



HOW DO WE REDUCE VEHICLE RELATED DEATHS: EXPLORING AUSTRALIAN FLOOD FATALITIES 1900-2015

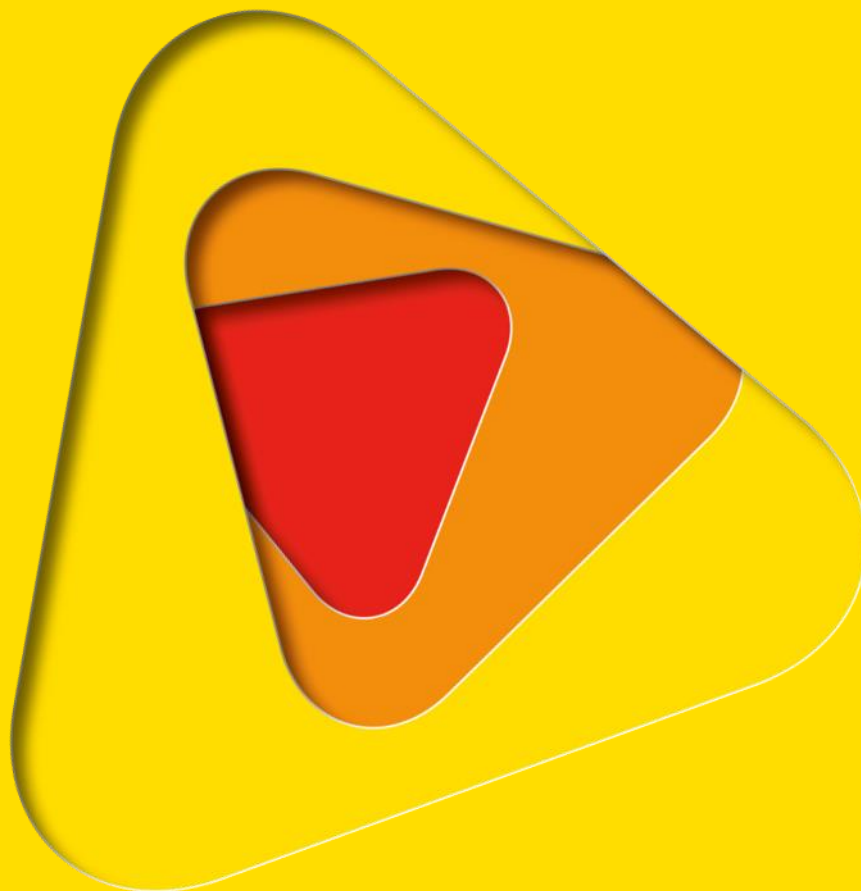
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INTRODUCTION

Floods are the second highest cause of death from natural hazard events in Australia following extreme heat (Coates et al 2014)¹. Research funded by the Bushfire and Natural Hazard CRC has so far uncovered 1874 flood fatalities between 1900-2015. This paper documents the initial findings and implications of research on flood fatalities. In particular, the growing number of fatalities associated with vehicles entering floodwaters will be discussed in relation to potential management strategies.

The analysis of flood fatalities is the first part of a wider project to examine human fatalities, injuries, rescues and building losses from natural disasters in Australia from 1900 to the present. The hazards of interest include: floods, cyclones, earthquakes, heatwaves, severe storms (gust, hail, lightning, tornado, flash flood) and bushfires. Measuring and understanding the impacts of natural hazards in terms of the toll on human life and building damage is a fundamental first step to enabling efficient and strategic risk reduction. The outcomes of this project will inform a wide-range of emergency management and government end users to advise on and update policy, practice and resource allocation.

RESEARCH PROCESS

Over the past 20 years researchers at Risk Frontiers have documented details of natural hazard events that have impacted Australia, from 1788. This information has been collected from publicly available documents, predominantly newspapers and government reports. Importantly, the information on fatalities contains, where possible, names of the deceased. This allows coronial files to be searched for further details on circumstances of the fatality. This information is crucial in order to meet the objectives of this project and conduct a comprehensive analysis for use by emergency services and government officials. The research is:

- Locating further names of the deceased
- Researching physical flood characteristics
- Adding details from coronial records.

Social and environmental factors of interest include:

- **Social** - Age, gender, occupation, preparation, risk reduction activities, knowledge / warnings received, activities / decisions leading up to and at the time of death, capacity to act, mode of transport, medical cause of death
- **Environmental** - Details of location and hazard: e.g. flood type, flood height and intensity (such as “a one in 100 event”).

The statistical analysis will provide a longitudinal analysis of social and environmental circumstances that led to the fatalities in order to examine trends over time in terms of exposure and vulnerability. Trends will be interpreted in the context of emerging issues (e.g. ageing population and population shifts) and how these issues might influence vulnerability and exposure trends in a future changed climate.

