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# Flash flood fatalities in New South Wales, Victoria, Australian Capital Territory and South East Queensland from 1 January 2000 to 30 June 2017

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Cover: Lismore CBD is seen flooded after the Wilson River breached its banks early Friday, March 31, 2017. Photo: Dave Hunt (CC-BY-NC)

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# EXECUTIVE SUMMARY

This report analyses the circumstances surrounding fatalities resulting from flash flood events in New South Wales (NSW) from 1 January 2000 to 30 June 2017, and also from Victoria (Vic), the Australian Capital Territory (ACT) and South-east Queensland (SE Qld) in order to inform emergency management policy. The foundation for this work is Risk Frontiers' natural hazards database *PerilAUS*, and the National Coronial Information Service. At least 130 flash flood fatalities have occurred in NSW, Vic, ACT and SE Qld from 1 January 2000 to 30 June 2017. Some of the more salient results found were that:

## Numbers and death rates

- raw numbers of annual flash flood deaths are not decreasing
- the NSW death rate shows a constant trend from 2000-2017, while male death rates trend upwards and female deaths downwards

## Gender and age

- males represent 66% of flash flood fatalities
- there are increasingly more male than female deaths occurring
- age groups most at risk are 10-19 then 60-69 and 70-79
- males in the 10-19 age group are dramatically over-represented
- a large increase is seen in deaths amongst the 60-69, 70-79 and 40-49 age groups over time

## Location and severity

- most fatalities occurred in the Brisbane River Drainage Basin
- Pine, Hawkesbury and Hunter river basins had the next most fatalities
- most deaths have occurred within a few drainage basins; there is also a wide spread of deaths across the areas studied
- most deaths (44%) have occurred in floods of a minor to moderate severity, correlating with the numbers of events of that severity

## Cause of death

- most fatalities were caused by drowning or a mix of drowning/ injury
- isolation due to floodwaters can be a contributing factor in fatalities

## Warnings, awareness, visibility

- despite clear signals of rain/ flood hazard and warnings, especially in the case where people are in the vicinity of watercourses, some people still make poor decisions in the case of flash floods, such as attempting to drive across
- most (60%) decedents driving a vehicle through floodwaters were killed during darkness
- 73% of those who died while attempting to cross floodwaters did so within 20km of their home, and 53% within 2km of home

## Activity prior to death

- 54% were attempting to cross a stream, creek or other watercourse: 67% of those male

- 9% of fatalities were in/ near a stormwater drain, the majority males and half of those aged 10-19: fewer such deaths have occurred in the more recent time period
- 8% of fatalities were engaged in a recreational activity in floodwater: fewer have occurred in the more recent time period

## Type of Transport

- 52% of decedents had driven through or up to floodwaters
- the majority of drivers and passengers were males
- the most common age groups amongst vehicle-related deaths were 60-69 and 70-79
- 25% of decedents were on foot and fewer of these deaths occurred in the more recent time period

## Flash flood casualties who died in their home

- all 20 individuals who died in their home did so during 2009-2017 and in severe or record events where three or more persons died
- there were equal numbers of males and females
- most (70% of) decedents were aged 50-89

## Reason behind action prior to death

- a "business as usual" attitude persists: in the majority of cases the decedent, having started out *en route* somewhere, persisted, despite floodwaters
- most deaths were amongst males, most *en route* home and most from recreation or non- essential shopping
- recreation was also a common activity amongst decedents: mainly males aged 10-19
- equal proportions of males and females were involved in the third most common activity: being in/ near homes

## Multiple-fatality events

- Half of the flash flood fatalities were single-fatality events

## Severity of event versus activity

- Most deaths have occurred in severe/ record flood events amongst those who were:
  - in or on a house or structure – 100%
  - attempting to evacuate (from home or work, or attempting a vertical evacuation at home) – 44% (with the remainder divided equally amongst major and low-moderate floods)
  - taken by surprise, with no attempt at/ very late evacuation – 100%
- Most deaths have occurred in low-moderate flood events amongst those who were:
  - engaged in an activity in/ near stormwater drain – 81%
  - recreating – 75%
  - attempting to cross a causeway/ watercourse – 59%

# INTRODUCTION

In terms of lives lost, floods are second only to heatwaves (Coates, 1996; Coates *et al* 2014), and are one of the top three natural hazards in terms of cost and damage caused, disrupting the functioning of businesses and communities due to building and infrastructure damage. In terms of reducing human casualties, flash floods pose a unique challenge to emergency responders and emergency management. Consideration must be given to the efficacy of public education campaigns and warnings, the relative risks occupants face inside and outside the dwelling and the behaviour of individuals during flood events.

The current report builds on that carried out by Risk Frontiers for the New South Wales State Emergency Service [Haynes *et al*, 2009], which examined the fatality and injury record for Australian flash flood events from 1950 to 2008. It also continues the work done for the floods component of the Bushfire and Natural Hazards Co-operative Research Centre (BNHCRC) project, "*An analysis of human fatalities and building losses from natural disasters in Australia*" [see Haynes *et al*, 2016]. The current research focuses on the circumstances surrounding fatalities resulting from flash flood events in New South Wales (NSW) from 1 January 2000 to 30 June 2017. To enable comparisons to be made, a few other jurisdictions were examined. The aim is to identify those most at risk and any trends in recent flash flood events in order to inform policy development by the NSW SES.

# BACKGROUND

Flash floods occur as a result of intense bursts of rainfall: they are typically characterised by short warning times and high velocity flows that rise and fall rapidly. This type of flooding poses the greatest threat to life as people can be very suddenly swept away. The Bureau of Meteorology defines a flash flood as that occurring "within about six hours of rain, usually the result of intense local rain and characterised by rapid rises in water-levels" [BoM, 2017].

Research into which groups of the population are most at risk from flash floods has improved over the last decade but is still sparse. In Australia, Risk Frontiers have developed a database of Australian flood impacts – as well as impacts from other natural hazards – that explore, amongst other characteristics, trends in fatalities. Lines of investigation have concentrated on population vulnerability with respect to location and seasonality of the hazard event and the demographics and activity of the decedent at the time of death. Research papers on flood fatalities arising from these databases include those of Coates (1999), Haynes *et al* (2009) and Haynes *et al* (2016).

# METHODOLOGY

The foundation for this work is the use of Risk Frontiers' database *PerilAUS*, which contains historical data on the incidence (magnitude, affected locations, etc.) and consequences (property damage and fatalities, etc.) of natural hazard events in Australia. *PerilAUS* contains many of the names of the deceased, which has enabled the collection of more detailed information on the circumstances of many of the fatalities from coronial inquest reports.

Coronial inquests are a crucial means of verification and adding further detail to the circumstances surrounding flood fatalities by enabling a better determination of the social, demographic and environmental circumstances of the deceased. A coronial inquest may be carried out if a death is sudden or untimely, but inquests will not necessarily be carried out for every flood fatality that has occurred. The National Coronial Information Service (NCIS), an internet-based data system provided to approved researchers and containing information about every death reported to an Australian coroner since July 2000 (January 2001 for Queensland), was utilised (http://www.ncis.org.au/).

For the present study, the *PerilAUS* database was updated from 1 January 2000 to 30 June 2017 utilising Factiva – an online search tool and current international news database that provides access to sources such as newspapers, newswires, journals, industry publications, websites, company reports, television and radio transcripts and more. Quite often, these reports have good data on the circumstances surrounding flood fatalities, although occasionally the facts require further verification. Where possible, the NCIS was interrogated for matching fatalities. Usually a name as well as a location (or at least a state) and year is required as the bare minimum for searching coronial cases but, occasionally, a record was able to be located despite no name being mentioned in media reports.

The time period under examination (1 January 2000 to June 2017) covers 17.5 years and was divided into two approximately equal time periods – 2000-2008 (nine years) and 2009-2017 (eight and a half years) – in order to determine any trends in population vulnerability.

