



FLOOD RISK COMMUNICATION

Final project report

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EXECUTIVE SUMMARY

THE CONTEXT FOR THE RESEARCH

The focus of this research project was informed by the findings of earlier BNHCRC research that investigated human fatalities from natural disasters (*Haynes et al., 2017*). This project focused on the two behaviours most frequently associated with flood fatalities:

1. Driving into floodwater in a motor vehicle, and
2. Recreating in floodwater.

Although there were pockets of information and more detailed knowledge about these behaviours held in some jurisdictions, there was no national picture of either the details surrounding vehicle-related flood fatalities or the incidence of these two general behaviours and the detailed contexts in which the public enters floodwater. Therefore, by studying the general public more comprehensively, there was an opportunity to quantify behaviours and identify the potential challenges and additional levers for communicating flood risk, as well as enabling greater insight into differences across Australia (both within and across jurisdictions).

In addition, the information that was already known about behaviour in floodwater related solely to the general public. Emergency services, in particular State Emergency Services (SES) personnel, were previously identified as an at-risk group for entering floodwater and flood fatalities.

In the context of established approaches to the investigation of risk perception, comprehension, and risk-taking behaviour, SES personnel represent an 'expert' group. This meant they could also provide insights about risk perception and risk communication when studied and compared to the 'lay public' (expert-novice paradigm), for example enabling identification of differences in use of words/language, conceptualisation of 'flood' and 'flooded roads', and identification and use of environmental cues when judging flood risk.

Finally, as a risk group there is an organisational imperative to study the behaviour of SES personnel entering floodwater when on/off duty. This research supports the evaluation, understanding, and provides opportunities to assist in the mitigation of a range of organisational risks, including

- workplace health and safety/duty of care, i.e., potential injuries to personnel,
- financial risk, i.e., through damage to vehicles, equipment and other assets, and
- reputational risk, i.e., through being seen to disregard the public risk messaging to never enter floodwater and/or being seen to take unnecessary risks and damage vehicles.

This project commenced in July 2017 and comprised broad two phases:

1. Understanding behaviour in and around floodwater, and



2. Collating flood risk communications and co-developing Community Service Announcements (CSAs) for flood for use in National broadcasting by the ABC.

PROJECT STRATEGY FOR RESEARCH AND COLLABORATION

The research strategy involved a suite of research studies, and employed mixed qualitative and quantitative methods, including experimental research, questionnaires, and in-depth interviews employing a mental models approach to ensure the research problem is well understood, the needs of those at risk could be met, and knowledge is co-produced with end-users and community.

Consultation and collaboration with key stakeholders and various end-users were key aspects of the overall research approach and helped to determine the research foci through the lifetime of the project. Following this collaborative approach, the research was responsive to stakeholder contexts. This enabled the team to take advantage of opportunities to explore some new topics in greater depth (e.g., SES behaviours around floodwater), but has also meant there were some delays and changes to the planned research activities (e.g., being unable to progress some approaches and outputs due to COVID-19). As a consequence, some of the resulting outputs and projects differ to the outputs outlined at the start of the project.

PROJECT OVERVIEW – EXTENDING WHAT IS KNOWN AND ADDRESSING THE GAPS

Previous research has established that floods in Australia are a significant, and often preventable, cause of death, and this research has provided some useful insights to the risk perceptions and planned behaviour among the public in relation to driving and floodwater (Fitzgerald, Du, Jamal, Clark, & Hou, 2010; Hamilton, Peden, Pearson, & Hagger, 2016; Haynes et al., 2017).

This project builds on existing knowledge in several important ways:

- Detailed analysis of recent vehicle-related flood fatality records (2001-2017) held in the National Coronial Information System (NCIS) provides a current synthesis of the specific demographic, situational and environmental conditions in which Australians have lost their lives entering floodwater in vehicles.
- Survey data provides insights to how often, and under what circumstances, the Australian public enters floodwater in vehicles and for other purposes.
- Surveys with SES personnel provide similar insights to how often, and under what circumstances, SES personnel enter floodwater in vehicles when both on and off duty.
- Mental models interviews with SES personnel and the general public provide nuanced insights into how each group understands flood risks, and supports the identification of shared understandings and differences.



- The development of a driving in floodwater version of an online tool (EXPERTise 2.0) allows for the assessment of the use of environmental cues when evaluating flood risk and deciding whether it is safe to enter floodwater. This research provides early support for an objective approach to understanding flood risk assessment, identifying and understanding individual differences in the use of environmental cues, and provides an additional metric to strengthen research into decision-making under conditions of risk and uncertainty.

Overall, these various studies highlight some of the complexity and challenges in flood risk communication and flood risk assessment and factors that need to be considered when developing communication materials. The detailed nature of the data collected also provides insights to how interventions and flood risk communication and engagement work can be targeted.

A SNAPSHOT OF KEY FINDINGS

As the project comprised a number of studies it also generated a substantial number of findings and insights. These have been condensed into a series of practitioner-focused Research into Practice Briefs¹ (see next section). In addition, the BNHCRC Communications Team has developed a short series of videos to showcase some key research findings and augment these Briefs².

A snapshot of key findings across the various studies is provided below.

- During the period 2001-2017 there were 96 vehicle-related flood fatalities in 74 separate incidents in Australia, with an average of 5.65 fatalities per year over the study period. The majority of deaths (87%) occurred when people were attempting to cross low bridges, creeks or causeways and in just under two-thirds of incidents (64%) the driver was travelling alone. At least 29% of incidents were in four-wheel drive vehicles, however this is probably an underestimate because the vehicle details were not always reported in NCIS records.
- The nationally representative survey of the general public found that 26% had engaged in activities in floodwater on land and 19% had engaged in activities in flooded rivers. For the latter, swimming and wading were the most frequently reported activities, but for the former there was a much greater variety of practical and discretionary reasons given for entering floodwater. Public enjoyment of water activities, their familiarity with it as a source or risk, and



¹ Research into Practice Briefs are available on the BNHCRC website here

<https://www.bnhcrc.com.au/resources/practicebriefs>

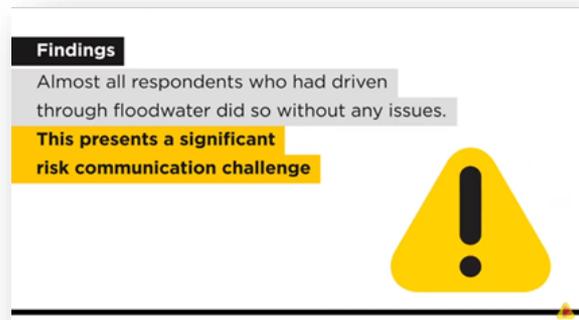
² Project videos can be accessed via the BNHCRC Hazard Channel here

<https://www.bnhcrc.com.au/playlist/2537/video/7513> (video images used on pp 8-10)



the multitude of reasons given for entering floodwater pose challenges for those promoting the blunt- but-safe official message of 'never enter' floodwater.

- Regarding driving through floodwater, 56% of respondents in the public survey had driven through floodwater and a similar proportion (53%) could recall the details of an event of driving through floodwater within the last five-year period. Although the depth of water that was driven through was generally shallow and still or slow moving (70% 30cm or less, and 89% still/slow flow) there were a number of respondents who had driven through deeper water, and in all cases (based on the definition provided in the survey) respondents were reporting driving through water in situations where they couldn't see the road/road markings underneath the water and therefore could not judge the integrity of the road surface.
- In 90% of incidents reported in the public survey, there were no negative consequences of driving through floodwater, i.e., no vehicle damage or issues for personal safety.
- Findings of the public survey research highlight the commonplace nature and potential risks of driving through floodwater on roads, but the lack of consequences for most people highlight the challenges for risk communicators in engaging the public with the potential risks and influencing behaviour change.
- Overall, only 40% of the public sample could recall seeing any official campaigns aimed at preventing people driving or playing in floodwater. However, these proportions were higher for respondents in Queensland (68%) and the Northern Territory (64%). Only 13% of the sample overall could recall any elements of campaign risk messaging and only 6% of the sample overall could recall the most commonly used 'if it's flooded, forget it' message (either in its complete form, or the key phrase 'forget it' or the general sentiment 'don't do it').
- Surveys with SES personnel found that 37% had driven through floodwater in an SES vehicle (as the driver) in the last two years, and 52% had driven through floodwater in their private vehicle in the last two years. Similar to the public survey findings, water depths were generally shallow, and flow





was still or slow (57% 30cm or less and 86% still/slow flow) and generally they were driving large/heavy vehicles (68% in light truck/dual cabs or medium/heavy trucks). However, also like the public, in all incidents reported they were unable to see the road surface/markings so there was a degree of uncertainty about the integrity of the road surface and heavier vehicles could be more of a hazard and cause more damage to an unstable road.

- In 75% of incidents of driving through floodwater reported by SES personnel there were passengers in the vehicle, and these passengers were reported to have influenced the decision to drive through in around a quarter of incidents. Further investigation indicated that passengers were more likely to have been part of cooperative discussions and risk assessment and, as such, a resource for deliberative decision-making, rather than advocates for risk taking. This finding supports the existing value placed on team training and dynamic risk assessment and general safety advocacy.
- Mental models interviews with (expert) emergency personnel and (lay) general public uncovered complexities in defining, assessing, and communicating flood risk. Although some public interviewees could articulate sophisticated approaches to judging risk when encountering flooded roads, emergency services personnel perceived the public generally to be underestimating these risks.
- Complexities in communicating about risk were based on the multiple variables that influence risk, differences in perceptions about risk from flood/water, e.g., compared to fire as a risk to self, and the realities of needing to live with floodwater as 'a part of life' in some rural and remote areas.
- Experimental research on cue utilisation and floodwater risk assessment has been promising. Individual differences in the use of environmental cues have been successfully recorded, however at this point it has not been possible to map higher cue utilisation to higher risk assessment performance. It is not clear if this is a short-coming of the performance tasks used in the research to date, or if this is due to other factors. Further development and evaluation in this area is required.



AREAS FOR RESEARCH UTILISATION

This project provides an in-depth understanding of how the public and emergency service professionals (SES) behave around, and understand the risks of, floodwater. The translation of these findings into utilisation and impact is an ongoing process that will continue beyond the formal end of the research.

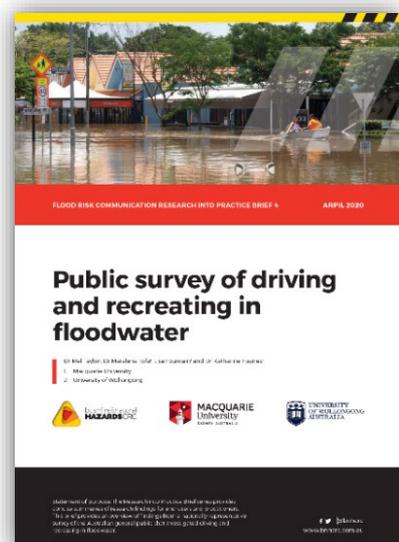


There are four main areas of research utilisation that are being pursued:

- Co-development of National Community Service Announcements (CSAs) for flood with the Australian Institute for Disaster Resilience (AIDR), the ABC, and the AFAC Community Engagement Technical Group (AFAC CETG) this is an existing and final deliverable of the project that was delayed and is being completed in 2021.
- Training and engagement: Through Phase 1 of the research survey tools and findings about how people behave, perceive risks, and make decisions around floodwater were developed. The research findings can be used to inform more targeted communications and safety-related training, and the survey tools themselves can be used as an engagement tool both with communities and SES personnel. Surveys with SES personnel about entering floodwater included evaluation of organisational safety climate as well as risk taking behaviour, these data provide a baseline against which a number of SES jurisdictions could evaluate WH&S improvements and the effectiveness of a range of safety interventions.
- EXPERTise 2.0: in this project we have developed, trialed and we're in the process of validating an online module of tasks to assess cue utilisation when evaluating floodwater risk. Effective cue utilisation is an important component of expertise that has been assessed and validated in a number of occupational domains. This tool could provide a low-cost approach to support and evaluate the effectiveness of targeted training interventions among SES staff and volunteer members.
- Research into Practice Briefs: Throughout the project, a series of Research into Practice Briefs has been developed. These are concise summaries of academic research and provide an accessible evidence base for end-users and practitioners to guide their work, whether that is community engagement, development of flood risk communication materials, or formulation of organisational WH&S policy.



In addition to the above areas of potential and emerging utilisation, the project team has worked actively with end-users and a range of additional stakeholders to co-produce project outputs, including conference presentations (Taylor, Wiebusch, Tofa, Haynes; AFAC 2019) and co-





authored peer-reviewed articles (Taylor, Tofa, Haynes, McLaren, Readman, Ferguson, Rundle, Rose, 2019).

RESEARCH CAPACITY BUILDING

The research project team has also supported research capacity building through the mentoring and inclusion of students in research activities, including a successful PhD completion (Ahmed, 2019), five Masters of Organisational Psychology students, two psychology honours students, and a number of short-term research and engagement placements. The project funding has supported early career researchers (ECRs) and has enabled these ECRs and students to progress through co-authored peer-reviewed publications and utilisation outputs, i.e., Research into Practice Briefs.



END-USER PROJECT IMPACT STATEMENT

Josh McLaren, *NSW State Emergency Service*

Emergency service organisations across Australia and the world have long dealt with the complexities of individuals driving through floodwaters. This behaviour is now more relevant than ever given the current La Nina climatic conditions that NSW has entered into. With the increased threat from hazards such as severe storms, cyclones, and heavy rainfall the risks from flooded road networks have also increased. As the risk escalates, so does the need for emergency services and governments to develop and issue targeted and effective flood risk communications.