¹ The numbers of flood fatalities have been updated since this publication. Flood fatalities are now higher than those from cyclones.



PRELIMINARY RESULTS²

OVERVIEW

- Total flood fatalities between 1900 and 2015 are currently 1874
- Of these 78% are male and 20% female (there are 50 fatalities of unknown gender)
- The majority of fatalities have occurred in Queensland, (39%) followed by NSW (37%) and Victoria (11%)
- In terms of age, children and young adults are the most vulnerable group
- The majority of both men and women die as they cross a watercourse or bridge in an attempt to maintain normal everyday activities. Other reasons include work, recreation and evacuation
- Of those infants who drown, many die whilst being evacuated and / or being taken across a watercourse or bridge
- Over the last 20 years to 2014, at least 81 people have died driving through floodwater in Australia, accounting for 43% of all flood fatalities over this period. 35% of these were driving 4WD vehicles: an increase in percentage over the previous two decades.

DISCUSSION ON THE VEHICLE RELATED FATALITIES

People entering floodwaters by vehicle constitutes a major cause of flood fatalities in Australia and globally (Haynes et al 2009). If water is fast-flowing, even thirty centimetres of floodwater can wash a car off the road. In addition, drivers may be unable to see what lies beneath flooded roads, with large sections of roads often washed away, creating hazardous conditions.

The problem is possibly easier to target than other flood deaths caused by walking or playing in floodwater, as motorist deaths occur largely in defined geographical areas where floodwater and roadways intersect.

² These results are preliminary and accurate as of July 21st 2015. Numbers will change as more data is gathered. Final flood results will be available in October 2015.

MANAGEMENT STRATEGIES

Typically, Australian management strategies have relied upon education and rescue interventions as the primary management tools. Figure 1 shows the four elements required for a more holistic strategy to change this behaviour: education and awareness, regulation and incentive, structural intervention and consequence management. The rest of this paper briefly explores each of these and identifies considerations for action.

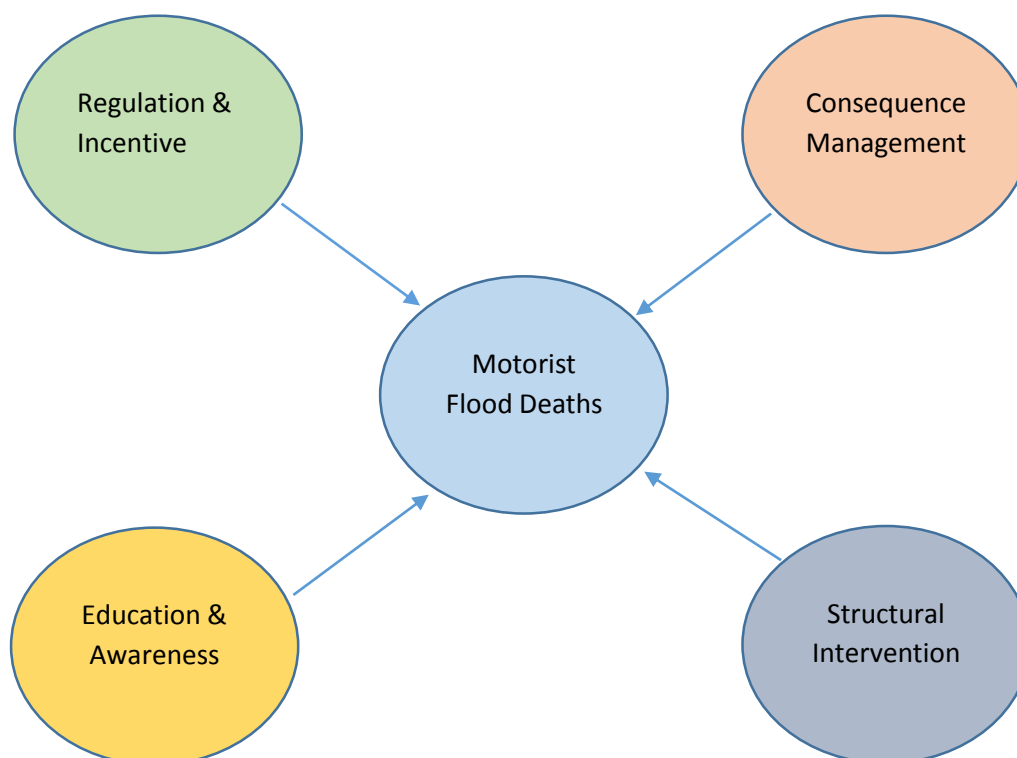


Figure 1 – Holistic Management Strategy elements

EDUCATION AND AWARENESS

Education and awareness, comprising both education campaigns and safety messages in public warnings, have been the primary strategies used to change behaviour. Some of the more prominent include:

- ‘If it’s flooded forget it’ (Queensland Government)
- ‘You don’t know what you’re getting into’(Victoria State Emergency Service)
- ‘Turn around don’t drown’ (US National Weather Service).