A characteristic of flash flooding is the lack of time between warning and onset of the event. It was seldom the case that records pertaining to flash flood fatalities had all the required data for that specific location to enable the flash flood definition to be conclusively applied. For example, the timing of both the rainfall and the resulting flood impact was not always known for instances of fatalities. In the absence of such complete data, we utilised what data was available from coronial reports, news media and BoM and the expertise and experience of the research team to determine whether a flood fatality was, in fact, a flash flood fatality. Any fatalities that could not be unquestionably classified as caused by flash floods were not included in the analysis.

Death rates – the number of deaths per a given number of a specific population group under consideration – were incorporated in order to gain a more accurate view of any trends in vulnerabilities to flash flood events. By incorporating population figures (from ABS census and annual population estimates data[1]), death rates per 1,000,000 population were calculated for various groups of interest. However, as flash flood totals have been considered only for New South Wales (NSW), the Australian Capital Territory (ACT), Victoria (Vic) and South East Queensland (SE Qld) rather than nationally in this study, it has not been possible to utilise death rates as extensively as in previous studies (e.g., Haynes *et al*, 2009; Haynes *et al*, 2016).

[1] population averaged from Table 1.1 at "Population Size & Growth in http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3105.0.65.0012008?OpenDocument and http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3105.0.65.0012014?OpenDocument

In order to provide some comparison, flash flood fatalities that occurred in Victoria, the Australian Capital Territory and South East Queensland (south of Bundaberg and east of Dalby) were examined, as well as those from NSW – the latter being the main focus of interest for this study. Fatalities assigned to drainage basins extending west of Dalby, Qld were included only if the point location of the fatality was east of Dalby (Figure 1).


Figure 1: Extent of SE Qld study area

The data was analysed in relation to informing the understanding of circumstances surrounding the fatalities and how this information could best be utilised to inform policy development for the preservation of life during flash flood events. In order to achieve this, a number of data fields were coded for analysis (see Appendix 1). Percentages were rounded to the nearest whole figure for ease of viewing, causing slight inaccuracies when adding tabular columns. Because of this discrepancy, tabular totals have not been entered for percentages.

# DATA LIMITATIONS

Importantly, in order to preserve anonymity of decedents, it is a requirement of the NCIS that any information gained from consultation of their records is distributed via aggregated tables only, such that no individuals can be identified, and that, if any cell should have a result of 1, 2, 3 or 4, that result be noted as "less than 5" ("<5"). This requirement has had an impact on the display of our results due to the fact that the analysis of many of our data fields dealt with relatively small numbers.

The fact that a decedent's name has been found for a flash flood fatality record in *PerilAUS* does not necessarily mean that sufficient detail will be found in coronial records to answer all the questions/ fields required. Not all flood fatalities have coronial records, and not all coronial records have detailed reports (such as the Findings or Police report) attached.

It should be noted that, due to the small number of total fatalities for each population under consideration, one or two larger events (whether freak or not) can easily skew the results towards a conclusion that may not be representative, and such skewing cannot be rectified by the application of death rates. Additionally, the fact that national figures as a whole were not dealt with had further implications in the use of death rates, as discussed above.

# RESULTS

## Fatality totals, death rates and gender

At least 130 flash flood fatalities have occurred in NSW, Vic, ACT and SE Qld from 1 January 2000 to 30 June 2017, as shown in Table 1 and Figure 2. There is a major peak of 30 deaths in 2011, due mainly to the devastating flash floods of SE Qld in January of that year. The next highest annual total is ten deaths, which was reached in the years of 2007 and 2008. There has been no discernible decrease in the number of fatalities with time.

**Table 1:** Flash flood fatalities by gender and year, 2000-June 2017 for NSW, ACT, Vic and SE Qld and NSW death rates

| Time Period | Number of fatalities | | | M:F death ratio | NSW death rates | | |
|---|---|---|---|---|---|---|---|
| | Male | Female | Total | | Male | Female | Total |
| 2000 | <5 | <5 | <5 | - | 0 | 0 | 0 |
| 2001 | 7 | <5 | 9 | 3.5 | 1.22 | 0.60 | 0.91 |
| 2002 | <5 | <5 | 5 | 4.0 | 0.61 | 0 | 0.30 |
| 2003 | <5 | <5 | <5 | 1 | 0 | 0 | 0 |
| 2004 | <5 | 5 | 8 | 0.6 | 0.60 | 0.59 | 0.59 |
| 2005 | 5 | <5 | 6 | 5.0 | 0.59 | 0 | 0.29 |
| 2006 | <5 | <5 | <5 | - | 0 | 0.29 | 0.15 |
| 2007 | 5 | 5 | 10 | 1.0 | 1.17 | 1.43 | 1.30 |
| 2008 | 6 | 4 <5 | 10 | 1.5 | 0.87 | 0.86 | 0.86 |
| 2009 | <5 | <5 | 5 | 0.7 | 0.29 | 0.28 | 0.28 |
| 2010 | <5 | <5 | 6 | 1.0 | 0 | 0.55 | 0.28 |
| 2011 | 17 | 13 | 30 | 1.3 | 0.83 | 0 | 0.41 |
| 2012 | <5 | <5 | <5 | - | 0.27 | 0 | 0.14 |
| 2013 | 8 | 0 | 8 | - | 0.81 | 0 | 0.40 |
| 2014 | <5 | <5 | <5 | 2 | 0.27 | 0.26 | 0.26 |
| 2015 | 7 | <5 | 9 | 3.5 | 0.53 | 0.26 | 0.39 |
| 2016 | 7 | <5 | 7 | - | 0.78 | 0 | 0.39 |
| 2017 | 5 | <5 | 7 | 2.5 | 1.04 | 0.51 | 0.77 |
| ***2000-08*** | *33* | *20* | *53* | *1.7* | *0.56* | *0.53* | *0.55* |
| ***2009-17*** | *53* | *24* | *77* | *2.2* | *0.42* | *0.21* | *0.31* |
| **2000-17** | **86** | **44** | **130** | **2.0** | **0.49** | **0.37** | **0.43** |

Results in the last three rows of Table 1 show an increase in flash flood deaths of 24 within the 2009-2017 period compared to the 2000-2008 period – from 53 to 77. This more recent period includes the SE Qld flash floods of January 2011.

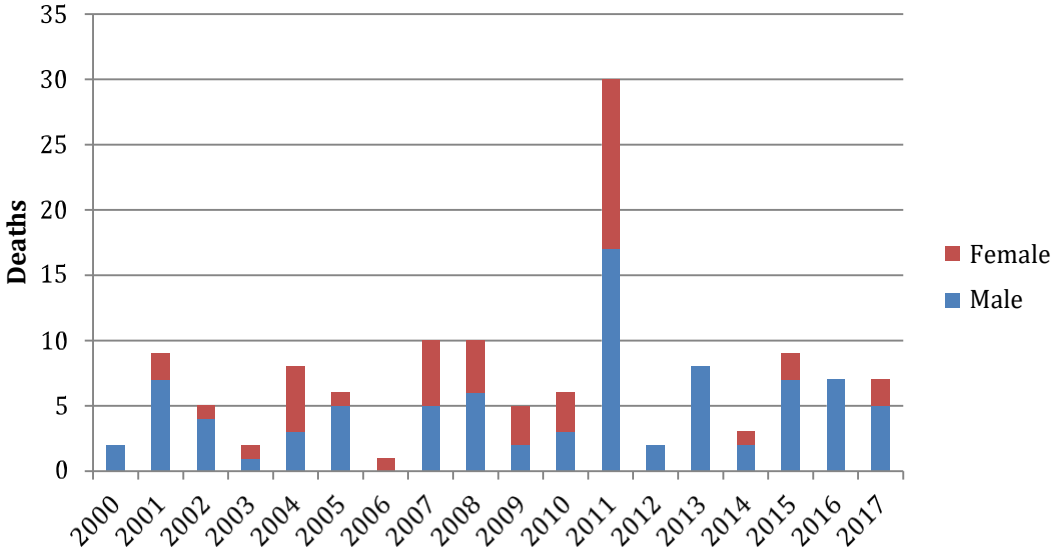


**Figure 2**: Distribution of flash flood fatalities in NSW, ACT, Vic and SE Qld, 1 January 2000 to June 2017, by gender.

