** translates to citizens’ capacity to gain mastery over their affairs and to deal with issues and opportunities using intrinsic resources. People will need to draw upon their resources when a disaster occurs.
- **Trust** is an important facet of resilience as it influences the effectiveness of relationships between individuals and organisations. People are more likely to adopt protective measures, or undertake the correct actions in a disaster, if they trust the source of the information.

The attributes listed above are important in helping motivate individuals to prepare and plan for events such as flooding. However they also contribute to assisting people in making appropriate decisions when responding to an event (e.g. deciding not to enter floodwater). Ensuring these aspects are addressed in some way as part of a strategy or program before a flood event, will assist with promoting behaviour change.

### 3.2.3 Floods as a comparison with other risks in NSW, Australia

The Emergency Management Australia (EMA) Disasters Database currently lists known disasters or emergency incidents from the early 1800s to 2007. Table 7 shows recorded deaths and injuries from disasters in New South Wales from 1950-2007. Figures 5 and 6 depict deaths and injuries for NSW in graphical format for the years 1950-2007. The figures illustrate that in recent years the number of deaths from floods and flash flooding are similar in proportion to those experienced from other hazards. Many of these other hazards already have strategies, programmes or legislation in place to help avoid death or injury (e.g. urban fire). Additionally, there have been a number of floods in historic times that have caused a significant number of deaths (e.g. 50 deaths in one flood in 1955), showing the potential of flooding to cause harm.

Given the risk posed by flooding, the fact that flood-related injuries and deaths are largely avoidable, and the precedent set in terms of strategies to avoid death or injury for other hazards, it would be considered appropriate to develop a strategy to assist with advocating correct behaviour in and around floodwater.

Table 7 Injury and death statistics for natural disasters (including urban fire) recorded in the EMA Disasters Database (1950-2007)

	1950-1959		1960-1969		1970-1979		1980-1989		1990-1999		2000-2007		Total	
	Deaths	Injuries	Deaths	Injuries	Deaths	Injuries	Deaths	Injuries	Deaths	Injuries	Deaths	Injuries	Deaths	Injuries
Flash floods	-	-	-	-	-	-	0	0	5	9	3	30	8	39
Riverine Flood	80	420	2	0	7	67	23	97	7	46	6	15	125	645
Total flood	80 <sup>1</sup>	420 <sup>1</sup>	2	0	7 <sup>2</sup>	67 <sup>2</sup>	23	97	12	55	9	45	133	684
Bushfire	4	5	15	85	14	37	12 <sup>3</sup>	42 <sup>3</sup>	10	172	8	69	63	410
Cyclone	2	0	0	0	1	0	-	-	-	-	-	-	3	0
Drought	-	-	-	-	-	-	-	-	0	0	-	-	0	0
Earthquake	0	0	0	0	0	0	13	160	0	5	-	-	13	165
Hail	-	-	-	-	-	-	0	12	1	75	0	44	1	131
Landslide	-	-	0	0	-	-	2	0	4	1	-	-	6	1
Severe storm	-	-	36	4	9	52	2	53	34	416	26	223	107	748
Tornado	-	-	-	-	-	-	-	-	0	34	0	0	0	34
Tsunami	-	-	0	0	-	-	-	-	-	-	-	-	0	0
Urban fire	-	-	0	0	22	1	36	72	38	122	9	42	105	237

<sup>1</sup> Floods in 1954 and 1955 contributed most to flood fatalities and injuries during the period 1950-1959

<sup>2</sup> The 1978 flood contributed most to deaths and injuries in the period 1970-1979

<sup>3</sup> Most deaths and injuries were from the 1984, 1986 and 1989 floods.

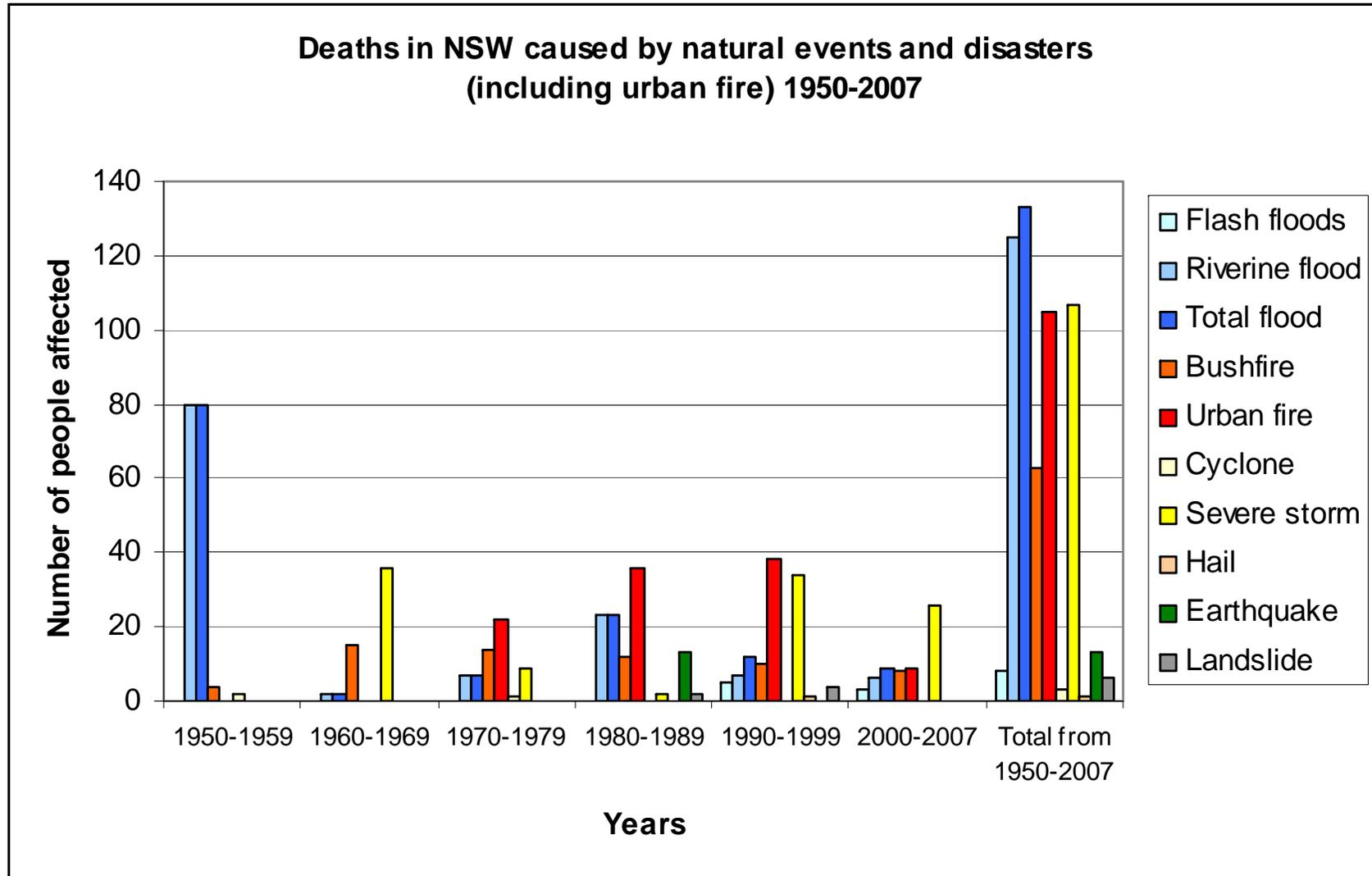


Figure 5 Deaths in NSW caused by natural events and disasters, 1950-2007 (EMA, 2010)

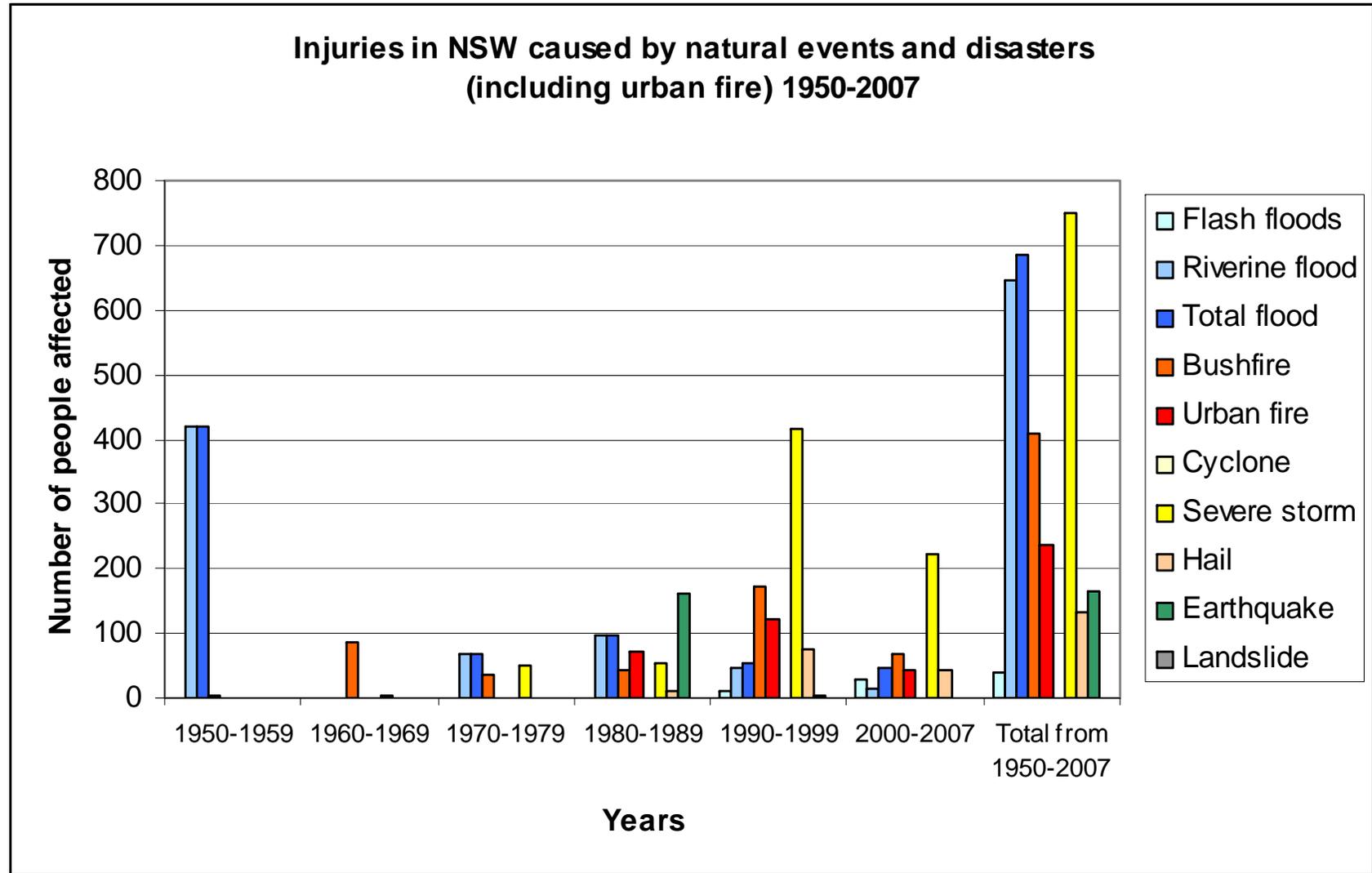


Figure 6 Injuries in NSW caused by natural events and disasters, 1950-2007 (EMA, 2010)

### **3.3 Flood education strategies, including strategies to deter people from entering floodwater**

#### **3.3.1 Australian Context**

O'Neill (2003) and Dufty (2008 a, b) note that traditionally public education in Australia about flood risk, preparedness and response behaviours has been a one-way information flow system of pamphlets and guides. There is no evidence to suggest that such an information delivery system encourages better preparedness and response (Dufty, 2008a; O'Neill, 2003), and in some studies there is evidence that provision of hazard information only (rather than hazard information and what actions to take) can result in reduced preparedness (Ballantyne et al., 2000; Johnston et al., 1999). The reason for this negative effect was that the public perceived that authorities had a greater understanding of and engagement with hazards and their impacts, and therefore the risk was reduced because authorities were "in control". Merely making people aware of the hazard and its potential consequences is not in itself likely to change behaviours; rather a spectrum of factors that contribute to behavioural change (including responding appropriately to floodwater) is required (Paton & Johnston, 2006). Additionally, it appears that much of the public education material that has been produced in the past (and to a degree at present) regarding flood behaviour actions is focussed on evacuation and property/stock protection rather than personal safety around floodwater (O'Neill, 2004, Lismore City Council, 2002).