Over the past 18 months, NSW SES has worked closely with the team to look at multiple facets of this behavioural problem. The research conducted by the BNHCRC has and will continue to shape the way we engage with communities in NSW. Some specific areas include:

- Informing the future NSW SES messaging for flood risk communication
- Using risk factors to better tailor and target key messages leading up to and during flood events
- Collaboration with key stakeholders to educate young drivers on the risks of driving through floodwaters.
- Using the findings from EXPERTise 2.0 to better understand the cues that individuals look for to support their decision-making process
- Using findings from the public surveys to better understand the community's key drivers for entering
- Working towards a holistic and meaningful definition of floodwaters to socialise with NSW communities
- Incorporate the research on vehicle-related deaths to better inform future awareness campaigns.

This research has been critical to informing our future flood risk communication strategies and has provided our agency with an evidence-based foundation to build upon.

INTRODUCTION

A recent analysis of fatalities caused by natural hazards in Australia, which provided the foundations of this research project, demonstrated that floods are the second most deadly natural hazard following heatwaves, in terms of the total number of fatalities since 1900, and that many flood deaths (and rescues) are avoidable (Haynes et al., 2017).



Entering floodwaters in a vehicle, particularly in 4WDs, was identified as an increasingly common high-risk behaviour. While young males comprise the highest risk group for this activity, there are also high proportions of women and older men dying in recent years.

Of note are the high numbers of fatalities among passengers, particularly females (Haynes et al., 2017).

In recent years, the second highest risk group following drivers comprises young male adults and children who play in floodwater (enter floodwater on foot, while swimming or in a small boat or craft). Emergency services personnel have also been identified as a risk group.

This three-year project utilises a mixed methods design, involving both qualitative and quantitative approaches, to address the following two major aims:

- To understand behaviour and attitudes to driving into and recreating in floodwater.
- To evaluate flood risk communication materials and develop national Community Service Announcements for flood risk communication.

Over the lifespan of the research project the focus of the research has developed to be greater on driving into floodwater, as this is a more widespread and higher incidence behaviour across the population, creating a greater public safety dividend.

Due to end-user interest, opportunity, and the ability to explore a novice-expert approach to risk perception and communication more comprehensively, SES personnel have been a group studied in detail, alongside the general public.



BACKGROUND

Analysis of fatalities caused by natural hazards in Australia shows that floods are the second most deadly natural hazard in Australia (following heatwaves) in terms of the total number of fatalities 1900-2015 (Haynes et al., 2017). Entering floodwaters in a vehicle, particularly in 4WDs, is an increasingly common high-risk behaviour (Haynes et al., 2017) – indeed, Fitzgerald et al. (2010) found that 48.5% of flood deaths in Australia between 1997 and 2008 involved a motor vehicle. A recent literature review shows that the number of vehicle-related flood fatalities is globally significant (Ahmed, Haynes, & Taylor, 2018). In the Australian context, these fatalities are considered largely preventable and driving into floodwater continues to be a focus of risk communication, advice, and warnings in Australia.



Campaigns advise the public to never enter floodwater (e.g., 'If it's flooded, forget it' QFES, NSW SES) and that it takes only 15cm of water for a car to become buoyant ('15 to float' VICSES, see left). This project contributes to building an evidence base to support end-users in developing more effective and targeted flood risk communications to address this issue.

Risk communication typically comprises the one-way flow of information via a communication chain that involves a 'sender' who determines the information or advice to be conveyed, 'mediators' who communicate the message, and 'recipients' who should act upon the advice provided (Boase, White, Gaze, & Redshaw, 2017; Smillie & Blissett, 2010). Factors that affect the efficacy of risk communication include the accuracy, comprehensibility, and relevance of the information communicated, public trust in the information sender and mediator, as well as "differences between the lay and expert understanding" of risks (Smillie & Blissett, 2010, p. 117).

Indeed, one of the key challenges in risk communication is differing views between, and among, communities and experts about risks, the appropriateness or acceptability of activities and behaviours, and the trustworthiness of institutions (Morgan, Fischhoff, Bostrom, & Atman, 2001). A key focus of this project, therefore, was to generate a thorough understanding of both public perceptions and behaviour around floodwater, alongside an understanding of emergency services' perspectives.



Within the academic literature, there is a growing body of work that investigates what motivates or causes members of the public to enter floodwater in a motor



vehicle as changing this behaviour is one of the key mechanisms for reducing the incidence of fatalities and rescues (Hamilton et al., 2016; Pearson & Hamilton, 2014). Hamilton et al. (2016), for example, argue that willingness to enter floodwater is related to attitudes, social norms, and belief in self-efficacy, and these are key factors that should be targeted in risk communications to prompt behaviour change. Risk perception was identified as a prime determinant of decision-making, however this is understudied in the literature (Ahmed et al., 2018). Peden, Franklin, Leggat, and Aitken (2017) identified in a recent publication that almost two-thirds of fatalities occurred on roads that were not closed off at the time, indicating that a lack of physical barriers or road closed signs may have meant that the risks were underestimated at the time of death (Ahmed et al., 2018). These studies provide valuable insights to public understanding and motivations that can be used to inform risk communication.

This project builds on this work through generating data on public behaviour around floodwater and an in-depth understanding of how people perceive flood risks, engage with floodwater, and make decisions.

In addition, the perspectives of emergency services personnel are also important



to understand. Their occupation means that they are exposed to floodwater on roads as part of their work and need to make quick and safe decisions under time pressure and changing conditions. Keech, Smith, Peden, Hagger, and Hamilton (2019) undertook interviews with emergency service workers who undertake flood rescues of those who have driven into floodwater and identified four challenges in this work: involvement of untrained personnel; varying information provided by emergency telephone operators; behaviour of drivers complicating the rescue; and

people sightseeing floods or flood rescues or ignoring closed roads providing rescuers with sources of distraction and frustration.

Occupational safety of emergency workers is also an important area of concern, particularly as due to the nature of the work, it may not be possible to reduce risk to zero and stop personnel from ever driving through floodwater.

From an organisational perspective, understanding the risk perception, decision-making, and behaviours of emergency service personnel is important firstly to protect their safety, but also to reduce the costs of physical damage to vehicles and other assets. Agencies generally rely on safety management practices and interventions to encourage their personnel to avoid floodwater risks, but little is known about the extent to which personnel adhere to this advice, or of their risk perceptions and attitudes. This project helps to address this issue by providing data on SES personnel's perspectives, decision-making, and behaviours around floodwater.



RESEARCH APPROACH

The research strategy involved mixed qualitative and quantitative methods, including questionnaires and in-depth interviews with mental models to ensure the research problem is well understood, the needs of those at risk are met and knowledge is co-produced with end-users and community. Experimental approaches were also used in the investigation of expertise and cue utilisation.

Consultation and collaboration with key stakeholders and various end-users was a key aspect of the overall research approach and helped to determine the research foci through the lifetime of the project. Following this collaborative approach, the research was responsive to stakeholder contexts. This enabled the team to take advantage of opportunities to explore some new topics in greater depth (e.g., SES behaviours around floodwater), but has also meant there are some delays and changes to the planned research activities (e.g., unable to progress some outputs due to COVID-19). As a consequence, some of the resulting outputs and projects differ to the outputs described at the start of the project.

PHASE 1: DEVELOPING A DETAILED UNDERSTANDING OF BEHAVIOURS, BELIEFS AND DECISION-MAKING PROCESSES

In this phase of the project we sought to gather and compile data and develop a detailed understanding of the decision-making processes, motivations, beliefs and information needs of individuals. Table 1 summarises the various approaches used to build an evidence base in this phase of the study. Each study was subsequently developed into a Research into Practice Brief.

In this phase, a definition of floodwater on roads was developed to support consistency in responses, particularly in survey based work (Study 3 and 4 in Table 1). In this phase, a standard definition of floodwater on roads was developed with end-user input for the purposes of this project.

We defined floodwater on the road as an environment with:

- Water across the road surface.
- Little to no visibility of the road surface markings under the water
- (i.e., uncertain of road quality/integrity and possibly depth).
- Water on normally dry land – flowing or still.

This definition was used to ensure consistency, particularly in responses to survey questions. However, it is worth noting that the absence of a shared understanding among professionals and the public of what constitutes floodwater on roads is one of the findings of this project.



TABLE 1: SUMMARY OF STUDIES IN PHASE 1

Number	Study name	Focus	Methods and participants
1	Driving into floodwater: Systematic literature review	Driving into floodwater, decision-making, risk perception, public	Systematic literature review
2	Vehicle-related flood fatalities	Driving into floodwater, public, fatalities	Coronial records
3	How the public engages with floodwater	Driving into floodwater, recreating in floodwater, public, decision-making, behaviour	Online survey administered nationally (n=2,184). Sample was proportionally representative of the adult Australian general population by state and balanced for age and gender.
4	How SES personnel (salaried staff and volunteers) engage with floodwater	Driving into floodwater, emergency services, decision-making, behaviour	Online survey completed by SES personnel in four jurisdictions (n=1251).
5	Environmental cues and assessment of floodwater risk (EXPERTise 2.0)	Driving into floodwater, emergency services, public, cue utilisation, risk assessment	Online assessment tool completed by 162 participants (54% SES personnel and 46% general public).
6	Mental models	Driving into floodwater, recreating, emergency services, public, behaviour, perceptions	Modified mental models research approach to risk communication. Interviews conducted with 10 SES professionals who specialise in risk communication and 18 members of the general public.
7	Current approaches to flood risk communication	Flood risk communication, public	Desktop review of flood risk communication materials. Analysis of responses (n=844) from the public survey who could recall a flood risk campaign message.

PHASE 2: COLLATING FLOOD RISK COMMUNICATIONS AND CO-DEVELOPING COMMUNITY SERVICE ANNOUNCEMENTS (CSAS)

This phase of the project built on the findings of Phase 1 to identify the key challenges and issues in flood risk communication based on the research evidence, collate recent and current flood risk campaign messaging, and co-develop national CSAs for flood for use by the ABC in collaboration with the Australian Institute for Disaster Resilience (AIDR) and the AFAC Community Engagement Technical Group (AFAC CETG).

A peer-reviewed publication was co-authored with a number of emergency services end-users and stakeholders from local government and emergency broadcasting (Taylor et al, 2019 see right). This opportunity was taken to highlight the challenges for risk communication and some of the approaches being taken to tackle those challenges from the different end-user/stakeholder perspectives. *Community Service Announcements for flood* are currently being co-developed with AIDR, ABC, and AFAC CETG. These will be completed in the first half of 2021.



FINDINGS

This project explored public and emergency services behaviour around floodwater and flood risk communication issues using a range of studies. The findings of each study are reported here.

DRIVING INTO FLOODWATER: SYSTEMATIC LITERATURE REVIEW

Focus: Driving into floodwater, decision-making, risk perception, public

Aim: The aim of this study was to compare international research; identify risk factors; document theoretical models used to explain people's behaviours; and identify intervention strategies utilised or proposed.

Overview: Following a systematic review protocol registered in PROSPERO³, this study examined academic literature published before 31 August 2017 that included the keywords 'flood', 'risk', 'drowning', 'driving' and 'vehicles' and met the inclusion criteria. In total 24 articles were analysed.

The analysis produced two models. The first, shown in Figure 1, identifies seven risk factors that influence decision-making to drive into, or turn back from, floodwater on roads. These are: risk indicators, situational factors, individual factors, reasons for driving into floodwater, demographic factors, environmental factors, and social factors.

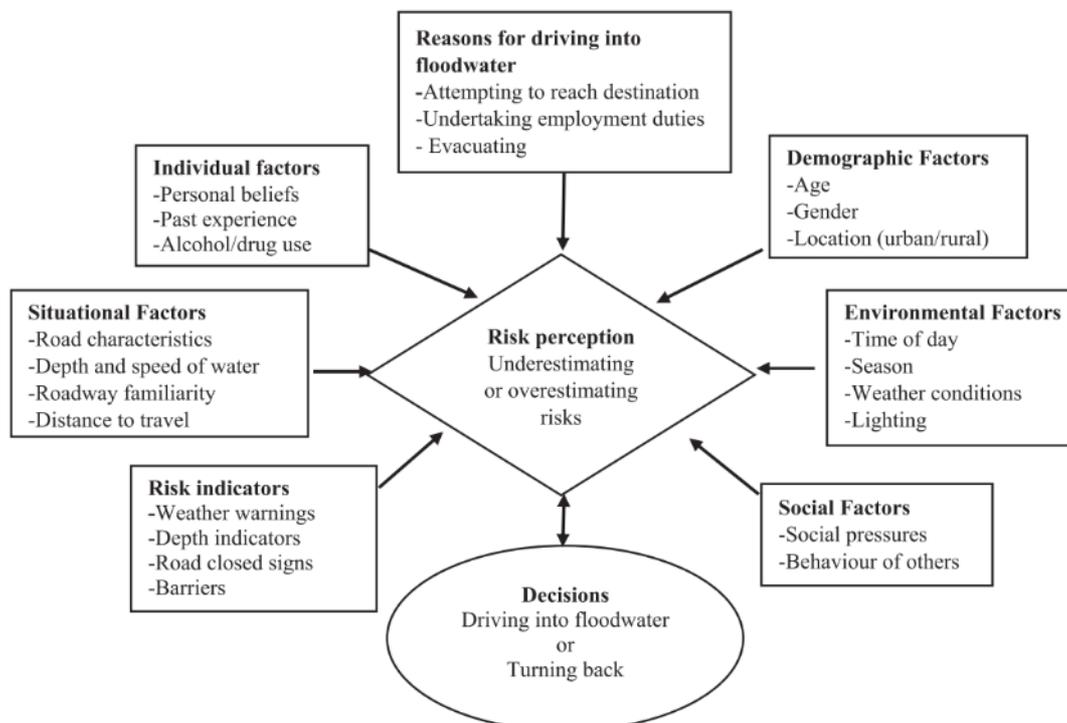


FIGURE 1. MODEL OF FACTORS THAT INFLUENCE THE DECISION TO ENTER FLOODWATER ON THE ROAD (AHMED ET AL., 2018, P. 9591)

³ PROSPERO is an international database of registered systematic reviews where there is a health related outcome. Key features from the review protocol are recorded and maintained as a permanent record.