Annual death rates per million population have been calculated for NSW (Table 1). Figure 3 better illustrates this, showing male, female and total flash flood death rates over the period of study. The death rate for NSW has ranged from 0 to 1.30 (in 2007) per million population over the period of study, but annual death rates do not show a discernible downward trend. Deaths for males show a slight increase over time and, for females, a slight decrease.

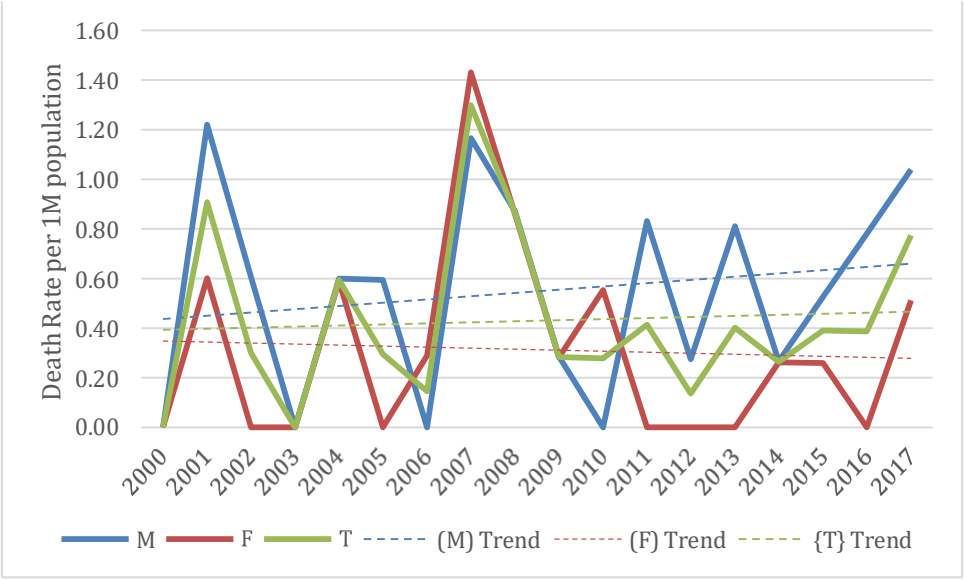


**Figure 3**: Distribution of male, female and total flash flood death rates per 1,000,000 population, 2000-2017, for NSW

## Age and gender distribution of fatalities

Of the 130 flash flood fatalities found for NSW, ACT, Vic and SE Qld, 66% were male.

Table 1 indicates that twice the amount of males as females died during the period 2000-2017. Examination of the annual record shows that the ratio of male to female deaths have fluctuated from 0.6 (in 2004) to 5.0 (in 2005). However, there is no discernible trend towards equality: that is, there are still a greater number of males being killed in flash floods than females – see Table 1 and Figure 4. Investigating the time periods 2000-2008 and 2009-2017 shows an increase in the ratio of male: female deaths from 1.7 to 2.2, indicating that, rather than approaching equality, an increasing proportion of males are being killed in flash floods.

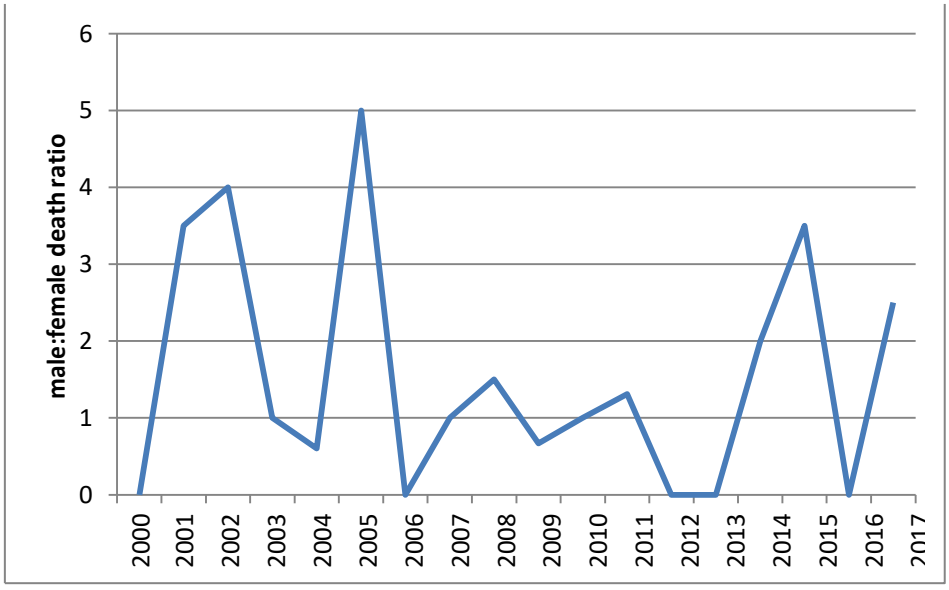


**Figure 4**: The male: female flash flood death ratio for NSW, ACT, Vic and SE Qld, 1 January 2000 to June 2017

Table 2 shows the total number and percentage of the 130 flash flood fatalities by ten-year age range. Those age groups most at risk in the period 2000-2017 have been the 10-19 and then the 60-69 and 70-79 age groups.

**Table 2**: Number of NSW, ACT, Vic and SE Qld fatalities by ten-year age range for 2000-2008, 2009-2017 and 2000-2017.

| Time Period | 2000-2008 | | 2009-2017 | | 2000-2017 | |
|---|---|---|---|---|---|---|
| **Age** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| 0 - 9 | <5 | <8 | 7 | 9 | 11 | 8.5 |
| 10 - 19 | 11 | 21 | 10 | 13 | 21 | 16.1 |
| 20 - 29 | 10 | 19 | <5 | <5 | 14 | 10.8 |
| 30 - 39 | 5 | 9 | 7 | 9 | 12 | 9.2 |
| 40 - 49 | <5 | <8 | 9 | 12 | 13 | 10.0 |
| 50 - 59 | 7 | 13 | 8 | 10 | 15 | 11.5 |
| 60 - 69 | <5 | <8 | 14 | 18 | 18 | 13.8 |
| 70- 79 | 5 | 9 | 13 | 17 | 18 | 13.8 |
| 80- 89 | <5 | <8 | 5 | 7 | 8 | 6.1 |
| **TOTAL** | **53** | | **77** | | **130** | |

The relative risk of the different age groups of decedents is illustrated in Figure 5, which also shows the gender differences amongst those groups. It can be seen that, for almost all age groups, more males have been killed in flash floods than females. In the 0-9-year age group, more females have been killed than males. Equal numbers of males and females have been killed in the 80-89 age group.

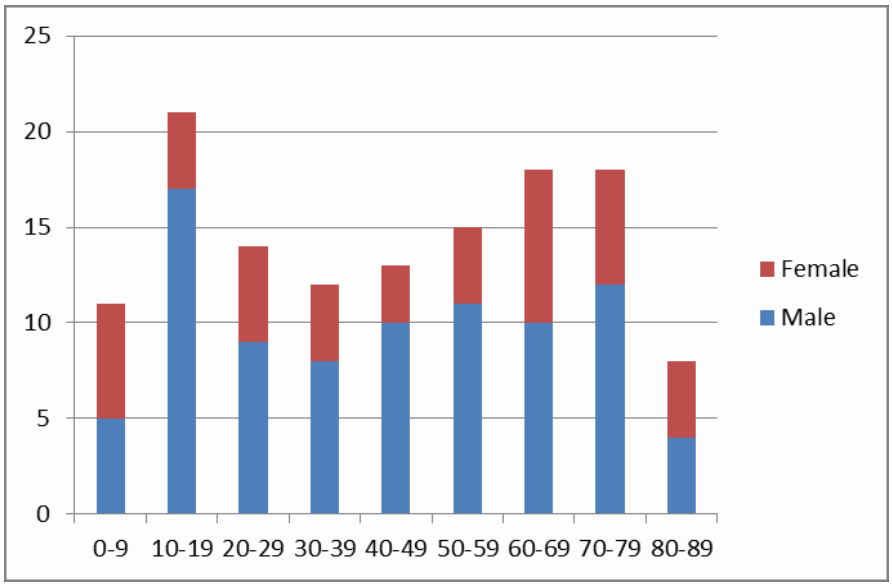


**Figure 5**: Distribution of male & female flash flood fatalities by 10-year age group, January 2000 to June 2017

## Areal distribution of fatalities

### Jurisdiction

Table 3 shows the flash flood fatalities for NSW, Vic, ACT & SE Qld, by total number and percentage. The raw figures show that 45% of the fatalities have occurred in SE Qld and 42% in NSW.