In a discussion paper presented to the SES Division Controllers Conference in 2003, O'Neill (2003) highlights the importance of incorporating safety messages into public messaging programmes before emergencies (public education phase), when emergencies are imminent (warning phase), and during and immediately after disasters (response phase). However, these public safety messages are not identified as pertaining to behaviour around entering floodwater and are primarily concerning evacuation behaviour. Nevertheless, O'Neill's theory is important; personal safety messages should be promulgated at each of these phases, reinforcing the importance of avoiding floodwater, not only because of drowning or injury risk but also because of the risk from contaminated or electrified waters.

In Australia, public education for floodwater behaviour is largely the domain of the SES and local councils. Warnings (which could include floodwater behaviour messages) are mostly promulgated by the Bureau of Meteorology via the media, and in some cases through SES and emergency services (e.g. door-knocking). Integration of public education strategies and messaging with public warnings content will produce the most consistent information for the public.

Barry (2008), head of VIC SES notes that when flood warning messages are disseminated, businesses, organisations and individuals should respond in a premeditated way based on flood education and awareness programs. It is also noted that international research of flood warning systems has found that warnings alone are less effective in saving lives than previously supposed (Parker et al., 2007).

The goal of community resilience aspired to by emergency management agencies relies on these agencies supporting communities to develop their collective and individual skills, abilities and resources (Gissing et al., 2010a). The recently updated and released Flood Preparedness manual from the Australian Attorney General's Office has a comprehensive section on public education strategies including community engagement options, and

recommends that personal safety messages (wider than evacuation actions) be part of any public education programme (Australian Government, 2005). The manual cites the following as the principles of creating flood-ready communities (paraphrased from Australian Government, 2009):

- Engagement (create awareness of flood risk and the need for preparation and correct response)
- Empowerment (people taking responsibility and adopting appropriate actions)
- Information delivery to community members (what tools are available for developing appropriate actions?)
- Collaborative involvement (of community representative, services and organisations)
- Flexibility of services (meeting education needs reflects diverse communities).

The manual places a strong focus on community engagement and promotes a variety of two- and one-way learning methods. The manual also promotes that baseline measures of community resilience should be established so that effectiveness of resilience-building can be determined. The need for baseline measures and the incorporation of monitoring and review methods for strategies are important steps in determining whether strategies really are effective (Australian Government, 2005). The manual does not go into detail into how resilience can be measured. In New Zealand, as in Australia where community resilience is now a strong focus of civil defence emergency management planning, measuring resilience is not a well-established process, but work continues with the aim of making this happen in the future.

One further point that should be considered with respect to flood behaviour strategies is the rise of social media (e.g. Twitter, Facebook, YouTube) in communicating and responding to flood warnings (Gissing et al., 2010b). Evidence exists that people are using such avenues to gather and disseminate information about flooding and may base their decisions on information they receive through this medium (e.g. Catone, 2008; Reisinger, 2009). However, this is an emerging area of study and further research work on social media will inform future flood warning and education strategies.

### 3.3.2 Australian Strategies and Activities Summary

Most of this section is concerned with activities, as comprehensive strategies are limited. One initiative that can be classed as a strategy is described in detail, with a summary following of other existing activities.

**Benalla Community FloodSmart.** The Benalla Community FloodSmart program (now FloodSafe) takes a broader approach, more aligned with behavioural change. It is a recent initiative of the Victoria SES and Benalla Rural City to provide a multi-pronged, ongoing flood education programme that “elicits appropriate responses from the community before, during and after flood Events”.

*“Local people helping local people” (Haley, 2008).*

Flooding has been a problem for Benalla for many years, but like many communities in Australia, periods of hazard quiescence and new residents moving into the area results in lower awareness and preparedness for flood hazard. To create an ongoing and sustainable strategy the Benalla FloodSmart programme draws on other community FloodSafe and StormSafe community engagement programmes (particularly from NSW). However, how this

program differs from traditional programs based largely on one-way information delivery, (which in this project is called the 'static' phase of the project), is that it also includes a 'dynamic' phase which focuses on community engagement using two-way methods. The static phase delivers information through a wide range of methods: flood information signage, brochures, stickers on meter boxes, local action guides, maps of flood zones, and mail outs. The dynamic phase is a "grass-roots" campaign which incorporates SES volunteers and staff, council staff and key community groups. The program includes service club meetings, community group meetings, community displays, events targeted at involving people on a one-on-one basis (e.g. barbeques and market stalls), an eight day door-knocking campaign, and a program in schools (Haley, 2008). By utilising existing community groups to share flood safety information with their neighbourhood peers, the Benalla FloodSmart organisers have developed a framework for ongoing dissemination of flood safety messages which the community themselves own.

The Benalla FloodSmart project includes a monitoring and evaluation component. The Haley (2008) report includes the results of the first short to mid-term effectiveness surveys. In the 'Safety and floodwater' part of the survey, participants were asked about past behaviours and present attitudes to entering floodwater. The survey was conducted after the FloodSmart campaign to test initial changes in attitudes and proposed behaviours. Survey participants were asked if they would walk or drive through floodwater; 37% said they would. However, data on past behaviour showed that 80% of survey participants had either walked or driven through floodwater in a recent, past flooding event. This shows although a high number of Benalla people are willing to enter floodwater on foot or on vehicles, half of those who had taken these actions prior to the FloodSmart campaign, now considered they would not enter floodwater in a similar situation.

The FloodSmart project is a planned program using community groups as advocates and community activities as focus points, as well as posters, signage, stickers, maps, and other printed materials to raise flood awareness and enhance preparedness and safety behaviour. The program is not specific to entering floodwater (as it includes education about evacuation etc). The program method and budget has been documented and basic evaluation following the campaign was undertaken. Key messages: "*DO NOT drive through floodwater & DO NOT allow children to play in floodwater*" (Haley, 2008).

Other current strategies and activities in Australia which include advice or warnings specific to entering floodwater include:

**The NSW SES FloodSafe programme.** (Similar-titled programmes have also been called FloodSafe in some parts of Australia). FloodSafe is a multi-level programme focussed on those living in urban and rural areas, and businesses. The campaign includes a Business and Home FloodSafe Toolkit, generic and localised brochures and general information-based resources about preparing, responding and recovering from floods (including television and radio Community Service Announcements). The FloodSafe programme also has an on-the-ground community engagement component. The SES works in partnership with local groups and networks to hold business breakfasts, undertake doorknocking for businesses and residents to deliver toolkits, and hold local meetings, displays and events. None of the FloodSafe materials are wholly focussed on people entering floodwater, but instead focus on a variety of aspects of flood safety. There is no overall plan available for how FloodSafe is rolled out, however some plans do exist with respect to delivery of specific aspects of the programme. There is no evaluation or whether the FloodSafe programme is effective in its

entirety, however some research has been undertaken to understand and evaluate particular aspects. For example, research undertaken by Becker et al., (2007a; 2007b; 2008a; 2008b) has helped the SES understand people's perceptions and actions with respect to flooding, and has fed into developing messaging for the programme (e.g. about entering floodwater). Key messages: An older (pre-2005) message promoted by NSW SES which may still be in circulation is, *"Avoid driving or walking through floodwater – it is the main cause of death during floods."* Current messaging (post-2005) about entering floodwater is, *"Never drive, ride or walk through floodwater – this is the main cause of death during floods as water may be deeper or faster flowing than you think and may conceal hidden snags and debris"* (NSW SES, 2007-2008).

**Hunter Central Rivers Catchment Management Authority and NSW SES Community Flood Education Strategy.** This strategy is a partnership between the Hunter Rivers Catchment Management Authority and the NSW SES. The strategy is well documented and includes a wide range of activities, baseline and ongoing survey work and includes a strong emphasis on community participation (Hunter Central Rivers Catchment Management Authority, 2006). The working group comprises representatives from local business, residents, the CMA, SES, and local council. The strategy covers flood education about historical events, the flood mitigation scheme, the role of the SES, warning systems, preparedness for flooding, and safety around floodwater. It is delivered through use of SES resources (pamphlets, magnets, other materials), public displays, community events, business breakfasts, television advertising, videos and the delivery of toolkits to homes and businesses. Key messages pertaining to floodwater safety include: Flood safety on the road: *"Explain dangers of driving in floodwaters – many flood related emergencies are due to cars washed off flooded causeways/road"*. Dangers of entering floodwater: *"Driving, riding, walking or playing in floodwater is the largest cause of death during floods in NSW"* (Hunter Central Rivers Catchment Management Authority, 2006).

**M8s4life (Mates for life) Gold Coast City Council.** This school-based program has been designed alongside primary school educators to be delivered to years three to seven. It is specific to playing in floodwater and stormwater and is delivered through a variety of media. There is a website containing games, competitions and resources; children and adults can use Facebook or Twitter to follow the program, and there are modules designed for teaching in schools. The program is designed to be rolled out prior to the wet months (October to March). Key messages of the program are: "Don't let your life go down the drain", "Look after your mates", "Stay away from stormwater" and "The water could be deep, fast flowing or contain objects that can hurt you". Assessment of the program is through normal school curriculum methods (Gold Coast City Council, 2008). The content of the teacher resources is based on: Queensland Studies Authority (2000) Studies of Society and the Environment Years 1 to 10 Syllabus, Brisbane; Queensland Studies Authority (2003) English Years 1 to 10 Syllabus, Brisbane; and Queensland School Curriculum Council (1999) Science Years 1 to 10 Syllabus. Brisbane.