<https://www.crd.york.ac.uk/prospéro/#aboutpage>



The second model proposed an integrated systems approach to address these seven factors (Figure 2).

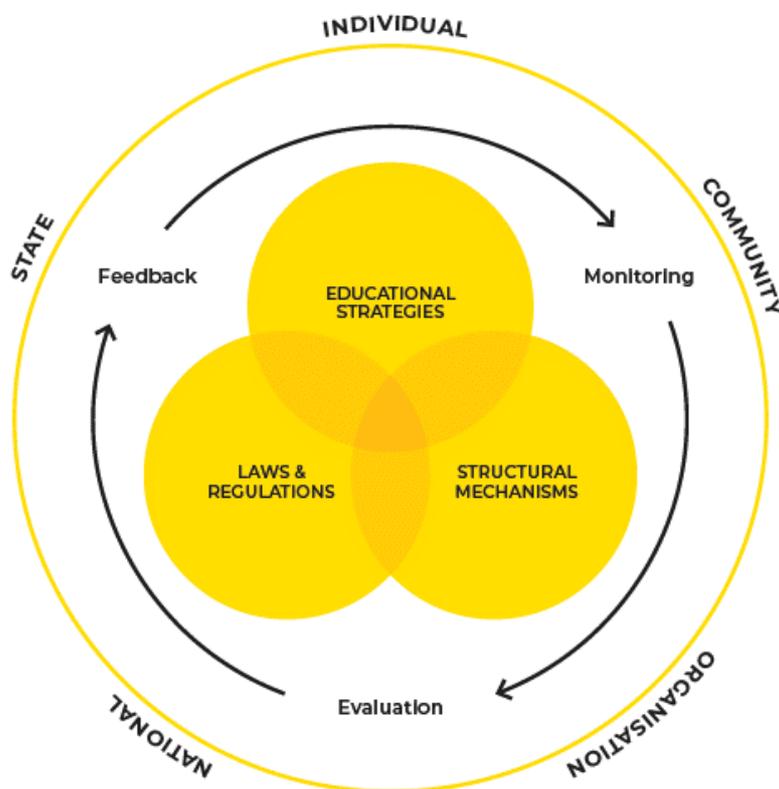


FIGURE 2. PROPOSED INTEGRATED INTERVENTION MODEL TO REDUCE THE RISK OF PEOPLE DRIVING INTO FLOODWATER

Three major intervention strategies are used together:

- Educational initiatives for awareness building;
- Structural developments through advanced technology and equipment for improving decision accuracy; and
- Law and regulations.

Monitoring and evaluation of the three strategies should occur at five levels: individuals (public, workers, employees); communities and local government (e.g. local authorities, council, community groups and clubs); organisations (e.g. corporates, insurance companies, financial institutions); state (e.g. police, state emergency services, hospitals); and national (e.g. government ministries, policy makers, implementers, and planners).

Outputs: This work was published as a peer-reviewed journal article (Ahmed et al., 2018) and in a Research into Practice Brief (No.1). It was also used to inform later aspects of the project.

FLOOD FATALITIES IN AUSTRALIA 2001-2017

Focus: Driving into floodwater, public, fatalities



Aim: The aim of this study was to analyse the circumstances of vehicle-related flood fatalities between 2001 and 2017 in Australia, to identify demographic, spatial and temporal patterns, and the situational conditions in which fatalities have occurred.

Overview: This study used NCIS coronial records to identify and analyse vehicle-related flood fatalities. It found that between 2001 and 2017 there were 96 individual vehicle-related flood fatalities that occurred in 74 incidents. Analysis identified the following patterns:

- **Demographic:** Males accounted for a higher number of deaths (66%, n=63) and the majority of fatalities were aged over 30 years (88%, n=49). Most of fatalities were drivers (60%, n=58).
- **Spatial and temporal patterns:** The mean death toll across the study time period is 5.65 fatalities per year. Analysis of the 74 incidents showed that more fatal incidents occurred in summer (49%, n=36) and in the evening/at night (50%, n=37). The majority of incidents occurred when victims were attempting to cross creeks, bridges or causeways (87%; n=64) and the crossings were flooded due to rising water levels. As shown in Figure 3, the majority of fatalities occurred in east coast NSW and QLD.
- **Situational factors:** Drowning is the leading cause of death (66%); 43% (n=32) of incidents occurred within 20 km of driver's home address; the shallowest water depth was only 20 cm, and 63% reported fast flowing water. Just over a quarter of incidents (28%) occurred in cars (e.g., sedan), 26% in sports utility vehicles (SUVs) and 20% in utility vehicles (utes). At least 29% of all vehicles trapped in floodwater were officially reported as four-wheel drive vehicles (4WD).



FIGURE 3. GEOGRAPHICAL HEAT MAP OF VEHICLE-RELATED FLOOD FATALITIES IN AUSTRALIA 2001-2017

Outputs and future plans: This work was published as a peer-reviewed journal article (Ahmed, Haynes, & Taylor, 2020), a Research into Practice Brief (No.2), and a poster. Currently planning is underway to adapt the analysis approach developed here to identify patterns within fatality records for use in future work analysing flood rescue data to identify patterns in the demographic, spatial and temporal, and situational conditions.

WILLINGNESS TO DRIVE THROUGH FLOODWATER

Focus: Driving into floodwater, risk perception, anticipated behaviour

Aim: The aim of this study was to identify a set of images that could be used to assess and differentiate people's risk-taking propensity in relation to driving into floodwater. The intention was to use this set of images to develop a 'willingness to drive through floodwater' variable to use in survey analysis and to assess the relationship between anticipated 'willingness to drive through' and actual behaviour.

Overview: As a result of extensive piloting and analysis, four images were chosen to provide variability in responses across different testing groups. A mixture of rural and urban scenes, and mixture of images with other vehicles present were chosen (Figure 4). In piloting and in surveys participants were asked two questions for each image:

1. Would you consider driving through this water...
 - a. in normal/everyday situation?
 - b. in urgent situation?
2. Would you consider this road flooded?



FIGURE 4. WATER ON ROADS IMAGES

These images were trialed opportunistically with a range of participant groups, including flood experts and emergency services personnel at meetings and



conferences, university students, traffic offenders at local government run remedial driver training courses.



FIGURE 5. SUMMARY OF DATA FOR WATER OVER ROADS TESTING WITH A RANGE OF PARTICIPANT GROUPS

During the course of the project, especially in the early stages, using this set of images proved to be a great way to engage people with the project, to get them to reflect on their own attitudes to risk, and to open up discussions about the challenges for communicating risk. The potential for using a validated set of images for engaging groups of people (community, SES personnel, essential service workers) was realised, and the question about whether people regarded the images as depicting ‘flood’ was useful for eliciting the words lay people and experts use, and the cues they are picking up to make these judgements.

Recently data from the public survey has been analysed, using a machine learning predictive data analytics approach, to investigating the various factors that predict whether people actually drive into floodwater. This measure (anticipated willingness to drive through floodwater) was one of the variables that was found to predict behaviour. Although as a general finding this is perhaps not surprising (anticipated willingness to do something predicts actually doing something), the robust analysis provides strength to the proposition that using these images to test/assess willingness to drive through floodwater is a valid approach that could be used as a general risk engagement tool and also as a tool in training. This set of images could be useful for identifying those at higher risk of this behaviour and could be a conduit to engage in more detailed discussion about risk.

Outputs: After extensive trialling, these images were incorporated into survey work for this project and proved to be a strong predictor of actual driving through floodwater behaviour. There is utilisation potential in the use of this set of images for engaging with people about risks and in prompting discussions with those identified as ‘at-risk’ of this risky behaviour. The team is currently following up image ownership/copyright to gain permission to use these images, as this potential was not foreseen at the start of the project.



HOW SES PERSONNEL ENGAGE WITH FLOODWATER

Focus: Driving into floodwater, emergency services, decision-making, behaviour

Aim: The aim of this study was to explore the experiences of SES personnel encountering floodwater in SES vehicles, to describe the contexts and conditions in which they have entered floodwater, and to investigate the factors that influenced decisions to enter floodwater.

Overview: As an occupational group, SES staff and volunteers are exposed to floodwater risks and may experience real or perceived pressure to enter floodwater. Understanding the circumstances under which SES personnel enter floodwater in either SES or personal vehicles can inform risk assessment strategies for emergency workers by helping to build a picture of 'typical' floodwater entry and creating an opportunity for further discussion of scenarios that would be useful for training and safety. It can also support targeted interventions to those personnel more 'at risk' of driving through floodwater, and for individual agencies, guide the development of policy, and larger agencies can use these data as a benchmark against which to assess changes in safety practice over time.

In this study, 1,251 SES personnel from four jurisdictions completed an online survey in 2018 and 2019.

The survey comprised questions on:

- Driving experience and demographics
- Willingness to enter water on roads/while driving (using the four images above)
- Experiences of driving into or turning away from floodwater
- Key factors of risk assessment: spatial characteristics, environmental characteristics, vehicle characteristics, floodwater characteristics
- Influences on decision-making: duties and responsibilities, training/skills/abilities, prior experience, social pressure, organisational norms, individual factors, and cues
- Risk perception and organisational safety culture

The median age range of respondents was 45-54 years and 71 per cent (n=862) of respondents were. The majority (88%) were volunteer members (7% salaried members, 5% both) and most respondents (90%) had approval to drive SES vehicles and were deployed in floods and storms (81%). Under half (43 %) had received 4WD training and few (13%) had received advanced level flood rescue training.

Key findings from this survey provide an insight to SES personnel behaviour and decision-making:

- **SES personnel had entered floodwater on roads in the past 2 years – both in SES vehicles and in their private vehicle**

Overall, 37 % (n=463) reported they had driven into floodwater in an SES vehicle as the driver, 39 % (n=488) reported they had been driven into floodwater in an

SES vehicle as a passenger, and 52% (n=650) reported they had driven into floodwater in their own private vehicle. This suggests that entering floodwater in a vehicle is a fairly common practice.

- **When entering floodwater on roads, most entered shallow water (<30cm) with slow or no flow, and were typically in larger vehicles**

Respondents who had driven through floodwater (n=506) were then asked to provide details of a recent event where they had entered floodwater in an SES vehicle, either as a driver or passenger. This allows a more detailed insight to the situations and circumstances under which SES personnel are entering floodwater on roads. Most events occurred in rural areas (41%) on a minor/residential road (54%). Over half the respondents estimated the water depth to be <30cm, though 24.6% estimated the depth to be 30-45cm. The vast majority (86%) reported that the water was either still or slow flowing. Almost half (49%) the respondents were in a light truck/dual cab, and just over half (53%) were undertaking an emergency response with no light and sirens.

- **Characteristics of SES personnel who are more likely to have driven into floodwater**

Chi square analysis identified several demographic, driving, and flood-related characteristics of SES personnel who have driven into floodwater (Figure 5).

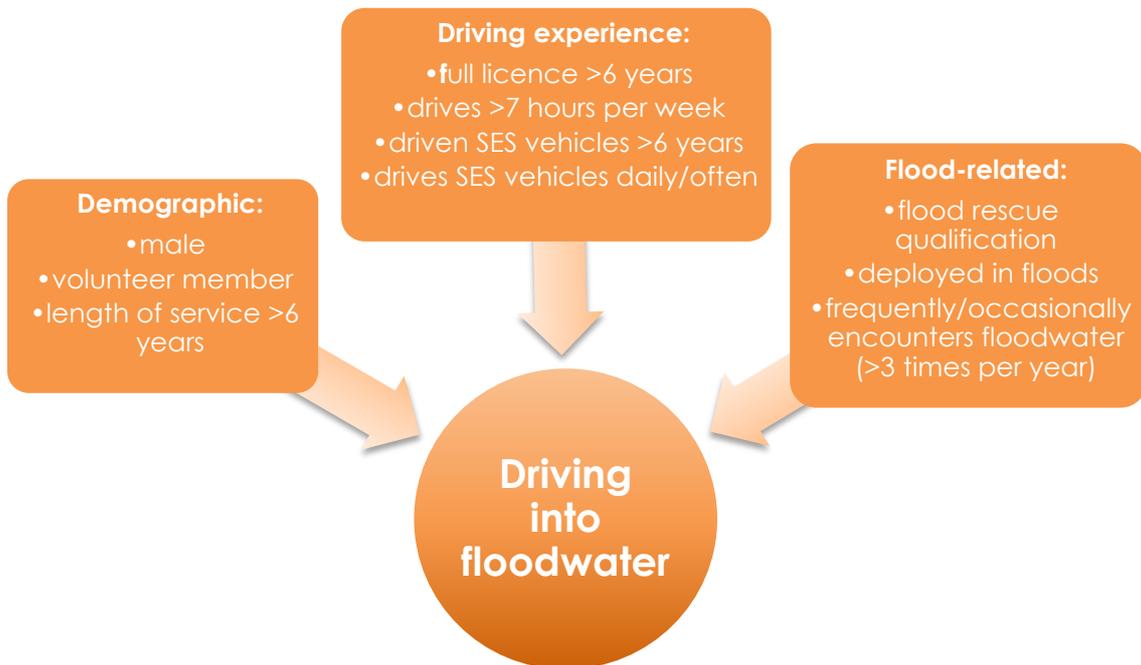


FIGURE 5. FACTORS THAT INFLUENCE SES PERSONNEL DRIVING INTO FLOODWATER

- **Decision-making is impacted by ‘careful consideration of the situation’ and social influences**

In a list of 18 potential influences on the decision to enter floodwater on the road, the influences rated as most important by respondents were:

- Careful consideration of the situation



- Belief in own physical ability to drive through
- Knowledge of road
- Professional SES training/knowledge
- No alternative route
- Impractical alternative route (time/distance)

That 'careful consideration' was the top influence suggests that entering floodwater was not a surprise or habitual event; rather, SES personnel felt the decision to enter was a considered one.