**Table 3**: Total flash flood fatalities and percentage of known fatalities by state for the time periods 2000-2008, 2009-2017 and 2000-2017.

| Time Period | 2000-2008 | | 2009-2017 | | 2000-2017 | |
|---|---|---|---|---|---|---|
| **State** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| ACT | 0 | 0 | <5 | <5 | <5 | <3 |
| NSW | 30 | 57 | 24 | 31 | 54 | 42 |
| SE QLD | 12 | 23 | 47 | 61 | 59 | 45 |
| VIC | 11 | 21 | 5 | 6 | 16 | 12 |
| **TOTAL** | **53** | | **77** | | **130** | |

Examination of deaths occurring within the two time periods shows that, in respect of raw numbers, deaths have slightly decreased in NSW within the 2009-2017 period compared to the 2000-2008 period: however, the relative percentage of deaths compared to those of the other jurisdictions examined has almost halved. Contrarily, the numbers of flash flood deaths within SE Qld has almost quadrupled, with the relative percentage of deaths compared to those of the other jurisdictions examined having increased by a factor of 2.6. This increase is due in the main to the large loss of life occasioned by the January 2011 flash floods in that area.

## Drainage basin

Figure 6 illustrates the number of deaths due to flash flooding by the drainage basins in the areas under study. The drainage basin was known for 123 of the 130 fatalities. By far the greatest number of deaths (30) has occurred within the Brisbane River Drainage Basin of Qld – 28 of these in the latter 2009-2017 period and mostly (22) during the January 2011 flash flood events. Three double fatality events occurred in March 2001, November 2008 and January 2013.

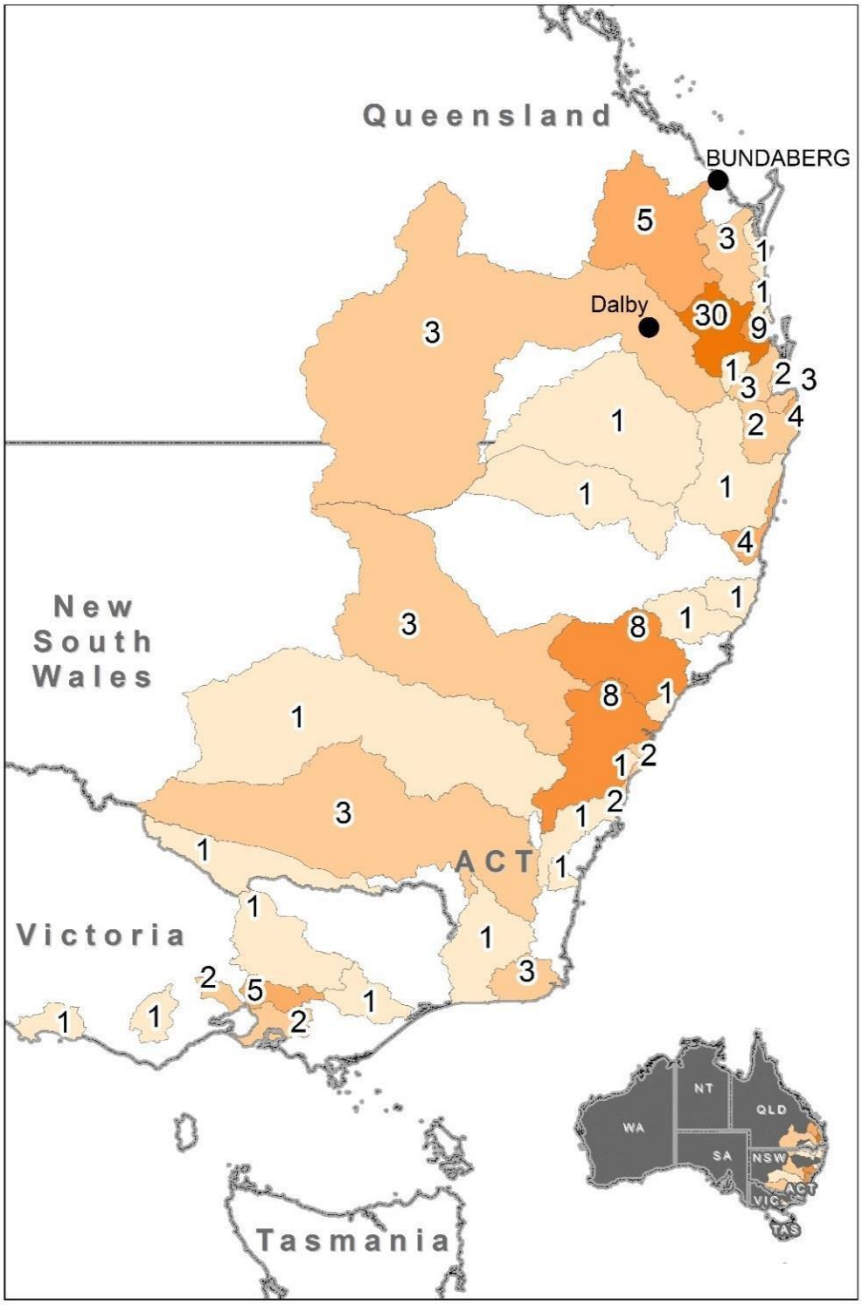


**Figure 6**: The location of flash flood fatalities in NSW, ACT, Vic and SE Qld, 2000-June 2017, within drainage basins of the area under study.

The next most risky drainage basins to live within are listed below. Again, these relatively high death totals correspond with multiple-fatality events (see also Tables 22-24):

- Pine River (Qld) – nine deaths in total, five of which occurred in May 2015
- Hawkesbury River (NSW) – eight deaths in total, five of which occurred in June 2007 and two in June 2016
- Hunter River (NSW) – six deaths in total

Drainage basins having a total of five fatalities were those of the Yarra River (Vic) and the Burnett River (NSW, Qld).

## Flood severity

Data was categorized according to flood severity (minor, major, record etc), where it was possible to determine (see Appendix 1). Table 4 sets out the numbers of flash flood fatalities against the severity of the flood. Most deaths (57; 44%) have occurred in floods of a minor to moderate severity. Major floods account for 22% of deaths, as do record/ unprecedented floods.

**Table 4**: Number of flash flood fatalities versus severity of fatal flash flood events and compared against the number of flood events of that severity, 2000-2017

| **Time period** | **Fatalities** | | **Fatal flash flood events** | |
|---|---|---|---|---|
| **Severity** | **No.** | **%** | **No.** | **%** |
| Low/ bank full | 6 | 5 | 6 | 7 |
| Minor-moderate | 57 | 44 | 47 | 55 |
| Major/ extensive/ serious | 28 | 22 | 19 | 22 |
| Severe/ disastrous | 11 | 8 | 7 | 8 |
| Record/ highest known | 28 | 22 | 6 | 7 |
| **TOTAL** | **130** | | **85** | |

## Timing of occurrence

### Month

Figure 7 illustrates the month of occurrence of flash flood fatalities. Summer months have been the riskiest overall.