**SA SES Community FloodSafe/FloodSmart.** Community FloodSafe is modelled on the New South Wales State Emergency Service (SES) program of the same name. FloodSafe is operating successfully in six southern metropolitan councils and is being introduced in other metropolitan and semi-rural councils in 2010. Key messages regarding entering floodwater on the SA SES website include:

- *"Don't drive into water of unknown depth and current."*
- *Don't allow children to play in, or near, flood waters."*

- *Avoid entering flood waters. If you must, wear solid shoes and check depth and current with a stick. Stay away from drains, culverts and water over knee-deep.*
- *Never allow children to play in or near flood waters*
- *Never camp in a dry creek bed when bush-walking, creek trickles can turn into torrents very quickly*
- *Never drive in water of unknown depth or current” (South Australia SES, 2010).*

**South Australia - Mitcham Council.** Provides information on walking and driving in flood waters on the website. Key messages include:-

- *“Do not walk or drive in water of unknown depth or current.*
- *Avoid walking or driving in flood waters.*
- *Watch out for washouts, floating objects or hidden obstacles.*
- *Drive slowly and when out of the water dry out the brakes” (Mitcham Council, 2010).*

**Fire and Emergency Services Authority of Western Australia (FESA).** SES in Western Australia is a part of FESA. Key messages about entering floodwater on the FESA website include:

- *“Relocating to safer ground*
- *Don’t drive into water of unknown depth and current.*
- *Staying home*
- *Stay tuned to local radio for updated advice.*
- *Don’t allow children to play in or near floodwaters.*
- *Avoid entering floodwaters. If you must do so, wear solid shoes and check depth and current with a stick. Stay away from drains, culverts and water over knee deep” (FESA, 2010).*

Some regional/local Western Australia SES units have their own websites, but no additional information could be found on strategies or flood behaviour messages.

**Northern Territory SES.** Information about what to do in or around floodwaters was found on the Northern Territory website. Key messages included: *“Avoid wading, even in shallow water, as it may be contaminated - if you must enter shallow floodwater, wear solid shoes and check depth with a stick. Check with police for safe routes before driving anywhere and don’t enter water without checking depth and current”.*

There was also a limited amount of information in flood guides which states *“drive carefully, especially if roads are under water” (Northern Territory SES, 2010).*

**Children’s books – SES Flood heroes and SES Flooded In.** No detail on how many printed, who distributes and to whom (e.g. through schools). No evaluation of effectiveness. Key messages *“It’s too dangerous to drive through the floodwater!” and “The SES says you can’t drive through the Floodwater”.* These materials are dated and not being currently distributed but were provided as part of the literature review.

**EMA Flood Action Guide.** brochure, no information on how this is distributed or whether it is part of a wider, documented strategy. Key message: *“Act Safe - Never drive in floodwaters & Never swim or wade in floodwaters”.*

**EMA Flood warnings, preparedness and safety brochure.** No information on how this is distributed or whether it is part of a wider, documented strategy. Key message: *“Avoid*

*entering floodwater unless absolutely necessary, and never underestimate the strength of floodwater”.*

**EMA (booklet)** “What to do before, during and after a flood”. Printed booklet from EMA. No information on how this is distributed or whether it is part of a wider, documented strategy. Includes information on driving, and boating in floodwater but is not specific to floodwater safety. Key messages: *“The majority of flood-related deaths in Australia are a result of inexperienced people entering floodwaters either in boats, vehicles or on foot. Boating, driving and walking in flood areas should be avoided unless absolutely necessary”* (Australian Government, 2005)

**Health information and fact sheets.** Additional advice about behaviour in and around floodwater can often be found via health agencies, in fact sheets or in media releases during times of flooding. For example Health Queensland’s media statement for flooding in 2008 stated that, *“To minimise health risks, do not swim in floodwater and ensure that you and your children keep away from storm water drains and creeks. Avoid wading even in shallow water, as it may be contaminated - if you must enter shallow flood water, wear solid boots or shoes for protection”* (Health Queensland, 2008). A Northern Territory Health flooding fact sheet states that inside you should *“Avoid wading even in shallow water as it may be contaminated – if you must enter shallow floodwater, wear solid boots or shoes for protection.”* People outside should consider, *“If you must enter floodwaters, wear solid shoes, not thongs or bare feet, and check the depth and current with a stick. Stay away from drains, culverts and any water source that is that are more than knee deep. Don’t drive until you know it is safe.”* (Northern Territory Health, 2010).

These activities and strategies alongside (analogous strategies to do with health and safety) are evaluated and compared in Table 10.

### 3.3.3 International Strategies

An extensive literature review of countries with similar floodwater problems and communities to Australia was undertaken to determine whether strategies were in place elsewhere that could be used as templates for NSW SES to build on. The review found only a few programs that were specific to entering floodwater including “Turn Around, Don’t Drown”, “Ditch Playing In Ditches”, the Clark County Billboard Campaign from the United States, and some evaluation of the use of signage and barricades. As with Australia, other activities and strategies covered a mix of messages about flooding including, warnings, evacuation, protecting valuables, floodwater behaviour, etc. For this reason only five flood related strategies or activities are discussed alongside some comprehensive strategies for changing behaviour to do with personal safety when faced with hazards.

**“Turn Around Don’t Drown” (TADD).** TADD is a NOAA National Weather Service campaign to warn people of the hazards of walking or driving a vehicle through floodwater, and is therefore the only set of activities to be specific to entering floodwater. TADD is not a comprehensive strategy in that it has no documented process, action plan or decision making behind it and no evaluation of the methods or messaging used. The key activities are signage permanently stationed at low points in roads that may flood during extreme rainfall events, and a webpage that includes a brochure and presentation resources. Some of the resources are specifically targeted at addressing assumptions about vehicle safety, in terms of weight and buoyancy. There is no background information on whether people have

identified buoyancy and their own vehicle's capability/weight as a factor when they decide to drive into floodwater. There is also no information or reasoning why these resources have been specifically produced to target buoyancy assumptions. The key message of TADD is "Turn Around, Don't Drown" (meeting the McClure et al (2009) maximum effectiveness measures – see section 3.3.6) (NOAA National Weather Service, 2006). The effectiveness of this campaign still needs to be evaluated. For example, there may some circumstances when "Turn Around, Don't Drown" is not a useful message - if drivers are in heavy traffic then turning around may not be a viable option.

**Clark County Regional Flood Control District (CCRFCD) Campaign.** The CCRFCD in Texas, USA undertakes a number of flash flood hazard awareness activities including billboard campaigns and web-based activities, resources for children and adults (Clark County Regional Flood Control District, 2009). The CCRFCD holds an annual competition for the public to submit ideas for roadside billboards featuring inundated vehicles and witty number plate messages (Figure 7). The billboard campaign has been in existence 2003. Each year since 1999 the CCRFDC has undertaken surveys on people's awareness and behaviours around flash flooding, including questions on whether people had entered floodwater (in vehicles) and why. Respondents are also asked where they get information about flood hazard from. While there has been a drop in the number of people entering floodwater in vehicles in Clark County (Section 2.3.1.2), and regular surveying of the public, there is no clear link as to whether it is the billboard campaign or other reasons that are influencing people's decision making. The reason it is difficult to attribute to one particular cause is because within the surveys people are asked why they choose to enter floodwater but not why they choose to avoid floodwater or wait for them to subside. However, people's sources of flood information can be seen in Table 8, and this provides some indication of the reach of the billboard campaign which is specific to entering floodwater.

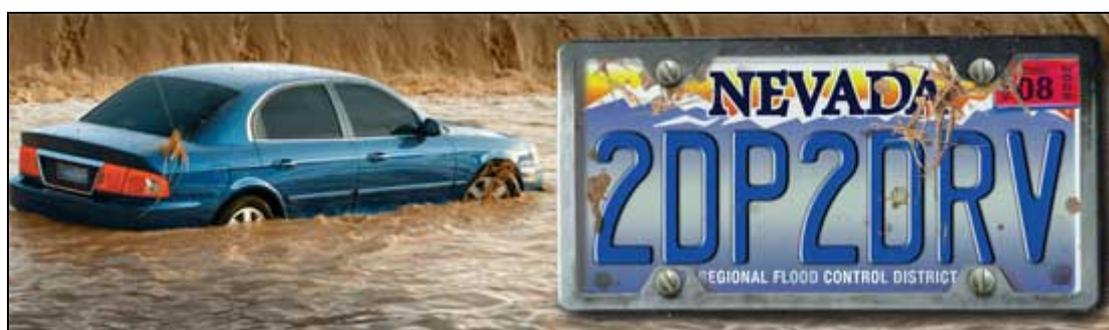


Figure 7 The 2008 winner of the Clark County Flood Control District Billboard Competition

Table 8 Summary of sources of flood information in Clark County 2007-2009 (Clark County Regional Flood Control District, 1999-2009)

Rank	Source	% 2009	% 2008	% 2007
1	Television	88	90	90
2	Newspaper	58	58	60
3	Friends/relatives	58	56	54
4	Radio	56	57	60
5	Billboards	56	53	51
6	Brochure	26	56	21
7	CCRFDC Website	21	20	20
8	Welcome Home Magazine	8	5	6

**Ditch Playing in Ditches – City of Colorado Springs, Colorado (USA).** This campaign specifically targets children playing in areas that may become inundated during flash floods. It is a reactive program instigated following the drowning of two children in the town of Colorado Springs. The campaign is web-based and provides resources for teachers (lesson plan) and parents and children videos and games. There is no documented evaluation or baseline data available for this program (City of Colorado Springs, 2010).

**San Antonio Flood Emergency (SAFE) (USA)** The City of San Antonio has potential for serious flooding, and as a consequence has developed a flood public education and preparedness program called SAFE. The mission of SAFE is to provide early flood notification during heavy rain events and to educate the public on actions necessary to protect life and property. The SAFE System goals are to:

1. Educate the public on flood awareness, preparedness and safety.
2. Develop a multi-media approach to public education and training.
3. Work with the first responder community, the National Weather Service, school districts, business community, media, neighbourhood and apartment organizations.
4. Enhance existing emergency notification systems under a unified front (San Antonio Flood Emergency, 2010).

The SAFE website includes information about flooding (e.g. historic floods, the nature of flooding, mitigation), preparedness (i.e. what to do before, during and after a flood), road closures, river gauges, educational material, and competitions. A Low Water Crossing Remediation Plan has been developed that seeks to address low water crossings that pose the greatest threat to public safety and implement options such as automated gates, signs, flashing lights and automated water level sensing devices. SAFE Routes have been established in key Low Water Crossing locations throughout the City of San Antonio so that citizens can easily find alternate routes away from flooded roads (Figure 8). SAFE also links with, and makes use of, messages from other programmes such as “Turn Around Don’t Drown”.