The majority (75%) of events of driving into floodwater took place with passengers in the vehicle, and passengers were reported to have influenced the decision to drive into floodwater in around a quarter of those events. In comments provided about the influence of passengers, consensus in the vehicle was the most common theme.

Outputs and future plans: The survey findings have been shared through various conference presentations and in a Research into Practice Brief No.6). A subset of this dataset was used to inform an academic publication (Ahmed, Haynes, Tofa, Hope, & Taylor, 2020) and the team co-authored a presentation and paper with VICSES that was published in the October 2020 edition of the Australian Journal of Emergency Management (Taylor, Tofa, Wiebusch, Beccari, Haynes, 2020). A summary of the findings for each participating jurisdiction has been written up into a series of summary briefs.

These findings can also assist in the development of training for SES personnel and policies for SES jurisdictions, e.g. developing realistic training scenarios using 'typical' situations/contexts in which personnel have entered floodwater whilst on duty in SES vehicles. This dataset can also be used as a baseline against which to measure changes in safety climate and improvements related to changes in organisational policies and practices over time. The research team will continue to support individual SES jurisdictions with utilisation of these data and further breakdowns and analysis.



There are still many areas that can be analysed and presented, especially with the combined set of >1200 responses. The team will begin analysis of the safety climate data next to look at relationships between this and risk taking attitudes and practices.



HOW THE PUBLIC ENGAGES WITH FLOODWATER

Focus: Driving into floodwater, recreating in floodwater, public, decision-making, behaviour

Aim: The aim of this study was to explore the behaviour and decision making of the general public in Australia in relation to driving into, or recreating in, floodwater.

Overview: An online public survey was administered between December 2018 and January 2019. The sample was constructed to be proportionally representative of the adult Australian general population by state and balanced for age and gender. A total of 2,184 respondents undertook the survey. The survey comprised questions on driving experience, demographics, experiences of entering floodwater, anticipated willingness to enter water on roads/while driving (using the four images), experiences of driving into or turning away from floodwater, general risk attitude, and recall of flood risk messages.

Key findings from this survey that illustrate the complexity of flood risk communication and provide an insight to public behaviour and decision-making include:

- **The reasons people enter floodwater on land are diverse**

Floodwater on land refers to water where it normally isn't, for example a flooded park or street. In total, 26 per cent of respondents reported that they had engaged in activities in floodwater on land. The highest proportion of respondents reported having waded through floodwater on land (n=340, 15.6 per cent). Out of those respondents who waded in floodwater, 34 per cent reported that the main reason was leisure, followed by testing the depth of water before driving through (17 per cent)



- **The majority of respondents had driven/been driven through floodwater**

Overall, 56% of respondents had entered floodwater in a vehicle. Respondents were more likely to have entered floodwater in a vehicle if they were male, rated their driving ability as 'high', had undertaken an advanced driving course, and typically engaged in more hours of driving, per week.

- **Factors that help predict whether someone is more likely to drive into floodwater**

Statistical modelling identified factors that have the greatest influence on whether a person has driven into floodwater (Figure 6).

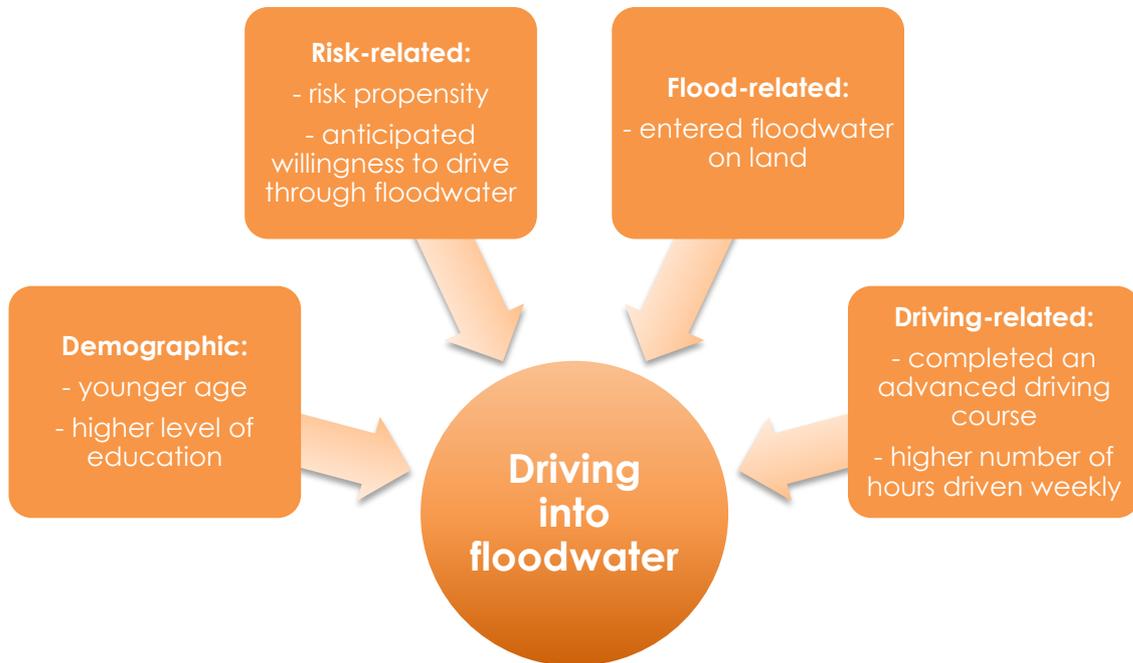


FIGURE 6. FACTORS THAT INFLUENCE THE PUBLIC DRIVING INTO FLOODWATER

- **Of those who recalled a specific incident of driving through floodwater, 90% experienced no negative consequences**

4.1% reported that the car was driven out without help - but it was damaged and needed repairs afterwards and 2.6% reported that they had to be helped or rescued by passers-by or family/friends. Less than 1% reported being helped or rescued by motor services (e.g., NRMA) or emergency services.

- **Only 40% of respondents recalled seeing official campaigns aimed at preventing people driving or playing in floodwater.**

Only 134 respondents (8% of the total sample) accurately recalled 'If it's flooded, forget it', one of the core risk communication messages.

Outputs and future plans: The survey findings have been shared through various conference presentations and in a Research into Practice Brief (No.4), and two academic journal articles are currently being prepared.

As this survey provides an important insight to the behaviour and experiences of the general public, further analysis of the survey data will also be undertaken to develop a more nuanced understanding of public behaviour. Further, because the public and SES personnel surveys contained sections with matching questions, statistical analysis to compare responses among the general public and SES personnel will also be undertaken.



CUE UTILISATION, EXPERTISE, AND FLOOD RISK ASSESSMENT

Focus: Driving into floodwater, emergency services, public, decision-making, cue utilisation, risk assessment, expertise

Aim: The aim of this study was to develop and validate a measure of cue utilisation in the context of driving in floodwater. Measuring cue utilisation in relation to driving in floodwater will help evaluate emergency workers' floodwater risk assessment skills. This may provide valuable assistance in the training and management of SES workers who need to make rapid decisions in floodwater situations.

Overview: SES personnel may be required to work in flood and storm contexts that demand they make quick and accurate decisions under time constraints and changing conditions. In these situations, fast and accurate situational assessment is vital to safety (Ahmed et al., 2018). However, the risks associated with floodwater are often not easily identified and drivers may not always accurately perceive the risks associated with driving through it. Risk perception is a critical determinant in the decision of motor vehicle drivers to enter floodwaters, and a poor ability to perceive risk is likely to result in increased engagement in risky driving behaviours (Ivers et al., 2009). This research developed and piloted a tool to examine the ability to use environmental cues to recognise floodwater hazard and adequately assess the level of associated risk. It is expected that SES personnel with higher levels of cue utilisation may have a greater ability to correctly and rapidly identify floodwater hazards and associated risks in the environment, improving safety outcomes for themselves and others, and avoiding costly damage to work vehicles.

EXPERTise 2.0: About the software tool

EXPERTise 2.0 is a software shell that can be tailored to assess user's ability to interact with task-related cues and make decisions in different contexts. It can benchmark a user's performance and allow objective assessment of targeted interventions to improve performance. It has been used in a range of occupational fields/professions – such as aviation, train control, anaesthetics, radiology, and lifeguarding ([Macquarie University, 2016](#)).

In this study, a floodwater driving version in EXPERTise 2.0 was developed and pilot tested to diagnose risk in floodwater environments. EXPERTise 2.0 is based on the RAPID model, where the application of cues is thought to be reflected in responses to features that are evident in the environment. These features are the 'triggers' for cues in memory. For example, an individual who is applying cues would be expected to:

- Recognise features quickly
- Associate related features
- Prioritise the acquisition of features during problem orientation
- Identify features from a complex scene, and
- Discriminate relevant from less relevant information during problem-solving.



This study was completed online via an assessment portal (Figure 8). Participants completed a questionnaire to provide some demographic details and information about their driving experience, then a floodwater risk assessment task, assessing the risk associated with driving through various flooded roads using driving in floodwater version of EXPERTise 2.0 (Figure 8).

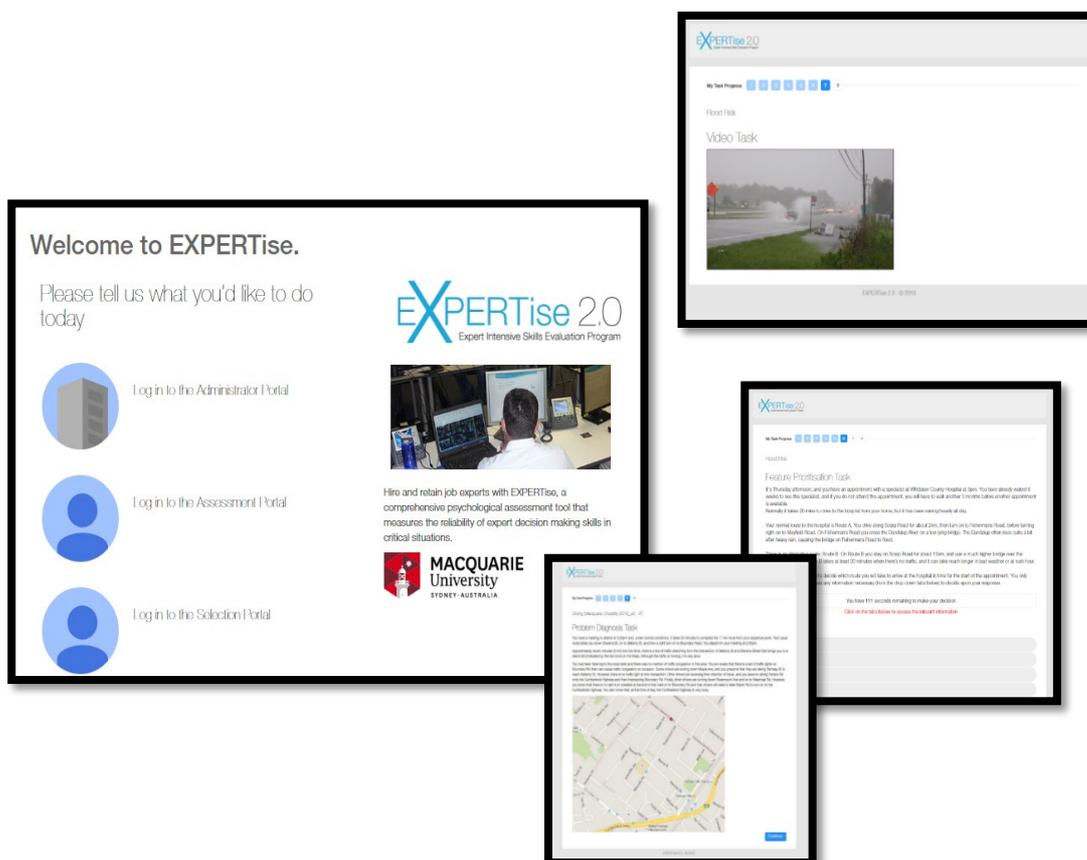


FIGURE 7. IMAGE SELECTIONS FROM THE DRIVING IN FLOODWATER VERSION OF THE EXPERT INTENSIVE SKILLS EVALUATION (EXPERTISE 2.0)

- **Pilot study findings**

In the pilot study, there were 162 participants, 54% were SES personnel (n=87) and 46% were from the general public (n=76). The average age was 40 years old and 39% of participants were male. All participants had prior exposure to flooded roads, and most SES participants (86%) had experience attending local flood events.

The pilot study found that the newly developed driving in floodwater version of EXPERTise 2.0 demonstrated patterns of behaviour consistent with higher and lower cue utilisation and it was possible to divide participants into two groups (higher and lower cue utilisation). It was anticipated that SES participants would be overrepresented in the 'high cue utilisation' group due to their occupational experience and knowledge, but surprisingly this was not the case.