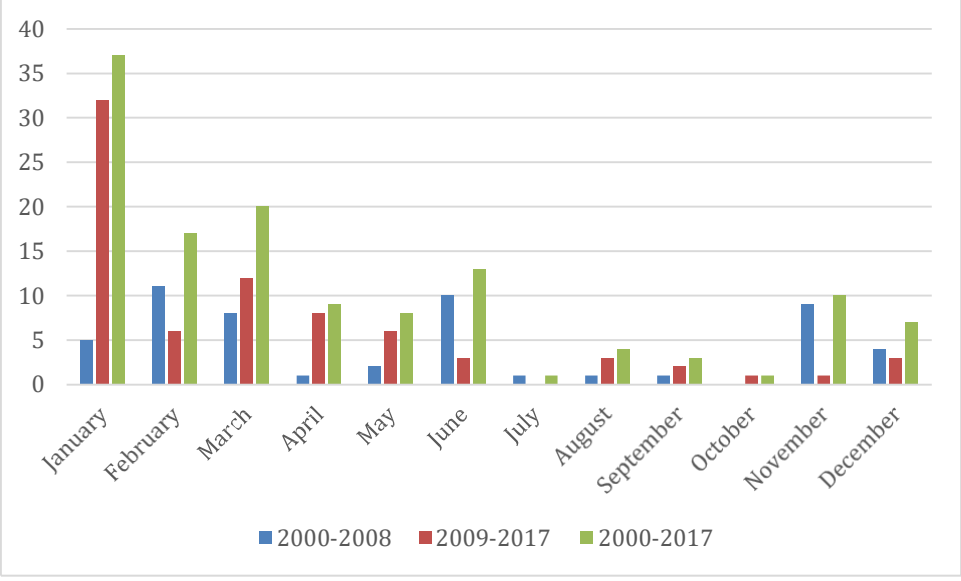


**Figure 7**: Month of fatal flash flood events for the time periods 2000-2008, 2009-2017 and 2000-2017. The x-axis is the number of deaths.

When jurisdiction is taken into account it can be seen that, although January is by far the most fatal month, this has been influenced by the Qld 2011 event (Figure 8). For NSW, March and June have been the most risky months: March in the 2009-2017 period and June in the 2000-2008 period (not shown).

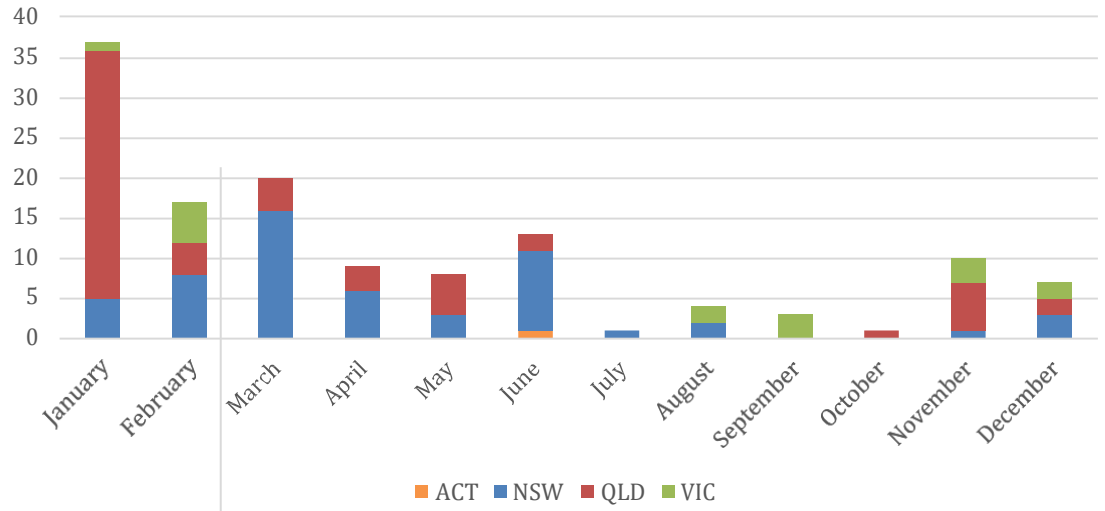


**Figure 8**: Number of deaths by month of event and jurisdiction, 1 Jan 2000- 30 Jun 2017

## Time of day

The majority of flash flood fatalities occurred in the afternoon (53 cases out of 120, or 44%); with night fatalities also prevalent (29, or 24%), as shown in Table 6.

The times of day were combined to calculate the effect of lowered visibility on flash flood fatalities: daylight vs night time hours (the last two rows of Table 7). Overall, more people (57%) have been killed during daylight hours by flash floods.

**Table 6**: Number of deaths by time of day, 2000-2008, 2009-2017 and 2000-2017

| **Time Period** | **2000-08** | | **2009-17** | | **2000-17** | |
|---|---|---|---|---|---|---|
| **Time of day** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| Early morning (night) | <5 | <9 | 6 | 8 | 8 | 7 |
| Morning | 8 | 17 | <5 | <4 | 10 | 8 |
| Noon | <5 | <9 | <5 | <4 | <5 | <4 |
| Day | <5 | <9 | <5 | <4 | <5 | <4 |
| Afternoon | 13 | 27 | 40 | 56 | 53 | 44 |
| Evening | 7 | 15 | 8 | 11 | 15 | 13 |
| Night | 15 | 31 | 14 | 19 | 29 | 24 |
| **TOTAL** | **48** | | **72** | | **120** | |
| *Day (morning, noon, day, afternoon)* | *24* | *50* | *44* | *61* | *68* | *57* |
| *Night (early morning, evening, night)* | *24* | *50* | *28* | *38* | *52* | *44* |

To observe the influence of visibility of the flood hazard on flash flood deaths, the "Time of day" was cross-correlated with "Transport" in Table 7 (see also Table 21 for more transport-related results). Information was known for 116 cases. Of the 16 known cases of decedents in a house or caravan, 11 (69%) were killed during daylight hours (all of those during the 2009-2017 period) and five (31%) in darkness (very early morning or at night). Of the 58 known cases of decedents driving some form of vehicle through floodwaters, 30 (52%) were killed during darkness (very early morning, evening, night).

**Table 7**: Flash flood fatalities when "Time of day" (day versus night) is cross-correlated with "Transport" for the time periods 2000-2008 and 2009-2017

| | Time period | 2000-2008 | | 2009-2017 | | 2000-2017 | |
|---|---|---|---|---|---|---|---|
| **Time of day** | **Transport** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| ***Day*** | | ***24*** | ***50*** | ***43*** | ***63*** | ***67*** | ***58*** |
| (morning, noon, day, afternoon) | on foot | 10 | 21 | 10 | 15 | 20 | 17 |
| | swimming | <5 | <9 | <5 | <7 | 6 | 5 |
| | carried by others | 0 | 0 | <5 | <7 | <5 | <4 |
| | in vehicle | 11 | 23 | 17 | 25 | 28 | 24 |
| | on boat (incl. makeshift craft) | 0 | 0 | <5 | <7 | <5 | <4 |
| | N/A – in house/ caravan | 0 | 0 | 11 | 16 | 11 | 9 |
| ***Night*** | | ***24*** | ***50*** | ***25*** | ***37*** | ***49*** | ***42*** |
| (early morning, evening, night) | on foot | 7 | 15 | <5 | <7 | 10 | 9 |
| | swimming | <5 | <9 | 0 | 0 | <5 | <4 |
| | in vehicle | 13 | 27 | 17 | 25 | 30 | 26 |
| | on boat (incl. makeshift craft) | <5 | <9 | 0 | 0 | <5 | <4 |
| | N/A – in house/ caravan | 0 | 0 | 5 | 7 | 5 | 4 |
| **TOTAL** | | **48** | | **68** | | **116** | |

## Circumstances of fatalities

### Cause of death

The majority (94%) of the 130 flash flood fatalities were caused by drowning or a mix of drowning/ injury, as detailed in Table 8. In the present study, a little over 2% of known fatalities were due to heart attack or overexertion. Some 3% of casualties were missing presumed dead (i.e., washed away; their bodies never located).