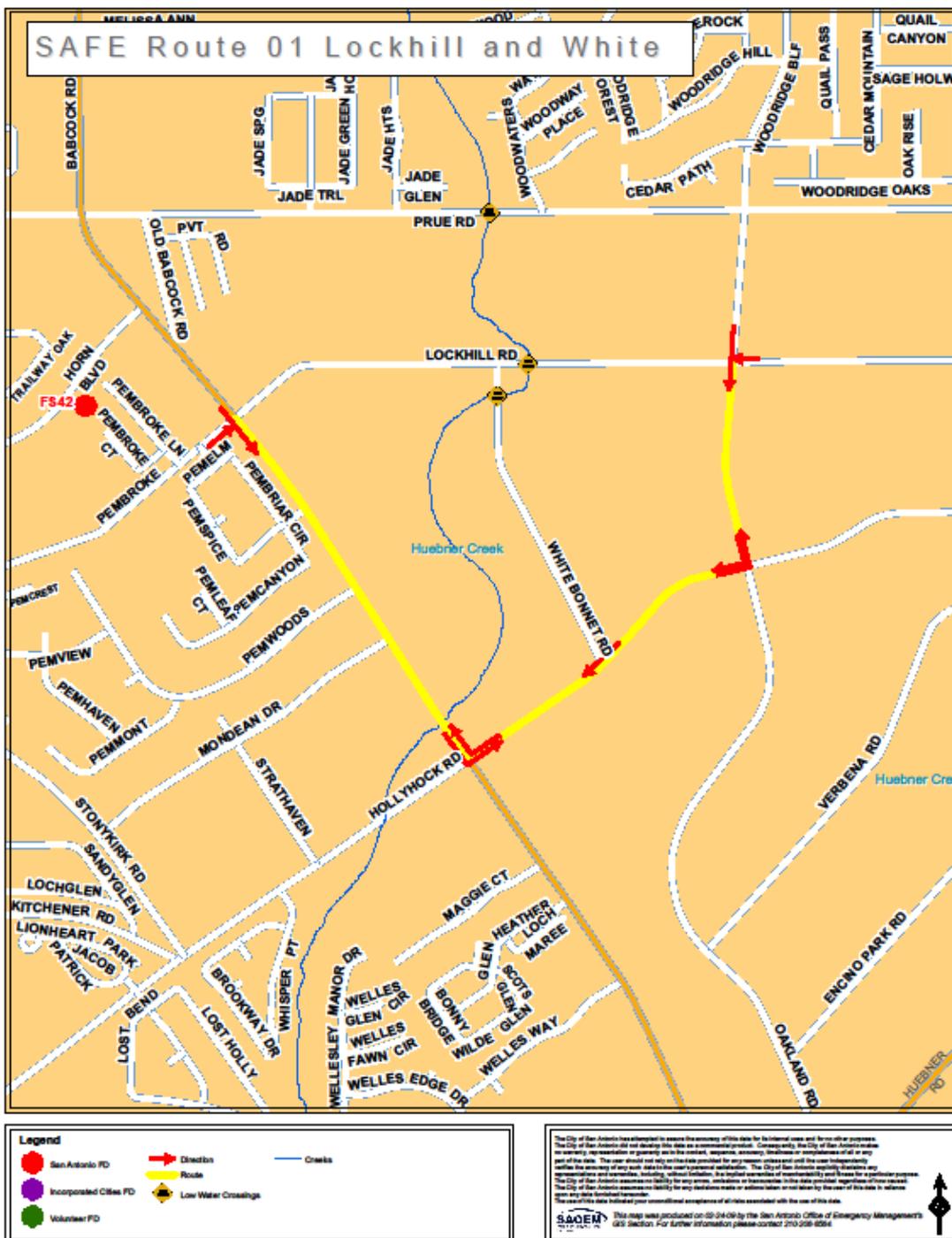


Figure 8 An example of SAFE Routes, a downloadable file from the SAFE website where citizens can find an alternate route to travel, away from flooded roads (San Antonio Flood Emergency, 2010).

**FloodSmart and the National Flood Insurance Program (NFIP) (USA).** FloodSmart is the webpage for the US National Flood Insurance Program run by the Federal Emergency Management Agency (FEMA). This program is primarily focused on ensuring that people are insured for flooding. Flood insurance is provided to homeowners, renters, and business owners if their community participates in the NFIP. Participating communities agree to adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding (Floodsmart, 2010).

The FloodSmart website provides information about flooding, flood risks and readiness/response, as well as flood insurance. There are some messages on the site about behaviour in and around floodwater and these include the following:-

*“Protect Yourself and Your Home - Here’s what you can do to stay safe during a flood:*

- *If flooding occurs, go to higher ground and avoid areas subject to flooding.*
- *Do not attempt to walk across flowing streams or drive through flooded roadways.*
- *If water rises in your home before you evacuate, go to the top floor, attic, or roof.*
- *Listen to a battery-operated radio for the latest storm information.*
- *Turn off all utilities at the main power switch and close the main gas valve if advised to do so.*
- *If you’ve come in contact with floodwaters, wash your hands with soap and disinfected water” (FloodSmart, 2010).*

**Environment Agency, UK.** The Environment Agency UK produces guidance on what to do during flooding in the form of a booklet. Their key message on entering floodwater is to *“avoid walking or driving through flood water”*. In one part of the guide they also link this message to the warning and suggest that in a severe flood warning you need to *“avoid walking or driving through flood water”* (Environment Agency, 2007).

**Herefordshire, UK.** A local website for Herefordshire has some slightly different messages for behaviour in and around flood water. As well as stating what people should do, these messages also provide information on the consequences of entering floodwater, such as there being hidden hazards. The messages include:

*“Do not enter floodwater as there is no way of telling how deep it may be. This applies if you are on foot as well as in a vehicle - manhole covers may have been loosened or removed so there could be extremely dangerous hidden hazards in floodwater. Please respect road closure signs - they are there for your safety and mean the road is impassable. Avoid any non essential journeys.” (MyHerefordshire.com, 2010).*

### **3.3.4 Other safety strategies with methods that may be applicable to behaviour in and around floodwater**

The strategies identified for inclusion in this section are examples of different types of strategies that have elements of success for behavioural change. Where possible we have tried to review strategies concerned with motorist and pedestrian safety, or strategies for natural hazard behaviour change. Consideration was given to other hazards that may close roads or block access (such as snow and ice or volcanic hazards), however no distinct strategies on educating people on the risk of driving in such conditions was found during the literature review.

**Skills for Preventing Injury in Youth (SPIY) Intervention program (USA).** This program targeted adolescents aged 13-14 through practical training of first aid skills (teaching consequences and problem solving) and theoretical presentations, role play and peer discussion groups. The program included baseline research, documentation of why, when and how activities would be undertaken, and evaluation following the program. Teachers were trained and involved in delivery of the program. The program had a clear goal of behavioural change around certain risk-taking behaviours (Soole et al., 2007).

**Preventing Alcohol Trauma; Community Trial.** A five year project with a goal of reducing alcohol-involved traffic injuries. The program follows an environmental policy approach incorporating community participation in three US communities. The strategy involved working with existing community groups, and using low cost media advocacy as a major communication strategy. Effectiveness of the program was measured for several targets (Howat, et al., 2001).

**Operation Bushfire Blitz** Victoria County Fire Authority (Aus). This program was designed to fill the gap between largely community run initiatives such as Community Fireguard neighbourhood programs and top-down information delivery programs. The goal was to increase preparedness and appropriate action taking during bushfires in Victoria. The program has been evaluated several times since inception (Hill, 1998; Rhodes, 2003) and found to increase preparedness and reduce financial loss. "Bushfire Blitz cost the public \$400,000, or the approximate value of two homes in the Dandenong Ranges. The fires at Macedon and Kalorama last summer directly threatened more than a dozen homes (value approximately \$2.4m), none of which was lost" (Hill, 1998).

**Land Transport Safety Authority – "Changing the Way we drive"** (NZ). The Land Transport Safety Authority in NZ has undertaken a long term social marketing campaign (a form of public education) to try and improve driver behaviour in New Zealand. Finnis (2004) discusses the programme and evaluates its success. The LTSA campaign has been running since 1995 and has a strategic purpose. The strategy relies on increased law enforcement (i.e. breath testing for alcohol, and issuing infringements for speeding, seat belt and other traffic offences), supported by hard-hitting, high profile advertising. Research is undertaken to identify problem 'areas', and the advertising uses this research to target 'at risk groups' for each road safety issue. Some of the advertising uses emotion and shock to deliver messages, showing realistic crashes and the consequences (e.g. prompting people to think "it could be me"), while more recent advertisements have also shown responsible behaviour (e.g. if you don't drink, you can drive your friends home safely). Evaluation statistics from 1999-2001 showed that during this period there were significant reductions in road deaths and injuries, and small improvements in attitudes and behaviour. While the LTSA campaign is considered a 'social marketing' strategy, it differs from social marketing in that it uses law enforcement to help achieve desired outcomes rather than voluntary behaviour change. This enforcement is likely to be part of the reason why this strategy has had some success. In comparison, other NZ social marketing efforts reported by Finnis (e.g. the SunSmart skin cancer campaign) have not reported a great deal of success. Additionally some of LTSA's success in reducing the road toll has also come from engineered solutions, as part of the funding for reducing the road toll is allocated to road work (realigning roads, adding barrier, resurfacing, etc).

**Federal Emergency Management Agency (FEMA) Disaster Resistant Communities Initiative – Project Impact.** In 1995 FEMA launched a new national initiative to encourage state and local adoption of disaster mitigation policies and programmes. A new program was launched entitled the Disaster Resistant Communities Initiative, later renamed Project Impact. The intent of the program was to establish a wide variety of community based initiatives to address mitigation issues deemed important by the communities, and to encourage the development of innovative solutions to hazard-related problems. FEMA outlined the general goals and objectives for the program, while communities were given the latitude to develop their own strategies. The overall goals of Project Impact were to:-

- build community partnerships (including between community, government and business);
- identify hazards and community vulnerability;
- prioritise risk reduction actions;
- develop communication strategies and educate the public about disaster mitigation (Finnis, 2004).

A variety of activities and programs have been undertaken by communities involved in Project Impact, some are focussed on flood mitigation activities (e.g. erecting markers/images of previous flooding events and high risk activities). Despite the successes made by Project Impact, this program is no longer supported by FEMA. However Project Impact continues to operate in communities that initially were involved. The benefits of Project Impact include:

- Leverage of resources
- Better understanding of risks and planning
- Reduction of losses in events (in at least two communities)
- Aided education and outreach
- Building of partnerships (Finnis, 2004).

**Southern California ShakeOut.** The Southern California Shakeout was a strategy aimed at getting organisations and the public more prepared for earthquakes. The program started out with the modelling of a scenario of an earthquake event on the San Andreas Fault. This model was then used by emergency managers as a basis for emergency planning, and for a Southern California earthquake drill and exercise. The ShakeOut started off as a modest effort but grew in interest and participation over the months it was running. It gained an enormous amount of support with over 5 million participants registering on the ShakeOut Website to participate in the exercise and drill. Initial evaluation of the programme showed that there was an increase in people undertaking earthquake preparedness activities as a result of the programme. Key elements of its success include (Becker, 2009):-

- Provision of scientific information to assist people's understanding of the earthquake hazard;
- Partnerships between government (e.g. county and state emergency management organisations), community (e.g. schools) and private interests (e.g. businesses like the hardware store HomeDepot);
- Implementation of community based activities to get the public involved in ShakeOut (e.g. school ShakeOut activities, neighbourhood ShakeOut parties, talks at local museums and community centres, etc);
- Use of community and organisational volunteers;
- Securing in-kind funding and sponsorships to assist with finances
- Use of evidence based messages based on previous social science research (e.g. Mileti et al., 1992) to motivate as many people in Southern California as possible to prepare.