Typically, campaigns have consisted of signage, TV commercials, social media and media engagement. Evaluation of Australian and international campaigns has been limited.

To be successful, campaigns must utilise messages and communications channels that target key risk groups, in particular males, and involve multiple partner agencies not just the emergency services e.g. road safety groups, peak motorist groups, water safety bodies, insurance companies and schools.



During flood events, variable message signs can be utilised to reinforce key messages about the dangers of floodwaters. Current roadside markers indicate depth of flooding, but leave motorists to interpret the risk. Provision of road information is also key so motorists are aware of flooded roads and less likely to travel routes which include traversing flooded roads. Today live traffic and road closure information is more widely available using online tools, radio broadcasts and broadcasting directly into car GPS units.

Some additional methods for consideration include:

- Inclusion of educational messages in driver training materials
- Altering road side depth markers to indicate level of risk rather than just depth of floodwater
- Implementation of a nationally consistent campaign as recommended by the Queensland Floods Commission (2012)
- Enhancement of flood warning systems, particularly in flash flood environments, enabling agencies to engage with communities, pre-deploy resources and close roads in a proactive manner
- Specific location-based warning systems in high risk locations. These may include lights and sirens, or locally based broadcasts through car radio systems.

REGULATION AND INCENTIVE

Regulation is an instrument frequently used to change behaviour: for example in enforcing speed limits and reducing the prevalence of smoking. Regulation, however, has not been used across Australia as a key strategy in stopping motorists from driving through floodwater. Queensland Police have utilised the enforcement of driving laws during flood episodes to change behaviour: drivers have been convicted of careless driving, resulting in fines and license disqualification. In 2012 a Queensland man was found guilty of manslaughter and jailed for driving into a flood. His action had caused a passenger's death.

In a similar vein, motorists who remove temporary barriers to allow their vehicle to pass could be prosecuted. In addition, a series of mobile cameras similar to speed cameras could be positioned at high-risk flooded roads to assist in enforcement.

The enforcement of regulation does require some discretion, however: for example, in the event of circumstances where motorists have travelled through floodwater due to emergency circumstances such as evacuation.

Incentives should also be considered and may include:

- Motorists requiring rescue being required to pay for the cost where behaviour is deemed reckless
- Insurance companies not being obliged to pay claims for vehicles damaged as a consequence of reckless driving through floodwater.



STRUCTURAL INTERVENTION

The erection of barricades and signage aims to physically prevent motorists from entering floodwater. However, due to the portable nature of barricades, motorists are able to move or drive around them. Often, flooding may occur before authorities can establish barriers.

To enhance the effectiveness of barriers we propose the following:

- Manning of barricades in high risk areas with personnel from emergency services or road authorities
- Establishment of automatic gates in high risk areas activated remotely or when triggered by a flood warning system.

Road design in flood-prone areas could have an important influence on survival outcomes of motorists once their vehicle becomes buoyant and should be an area of further research. The following road characteristics may influence the level of risk posed:

- Presence of roadside barriers to prevent vehicles being swept off
- Height of the road above surrounding terrain, determining the depth of floodwater a vehicle may be swept into
- Presence of vegetation as a natural barrier to prevent a vehicle being swept downstream
- Presence of road lighting to illuminate dangers at night.

If these factors were proved to have a significant impact, their consideration in road design and in prioritising emergency service resources could assist in reducing the death toll.

Vehicle design has proved to be a key factor in reducing the overall road death toll, with innovations such as seat belts and airbags becoming commonplace. Future innovations may be possible to reduce flood deaths through the production of autonomous vehicles programmed to avoid flooded roads.

CONSEQUENCE MANAGEMENT

Flood rescue is the primary consequence management strategy. Emergency services have long-standing flood rescue capabilities and significant investment has occurred recently in swift-water rescue capabilities. There is much still to learn about the overall influence of flood rescue in reducing the death toll of motorists. For example, do most flood fatalities occur before rescue resources arrive or bystanders can act? Do they occur after rescue resources arrive, indicating the overall ineffectiveness of the intervention? Further work on the detailed analysis of the most recent fatalities is needed to answer these questions. However, no matter what the answers are, it must be concluded from the death toll that preventative actions alongside rescue must be considered.



KEY CHALLENGES AND NEXT STEPS

The overall key challenge for policy makers in developing a holistic strategy is the lack of evidence regarding the effectiveness of the interventions outlined in this article. Evaluation of existing and potential new measures is critical to assess their influence on behaviour.

It must not be expected that the death toll can be reduced to zero, but ambitious targets need to be set and new holistic approaches considered to reduce the incidence of motorists travelling through floodwater.

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