**Table 8**: Cause of flash flood death versus numbers and proportions of flash flood fatalities, 2000-2017

| Cause of Death | No. | % |
|---|---|---|
| Drowning | 82 | 63 |
| Drowning/injury/exposure | 40 | 31 |
| Injury - other | <5 | <3 |
| Heart attack, overexertion, shock, collapse | <5 | <3 |
| Missing presumed dead | <5 | <3 |
| **TOTAL** | **130** | |

#### Isolation as a cause of death

There was one fatality within the "Injury – other" category. The decedent had been bitten by a Stephen's banded snake but paramedics were unable to reach the property, which was cut off by floodwaters. A rescue helicopter was unable to land, and wild winds and torrential rain prevented rescuers from winching the casualty out. An inflatable rescue boat was finally able to get to the casualty, some five hours after the incident. The decedent died a week later in hospital.

Another fatality that could have been influenced by isolation due to floodwaters, within the "Heart attack, overexertion, shock, collapse" category, occurred when the decedent collapsed at home near the height of the flood in the very early hours of the morning. CPR was commenced when the decedent ceased breathing and the SES and ambulance were called for help, but flood waters delayed them for 20 minutes, despite their best efforts.

## Detailed location of fatality

Details of the location of the fatal flash flood incidents are illustrated in Table 9. The majority (95, or 73%) of decedents were near, on or in a watercourse at the time of death; 18 (14%) were in a house or other built structure and 13 (10%) were on top of a house or other built structure. Another 14 (11%) were near, on or in floodwaters not normally associated with a watercourse, e.g., in a flooded paddock, or on a road. All of those who died whilst in or on a house or structure did so during three recent events: January 2011 in SE Qld (15 fatalities), April 2015 in Dungog, NSW (three) and March 2017 in the Northern Rivers area of NSW (two).

Of the total 20 decedents who were in or in the vicinity of their house or another structure, one was in a caravan, one had just walked outside of the house and two were on top of a vehicle parked in a garage. The remaining 16 were inside their house when the flash flood event occurred and when death took place.

**Table 9**: Detailed location of fatal incident versus numbers and proportions of flash flood fatalities, for 2000-2008, 2009-2017 and 2000-2017

| | 2000-2008 | | 2009-2017 | | 2000-2017 | |
|---|---|---|---|---|---|---|
| **Detailed location** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| Outside – near/ on/ in watercourse | 52 | 98 | 43 | 55 | 95 | 73 |
| Outside – near/ on/ in floodwaters | <5 | <2 | 13 | 16 | 14 | 11 |
| In a house/ structure – destroyed | 0 | 0 | 7 | 9 | 7 | 5 |
| In a house/ structure – not destroyed | 0 | 0 | 11 | 14 | 11 | 8 |
| On a house/ structure – not destroyed | 0 | 0 | <5 | <3 | <5 | <3 |
| Other | 0 | 0 | <5 | <3 | <5 | <3 |
| **TOTAL** | **53** | | **77** | | **130** | |

## Awareness of the flood hazard

Of the 128 cases where the decedent's awareness of the flood hazard was known, 70 (55%), knew there was a flood or imminent risk of one but the depth, speed and/ or debris took them by surprise (Table 10). Of these, 71% were male. Another 33 (26%), were unaware and taken by surprise or had too little time to enact a survival strategy. Of these, 55% were male.

**Table 10**: Awareness of the flood versus numbers of flash flood fatalities, by gender, for 2000-2008, 2009-2017 and 2000-2017

| **Awareness of the flood** | **2000-2008** | | **2009-2017** | | **2000-2017** | | |
|---|---|---|---|---|---|---|---|
| | **M** | **F** | **M** | **F** | **M** | **F** | **TOT** |
| Knew there was a flood or imminent risk of a flood but did not expect to encounter it | <5 | <5 | <5 | <5 | <5 | <5 | 8 |
| Knew there was a flood or imminent risk of a flood but depth, speed, debris and/ or stormwater drain took them by surprise | 17 | 8 | 33 | 12 | 50 | 20 | 70 |
| Unaware and taken by surprise/ too little time to enact survival strategy | 7 | 6 | 11 | 9 | 18 | 15 | 33 |
| N/A – child < 11 yo | <5 | <5 | 5 | <5 | 9 | 6 | 15 |
| N/A – other | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| **TOTAL** | **32** | **20** | **51** | **24** | **83** | **44** | **128** |

## Flood warnings received

Information was known for only 53 cases out of 130 as to any warnings received by the decedents (Table 11). Of these, over half had received no warning. However, 25% had received an official warning and 13% had received a warning from friends, family or bystanders.

**Table 11**: Warnings received versus numbers and proportions of flash flood fatalities, 2000-2017

| Warnings received | Number | % |
|---|---|---|
| Had received an official warning relating to potential flood risk | 12 | 23 |
| Had received an official warning to evacuate | <5 | <8 |
| Had received a warning from friends, family or bystanders relating to potential flood risk | 6 | 11 |
| Had received a warning from friends, family or bystanders to shelter in place / vertical evacuation | <5 | <8 |
| Had received no warning | 30 | 57 |
| N/A/ Other | <5 | <8 |
| **TOTAL** | **53** | |

"Location of fatality – details" was cross-correlated with "warnings received" in terms of what warnings had been received by those who perished in their house versus those who died whist near or in a watercourse or in floodwaters that had otherwise reached an area not near a usual watercourse. Table 12 (percentages not shown) shows that of those who died near a watercourse, 14 (52%) had received some kind of warning and ten (37%) had not. Of those in or on a house or other structure, three (17%) had received some kind of warning and 15 (83%) had not.

Because we are dealing with relatively small numbers, here and below in table 13, these results should be treated with some caution.

**Table 12**: Numbers of flash flood fatalities with respect to "Warnings received" versus "Detailed location", 2000- 2017

| Warnings received | Near watercourse | Near floodwaters | In/ on house | Total |
|---|---|---|---|---|
| Official warning re flood risk | 9 | <5 | <5 | 12 |
| Official warning to evacuate | 0 | 0 | 0 | <5 |
| Warning from friends etc re flood risk | 5 | <5 | 0 | 6 |
| Warning from friends etc to shelter in place/ undertake vertical evacuation | 0 | 0 | <5 | <5 |
| Had received no warning | 10 | 5 | 15 | 30 |
| N/A/ Other | <5 | 0 | 0 | <5 |
| **TOTAL** | **27** | **7** | **18** | **53** |

The decedents' "capacity to respond" to the flash flood situation was cross-correlated with "warnings received" in terms of what effect warnings may have had on those who were capable of independent action versus those who were under the influence of drugs (prescribed or illegal) or alcohol and those who were following the decision-making of others – e.g., children following adults' decisions or passengers in a car. Table 13 shows that, of the 28 cases known for those capable of independent action, equal numbers (13, or 46%) had received some form of warning as had received no warning.

The proportions are much the same for those affected by drugs or alcohol: each with four (or 50%). Of those following the decisions of others, three (30%) had received some form of warning while seven (70%) had not.

**Table 13**: Numbers of flash flood fatalities with respect to "Warnings received" versus "Capacity to respond", 2000- 2017

| Warnings received | Capable | Drugs/ alcohol | Others' decision | Total[1] |
|---|---|---|---|---|
| Official warning re flood risk | 8 | <5 | <5 | 12/12 |
| Official warning to evacuate | <5 | | | <5/<5 |
| Warning from friends etc re flood risk | <5 | <5 | <5 | 6/6 |
| Warning from friends etc to shelter in place / vertical evacuation | | <5 | | <5/<5 |
| Had received no warning | 13 | <5 | 7 | 24/30 |
| N/A/ Other | <5 | | | <5/<5 |
| **TOTAL** | **28** | **8** | **10** | **46/53** |

[1] This column totals all those who had received that type of warning: the first figure is the total in the current table; the second figure includes the totals of the five other "Capacity" fields not shown here

## Visible signs of the flood hazard

Of the 118 cases where information was known, the vast majority of decedents (72, or 91.5%) had observed obvious signs of floodwater and/ or rain (data not shown).