- Organisers wanted to stimulate critical awareness and (a) get people thinking and talking about earthquakes and preparedness; and (b) actually get people to go and undertake preparedness actions. To encourage this, communications were focussed on three key areas:
  - Earthquake scenarios and preparedness messages were presented to communities, repeatedly and consistently. Messages came from multiple sources.
  - Organisers provided visual images of people preparing for earthquakes to show what others were doing and the specific actions they were undertaking; and
  - Organisers encouraged the ‘milling’ principle whereby people talk about the drill and preparedness with the people they care about (e.g., families) and also with others who may have taken action.

Some of the key messages used for ShakeOut included:

- *“We’re all in this together...”* – Designed to promote an individual’s sense of responsibility for their family, community and relevant organisations, and motivate preparedness.
- *“Everyone can participate!”* and *“Join us for the largest earthquake drill in history”* – There was an emphasis on everyone participating in ShakeOut, so individuals felt they should join in too.
- *“California is earthquake country!”* – The ShakeOut campaign focussed on telling people that a real risk existed with respect to earthquakes, and what the implications of an earthquake might be.
- *“ShakeOut. Don’t freak out.”* – While the campaign wanted to let people know what the risk of an earthquake was, it didn’t want to scare people into denial and fatalism (I can’t do anything about the problem). So it made sure that people knew what preparedness actions they could undertake that would help them in a big earthquake and increase their chances of survival (thus reducing negative outcome expectancy and building positive outcome expectancy).

### 3.3.5 The importance of community participation and engagement

Research in Australia and internationally has highlighted the benefits of community based programs for behavioural change (Finnis et al., 2007). Benefits of such an approach include: the program is likely to be more sustainable in the long-run than a stand alone group set-up specifically for one issue (Howat et al., 2001; Haley, 2008), the community takes ownership of the program and can learn from past experiences (Pfister, 2002; Gissing et al, 2010a), and people are more strongly influenced by their peers (neighbours, relatives) than by authorities when the benefits of behaviour change are not clear (as is often the case with low probability, high consequence events)(Paton and Johnston, 2001; Paton et al., 2006). A strategy that incorporates the community into message construction (pre-testing) and delivery will have greater opportunities to effect behavioural change. Respected community members with long-term local knowledge can often be regarded as more knowledgeable than authorities with regards to flood hazard, as was found during focus group interviews in NSW in 2009 (Becker et al., 2010).

A recent review of community safety programs for bushfire hazard found that community involvement and collaboration are two of the critical causal processes when determining whether safety programs will invoke desired outcomes (Elsworth et al., 2009). Their research reflects a similar shift in thinking to that of flood hazard management; the change from response focussed programs to community resilience initiatives. The benefits of community-

based programs described by Elsworth et al. include shared responsibility, identifying and protecting those at risk, and the development of community-based programs and multi-agency partnerships. The overall conclusion reached by Elsworth et al (2009) was that community based programs at both the top-down and bottom-up level have the clear potential to achieve positive outcomes at both individual and community levels.

### 3.3.6 Effective messaging for hazards

Section 2.2.5 has already covered the background theory on the factors that influence peoples' responses to warning messages. However, we can test existing and potential strategies more directly by examining whether messages meet the criteria for content most likely to induce safety behaviour as found through psychological research.

Considerable research has been conducted on the effectiveness of varying content in messages designed to promote risk reducing actions. McClure et al. (2009) summarise past research from a range of international studies and provide new research to assess whether people are more likely to take action to reduce risk based on how messages are framed. Their analysis of message framing includes testing the messaging of: **Outcomes:** as positive gains or negative losses; and, **Actions:** as positive or negative.

While many researchers have looked at whether positive or negative framing of outcomes or actions create behaviour change, McClure et al. (2009) are among the first to combine the two to identify whether it is the outcome framing or the action framing that has the greatest influence on whether people will change behaviour and undertake safety actions when faced with hazards. They used four combinations of messaging for preventative actions to reduce potential earthquake losses; these are listed alongside equivalent example messages for floodwater safety in Table 9.

Table 9 Positive and negative framing of actions and outcomes

<b>McClure et al. (2009)</b>	<b>Example in floodwater context</b>
Positive action, positive outcome. If you are well prepared for a major earthquake you are likely to have a greater chance of surviving the event unharmed.	Avoid floodwater, stay <b>alive</b>
Negative action, positive outcome. If you are poorly prepared for a major earthquake, you are likely to have a lesser chance of surviving the event unharmed	If you don't avoid floodwater you might not <b>survive</b>
Positive action, negative outcome. If you are well prepared for a major earthquake you are likely to have a lesser chance of experiencing harm in the event.	Avoid floodwater, don't <b>drown</b> (or potentially Turn around, don't <b>drown</b> )
Negative action, negative outcome. If you are poorly prepared for a major earthquake you are likely to have a greater chance of experiencing harm in the event.	If you don't avoid floodwater, you could <b>drown</b>

Statistical analysis was conducted to determine whether effectiveness could be attributed to framing of outcomes, framing of actions, or equally attributed. Results of McClure et al.'s (2009) research confirmed what previous researchers had found about outcome framing – that negative outcome framing describing potential losses is more effective in initiating behavioural change than positive outcome framing. For the purposes of this report “Don't

“Drown” including the potential of loss of life, is expected to have greater effectiveness than “Stay Alive”. A lesser difference was found between the effectiveness of framing actions as positive or negative, although positive actions e.g. “Turn Around” were found to be slightly more influential. This finding is also in agreement with past international studies. The conclusion was that messages with positive action and negative outcome framing would have greatest efficacy for initiating behaviour change with regards to people’s actions when faced with hazards. Thus the message “Turn around don’t drown, or a variant on this framing, could potentially be the best type of message to use.

Messages should also target attributes that contribute to enhancing people’s preparedness and response to flooding, such as self efficacy and outcome expectancy. For example (Finnis, 2004, McClure et al., 1999; Paton et al., 2006):-

To enhance self-efficacy messages should:-

- Include “what to do” alongside educational hazard and risk information so that individuals can identify what they can personally do to reduce their risk, both in terms of preparedness and response (e.g. behaviour in and around floodwater). People are more likely to do the ‘right thing’ if shown what the correct behaviour is, as opposed to pictures of damage.
- Encourage personal responsibility for hazards and safety.

To encourage positive outcome expectancy messages should:-

- Outline the complex nature of natural hazards, rather than focusing on widespread damage and destruction.
- Demonstrate that losses are avoidable, and show how people can practically avoid losses.
- Engender a belief in people that mitigation measures can be effective
- Emphasize an immediate benefit from the protective action e.g. “It will save you money”.

To reduce negative outcome expectancy messages should:

- Damage from an event, or potential event, is not universal and total. Remove the focus from ‘awe-inspiring and catastrophic events’ to focus on realities of an event (in terms of damage/loss).
- Show that the distribution of losses from an event is not evenly spread (i.e. impacts occur when communities are more at risk or more vulnerable).
- Show how the distribution of losses reflects factors about which people can make choices (e.g. building design, preparedness actions, appropriate response).
- Encourage people to see themselves as having control over events.
- Encourage more balanced and analytical articles (e.g. showing the relationship between hazard activity and how to cope).

In the warnings section (2.2.5) some discussion was provided about the attributes of warning messages. To reiterate, messages should be clear and consistent across multiple sources (Mileti and Sorenson, 1990). The review shows that a variety of messages are being used across states in Australia, with some indicating to stay out of water altogether, and some indicating that people should test the water or be careful before entering. It is possible that this lack of consistency with respect to messages may cause confusion and have some influence over people’s behavior in and around floodwater. Without research this is difficult to confirm, however.

It is important to note that messages alone will not elicit appropriate behaviors but must also be integrated with approaches that include community participation and empowerment, and build people's capacity to discuss problems, take action, and have trust in institutions involved with hazard issues (Paton et al., 2006). For example, with respect to trust, people need to be able to trust a message about flood behaviour and the source from which it came before they will act on that message (Paton, 2007). Therefore the building of trust should be considered as a part of any strategy, whether this activity is undertaken by the main organisation/s in charge of the strategy itself, or by other key organisations involved in local communities.

An assessment of the effectiveness of key messages in the strategies and activities identified in this report is included in the strategy evaluation table, Table 10.

### **3.3.6.1 The role of the media**

It is well established that the media has an influence on the public's understanding and response to hazards (e.g. Wagner, 2007). The role of the media with regards to advice given about entering floodwater appears to vary considerably between various media types. While radio is used for preparedness and warning messages, there is an expectation or desire from the public that television also be used in a similar way – to provide up to date flooding information during events, as well as public information messages on safety and preparedness. Print media (primarily newspapers) is used more commonly for preparedness and public education purposes. However, a clear conflict in advice is apparent in how the media portrays people who have entered floodwater, and especially children.

The use of television in the immediate build up to and during events is recommended as many people will seek up-to-date images and details on a changing hazard situation. It is important that a strong partnership with media is developed so that inclusion of safety messages is standard with all flooding updates, and that there is repetition of strongly worded advice on not entering floodwater.

There are two main types of images shown with regard to people entering floodwater – those who appear weary, either struggling through floodwater or being rescued from floodwater; and, those who are enjoying themselves recreating in floodwater. With regards to the rescuing/struggling images; these could contribute to a positive effect in terms of people's perceptions of the SES – that someone will be there to save them. This is good in terms of developing a trusting relationship with the community but may lead to unrealistic expectations of SES volunteers and unnecessary risk-taking. It would be preferable if the rescuers and rescuees were not placed in these difficult and dangerous situations in the first place. This message could be reinforced with every image showing a rescue; that there is danger for all concerned and the SES would prefer not to place their people at risk, to deal with these dangerous and avoidable situations.

Many images can be found in the newspaper media of children playing in potentially contaminated floodwater, and their playfulness is most commonly portrayed in a positive manner as a harmless, fun activity. It is likely these types of images will be screened during flood events on television. Such images are common on television for their "human interest" and dramatic effect. The portrayal of people, particularly children recreating in floodwater is problematic; the media are not likely to want to remove these types of images from

broadcasts due to the human interest factor. Therefore, the use of appropriate messaging by the media about likely contamination, open, unseen drains and the risk of unseen debris should be encouraged. It could be just as newsworthy to interview children and others recreating in the waters about their knowledge of potential contaminants such as sewage and chemicals, compared with merely showing children and adults playing in floodwater. The media are driven by ratings and although they have some public good function, ultimately reporting these events in a different manner must provide the newsworthy “hooks” for a new approach to be adopted. If the media can get on board with the danger and contamination messages, showing of these images will potentially still provide the visual human interest factor but could also be used to illustrate what not to do.