The results confirmed that the tasks developed to assess cue utilisation in EXPERTise 2.0 were successful in distinguishing patterns of responding that suggest higher and lower levels of cue utilisation and provided confidence that the



premise of the study and the general approach were sound. To understand some unexpected findings, further analysis has been conducted which identified several areas for further development and improvement. This was not unexpected and was part of the rationale for the pilot testing - to ensure all aspects of the testing procedure work accurately and effectively. Our research team worked in partnership with subject matter experts in NSW SES to identify and resolve testing issues. This collaboration has led to development of revised performance tasks for the planned next phase of research testing (Aug – Oct 2020) and provided valuable knowledge and insights into several aspects of floodwater risk assessment.

Outputs and future plans:

The pilot testing of this tool has been written up as a Research into Practice Brief (No.7), Figure 8, and an academic manuscript has been prepared. Cognitive interviews with subject matter experts from NSW SES were conducted to assess improvements in the testing environment, and data collection with students (May-July 2020) and SES personnel (July - October 2020) has been completed with the updated driving into floodwater version of EXPERTise 2.0. Analysis and reporting are currently underway.

The potential utilisation of this tool is discussed in the Utilisation and Impact section.



FIGURE 8. RESEARCH INTO PRACTICE BRIEF NO.7 DETAILING EXPERTISE 2.0 PILOT RESEARCH



- **Individual and social factors influencing behaviour**

The main individual factors identified in interviews with professionals and public were past experience, awareness and acceptance of the risk, and confidence, ability and self-efficacy. Social factors have also been identified in the literature as an important influence on driver's willingness to enter floodwater (Ahmed et al., 2018; Hamilton et al., 2016). In this study, both interview groups discussed social influences on their willingness to enter floodwater, such as presence of passengers, the behaviour of other drivers, and presence (or absence) of people nearby. Interestingly, emergency service professionals noted reputational damage and embarrassment as a significant influence on whether they would enter floodwater:

...my main thing was everyone I know knows that I made a campaign and say "don't do it [drive into floodwater]" so I probably feel the guilt to not do it even more. The reputation damage would be the biggest motivator. (Professional 8)

Both interview groups suggested that young people were more likely to take risks and enter floodwater in a vehicle, and some emergency services professionals identified young males as more likely to engage in this behaviour.

When considering location type and comparing urban and rural communities, both interview groups identified factors specific to urban and rural settings that may affect the (perceived) risk of water on roads and that may influence behaviours. For example:

More danger in an urban area in a sense that usually the people in the urban area may not be used to it. There may be other factors that when more congestion, more people, but at the same stage in a rural area, there could be less cars so you could be more isolated and more remote and then help will take longer presumably to reach. (Public 1)

- **Situational factors**

Situational factors are defined as aspects that are specific to the location and situation when water on the road is encountered; examples from the literature include road characteristics, type of vehicle, roadway familiarity, and number of occupants in the vehicle (Ahmed et al., 2018).

Emergency services professionals and the public frequently discussed the depth and flow/velocity of the water, the road characteristics and visibility, the type of vehicle being driven, as well as their familiarity with the location and geography (Table 3). Public interviewees additionally considered the distance to travel, while emergency services interviewees discussed the type of flooding and geography (e.g., drainage, catchment geography, storm water drain overflow vs. riverine flooding).

A key characteristic that emerged in interviews with emergency services, and to a lesser extent in interviews with public participants, is the idea of uncertainty and the difficulty – or impossibility – of accurately assessing situational factors. This uncertainty emerged as a key reason that emergency services professionals conclude that people should not enter floodwater:



Look, from my point of view, I think once you start talking about – for me, floodwater is obviously dirty, yucky, fast-moving floodwater, and the danger or the hazard itself with floodwater is that you don't know the depth, you don't what it's done to the infrastructure underneath the road, you don't know the debris that's in the water, you don't know the force of water. (Professional 7)

TABLE 1. SITUATIONAL FACTORS

Situational Factor	Professional interviews example quote	Public interviews example quote
Water depth	I'm aware of the things that you need to identify, "So can you see the bottom of the road? Is the water flowing fast?" and the height of the water and I can assess the situation and know whether it is safe to cross or not (Professional 6)	It depends how deep it was. I mean let's just say if it was only just beginning but if you can't see the road, especially when it goes down the deep, you've got no idea what's under there, I wouldn't go there, no. (Public 10)
Flow/velocity of the water	So the fact as well that sometimes the water can look very still on the surface but underneath, it could be quite fast (Professional 4).	I guess if the water looked like it was still rather than flowing, that that might lead one to the perhaps edge cautiously across a waterway as opposed to something that was obviously flowing with great speed. (Public 12)
Type or cause of flooding	...it's the conditions that have led to that water being on the road. So if it is a flash flood, storm or water and that water has travelled from somewhere else to be there, then those risks around erosion and not knowing what's under the surface and all those other things go up, whereas if it's clearly evident that the water has come across the road surface and there is an inch or two of it across the road surface and your natural human instinct is to be able to try and weigh up and assess that risk and if it's evident, that's considerably lower than there is a risk that you might try and take that chance. (Professional 1)	
Road visibility	So I'll take into consideration whether if I could see the road itself, whether the water was murky because obviously if it's murky, you can't see	So I would not drive through it if I didn't know what the surface was underneath the water, if that makes sense. So if I'm somewhere



	<p>any debris that's floating by. (Professional 6)</p>	<p>unfamiliar and I don't know what's underneath the water, there could be potholes...it could be all sorts of things under the water that I can't see. If it's just a normal tarmac, I would probably not drive through more than – as long as I know where I am. (Public 13)</p>
<p>Road characteristics and infrastructure</p>	<p>...if you've come to that point where it's after a large volume of water that has already been though and the waters have receded down to that and maybe just slowly going over or still sitting, so you still don't know what damage of the infrastructure is going to be. You could drive through there thinking you're perfectly okay and the road collapses because of whatever underneath could be damaged or non-existent. (Professional 7)</p>	<p>Yes, because you have no idea of how deep that water is and whether there's any part of the road that's been washed away that you can't see because of the water. (Public 5)</p>
<p>Vehicle type</p>	<p>So types of vehicles. And then you can have four-wheel-drive type vehicles and then there're even differences in amongst those, so we have a utility versus a station-wagon-type vehicle. A utility will generally let the water flow through the body of the vehicle and underneath the tray, whereas something like a station-wagon-type vehicle will more tend to float, and while somebody might – and just to think they can drive through it but actually the rear wheels of the vehicle float or the whole vehicle floats, and then actually comes off the causeway because they didn't anticipate the buoyancy factor. (Professional 5)</p>	<p>I guess it depends on what vehicle you have as well. I mean if you got a specially prepared four-wheel drive and you used to transverse in flooded waterways, and you've got a snorkel air filter, and you're very, very confident that all your engine seals are good and that the vehicles capable of it, then you might take different levels of calculated risk over and above a sports car without a roof on it, if that makes sense. I mean it would depend on the type of vehicle that you've got and your experience in navigating flooded waterways. (Public 12)</p>
<p>Familiarity with the location and geography</p>	<p>Any other place where I would see water over the road in a location that I wasn't familiar with, I would consider as dangerous and have regardless of what kind of floodwater what that was, whether it was still or fast flowing, I would consider that as dangerous just because I wouldn't</p>	<p>So I think the familiarity is the important part. If I know where I am and I know that that's like an inch or two or three then I will go through it, but anything more than that I would seriously consider not driving through it. (Public 13)</p>



	know the road or the location or any of that stuff, and I would certainly probably not drive through it (Professional 8)	
Debris and animals	So I'll take into consideration whether if I could see the road itself, whether the water was murky because obviously if it's murky, you can't see any debris that's floating by. (Professional 6)	It can be dangerous and sweep your vehicle away if the floodwater is more than 30 centimetres high and you don't know what's in the water. There could be trees and branches or anything. (Public 11)
Distance to travel		So I guess most people would weigh up the risks and the rewards of doing something. So if I had to turn around – I mean I'd probably only have to do a half-hour detour to get around the area that floods here, but if you're out bush when you might have to travel for two or three hours or whatever, and night's falling, I would imagine that that would make you more inclined to cross. If you were in a hurry, if you were heading to pick up young kids or whatever, I would imagine that would make you more inclined to perhaps risk where you shouldn't. I guess logically that would be whatever the cost of not crossing it would be, I suppose. (Public 3)

- **Reasons for driving into floodwater**

The key reasons for entering floodwater described in the literature were attempting to reach destination, undertaking employment duties, and evacuating (Ahmed et al., 2018). While evacuation and rescue work were mentioned by some emergency service professional and public interviewees, this was only a minor discussion point. Among emergency services, the main reason for entering floodwater was described as attempting to reach destinations in order to carry on with daily life in flood prone areas:

That being said, there are many places and many examples where people, if they strictly adhere to that message [if it's flooded, forget it] would be significantly inconvenienced because they would be stuck in an area away from home or between two centres and stop if they didn't go through those floodwaters. (Professional 5)

And now, we don't encourage people to enter floodwaters, but we know there are circumstances where it's not avoidable particularly in remote communities and remote regions of our state. (Professional 6)



Public interviewees discussed the urgency of the situation as a key (potential) factor for entering floodwater, with some suggesting that they would only consider driving into floodwater under 'life and death' scenarios:

Like if you have to get to the hospital or something, then maybe I would go through it. It just depends on what the reasoning is. If it was to go to work but it looks like it's dangerous, then I wouldn't drive through it. (Public 2)

I wouldn't blindly drive through it... If I see it's safe, if I feel it's not safe, then also it depends on my own timetable, do I need to be somewhere if I needed to be somewhere, I'm more likely to take a risk and go through it. If I'm not on a timetable, then I'll be more than happy to wade it out or try and find an alternate route. (Public 1)

- **Decision-making**

The framework in Ahmed et al. (2018) posits two potential decisions: driving into floodwater and turning back. While most professional interviewees stated that they would not drive into floodwater, some identified specific situations where they would or have entered floodwater in a vehicle:

I'd first take a look at the road itself. If it's an area that I'm experienced with and I can see how deep the water is, I can see how fast the current is moving, and I've got the type of vehicle that is appropriate to cross that kind of floodwater, then, yes, I would. But if I wasn't sure or if I had any concerns, I would have to turn around. (Professional 10)

...we had flash flooding during winter, and I was driving to work, and it was really early morning, it was still dark, it was at six o'clock in the morning, it was still dark, and I was going along a road that is 80 Ks [km/hr] 'cause I live in the outskirts of the city...and I hit a flooded area and it was there before I could stop. I crossed a flooding that I would not have gone through because it was too late to stop. So, there're also the accidental crossings. I'm not sure my car was very happy about it, but I got through it nonetheless and the car behind me almost crashed into me (Professional 6)

Public interviewees, in contrast, identified a range of decisions that they would make if they encountered water on the road (Table 3). The decisions articulated were often context or situation-specific, suggesting that these public drivers assess each flood situation and the importance of the journey when deciding whether to enter floodwater. A minority of public interviewees suggested that they would not enter floodwater at all, and a minority of interviewees identified steps they would take to enter floodwater more 'safely'.



TABLE 2. DECISIONS BY PUBLIC INTERVIEWEES

Decision	Public interviews example quote
Not enter floodwater	You should never do it because you don't know what's underneath, what road could be washed out. Even if you think it's not that deep, there might be something going on under the water that you can't see, so it's best just not to do it at all. (Public 15)
Make alternative plans	So I guess I don't drive in areas where I'm forced to cross any flooded rivers or flooded waterways but would I guess, with a benefit of age, would really not take it on. Look for ways around or make alternative plans so that you don't need to cross somewhere because it could end up really badly. (Public 12)
Drive through or take an alternative route depending on situational factors	<p>My rule is if it's the road I know and if I gauge the floodwater to be less than 30 centimetres, I would do it. Other than that, I mean if I was in the same situations which I'm on my own, I would drive the three-hour track instead of going through the floodwater. I'd go around it. (Public 11)</p> <p>I probably just find a different way to get through. I just don't think I would risk it, I guess unless it was only a couple of inches, maybe. (Public 15)</p>
Drive through or take an alternative route depending on urgency of journey	I think possibly it depends on my need to cross that road or on how much I have to be on the other side really. If I have to go a different way which is longer, then I'll do that but I think it depends on my need to be there, I guess. (Public 6)
Prepare vehicle to enter floodwater	Just off the top of my head, I guess – the things I might consider would be if I have one window down, you should have one on the other side open as well. At least that way you've got water flowing through rather than just if you're the driver and you wind down your window and all the other windows are closed, then you really just filling the car up with water with nowhere for it to go, whereas as if you had your window down and the passenger window down, at least there're some ways for the water to move through and for you to get out. That's what immediately springs to mind other than don't do it in the first place. (Public 12)
Drive slowly and carefully	Entering – well, going slow for a start and just trying to sort of navigate where the – it's just a bit hard – depends on where you're crossing it and whether the water has been really fast. If it's been really fast, there's a whole – there's a high likelihood that there's gonna be a good chunk of road that's been washed away, so you're gonna have big holes and potholes. So it is with great caution you should do it, really, to cross it. (Public 5)



- **Consequences of entering floodwater in a vehicle**

Both emergency services and public interviewees identified a range of potential consequences from entering floodwater. The consequences for vehicles identified in this study included:

- Engine stalls
- Vehicle is damaged
- Damage is not covered through insurance
- Vehicle fills with water
- Vehicle floats and is washed from the road
- Vehicle sinks
- Vehicle hydroplanes

The potential consequences for people included:

- Become trapped in vehicle
- Panic, distress
- Death (by drowning)
- Other injury
- Passengers drown

Social consequences were also contemplated by both groups. These included the risk to rescuers, the cost of conducting rescues, endangering other people – such as cars that may follow your vehicle into the water.