## Familiarity with site of fatality

Familiarity with the site of the fatal incident was investigated for those decedents who drove or walked through/ into floodwaters. Of these 71 cases, 70 contained data on the location of the fatal event and the home address of the decedent. The distance between home and the event site can generally be taken as one measure of familiarity with a place. It can be argued that some persons living close to the location where the fatal incident occurred may have been newly arrived to the area; it can also be argued that some persons living distant from that location may drive that way to work five days a week and thus be familiar with it. Table 14 should therefore be taken as an approximation. It shows that most of those killed whilst driving or walking through a flooded causeway or similar lived close to it: 73% within 20km of the crossing (with a fairly similar proportion of males and females); 66% within 10km (70% of males; 57% of females) and 53% within 2km (57% of males; 43% of females).

**Table 14**: Number and proportion of fatalities amongst those who drove/ walked through/ into floodwater in regard to how far the fatal event occurred from the decedent's home address, by gender

| Km from fatal event to home address | Males | | Females | | Total | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| 0-2 | 27 | 57 | 10 | 43 | 37 | 53 |
| 2-5 | <5 | 6 | <5 | 13 | 6 | 9 |
| 5-10 | <5 | 6 | 0 | 0 | <5 | <5 |
| 10-20 | <5 | <5 | <5 | 13 | 5 | 7 |
| 20-50 | <5 | <5 | <5 | <5 | <5 | <5 |
| 50-100 | 0 | 0 | <5 | 9 | <5 | <5 |
| >100 | 11 | 23 | <5 | 17 | 15 | 21 |
| **TOTAL[1]** | **47** | | **23** | | **70** | |

## Activity prior to death

Details of the activity of flash flood victims prior to the time of death are available for 129 of the 130 total fatalities, as illustrated in Table 15 (percentages not shown). Of these, 70, or 54%, were attempting to cross a stream, creek or other watercourse by wading, swimming or driving. Almost 19% were in an area not near a usual watercourse (e.g., in their house).

Approximately equal numbers (7-9%) of fatalities were in or near a stormwater drain, engaged in an activity in the floodwater (e.g., swimming or joyride), or attempting to cross the floodwaters not near a usual watercourse (as opposed to crossing a permanent watercourse) – i.e., on a road or in town. Every instance of the latter activity occurred during the more recent time period of 2009-2017. However, the more recent time period has seen fewer deaths due to activities close to stormwater drains, and slightly fewer due to activities within the floodwaters.

**Table 15**: "Activity prior to death" versus numbers of flash flood fatalities, by gender, for 2000-2008, 2009-2017 and 2000-2017

| **Time period** | **2000-2008** | | | **2009-2017** | | | **2000-2017** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Activity prior to death** | **M** | **F** | **Tot** | **M** | **F** | **Tot** | **M** | **F** | **Tot** |
| Attempting to cross bridge/ causeway/ culvert/ ford /road | 20 | 15 | 35 | 27 | 8 | 35 | 47 | 23 | 70 |
| Attempting to cross floodwaters [paddock; town; on road] | <5 | <5 | <5 | 6 | <5 | 9 | 6 | <5 | 9 |
| Engaged in an activity near the water (bank/ bridge) | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | 5 |
| Engaged in an activity in/ near a stormwater drain | 5 | <5 | 7 | <5 | <5 | <5 | 9 | <5 | 11 |
| Engaged in an activity in the water (swimming, joyride etc) | <5 | <5 | 6 | <5 | <5 | <5 | 6 | <5 | 10 |
| Engaged in activity not near usual watercourse (e.g., in house, driving through town etc) | <5 | <5 | <5 | 12 | 11 | 23 | 13 | 11 | 24 |
| **TOTAL** | **33** | **20** | **53** | **52** | **24** | **76** | **85** | **44** | **129** |

Of the 70 fatalities attempting to cross a stream, creek or other watercourse by wading, swimming or driving, two-thirds (47) were male.

Of the 129 known fatalities, 11% were engaged in an activity in or near a stormwater drain and the majority of these (82%) were males: this higher percentage is a constant feature across both time periods.

Another 24% of decedents were engaged in an activity not near a usual watercourse – for example, in a house, or driving through town. There is a more even distribution of male and female fatalities in this category, with just one more male than female killed in each of the time periods.

## Transport

In terms of transport at the time of death, most (35%) of the 130 flash flood fatalities were inside a vehicle at the time of death, as detailed in Table 18: an additional 18% had been inside a vehicle but exited just prior to being washed away. This gives a total of 52% of those killed during flash floods associated with driving through or at least up to floodwaters (discrepancies in additions due to rounding up of percentages).

The bottom four rows of Table 18 examine vehicular deaths more closely.

Of the known fatalities, 25% were on foot, whilst 6% were swimming or wading; 12% were in a house or other shelter. All the fatalities inside a house or other shelter were in the more recent time period. Two of the decedents noted as on foot had evacuated their house (late) and had then climbed onto another structure (a vehicle, which had been parked in their garage). One decedent noted in Table 18 as "Carried by others" was also in a house.

**Table 18**: Transportation at time of death

| **Time Period** | **2000-2008** | | **2000-2017** | | | |
|---|---|---|---|---|---|---|
| **Type of transport** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| On foot | 19 | 36 | 13 | 17 | 32 | 25 |
| Swimming (incl. boogie board, inflated tyre…) | <5 | 8 | <5 | 5 | 8 | 6 |
| Carried by others | 0 | 0 | <5 | <5 | <5 | <5 |
| In vehicle | 26 | 44 | 42 | 55 | 68 | 52 |
| On vehicle: push bike | <5 | <5 | 0 | 0 | <5 | <5 |
| On boat (incl. makeshift: raft, canoe, dinghy…) | <5 | 6 | <5 | <5 | <5 | <5 |
| N/A – in house / caravan | 0 | 0 | 16 | 21 | 16 | 12 |
| **TOTAL** | **53** | | **77** | | **130** | |
| *All 4WDs*[1] | *11* | *21* | *16* | *21* | *27* | *21* |
| *All non-4WD vehicles*[2] | *15* | *28* | *26* | *34* | *41* | *32* |
| *All vehicles [decedent in vehicle]* | *15* | *28* | *30* | *39* | *45* | *35* |
| *All vehicles [decedent exited/ ing]* | *11* | *21* | *12* | *16* | *23* | *18* |

[1] not including utes not noted as 4WD

[2] including utes not noted as 4WD

Detail around whether the decedent, as driver or passenger in a vehicle driven through floodwaters, had drugs or alcohol present in their blood (from the Capacity (Primary) coding field) was examined (data not shown). Information was available for 16 of the decedents. Of these, 63% were male. There is a fairly even distribution across the age groups from 20-29 to 70-79.

Mode of transport was cross-correlated with Capacity (Primary) code 1: "Capable of independent action" to determine the age and gender of drivers of the vehicles that drove into or went too near floodwaters. Information was available for 29 cases and, of those, 21 (72% of) drivers were male. The age groups of most decedents were 60-69 and 70-79 (the vast majority of the latter group males), followed by the 30-39 and 40-49 age groups. The fifth most vulnerable age group was 80-89 (all these were males).

Transport was cross-correlated with "time of day" (day *versus* night) to determine whether the vehicle the decedent was in went into floodwaters during night time hours or not, to determine if visibility was a factor. Information on time of day was available for 57 out of a possible 68 cases amongst drivers and passengers (data not shown). Overall, the number of deaths whilst driving through or near floodwaters is evenly spread, with 30, or 53%, occurring at night.