### 3.3.7 Signs and barricades

A search of the international literature revealed some information around the use of signage and barricades to deter people from entering floodwater. One study looked at how effective signage and barricades are in deterring people from driving into floodwater (Coles et al., 2009). Coles et al. (2009) who conducted a survey in Tuscan, Arizona, United States, found that over half of respondents self-reported they had driven through a flooded roadway (61%). They found that signs, barricades and laws often do not deter motorists from entering floodwater and can provide unclear messages to motorists. They attribute the ambiguity of signs and barricades to the fact they are not present at all intersections that flood, which creates a false sense of safety, and in instances where they are, they are present throughout the year even when streets are dry (Coles et al., 2009). Most of the respondents (90%) felt the presence of a sign or barricade was indicative of the *likelihood* of flash flood danger but less than half felt they indicated the *degree* of flash flood danger (Coles et al., 2009). Further, they found that respondents who suggested they had not driven into floodwater reported slightly higher levels of trust in signs and barricades than those who had (Coles et al., 2009).

In Texas and in Missouri many deaths occur at low water crossings along roads. The warnings from the National Weather Service are not precise enough to specify which low water crossings will be affected. However, there are numerous places in the US where low water crossings are marked by automatic or manual gates (similar to train crossings). Automated gates were suggested in Austin and San Antonio, Texas to deal with the problem of barriers not being removed when the water recedes, and of people driving around them. However, at the time of compiling this report the gates had not been automated and still need be operated manually (pers. com. Gruntfest, 2010). No literature was found on the use or effectiveness of automated gates.

In addition to the research undertaken by Coles et al. (2009) a number of studies have sought to examine how effective various road signs (temporary and permanent) and law enforcement are on influencing motorist behaviour particularly in relation to speeding (Bai et al., 2010; Brewer et al., 2005; 2006; De Waard & Rooijers, 1994; Hauer et al., 1982; Holland & Conner, 1996; Shinar & McKnight, 1985; Ullman et al., 2006). In general, research suggests that signs can be effective in encouraging people to reduce their vehicle speeds but not necessarily to desired levels (Bai et al., 2010; Brewer et al., 2005). Research undertaken in highway work zones, however, highlights that temporary signage is not necessarily as effective (Bai et al., 2010; Brewer et al., 2006; Brewer et al., 2005). Brewer et al. (2005), for example, identified and tested measures to improve work zone speed limit compliance. They concluded that without active enforcement, drivers are likely to drive as fast as they feel

comfortable irrespective of the posted speed limit (Brewer et al., 2005). No research was found on the use or effectiveness of flood height indicators.

The issues encountered with signage, do not mean it should be discounted completely. As Keys and Cawood (2009) write, visual cues such as flood markers in publicly visible places and graduated flood gauges on bridges and river banks are useful in helping people understand the flood hazard. It is essential however that people are able to make some meaning of the signage, e.g. know what a critical flood height is in relation to a certain marker and how they will need to respond to that height of flooding. Keys and Cawood also suggest that education about what signs and markers mean should take place in times of quiescence, or immediately after a flood when the topic is salient.

### **3.3.8 Partnerships**

A number of the strategies outlined above have used partnerships to assist with changing behaviour (Becker 2009; Finnis, 2004; Haley 2008). Partnerships can be developed at many levels, including between individuals, community groups and communities, organisations, businesses and government. Partnerships can assist with engendering support, helping get activities underway, and procuring resources and funding. In particular key partnerships can be made with schools, and a number of researchers suggest that schools should be a core component of reducing risk in communities (Finnis et al., 2007; Ronan and Johnston, 2005). The Texas Flash Flood Coalition (TFFC) is one example of a partnership approach in the US that coordinates flash flood related activities. The TFFC serves as a comprehensive flood resource council for prevention of flooding injuries and deaths; to prepare Texans for adverse flash flood events; to make recommendations to stakeholders to promote relevant research, education, and communications that will save the lives and property of Texans. The coalition has helped develop resources for programmes like “Turn Around, Don’t Drown” and is working on other initiatives such as how to send text messages to motorists about potential flash flooding (pers. comm. H. Guerrero, 2010).

### **3.3.9 Aligning with community development strategies to include flood safety messages**

Many councils (cities/shires) will already have in place community development strategies that are not focussed on hazards or emergencies. Examples include: public safety initiatives (e.g. crime or safer urban spaces), sustainable cities programs (enhancing the built and natural environment and reducing negative development impacts, better design of spaces), urban renewal or development projects (encouraging diversity of businesses and residential, mixed-use planning, hubs and clusters). While programs such as these might not appear on the surface to have much to do with flood safety, the decisions made by these forums could potentially impact on flood hazard (e.g. urban design, increasing impervious surfaces), or be linked through a general theme of safety (e.g. public safety programs could include natural hazards as well as crime hazards). By attending these forums and participating in their planning, members of the SES could for example, raise awareness of the potential safety issues that might arise out of new road network plans, or work to develop community resilience plans that help communities solve problems of crime (e.g. create a neighbourhood watch group), as well as increase preparedness and include safety messages for all types of threats. Because these community development programs are managed by other organisations, it is important that any inclusion for flood safety initiatives do not detract from the purpose of the forum, but rather that participants in the forum are aware of the issues of

flood safety and that programs are aligned so there are not conflicts between purposes (e.g. one program inadvertently creates greater risk from flooding, while one seeks to reduce it).

### **3.4 Which of the strategies/programmes discussed are deemed effective (including non-flooding strategies and evaluations of messages)?**

Table 10 summarises the identifiers of an effective strategy with regards to entering floodwater and how activities and strategies discussed in this report rate within this criteria. Comments are given as **Yes** – meets criteria, **No** - does not meet criteria, **Somewhat** – has multiple methods/messages and some meet criteria or main message partially meets criteria, and **Unknown** - not enough information to rank. Because some strategies or activities are summarised in reports reviewed, not all information such as whether there is one key message aligned with the program is available. This is particularly the case where a variety of media (street meetings, printed information, maps) are used to deliver the program.

Table 10 Summary of strategy effectiveness measures and qualitative scores for strategies/ activities with respect to entering floodwater

<b>Strategy/ Activities</b>	Clear goals/ objectives specified (focussed)	Specific to entering floodwater (focussed)	Baseline and post-strategy data available/ collected (measurable)	Evaluation incorporated into planning (effectiveness)	Targets high-risk or vulnerable group (cost/benefit)	Involves community as active participants (sustainability)	Action Plan Documented (responsibility and repeatability)	Range of methods/ media used (saturation)	Message content based on best practice (effectiveness)
FloodSafe (NSW SES)	No	No	Somewhat	No	Somewhat (e.g. Business FloodSafe)	Somewhat	No	Yes	Yes
Community Flood Education Strategy (Hunter Central CMA)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Somewhat
M8s4life (mates for life) Gold Coast City Council	Yes	Yes	No	Yes (school assessment)	Yes	Yes	Yes	Yes	Somewhat
Turn Around Don't Drown (US)	Somewhat	Yes	No	No	Somewhat	No	No	Yes	Yes
SAFE (US)	Yes	No	No	No	Somewhat	No	Yes	Yes	Yes
Benalla FloodSmart (VIC SES)	Yes	No	Yes (limited)	Yes	Somewhat	Yes	Yes	Yes	No
CCRFC Billboard campaign	Somewhat	Yes	Somewhat	No	Yes	Yes	Yes	No	Somewhat
EMA Materials	No	No	No	No	No	No	No	Somewhat	Somewhat
Children's Books (SES)	No	No	No	No	Yes	No	No	No	No
Skills for Preventing Injury in Youth	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Unknown
Preventing Alcohol Trauma	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Unknown

<b>Strategy / Activities</b>	Clear goals/ objectives specified (focussed)	Specific to entering floodwater (focussed)	Baseline and post-strategy data available/ collected (measurable)	Evaluation incorporated into planning (effectiveness)	Targets high-risk or vulnerable group (cost/benefit)	Involves community as active participants (sustainability)	Action Plan Documented (responsibility and repeatability)	Range of methods/ media used (saturation)	Message content based on best practice (effectiveness)
Operation Bushfire Blitz	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Unknown
LTSA road safety campaign (NZ)	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Project Impact (USA)	Yes	No	Somewhat	Somewhat	Yes	Yes	Yes	Yes	Unknown
Southern California ShakeOut (USA)	Yes	No	Yes	Yes	Somewhat	Yes	Somewhat	Yes	Yes

### 3.4.1 Suggested strategies for behavioural change

In our literature review, we found very few strategies that were specifically aimed at targeting people's behaviour in and around floodwater. There also appear to be no strategies that specifically target many of the reasons for people entering floodwater, outlined in Chapter 2 (apart from the fact that some strategies do address reason number three, awareness of flood risk). The "Turn around, don't drown" strategy was one of only a few strategies specifically aimed at flood behaviour, trying to get drivers to stop driving into floodwater. There are a number of other mainly Australian flood safety programmes that also make reference to elements of behaviour in and around floodwater, but they are not specifically geared toward changing it as the sole goal. As a consequence, there appears to be no one existing strategy that could be applied in a NSW context; instead a specific flood behaviour change strategy would need to be developed, drawing upon elements of the outlined strategies above, and building in additional elements of good practice.

The "Turn around, don't drown" strategy was found to use what appears to be good messaging techniques, based on research previously done. However the strategy focussed mainly on signage and the provision of educational resources. There was no evidence of an action plan outlining objectives and targets, no collection of baseline data, and no evidence of community engagement. Additionally, there has also been no evaluation of this strategy to assess its effectiveness (pers. comm. Grunfest 2009). As the messaging, does appear to follow good practice, similar techniques could be employed in the creation of any new messages a part of a wider strategy.

The Benalla Community FloodSmart programme is an example of a strategy which incorporates a wide range of activities (including information dissemination and community engagement) to ensure maximum effectiveness. Initial evaluation of the Benalla program has shown it to be effective in changing some attitudes, including those relating to entering floodwater. Other successful road safety strategies such as the SPIY programme and the Preventing Alcohol Trauma Programme have also included similar components. Key activities within these programmes, which can be used as a guide to develop future strategies include:-

- The development of a clear outline of the activities to be undertaken, including what, why, how and when
- Research to get a baseline measure and understanding of issues related to the behaviour in and around floodwater
- An information dissemination component. Information should be disseminated in a variety of ways (e.g. educational resources, warning messages, traditional and social media, signage, etc) and via a variety of sources
- A community engagement component (e.g. service club meetings, community activities, community displays, one to one interactions, door-knocking, working directly with school aged groups, etc)
- Targeting at-risk or vulnerable groups where necessary
- Showing the consequences of what might happen if you undertake certain actions
- Using existing community groups in engagement
- Creating partnerships with key groups or organisations (e.g. schools, community groups, businesses, government)

- Close relationships with the media (allowing capacity building of the media and the ability to derive benefits such as low-cost media representation).
- Training and capacity building for people delivering the strategy
- Training and capacity building for those being engaged/educated.
- Using community members for further information dissemination, engagement or training
- Long term commitment to run the strategy (e.g. over many years), with support of policy where possible
- Monitoring and evaluation of the programme.