- **Complexity of communicating about the risk of floodwater on roads**

These findings highlight the complexity of understanding and communicating the risk of water on roads. This complexity arises from the many variables that influence how dangerous any instance of floodwater on a road is, and the reality that in regional and remote areas driving through floodwater is 'a part of life.' A major challenge identified by SES interviewees is that risk is underestimated by the public, particularly in comparison to other hazards (e.g., fires). Given this, top-down campaign messaging is considered important, but localised engagement and long-term culture change are considered critical to reducing the number of drivers who attempt to drive through dangerous floodwater.

Outputs and future plans: The findings have been shared through various conference presentations and in a Research into Practice Brief (No. 3), and an academic journal article is currently being prepared.

This first analysis examines mental models related to driving into floodwater on roads. Interviewees were also asked about recreating in floodwater, and this portion of the data will be analysed separately for a second publication.

CURRENT APPROACHES TO FLOOD RISK COMMUNICATION

Focus: Flood risk communication

Aim: The aim of this study was to collate and assess current flood risk communication approaches using public survey data.

Overview: The first stage of this study was a desktop review of flood risk communication materials using such search terms as “flood risk” and “floodwater AND driving,” as well as jurisdiction-specific emergency service groups (e.g., NSW SES). Most of these campaigns focused on the risks or dangers associated with driving into floodwater (Figure 10). The key advice conveyed was to never enter floodwater, and less information was provided about what drivers should do instead of driving into floodwater (e.g., find another route, turn around, delay travel).



FIGURE 10. EXAMPLES OF FLOOD RISK CAMPAIGNS

- **Campaign awareness**

Generally, those who could recall a campaign were older (typically 45+) (42-48 per cent across older age groups), drove utes (51%) or medium/large cars (43%), had taken an advanced driving course (49%), and were from QLD (68%) or NT



(64%). Respondents provided their postcode and from these data their location type was identified using the Accessibility and Remoteness Index of Australia (ARIA). This analysis indicated that those in outer regional areas (more rural/remote areas) were also more likely to have seen a campaign (49%) compared to those from inner regional areas (41%) and those from urban areas (33%). Overall campaign awareness for the sample was quite low, at 40%. Notable exceptions were those in the sample from QLD and NT with recall around or above 65%. Respondents living in urban areas had the lowest awareness of campaigns overall (33%).

- **Recall of campaign messages**

Of the 844 who reported recalling one or more campaigns, when prompted to recall a main message or something from a campaign, only 33% (n=278) could recall any aspect of the content (13% of the total sample). The most frequently recalled message, by 8% of the total sample (n=135) of people who could recall an official campaign, related to the general campaign message “If it's flooded, forget it”. Not all 135 respondents accurately recalled the full message. This count includes those who provided sufficient written responses that conveyed the general meaning of this campaign, i.e., that you should not enter floodwater. This included phrases such as “forget it”, “don't do it”.

Responses included phrases that could be linked to known campaigns, such as “15 to float” (VICSES), “Safe pipes and drains” (NT), “Know the dangers” (QFES), and the “If it's flooded forget it” campaign used by multiple jurisdictions, as well as a range of other campaigns.

Campaigns were generally rated favourably, with their ability to raise awareness generally being rated higher than their ability to influence behaviour. Physical interventions were felt to be most useful, with signage, barriers, lights, and more depth indicators topping the list. More accurate and timely warnings and mandatory education in driver training were the next most favoured approaches. Punishments (fines, points, disqualifications), advertisements on social media and in newspapers, and public events, like roadshows and workshops were felt to be the least effective.

Outputs and future plans: This element of the project was the first part of Phase 2 and formed a bridge between interpreting the data from the earlier studies in the context of how they were reflected (or not) in existing risk communication campaigns and what additional aspects could be developed from the evidence in the research data to fill gaps. This part of the research was written up as a Research into Practice Brief (No.5).

CHALLENGES IN COMMUNICATING ABOUT ENTERING FLOODWATER

Focus: Flood risk communication, public

Aim: To identify a key set of challenges in flood risk communication to inform a national series of Community Service Announcements for use by the ABC in broadcasting for flood awareness and in the event of flood emergencies.



Overview: Drawing together findings from the public and SES personnel surveys and the mental models, this final set of findings identifies a range of challenges related to flood risk that need to be considered in communication and advice.

- **What do we actually mean by floodwater? When is a road flooded?**

Developing a shared understanding of what constitutes 'flood' in the context of driving into floodwater is important. Currently the central flood risk communication message is 'If it's flooded, forget it,' but that quality of 'floodedness' is subjective. This is an important issue as people are good at identifying 'exclusion' in warning messaging and dismissing communication that is not deemed relevant (Smillie & Blissett, 2010, p. 117). For example, shallow water on a road may not be recognised as being 'flooded' and therefore the advice to 'forget it' could be ignored. This is perhaps particularly the case where the imagery used in flood risk communication messaging shows more 'extreme' situations than those regularly encountered (and entered) by the public.

As discussed in Taylor et al. (2019) discussion with experts from a range of emergency services in a conference panel at ANZDMC 2019 provided further insight to this issue. Firstly, providing communities with the right tools, skills, and knowledge to identify dangerous features of floodwater may be more achievable than a shared definition of floodwater. These includes such factors as not knowing what is below the surface and understanding how even shallow floodwater can impact vehicle stability ('Know the dangers', QFES; 'You don't know what you're getting into', VICSES), and understanding the impact of water flow on vehicle stability ('15 to Float', VICSES).

Secondly, the location and context of flooding is also important to consider. For instance, in areas that could be flooded for long periods or on multiple occasions, the practicality of *never* entering floodwater, prolonged road closures, and other socio-economic factors need to be considered.

Lastly, road closures for floodwater are related to definitions of 'floodwater'. While some jurisdictions have clear directives relating to the depth of floodwater required to close a road, there was discussion about how realistic procedures are for closing and opening roads in a timely way, when this is largely a manual operation. Further, while defining when a road is flooded is an important issue, considering when a road stops being flooded is also important (i.e., when has the flood ended?). Consideration of the impact on road safety of mud and debris left on roads after floodwater has subsided and roads are reopened is needed.

- **Despite advice and warnings, people are still entering floodwater.**

The public survey found that 56% of participants had ever driven/been driven into floodwater. When recounting a specific driving event, 90% reported no negative consequences of driving through floodwater, and less than 5% reported needing assistance. Given this finding, firm, definitive messages advising 'never' drive through floodwater are unlikely to resonate with these individuals, as the risks conveyed will conflict with the personal experiences they



draw on when receiving and processing these messages. In the mental models interviews with SES personnel discussed the limitations of 'never enter' being the only advice and identified important dilemmas faced by their agencies in terms of the advice they can provide:

We're not going to say we're going to stop people from driving through floodwaters because that's unrealistic and it's not suitable for areas of our state. But if we can get people to better analyse the situation and make decisions based on that particular risk at the time then and we have people that go, "You know what, I'm gonna turn away from this. This time around I'm not going to go through," then that's a win for us.

Do you try and help them survive [if stuck in floodwater] or do you say, "Well, no, you shouldn't have done it in the first place?" ... I think most government departments, most emergency services will, turn around and say, "I don't want you to do this at all." ...I think it's probably a lot of internal conversations about what is the right thing and actually it's where does the risk lie, because if someone turns around and say, "Well, this agency told me that if I did those things, I would minimise my risk of being injured or dying," if someone dies, what happens? I don't know. I wish I could give you an answer.

- **The vastness and diversity of flood contexts across Australia complicates messaging.**

Australia is a large and diverse country and flood risks and cultures of dealing with floods differ according to the context. Interviews with SES professionals in the mental models project highlighted that the absoluteness of messaging like 'if it's flooded, forget it' may be impractical and difficult to police in some contexts:

*[There] are a lot of roads around here that are flooded for most of the year, but they're pretty safe to get through as long as you know what you're doing. **And it gets pretty hard to get around [our jurisdiction] if you weren't allowed to cross, for instance, the more remote communities that get blocked off completely by these flooded roads.***

*I would say we would like to reduce the incidences of people driving through floodwater, people taking less risks.... We know we can't stop, and **we don't wanna stop it because in some areas it's a necessity... there are instances where it is safe, and it can be done if it's done properly.***

These kinds of comments evince a pragmatic assessment of local geographies of risk, of local cultures of mobility, and a level of nuance that is missing from "never enter floodwater." These sorts of discussions suggest that there are limitations to top-down messaging and the need for more localised and more contextualised messages. Professionals recognised the need for on the ground workshop, meeting face to face, and localising the messaging, yet this would require significant resource and staffing.



- **Emergency services personnel and other professionals enter floodwater. What is the advice to emergency services personnel (and other professionals) about entering floodwater? Why do they enter floodwater? To what extent do they think about the consequences for themselves? Does this behaviour influence the public's views of entering floodwater?**

Survey work with SES personnel indicated that entering floodwater is a fairly common behaviour. In addition, news footage during flood events often shows journalists and emergency services entering floodwater in vehicles. A key consideration here is whether seeing emergency services, journalists or other professionals, driving or wading in floodwater might undermine public risk messaging. This issue has been the focus of a Churchill Fellowship (Campbell, 2014) and investigation of conflicting cues on protective action is part of a current BNHCRC research project (Dootson et al., 2019).

This is also an occupation health and safety issue that is increasingly being addressed through policies and training in the workplace. Communication and engagement to shift cultures around entering floodwater and social norms within emergency services is an important focus for current and future work.

- **The reasons people enter floodwater are diverse.**

The public survey found that 28% of the public sample had engaged in activities in floodwater on land and 19% had engaged in activities in flooded rivers. These included such activities as wading, swimming, kayaking, riding on inflatables. Notably, the range of reasons given for wading in floodwater were diverse; while 34% of respondents entered floodwater for recreation, other reasons included testing the depth of water before driving through, returning to home or business, rescuing pets, livestock, or belongings, and travelling to shops, work or school. While flood risk communication typically focuses on not entering floodwater for leisure reasons, two-thirds of survey respondents entered for other reasons and are therefore likely to dismiss advice not to 'play' in floodwater as irrelevant to their situation.

- **Water-based activities are significant in Australian culture. It is difficult to frame 'floodwater' in a compelling way that makes the risk/danger visible.**

SES professionals interviewed in the mental models study noted that communicating flood risk is challenging because it's difficult to 'visualise the risk' or to make the risk 'real' for the public. Many discussed the cultures of risk and water in Australia – a culture of being in and around water, and a belief that 'water is fun' and part of the lifestyle. Because water is familiar and usually fun – some professionals talked about people seeing floods as more of a challenge than a risk. Others talked about how the message that 'recreating in floodwater is dangerous' is difficult message to sell – particularly when the media shows people having a great time:

*So, every time it rains, you see people on that surfboard in the flooded streets or the floating down the hill or in a tube, **all those things and the media love it.** It looks great on a front page of a paper or on the six o'clock*



news and it looks fun, so **there is a direct emotional link to fun and turning that bad situation into a good situation by embracing it.** And so, fighting that is very, very difficult...

...I don't want to be killjoy. It's a real fine line because I think they were some images or footage in the [region] where we had paddocks, paddocks and paddocks flooded... and so the parents were in four-wheel drive, dragging the kid behind the vehicle on a boogie board. It looked like loads of fun. **Yes, it looked like loads of fun. Is it dangerous? Probably. Am I being killjoy by saying don't do it? Yeah, I am.**

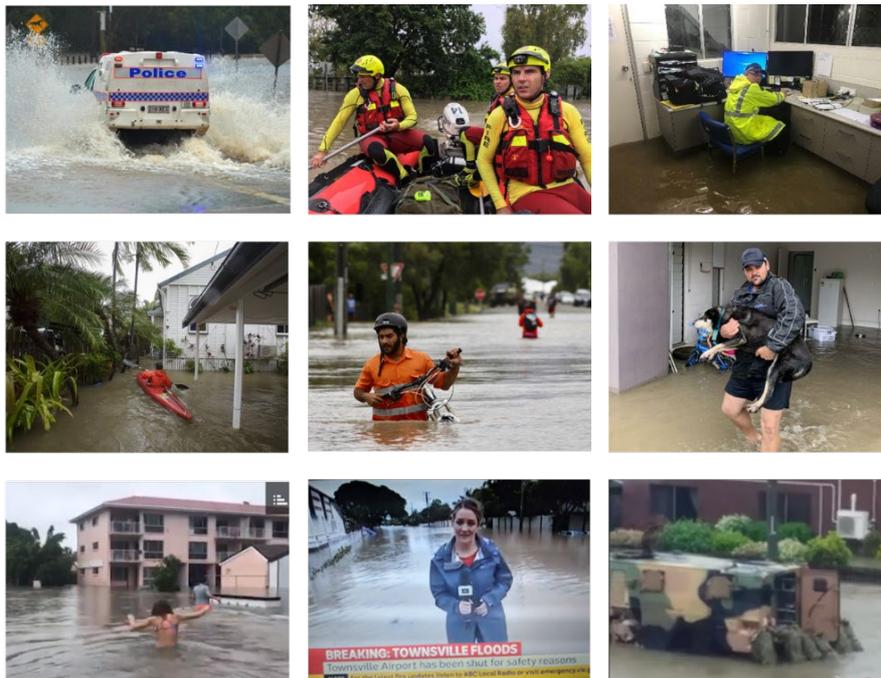
In addition, advice not to recreate in floodwater is complicated precisely because playing in water is a national pastime and floodwater on land often accumulates in recreation spaces:

These spaces [rivers, dams, parks] are generally quite fun, and we want you to recreate here, but in other times the potential to 'not be fun' is there. It's a hard one to reconcile, I think, especially if there's a lack of recreating spaces within a community.