While a strategy should include community education and engagement, the LTSA example also shows that law enforcement support and mitigation works may also assist with gaining desired results, namely reducing numbers of deaths (Finnis, 2004).

In terms of focusing on the seven reasons why people enter floodwater, strategies such as the SPIY youth intervention and LTSA road safety campaign show that programmes can be effective when 'at risk' groups are targeted specifically as part of a strategy. The identification of who is at risk, and why people undertake risky behaviours, needs to be understood before a strategy is developed, so that these behaviours can be targeted effectively (Finnis 2004; Soole et al., 2007).

A strategy could be implemented at many levels, from top down to bottom up, or using a mix of these levels. The Project Impact case study provides a good example of a structure that could work well. For Project Impact, key goals and objectives were agreed upon at a higher level, while local communities were given the latitude to develop their own solutions to problems in their area (Finnis, 2004).

### **3.4.2 Costs and benefits**

The only strategy discussed in this report for which the budget is available is the Benalla FloodSmart program (Haley, 2008). The costs were shared between VICSES, (\$42981.60) and Benalla Rural City (\$7428.27). The breakdown of spending on the project is listed below (Table 11) to give an idea of the range of supporting materials and other items that were included.

Table 11 Breakdown of expenses for the Benalla FloodSmart campaign (Haley, 2008)

<b>Expense</b>	<b>Quantity</b>	<b>Cost (less GST) \$</b>
Inundation mapping		5000.00
Clothing		3013.64
Events		1251.34
Employment costs		5111.00
Street signage		1527.27
Display material		3101.82
Flash content		500.00
DL Brochure	20000	3875.45
A3 poster	100	180.00
A5 booklet	5000	3879.09
Meterbox stickers	5000	3243.64
Fridge magnets	5000	1390.91
Kids stickers	20000	1183.64
Byron pen in two colours	10000	3300.00
Frisbee (3 colour)	500	1250.00
Tote bags air freight	10000	8500.00
Australia Post mail out		721.11
Additional meterbox edits		800.00
Media advertising		0.00
Additional printing		69.86
Cue cards	50	50.00
Other expenses		601.10
Lease expenses		1860.00
<b>Total</b>		<b>50409.87</b>

The largest expenses were incurred for inundation mapping, employment costs and some of the display and giveaway materials. Employment costs were relatively low considering the scope of activities; they were able to be kept down because there was considerable involvement from community groups and volunteers. Events appear to be good value for money, and the meterbox sticker program also ranked well in the effectiveness evaluation. Door knocking as part of the meterbox campaign was considered to be one of the most successful facets of the campaign, and because it was conducted by community groups, incurred little cost.

Because no other budgets are available for evaluation, general comments about cost effectiveness and cost/benefit will be made.

- A program that has a high level of input from volunteers will be less expensive, however there will be staff costs involved in recruitment, training, mentoring and overseeing volunteers (Finnis, 2007; Finnis et al., 2007).
- A program that uses the resources and skills of existing community groups will be less expensive and potentially more effective because the groups are self-sustaining with established networks so can be engaged for short-term, repeated or long-term projects (Hill, 1998; Howat et al., 2001; Rhodes, 2003). These groups often already have a

community good focus (e.g. public service clubs). Groups consist of members of the community so are likely to be believed and trusted (especially important where there is low trust in information from authorities). There will be staff costs incurred in liaison, training, mentoring and overseeing community group activities.

- Programs in schools can be cost effective, although special resources targeted at children and take home giveaways are likely to be required. Schools are likely to have very busy schedules already, so it is important any formal and ongoing program be planned with educators to fit into the existing curriculum. School activities can be rewarding for staff and volunteers, and provide the opportunity for wider gains in the community as schools are a trusted source of information for locals (Finnis et al., 2007). School programmes that require child/parent interactions (i.e. homework) have been found to be more effective than programmes that only provide information and/or school-based activities (Ronan and Johnston 2001, 2003).
- Websites are relatively low cost, but they must be updated regularly to keep them fresh, and to encourage repeat visits, and information should be provided that is appropriate to several target groups (e.g. children, those with disabilities, in languages other than English). However, websites are primarily passive and are not effective at teaching the broader community unless they are already prompted to seek information.
- Programs that are linked to other community development initiatives can use cost sharing to reduce expenses; however, they may be limited as to the scope of the flood safety activities included.
- The production of one-way information materials (brochures, fridge magnets, DVDs, posters etc) creates considerable expense (especially audio-visual materials). The effectiveness of these materials is difficult to gauge but it is unlikely they create behavioural change on their own (Gissing et al., 2010a; Barry, 2008). It is important these are made more cost effective by including them as one part of a multi-media and activity program so the messages are reinforced across a variety of formats.
- Newspaper articles and advertisements can incur costs if the paper is not offering free space, people are less likely to keep a newspaper than a DVD or fridge magnet (for example) so their effectiveness is potentially very short term, although local images and perspectives can be included. Newspaper images of people enjoying floodwater are detrimental to flood safety programs, and regular engagement with reporters and editors could prove a cost effective way to get the messaging around flood images to reflect the potential dangers.
- Television and radio messages are immediate and familiar. They are most often used in the lead up to a flood event. If an agreement for free broadcasting of community safety messages is in place these are a highly cost effective way of portraying images of correct behaviours and messages from trusted people. The use of well-known and trusted public figures as well as emergency management staff to deliver messages could be considered to increase levels of trust.
- Public displays at community events can be cost effective as once display materials are produced they can be re-used. What is important is being able to engage with people in a one-on-one manner at these displays so they are encouraged to articulate their views and discuss flood issues with SES staff, volunteers, or community group members who are assisting at display stalls (Haley, 2008). Static displays at libraries etc are less likely to be effective because while they may be interesting and offer takeaway brochures and the like, they do not challenge the person to think critically

about the information offered. Like brochures, they should be used as part of a wider multi-media and activity program.

- Involving community members in SES exercises could potentially increase staff planning time and employment expenses for exercises considerably, but offers the public a chance to discuss what actions they would take and how their decisions affect the application of SES resources.
- Public education materials focussing only on the flood hazard and technical aspects of measuring, monitoring, modelling, inundation levels and mitigation (e.g. levees) are not considered to be cost effective. While it is critical the public understand there is a risk and floods have dangerous consequences, it is more important people are provided with “what to do” information (Paton and Johnston, 2006).

It would have been useful for this report to have a wider range of costs available for different activities; however, without data on the effectiveness of various strategies cost-benefit analysis would not have been possible, even with more cost data. It is essential that some baseline measures are taken which are specific to flood safety actions, in particular driving, walking, and recreating in floodwater so that all future programs can be evaluated on key indicators relating to safety.

### **3.5 Methods for testing potential strategies**

Social research methods for evaluating effectiveness of different strategies have already been mentioned throughout the report. As behaviour change is a desired outcome, evaluation should attempt to measure this aspect. One measure which has not been discussed previously is monitoring trends in the numbers of injuries, fatalities and illnesses associated with entering floodwater. These figures would require calibration with other factors however, such as the number of floods per year and their severity, whether evacuation took place, whether roads were blocked, and whether waters were contaminated with sewage or other pollutants. Another measure that may be available with negotiation with insurance companies is monitoring the number of claims from vehicle damage due to floodwater entering interiors or engines.

#### **3.5.1 Methods for testing potential strategies**

If the number of deaths, injuries and illnesses are to be used as an indicator of the effectiveness of flood safety programs, a model must be developed to collect the necessary data to determine if in fact there is a trend upwards or downwards independent of population changes, event size etc. An economic modelling expert would be required to determine the data that would need collecting and to create the model. The outputs of the model would need to be easy to interpret and clearly state the uncertainties associated with any perceived trends. Once a model is established it should be possible for SES staff with a basic knowledge of statistics to collect and enter the data, and be able to interpret any trends. Data on illnesses and injuries would probably need to be accessed via health services, so some security and ethics guidelines would be required to protect the privacy of those concerned. It is also possible to collect some injury and illness data through surveying; however that data would not be as robust and would have far greater uncertainty due to sampling methods.

Insurance data could prove a very useful source of information, particularly flood damage claims for vehicles. It may be that insurance companies are willing to partner in a project with the SES as it is in their interests to reduce the need for these claims. Again, security guidelines would need to be established as insurance companies are commercial agencies and may not be willing to share their data at all. However, dialogue could begin on the matter and long-term this type of measure may be achievable. Also, insurance companies already have the in-house expertise to collect, analyse and interpret data.

The method recommended throughout this report for evaluating effectiveness of programs is one that has been used extensively by SES in the past – social research to measure attitudinal and behavioural change. Methods for collecting data include postal surveys (typically longer and more detailed), focus groups, one-on-one interviews, telephone surveys and clipboard type face-to-face (short) surveys. Each method has advantages and disadvantages: the amount of data that can be collected; the level of detail possible in responses; the randomness of the sample (i.e. is it representative of the wider community or are you targeting specific groups); the level of expertise required by data collectors (high = focus groups, low = clipboard surveys). As suggested earlier, to monitor the effectiveness of flood safety programs social research should be conducted at the following times:

1. To get a baseline measure of people's attitudes to entering floodwater, whether they have done so in the past, and if they think they would again (not during but could be following a flood event, and prior to the commencement of any new flood safety program);
2. Following the conclusion of the flood safety program that is being evaluated. Again measures of attitudes to entering floodwater, whether they have done so in the past and if they think they would again. Whether they found any part of the program changed the way they perceive entering floodwater.
3. Following a flood event. (If no flood event occurs within 2 years go to option 4). Again measures of attitudes to entering floodwater, whether they entered floodwater in the recent event, and why, and if they think they would again. If indications are that the program has been effective in triggering behavioural change, repeat the flood safety program yearly. If indications are that behaviours remain the same, trial an adapted or different flood safety program and conduct follow up research.
4. After one year follow up the same questions as in option 3 to see if beliefs have changed and if information from the safety program is retained.

It is clear that running two different programs at the same time in the same community will detract from the ability to measure effectiveness (Finnis, 2004). However, if two different programs appear to have equal merit, or appear to match certain community demographics better, they could be run at the same time in different communities, and effectiveness can then be measured for individual programs and in comparison with one another. This approach would require greater resource input depending on the activities included in each program.

The social research method which would provide the best value for money and useful data specific to flood safety would be the use of short surveys. These can be conducted as postal surveys. This could be supplemented with clipboard surveys at public events or conducted door-to-door (low cost if volunteers conduct the surveys). It would be important not to double

survey people. The use of a short survey (e.g. two sides of an A4 sheet, perhaps 10-15 questions) is that it can be completed relatively quickly and is easier to analyse due to the smaller amount of data collected per person. The short survey format allows for specific questions about flood safety beliefs and past behaviours, and could include some open ended questions about reasons behind why actions were taken without producing an unwieldy amount of data. Many marketing or social science research companies are available to create surveys and produce reports on the findings. Creating survey questions that are clear, progress in a logical fashion, and provide the data required is a skill, and if SES staff choose to create and administer the surveys themselves, it would be prudent to get survey questions reviewed by social scientists.