I think a lot of people would just because they don't necessarily see there's a risk. **They just think water equals fun,** so I'm gonna take advantage of the opportunity.

This highlights an important challenge for risk communicators to both highlight the danger and risk of floodwater. Australians are proud of 'making good from bad'. In floods, recreating in the floodwater may help with community spirit, so risk communicators risk being seen as 'fun police.' There is also a water culture where parks and dams are normally places for recreation but in flooding, the message is not to recreate in these places.

Outputs and future plans: These challenges, and other findings from the project, will be used to inform Community Service Announcements for flood communication (see Utilisation and impact).





KEY MILESTONES

Over the course of the project we have delivered many milestones; some as part of formal reporting and part of the project management plan, and some opportunistic, unexpected, or additional. The earlier sections of this report outlined activities undertaken in the two phases of the project, and there is a full listing of project outputs from the team at the back of this report.

In Phase 1 of the project, key milestones were:

- Completion of a systematic review of the literature (Ahmed et al., 2018) and of a detailed analysis of vehicle-related flood fatalities in Australia (Ahmed, Haynes, & Taylor, 2020)
- Completion of a national survey of the public about driving into floodwater on roads and recreating in floodwater.
- Completion of surveys with SES agencies about driving into floodwater on roads.
- Completion of mental models research with emergency service professionals and public interviewees.

Participation in such conferences as Floodplain Management Association (FMA) 2018 and 2019, Australia and New Zealand Disaster and emergency Management Conference (ANZDMC) 2019, and the BNHCRC Research Forum and AFAC Conference 2018 and 2019 provided important opportunities to share initial findings from these studies with end-users and in some instances led to co-authored outputs (Taylor et al., 2019). During Phase 1, the team also had the opportunity to include experimental research using EXPERTise 2.0. This presents an additional research area for the project and provides a potential tool for utilisation and impact.

In Phase 2 of the project, key milestones were:

- Collation of current flood risk communication materials and a research into practice brief providing an evaluation of these materials.
- Development of Community Service Announcements (CSAs) for flood.

Phase 2 of the project has been impacted by COVID-19, as this slowed down the national consultations and co-development work on the CSAs. This work is currently ongoing and is expected to be completed (pending final approval by state and territory jurisdictions) in the first half of 2021.



UTILISATION AND IMPACT

SUMMARY

This project provides an in-depth understanding of how the public and emergency service professionals behave around, and understand the risks of, floodwater. The translation of these findings into utilisation and impacts is an ongoing process that will continue beyond the formal end of the research.

ABC NATIONAL COMMUNITY SERVICE ANNOUNCEMENTS FOR FLOOD

Output description

The Community Service Announcements (CSAs) for flood are being co-developed with the Australian Institute for Disaster Resilience (AIDR), the ABC, and the AFAC Community Engagement Technical Group. The latter includes SES representatives from all states and territories.

The CSAs are a series of short (approximately 30 second to one minute) public messages that are pre-recorded and would be used in either rolling broadcasts around flood events, between specific warnings for local areas, or at times when heavy rain and storms are forecast, as a way to alert the public to the potential for flooding and provide advanced information about what they can do to protect themselves, to stay safe, and to take action ahead of flooding. For example, there may be a CSA for a 'major flood' that would provide information about what people in the area might expect in terms of the severity of flooding, and provide a series of messages about what to do ahead of evacuating and where to go for more information.

The CSAs can be used in a modular form and combined to create longer pieces of public messaging - up to three minutes in length. For example, there may be one for major flood (example above) which is combined with a CSA for people with animals – advising them what to do to prepare and protect their pets and livestock.

The target audience for CSAs is the general population across Australia.

The CSAs are not flood warnings. They are recorded in a variety of voices to attract listener attention, and are spoken in a friendly advisory tone. However, their content needs to be consistent with local (and/or national) warnings and optimised based on research evidence.

The ABC would like to have a set of fully agreed (i.e., national) CSAs to make broadcasting easier for their personnel across regions and to provide the public with consistent messaging. This is the ultimate aim of the CSAs co-development. However, even if a single national version of a specific CSA is not possible, it is advantageous for the ABC to have as few variants as possible (e.g., a variant that can be used in WA, NT and QLD and another that could be use in the remaining states) to simplify their roll-out and to reduce the potential for selection errors when broadcasting across regions.



Extent of use

- These would be used by the ABC across all regions and would reflect flood risk messaging agreed by all state and territory SES agencies and the BoM.

Utilisation potential

- High. These CSAs will be used across Australia by the ABC when broadcasting during flood events and at time when heavy rain and storms, with the potential to result in flooding, are forecast.

Utilisation impact

- These CSA would reach the Australian population in all areas at times when they are likely to need to increase their vigilance and require information about potential flooding events in their area. The CSAs would help advise the public on safe and appropriate behaviours that would protect them and their property in the event of flooding and direct them to official sources of information.

EXPERTISE 2.0 CUE UTILISATION

Output description

EXPERTise 2.0 is a software tool that assesses user's ability to interact with task-related cues and make decisions. It can benchmark a user's performance and allow objective evaluation of targeted interventions to improve performance. It has been used in a range of occupational fields/professions – such as aviation, train control, anaesthetics, radiology and lifeguarding ([Macquarie University, 2016](#)). In this project we have developed and trialed an EXPERTise module to assess cue utilisation when assessing floodwater risk and making decisions to enter, or not enter, floodwater in a vehicle. This tool could be used to support and evaluate the effectiveness of targeted training interventions among SES staff and volunteers.

Extent of use

- An updated version of the floodwater module for EXPERTise 2.0 is being trialed in 2020, and a final version of the floodwater module will be developed based on the findings of this trial.

Utilisation potential

- Moderate. This tool may be of interest to SES and other organisations whose employees encounter floodwater on roads due to their roles and responsibilities, e.g., essential service workers – utilities, logistics, roadside assistance.



Utilisation impact

- When released, this will provide a novel, interactive and reliable training tool that can help identify high and low cue utilisers and evaluate the impacts/transfer of training.

TRAINING AND ENGAGEMENT

Output description

Through Phase 1 of the research survey tools and findings about how people behave, perceive risks, and make decisions around floodwater were developed. The research findings can be used to inform more targeted communications and training, and the survey tools themselves can be used as an engagement tool both with communities and SES personnel. These include:

- Detailed information about scenarios where the public and SES have actually driven through floodwater. These can be used to support communications and training that resemble actual scenarios where people have entered floodwater.
- The four images used to assess willingness to drive into floodwater. Statistical analysis shows a link between willingness to drive into floodwater when assessing these images and actual reported behaviour. These images could be useful for community engagement and discussions and the research has identified 'norms' for public and SES personnel that would allow for engaging conversations.
- Surveys with SES agencies about driving into floodwater provide a baseline dataset against which the effect of new operational guidelines, organisational safety initiatives, or SOPs can be measured.

Extent of use

- To-date use of these data and tools has been focused on initial dissemination and sharing with end-users. This has resulted in two co-authored publications (Taylor et al., 2019, and Taylor et al., 2020).

Utilisation potential

- Moderate. These tools and data may be of interest to SES and similar agencies whose occupations mean they are more exposed to floodwater on roads, particularly when undertaking training or introducing new WHS guidelines. The tools and data may also be helpful to SES staff whose roles focus on community engagement and education.

Utilisation impact

- These tools and data will support more targeted training and community engagement efforts.

RESEARCH INTO PRACTICE BRIEFS

Output description

Throughout the project, a series of research into practice briefs have been developed (Figure 11). These are concise summaries of academic research and provide an accessible evidence base for end-users and practitioners to guide their work, whether that is community engagement, development of flood risk communication materials, or formulation of organisational WH&S policy.

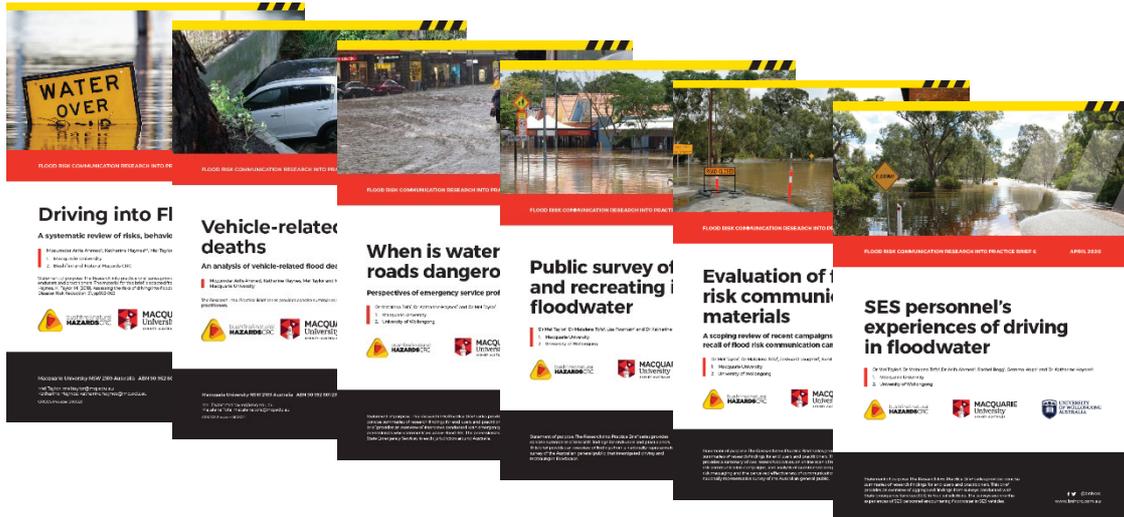


FIGURE 8. RESEARCH INTO PRACTICE BRIEFS (NO. 1-6, NO. 7 NOT SHOWN)

Extent of use

- These briefs are available on the BNHCRC website, and one has been shared through UNDRR's webpage *PreventionWeb*.

Utilisation potential

- Moderate. These provide concise and accessible summaries of the research findings to support and guide end-users, communications and safety practitioners, and other stakeholders. They can, and have, been used to inform official stakeholders, individual inquirers, and media representatives interested in the research.

Utilisation impact

- Ensuring that research findings are accessible to end-users is key to utilisation. These Research into Practice Briefs help ensure that research findings can be communicated easily and concisely and increase the potential for them to be integrated into practice.



CONCLUSION

Previous studies had established that floods in Australia were a significant, and often preventable, cause of death, and provided some useful insights to the risk perceptions and planned behaviour among the public in relation to driving and floodwater (Fitzgerald et al., 2010; Hamilton et al., 2016; Haynes et al., 2017). This project builds on this knowledge in several important ways:

- Survey data provides insights to how often, and under what circumstances, the public enters floodwater in vehicles and for recreation.
- Surveys with SES personnel provide similar insights to how often, and under what circumstances, the SES personnel enter floodwater in vehicles and draw together additional information, such as organisational safety climate.
- Mental models interviews with SES personnel and the general public provide nuanced insights to how each group understands flood risks, and supports the identification of shared understandings, vocabularies, and differences.
- The development of a driving in floodwater version of EXPERTise 2.0 allows for the assessment of the use of environmental cues when evaluating floodwater risk.

Overall, these various studies highlight the complexity and challenges in flood risk communication and key factors that need to be considered when developing communication materials. The detailed nature of the data collected also provides insights to how interventions and flood risk communication and engagement work can be targeted.

NEXT STEPS

The impact of COVID-19 has caused delays, particularly in Phase 2 of the project. The next steps in this project include:

- Finalising co-development of the *National Community Service Announcements for flood* with AIDR, ABC, and AFAC CETG.
- Finalising analysis and reporting of the driving in floodwater version of EXPERTise 2.0.
- Completing the writing up and submission of a number of academic papers and continuing with further analysis and write up of additional research papers.
- The current study has used fatalities data and survey data to understand public behaviour and experiences of entering floodwater. The opportunity to analyse flood rescue data with TAS SES is also being explored for 2021.
- The team will continue to support SES jurisdictions with use of their survey data and general project utilisation.