### 3.6 Summary

In Chapter 3 the concept of a strategy, as opposed to activities was outlined. A strategy seeks to target a particular issue and provide solutions or improvements to the status quo. Strategies therefore, ideally include a clear and documented plan of:

- Why – what is the issue being addressed, why does it need to be addressed (research may be needed to understand the problem);
- What - what is the goal of the strategy, what outcomes are desired;
- Who – who is responsible for delivering the actions to meet the strategy, and who is the intended audience;
- How – what processes and actions (activities) will be undertaken to meet the goals of the strategy, and how will the success of the strategy be measured;
- When – when will the strategy begin and end;
- How much – will the strategy cost and who pays; and,
- How will success be measured (evaluation) – what data is required, how will it be collected?

Key findings from the literature review in terms of existing strategies that target behaviour in and around floodwater include:-

- Only limited information exists on how Australia and other countries have specifically addressed issues regarding behaviour in and around floodwater. Aside from “Turn around, don’t drown” and a few other small campaigns, most advice about floodwater behaviour is included in general flood material available to the public alongside hazard, flood management and evacuation and recovery information. The dearth of available literature makes comparing the effectiveness of various strategies problematic.
- From the literature, we know that providing information via one-way methods is not an effective use of resources or likely to bring about desired changes in behaviours. Research has shown that strategies with a strong community engagement based component are more effective in eliciting behaviour change, as a community will take ownership of understanding and solving a problem. Future flood behaviour strategies could be developed and may take the specific form of an overarching strategy supporting a variety of community based programs, or a single community-based program in a targeted location. The community-based approach should be supported by a variety of other activities, including partnerships, information dissemination, messaging, and use of barriers and signage. Specific elements of behaviour and risk taking in and around floodwater could be identified in the strategy and specifically targeted.

- It is necessary to consider the framing of messages when putting together the messages used within a strategy. Research has shown that a message framed with a positive action and negative outcome should have the greatest efficacy for initiating behaviour change to hazards. This is untested in the flood context, but would include a type of message like, “Avoid floodwater, and you won’t drown” or “Turn around, don’t drown”. Messages should also be framed to build people’s self efficacy, increase positive outcome expectancy, and reduce negative outcome expectancy. There are currently a variety of messages across Australia – some advising people not to enter floodwater at all, and some suggesting you can enter if you test it, or if you are well protected (e.g. wearing boots). The variety of messages in the public domain may be contributing to the confusion about appropriate expected behaviour.
- Strong relationships and capacity building with the media are important to ensure that correct messages are disseminated to the public.
- A strategy should consider and incorporate the basic principles of effective warnings in getting people to act appropriately. During a flood event people will be warned about flooding, and about actions they should and should not take, including keeping out of floodwater. Warnings may come in the form of information through media, organisations such as the SES or BOM, door-knocking, signage, or even via natural warnings.

In particular people must be able to:

- receive the warning
- understand the warning
- believe the warning
- personalise the warning
- decide on how to respond to the warning.

Additionally the warning must:

- have a credible source
  - be consistent
  - be accurate
  - be clear
  - be certain about the events taking place
  - include sufficient information
  - clearly guide what people should be doing
  - be frequent
  - provide information about the location affected from multiple agencies or channels.
- In terms of signage and barriers, the literature review found that road signage used for flooding may not be effective due to the following reasons:
    - Signs are usually not present at all intersections, creating a false sense of safety in flooded locations where signs are not present.
    - Permanent signs are present throughout the year, even when the area is dry, reducing their effectiveness when flooding does occur.
    - People may feel a sign represents likelihood of a flood, but not the degree of danger.
    - People who do not trust the signs may ignore them.
    - People may comply with signage somewhat (e.g. slow down), but still drive within the limits of their own personal comfort, irrespective of the sign.

Despite challenges, the use of signage should, not be discounted altogether as it does provide some benefit in terms of educating the public about flood hazards and providing a warning of flood level or extent. However, the design and use of signage should be considered carefully, in combination with other activities.

- One study found that law enforcement and physical mitigation works provided some support to an educational approach, and could be considered as part of the mix of measures used in a strategy.
- A flood behaviour strategy should take into consideration the different time periods in which activities could take place, including: before (e.g. education and engagement); during (e.g. signage, warnings); and after flooding (e.g. continued education). In particular, it is important to work with communities before an event, so that communities can behave appropriately in a premeditated way when flooding occurs.
- Finally, the lack of information available about the cost of strategies means that it is difficult to do any in-depth analysis of costs and benefits. The only costs available were for the Benalla FloodSmart project, a multi-pronged, ongoing flood education programme. This programme appeared to generally be good value for money.

## 4.0 SUMMARY

Findings from the literature review in Chapter 2 show that people are often unaware of the risks posed by floods despite living in flood prone areas. Those who are aware often significantly underestimate the potential impacts, are not concerned about the risk, or believe that a flood event will not personally affect them. The most common behaviours or activities that people choose to undertake in or around floodwater are driving, walking, or recreational pursuits. Males and younger people (<30 years old) are more likely to undertake such activities. Most people who enter floodwater typically do so in order to reach a specific destination in their daily routines. The literature review revealed that a number of flood studies show that people may ignore warnings in order to maintain their daily routines such as travelling to and from work or dropping off their children at school. Only a small minority of people actually move into floodwater during evacuation. The most significant consequence of these various behaviours in and around floodwater is loss of life. Figures on flood fatalities consistently have highlighted the substantial proportion of vehicle, pedestrian and recreation-related deaths and the overrepresentation of males and those belonging to the <30 and >60 age groups in these statistics. Other consequences of behaviours in and around floodwater include both short and long-term physical effects (e.g., broken bones, amputations and paralysis), and mental health outcomes (e.g., post traumatic stress, anxiety and depression). Overall, the findings of this literature review suggest that a significant number of flood-related deaths, injuries and other health effects could be prevented as they are the result of unnecessary risk-taking behaviour.

The review of potential strategies currently in use to address behaviour in and around floodwater (Chapter 3) revealed that only limited information exists for Australia and other countries. Aside from the US-based "Turn around, don't drown" campaign, most advice about floodwater behaviour is included in general flood material available to the public alongside hazard, flood management, and evacuation and recovery information. The dearth of literature available on flood behaviour programmes themselves, success of these programmes, and cost-effectiveness makes comparing the effectiveness of various strategies problematic. From the literature it is evident that providing information via one-way methods is not an effective use of resources, or likely to bring about desired changes in behaviours. Research has shown that strategies with a strong community engagement based component are more effective in eliciting behaviour change, as a community will take ownership of understanding and solving a problem. In terms of signage and barriers the literature review found that road signage used for flooding may not be effective for a number of reasons. However, despite challenges, the use of carefully considered signage should not be discounted altogether, as it does provide some benefit in terms of educating the public about flood hazards and providing a warning of flood level or extent. No systematic program of evaluation has been carried out to test the effectiveness of signage campaigns, and should be considered as part of future research. Limited research on messaging shows that some messages may be more effective than others, and message construction should be a consideration as part of a strategy. One study also found that law enforcement and physical mitigation works did provide some support to current educational/community approaches, and could be considered as part of the mix of measures used in a strategy.

In terms of recommending future strategies (Part C - Chapter 3, Section 3.4.1), future efforts should focus on a community-based approach supported by a variety of other activities, including partnerships (e.g. with schools, media, community groups, businesses, etc), information dissemination (during quiescence and for warnings), messaging, and use of barriers and signage. Specific elements of behaviour and risk taking in and around floodwater could be identified in the strategy and specifically targeted as part of focussed campaigns. The framing of messages should be given consideration (e.g. using messages that build a community's capacity to respond and elicit an appropriate response from people), and consistency of these messages should be maintained. Finally the evaluation of strategies and programmes must take place to ensure pedestrian and motorist behaviour around floodwater is addressed effectively.

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## APPENDIX 1 EXAMPLES OF IMAGES IN THE MEDIA THAT ARE COUNTERPRODUCTIVE TO GOOD FLOODWATER BEHAVIOUR

(images were sourced from Australian newspapers printed January, February 2010)



**ABOVE:** Emilie Sorohan, of Mackay, kept dry in style yesterday, while celebrating Australia Day.

**RIGHT:** These youngsters made the most of their last day of school holidays, playing in flood-water surrounding the Mackay Gooseponds yesterday.



PHOTOS: PETER HOLT 260110/177  
260110/239





**WET A LINE:** A fisherman makes the best out of a bad situation after a swollen creek cuts off access on Macquarie Street in Gracemere.



**Kay Baxter, 14, and Tayte Roser, 15, cross flooded Glendale Drive**  
*Photo: EVAN MORGAN*



**DON'T DO THIS, SAYS RACQ . . .** Glendale Drive was closed to traffic yesterday *Photo: MEGAN BRAYLEY*



**No getting through:** SES workers clear a fallen tree at Karumba (top) while (left) Raymond, 6, and Charlie Wosomo, 4, get pulled through floodwaters by Therese Kura, 14 in the Torres Strait and (right) cars travel flooded roads near Normanton. *Pictures: ALISON FERRYMAN, THE SUNDAY MAIL and NOLA GALLAGHER*

**APPENDIX 2 EXAMPLES OF IMAGES IN THE MEDIA THAT ARE SUPPORTIVE OF GOOD FLOODWATER BEHAVIOUR**



The riverside carpark was closed as a precaution

*PHOTO: MEGAN LEIWS ML01/0210/8*

### **APPENDIX 3 ADDITIONAL FLOODING INFORMATION RESOURCES**

**“Flood Safety” Webpages (USA).** [www.FloodSafety.com](http://www.FloodSafety.com) is a repository of media resources documentaries, interviews and presentations on flooding losses in the USA. It contains stories of people entering floodwater and animations on the “four ways to die” in floodwater. The Flood Safety website is a collaboration between research agencies, councils and private organisations. The website and its resources cover many aspects of flood loss and is not specific to entering floodwater. Key message: *“Driving into floodwaters – four ways to die”*.

#### **Flood Control District of Maricopa County Flash Flooding Videos**

Maricopa County hosts a webpage of flash flooding videos to share with the public the dangers associated with flash flood incidents. The aim of the video sharing is to educate the public on the history of flooding in their area and the dangers associated with flash flood incidents. <http://www.fcd.maricopa.gov/Education/education.aspx>



[www.gns.cri.nz](http://www.gns.cri.nz)

#### Principal Location

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Avalon  
PO Box 30368  
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F +64-4-570 4600

#### Other Locations

Dunedin Research Centre  
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Private Bag 1930  
Dunedin  
New Zealand  
T +64-3-477 4050  
F +64-3-477 5232

Wairakei Research Centre  
114 Karetoto Road  
Wairakei  
Private Bag 2000, Taupo  
New Zealand  
T +64-7-374 8211  
F +64-7-374 8199

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