PUBLICATIONS LIST

PEER-REVIEWED JOURNAL ARTICLES

- 1 **Ahmed MA, Haynes K, Taylor M.** (2020) Vehicle-related flood fatalities in Australia, 2001-2017. *Journal of Flood Risk Management*. <https://doi.org/10.1111/jfr3.12616>.
- 2 **Taylor M, Wiebusch T, Beccari B, Haynes K, Ahmed A, Tofa M.** (2020). Improving workplace safety: Undertaking organisational research on driving through floodwater to inform safety policy and practice. *Australian Journal of Emergency Management*, 35 (2020).
- 3 **Sturman D, Hope G, Taylor M, Ahmed A, Wiggins M.** (2020). Floodwater on roads: Developing and validating a tool to assess drivers' cue utilisation. (submitted to BNHCRC – manuscript initially planned for AFAC 2020 conference publication or AJEM).
- 4 **Ahmed MA, Haynes, K, Tofa, M, Hope, G, Taylor, M.** (2020) 'Duty or Safety? Exploring Emergency Service Personnel's Perceptions of Risk and Decision-Making When Driving through Floodwater', *Progress in Disaster Science* 5 (2020). <https://doi.org/10.1016/j.pdisas.2020.100068>.
- 5 **Ahmed MA, Haynes, K, Taylor, M.** (2020). Vehicle-related flood fatalities in Australia, 2001–2017. *Journal of Flood Risk Management*. doi:10.1111/jfr3.12616.
- 6 **Taylor M, Haynes, K.** (2019). 'What Do We Really Mean by 'Floodwater' and Is It Ever Ok to Enter?', *Australian Journal of Emergency Management* 32 (2019), pp. 10-1.
- 7 **Taylor, M, Tofa, M, Haynes, K, McLaren, J, Readman P, Ferguson, D, Rundle, S, Rose, D.** (2019) 'Behaviour around Floodwater', challenges for floodwater safety and risk communication. *Australian Journal of Emergency Management*, 34 (2019), pp. 40-7.
- 8 Gissing, A, Opper, S, **Tofa, M, Coates, L, McAneney, J.** (2019). 'Influence of Road Characteristics on Flood Fatalities in Australia', *Environmental Hazards* 18 (2019), pp. 434-45.
- 9 Gissing, A, Van Leeuwen, J, **Tofa, M, Haynes, K.** (2018). 'Flood Levee Influences on Community Preparedness', a paradox? 33 (2018), pp. 38-43.
- 10 **Taylor, M, Haynes, K, Ahmed MA.**(2018) 'Driving into Floodwater: A Systematic Review of Risks, Behaviour and Mitigation', *International Journal of Disaster Risk Reduction* 31 (2018), pp. 10.
- 11 **Ahmed, MA, Haynes, K., Taylor, M.** (2018). Assessing the risks of driving into floodwater: A systematic review. *International Journal of Disaster Risk Reduction*. 31, pp953-963.
- 12 **Haynes, K, Tofa, M, Avci, A, Van Leeuwen, J, Coates, L.** (2018). Evacuate or shelter-in-place: exploring the behaviour of residents and businesses during rapid floods. *International Journal of Disaster Risk Reduction* 31, pp781-788.
- 13 **Haynes, K, Coates, L, van den Honert, R, Gissing, A, Bird, D, de Oliveira, FD, D'Arcy, R, Smith, C, Radford, D.** (2017). Exploring the circumstances surrounding flood fatalities in Australia—1900–2015 and the implications for policy and practice. *Environmental Science & Policy*, 76, pp.165-176.

PRESENTATIONS (ORAL)

- 1 **Taylor M.** Driving into floodwater – understanding behaviour and improving risk communication. VICSES Livestream presentation. 1 October 2020.
- 2 **Taylor M, Tofa M, Haynes K.** Making a splash! Addressing the challenges of floodwater risk communication. *Emergency Media and Public Affairs EMPA 2020*. Sydney. June 3, 2020.
- 3 **Taylor M, Wiebusch, T.** Encountering floodwater at work: How BNHCRC research is influencing SES approaches to personnel driving through floodwater. *Australasian Fire and Emergency Services Authorities Council (AFAC 2019)*, Melbourne. August 28, 2019.
- 4 **Taylor, M. Tofa M.** Behaviour around floodwater: Dilemmas for floodwater safety and risk communication. *BNHCRC Research Forum*, August 27, 2019.
- 5 **Taylor, M. Tofa M., McLaren J., Readman P., Sullivan D., Rundle S., Rose D.** Challenges for floodwater safety and risk communication. *Australia and New Zealand Disaster and Emergency Management Conference*. Gold Coast. June 12, 2019.
- 6 **Taylor M, Haynes K., Tofa M., Ahmed M.** Australia Speaks – National survey exploring experiences and attitudes towards entering floodwater. *Floodplain Management Australia Conference*. Canberra, May 15, 2019.
- 7 **Tofa, M, Haynes, K., Taylor, M.** Sheltering Experiences and Flood Risk Communication Research. Presentation to *North Coast Floodplain Forum*, Grafton, NSW, 13 March 2019.
- 8 **Taylor, M. (2018).** Leading a horse to water: What do Hendra virus and flood risk have in common? Presentation to the *Regulatory Science Network Annual Symposium*. 15 November 2018, Canberra.
- 9 **Taylor, M, Haynes K, Ahmed, A.M, Tofa, M., (2018).** Defining Floodwater – expert and public perspectives. *AFAC BNHCRC annual conference*. Perth, Australia. September 2018.
- 10 **Tofa, M, & Haynes, K.** Exploring mobilities during flooding. *NZGS/IAG Conference* July 2018, The University of Auckland, Aotearoa New Zealand.
- 11 **Tofa, M. and Haynes, K.,** 2017 Exploring the experiences of those who sheltered in place during severe flooding. *Sydney Water Panel*, Sydney.
- 12 **Tofa, M, and Haynes, K.,** 2017 Exploring the experiences of those who sheltered in place during severe flooding. *Australasian Fire and Emergency Services Authorities Council & Bushfire and Natural Hazards CRC*



- Conference, Sydney.
- 13 Morgan, M., **Haynes, K., Tofa, M.**, (2018) Exploring the experiences of those who sheltered in place during severe flooding. Floodplain Management Australia Conference, Gold Coast.
 - 14 **Ahmed M, Sato L, Haynes K, Taylor M** (2018). Calculated Risk? Understanding NSW Emergency Service Workers' Decisions to Drive into Floodwater. Floodplain Management Australia National Conference. 29 May-01 June 2018, Gold Coast, QLD, Australia.
 - 15 **Taylor M, Haynes K.** (2018). Driving into floodwater – Playing with fire! Understanding behaviour and improving risk communication. Australian Fire Awareness and Community Engagement. 17-19 May 2018, Coffs Harbour, NSW, Australia.
 - 16 **Haynes, K.** (2018). An analysis of flood fatalities in Australia. Unpacking Complexity: The Social Science of Emergencies, Disasters and Resilience.' Joint workshop with QuakeCORE, Bushfire and Natural Hazards CRC Australia, and Fire and Emergency New Zealand. Wellington, New Zealand. May 2018.
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PRESENTATIONS (POSTERS)

- 1 **Ahmed M., Haynes, K, Taylor M.** Vehicle-related flood deaths in Australia, 2001-2017. Floodplain Management Australia Conference. Canberra, May 15, 2019.
- 2 **Taylor M., Haynes K., Ahmed A., Tofa M.** Encountering floodwater at work: Factors contributing to decisions to drive into floodwater. Floodplain Management Australia Conference. Canberra, May 15, 2019.
- 3 **Ahmed, M.A., Haynes, K., Taylor, M.** (2018). Vehicle-related flood deaths in Australia, 2001-2017, AFAC Conference, Perth, 2018.
- 4 **Taylor M, Haynes K. Ahmed, M.A., Sato, L., Begg, R.,** Faulks, I., Irwin, J. (2018). Flood risk communication to reduce vehicle flood fatalities. AFAC BNHCRC annual conference. Perth, Australia. September.

CONSULTANCY REPORTS

- 1 **Fountain L, Taylor M, Tofa M, Haynes K.** (2018). Project U-Turn Evaluation. Evaluation of a community-based initiative to reduce vehicle-related flood risk. Prepared for Risk Frontiers and NSW SES. August 2018.

MEDIA PUBLICATIONS

- 1 Gorrey, M., **Haynes, K.**, (2019). Nine minutes to flee: Parramatta's catastrophic flash-flooding warning. The Sydney Morning Herald. Front Page. February 19, 2019.
- 2 **Haynes, K.**, (2017) How to stop people entering floodwater. Stories of Australian Science. (05/07/17) <http://stories.scienceinpublic.com.au/2017/floodwaters/>.

AWARDS

- 1 Mannix, L., Whittaker, J., **Haynes, K.**, 2019 EMPA Awards for Excellence in Emergency Communication. Judges choice award for the scientist in residence collaboration and the article 'Lessons of Black Saturday ignored as Australians forget, research shows. The Age. February 5, 2019'.
- 2 Tippett V., **Haynes, K.**, 2019 Excellence in Innovation Award 2019. National Cooperative Research Centre Association (NCRCA). Awarded for innovation with demonstrated impact for Australia for Bushfire and Natural Hazards CRC research on Risk Communication.

END-USER WRITTEN AND ORAL BRIEFS

- 1 Ahmed, M.A., Haynes, K., Taylor, M., Tofa, M. (2019). Vehicle-related flood deaths: An analysis of vehicle-related flood deaths in Australia 2001-2017. Flood Risk Communication Research into Practice Brief 2. June 2019.
- 2 Tofa, M., Taylor, M., Haynes, K. (2019). BNHCRC Flood Risk Communication Research Project Update. Presentation to AFAC SES CSG, 3 April 2019, Melbourne.
- 3 Ahmed, M.A., Haynes, K., Taylor, M., Tofa, M. (2018). Driving into floodwater: A systematic review of risks, behaviour, and mitigation. Flood Risk Communication Research into Practice Brief 1. September 2018.
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 - 7 Taylor M, Tofa M, Fountain L, Haynes K. (2020) Public Survey of Driving and Recreating in Floodwater. Flood risk communication Research into Practice Brief No. 4. April 2020. Bushfire and Natural Hazards CRC. <https://www.bnhcrc.com.au/resources/guide-fact-sheet/6870>.
 - 8 Tofa M, Haynes K, & Taylor, M. (2020) When is water on the roads dangerous? Perspectives of emergency service professionals. Flood risk communication Research into Practice Brief No. 3. April 2020. Bushfire and Natural Hazards CRC. <https://www.bnhcrc.com.au/resources/guide-fact-sheet/6869>.
 - 9 Taylor M, Hope G, Tofa M, Sturman D. (2020) Developing and validating a tool to assess expertise in the assessment of floodwater. Flood risk communication Research into Practice Brief No. 7. June 2020. Bushfire and Natural Hazards CRC.
 - 10 Taylor M, Tofa, M, Hope G, Haynes K. (2020) NSW SES Encountering Floodwater Survey Brief.
 - 11 Taylor M, Tofa, M, Hope G, Haynes K. (2020) VICSES Encountering Floodwater Survey Brief.
 - 12 Taylor M, Tofa, M, Hope G, Haynes K. (2020) ACTSES Encountering Floodwater Survey Brief.
 - 13 Taylor M, Tofa, M, Hope G, Haynes K. (2020) SA SES Encountering Floodwater Survey Brief.

STUDENT THESES AND OUTPUTS

- 1 Hope, G. (2017). The role of risk perception and cue utilisation in natural disasters and emergency situations: Decision-making of motorists to drive through floodwaters. Masters of Organisational Psychology Research Thesis. Macquarie University.
- 2 Najem, M. (2018). Understanding decisions to avoid driving through floodwater: Application of Protection Motivation Theory. Psychology Honours Thesis. Macquarie University. [Awarded Grade: First Class Honours].
- 3 Begg, R. (2018). Investigating NSW State Emergency Service members' willingness to drive through floodwater. Masters of Organisational Psychology Research Thesis. Macquarie University. [Awarded Grade: Distinction].
- 4 Begg, R. (2018). Investigating NSW State Emergency Service members' willingness to drive through floodwater. Poster. Voted best poster at Masters of Organisational Psychology Research Showcase. December 2018.
- 5 Humphris, B. (2018). Exploring the experiences of people who shelter during floods. Professional and Community Engagement (PACE) student report. November 2018.
- 6 Cross, R. and Musaddaq Sheikh, Z. (2018). Flood risk communication project: Systematic review of literature on children, youth and floodwater. Professional and Community Engagement (PACE) student report. November 2018.
- 7 O'Loughlin, J. (2019). Flood risk communication project: Campaign collection and analysis. Professional and Community Engagement (PACE) student report. June 2019.
- 8 Taneja, S. (2019). Public survey – driving through floodwater. Professional and Community Engagement (PACE) student report. November 2019.
- 9 Holton, N. (2019). Cue utilisation and risk propensity driving through flooded roads. Psychology Honours Thesis. Macquarie University.
- 10 Sadeli, I. (2019) Motorists' Decisions to Drive Through Floodwater – Does Cue Utilisation Contribute? Masters of Organisational Psychology Research Thesis. Macquarie University.
- 11 Ahmed, M. A. (2019). Driving into floodwater: Risk, Fatalities, and Challenges for Emergency Services Personnel. PhD. Thesis. Macquarie University.
- 12 Jones, B. (2020). The influence of emotional affect, domain specific risk taking, and cue utilisation on the appraisal of floodwater over roads. Masters of Organisational Psychology Research Thesis. Macquarie University.
- 13 Gallegos, J. Afalon, N. (2020). Analysis of flood risk campaign messaging in three Australian states. Professional and Community Engagement (PACE) student report. November 2020.



TEAM MEMBERS

PROJECT LEADERS

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RESEARCHERS

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Gemma Hope - Department of Psychology, Macquarie University

Lisa Fountain - Department of Geography and Planning, Macquarie University

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HIGHER DEGREE AND HONOURS RESEARCH STUDENTS

Several research students have undertaken projects that either complement the project by providing additional insights, or directly assist in meeting the overall project goals. These students, and their research theses details are listed in the previous section.

PACE PROGRAM STUDENT INTERNS

This project engaged with several undergraduate student interns through [Macquarie University's PACE program](#).

END-USERS

Throughout the project, the team engaged with the AFAC SES CSG.

End-user organisation	End-user representative	Extent of engagement (Describe type of engagement)
NSW SES	Josh McLaren	Project Lead End-User
AFAC SES CSG	VIC SES Kate White AFAC Amanda Leck Representatives from all SES jurisdictions as well as other stakeholders	Regular consultation and updates on project progress (membership has changed over time)
VICSES	Tim Wiebusch, Ben Beccari	



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- 2 Ahmed, M. A., Haynes, K., & Taylor, M. (2020). Vehicle-related flood fatalities in Australia, 2001–2017. *Journal of Flood Risk Management*. doi:10.1111/jfr3.12616.
- 3 Ahmed, M. A., Haynes, K., Tofa, M., Hope, G., & Taylor, M. (2020). Duty or safety? Exploring emergency service personnel's perceptions of risk and decision-making when driving through floodwater. *Progress in Disaster Science*, 5. doi:10.1016/j.pdisas.2020.100068.
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