## Flash flood casualties who died in their house

A detailed examination of those who died whilst in or on a house or structure, whether the structure was destroyed or not, was undertaken, to understand what vulnerabilities might exist (data not shown). All 20 of the fatalities that occurred in these circumstances did so during the latter time period of 2009-2017. Equal numbers of males and females died and there is a relatively even spread of ages across the 40-49 to 80-89 age groups. The majority (85%) of decedents were over the age of 39 and 70% were over the age of 49.

All deaths occurred within flash flood events of a severity classed as severe or record, and where three or more persons died. Fifteen deaths occurred within the Brisbane River drainage basin, Qld; three from Hunter River, NSW and two from Tweed River, NSW. Of the 18 in or on a house, the house was destroyed in 11 cases.

Eight decedents were capable of independent action although one was looking after a dependent. One couldn't swim and was also looking after dependents.

Six decedents were physically and/ or mentally disabled or incapable and four of those were also affected by drugs or alcohol. A total of six were affected by drugs or alcohol (including the four mentioned previously). Two were made to follow the decision making of others (i.e., children who followed an adult's decision- making or women who followed a certain action of their husband). A total of four decedents were looking after a dependent (including the two mentioned previously).

Note that some decedents had a secondary challenge with respect to capability so there is some "double counting". Also, because we are dealing with relatively small numbers here, these results should be treated with some caution.

## Reason behind action

Data on the reason behind action taken by the decedent prior to death was available for all 130 flash flood fatalities – see Table 16. The majority were *en route* to some destination (70; or 54%), with 48 (69%) of these males. In relation to age groups (not shown in Table 16), the greatest number of decedents were in the 70-79 group (mostly during the 2009-2017 period), followed by the 30-39 then 10-19 (mostly during the 2000-2008 period) groups, although numbers were fairly well dispersed across all age groups.

Of the 70 decedents that were *en route*, information as to where they were going to/ from was available for 52 cases (not shown in Table 16). Two-thirds (35) were *en route* home, mostly (18) from recreation or non-essential shopping, although four were coming home from work. An equal number (four) were *en route* to work from home, and eight were *en route* to a recreational activity or non-essential shopping.

The second most common activity was leisure: 24 (18%) of the decedents were undertaking some form of recreation, aside from travelling to or from it, mostly (ten) aged 10-19, mostly (eight) males and mostly (five) from the earlier time period. This latter result was the case across the board, with some 75% of the fatalities arising from recreational pursuits in and around floodwaters occurring during the 2000-2008 period.

The next largest group were those taken by surprise, with either no attempt at or a very late evacuation: 11 (8%) decedents died within or very close to their homes. All of these occurred within the 2009-2017 period and the ages ranged from the very young (0-9 yo) to the middle-aged and elderly (50-89 yo).

Total numbers of males and females were fairly even but there were more males amongst the 60-89 group and all of the 0-9 group were females.

The next largest group were those attempting to evacuate: nine (7% of) decedents were in this category, the vast majority (eight) attempting to evacuate either from home or vertically within their home (not shown in Table 16). Slightly more females than males were in this category.

Further data on those attempting to evacuate was available from the "Reason behind action *at time of death*" (as opposed to "… *prior to death*") field.

This second field, as explained previously, captured those people whose reason behind the actions they took changed at the immediate onset of the hazard.

In this instance, people were working, recreating or *en route*, and then attempted to evacuate. Considering both of the "Reason behind action" fields, a total of 13 people were attempting to evacuate. The characteristics of these people were investigated further. The numbers are very small and so should be taken with caution, but the majority (four out of 13, or 31%) were aged 40-49: aside from that group, fatalities were evenly spread across all age groups. In terms of capability, seven (54%) were capable of independent action, four (31%) were following the decision making of others, one was affected by drugs or alcohol and one was encumbered with clothing/ possessions etc.

**Table 16**: "Reason behind action prior to death" versus numbers of flash flood fatalities, by gender, for 2000-2008, 2009-2017 and 2000-2017

| **Time period** | **2000-2008** | | | **2009-2017** | | | **2000-2017** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Reason behind action** | **M** | **F** | **T** | **M** | **F** | **T** | **M** | **F** | **T** |
| Attempting to evacuate | 0 | <5 | <5 | <5 | 5 | 8 | <5 | 6 | 9 |
| Taken by surprise - no attempt at/ very late evacuation | 0 | 0 | 0 | 5 | 6 | 11 | 5 | 6 | 11 |
| Awaiting a planned rescue/ evacuation | 0 | 0 | 0 | <5 | 0 | <5 | <5 | 0 | <5 |
| Refused to be evacuated | 0 | 0 | 0 | <5 | <5 | <5 | <5 | <5 | <5 |
| Working | <5 | <5 | <5 | <5 | 0 | <5 | <5 | <5 | <5 |
| Recreating | 11 | 5 | 16 | 6 | <5 | 8 | 17 | 7 | 24 |
| *En route* | 20 | 13 | 33 | 28 | 9 | 37 | 48 | 22 | 70 |
| Attempting to rescue/ retrieve property/ livestock | 0 | 0 | 0 | <5 | <5 | 5 | <5 | <5 | 5 |
| **TOTAL** | **32** | **20** | **52** | **51** | **24** | **75** | **83** | **44** | **127** |

The reason behind action at time of death for those decedents who drove into floodwater was examined. In only two instances of the 69 cases known was this in an attempt to evacuate; there is one instance where an attempt was being made to rescue livestock and four where recreational activities were being undertaken. The remaining activities are basically "business as usual", as the decedent, having started out *en route* somewhere, sought to persist in that endeavour; there is one instance of the decedent working.

## Capacity to respond

The capability of the decedent to respond to the flash flood situation was available for 128 out of 130 cases and is set out in Table 17.

Most (63, or 49%) were capable of independent action. However, in 28 (22% of) cases, the decedent was affected by drugs (either prescribed or illegal) or alcohol. A fairly large proportion (17%) of decedents were constrained by the decision of another: either children following an adult's lead, or passengers in a vehicle.

A secondary "Capacity" coding scheme was utilized to capture those with a supplementary challenge – for example, those who were a passenger in a car (Capacity - Primary) but were also disabled or couldn't swim (Capacity - Secondary). There were additional challenges for 37 decedents.

Adding these figures to those of Table 17 gives 33 (25% of) cases where the decedent was affected by drugs or alcohol; 19% of decedents constrained by the decision of another; 14 or 11% disabled in some manner and 13 or 10% unfamiliar with the area. Note: any one decedent may have had more than one of the challenges to capacity mentioned.

**Table 17**: Capacity (Primary) to respond to flash flood situation

| **Capacity (Primary)** | **2000-2008** | | | **2009-2017** | | | **2000-2017** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **M** | **F** | **T** | **M** | **F** | **T** | **M** | **F** | **T** |
| Capable of independent action | 16 | 7 | 23 | 28 | 12 | 40 | 44 | 19 | 63 |
| Physically and or mentally disabled or incapable | <5 | | <5 | <5 | <5 | <5 | <5 | <5 | 5 |
| Cannot swim | | | | <5 | | <5 | <5 | 0 | <5 |
| Presence of drugs or alcohol in blood | 8 | 6 | 14 | 7 | 7 | 14 | 15 | 13 | 28 |
| Made to follow the decision making of others (i.e., children/ passengers in a vehicle). | <5 | 7 | 11 | 7 | <5 | 11 | 11 | 11 | 22 |
| A child or group of children on their own, age < 11 | <5 | | <5 | <5 | | <5 | <5 | 0 | <5 |
| Unfamiliar with the area (e.g., new resident; transiting) | <5 | | <5 | <5 | | <5 | <5 | 0 | <5 |
| Encumbered with clothing, possessions or equipment | | | | <5 | | <5 | <5 | 0 | <5 |
| Looking after dependents which affected ability to save themselves | | | | <5 | | <5 | <5 | 0 | <5 |
| **TOTAL** | **31** | **20** | **51** | **53** | **24** | **77** | **84** | **44** | **128** |

## Multiple-fatality events

Half (65) of the 130 flash flood fatalities found in this study occurred in events where just one person was killed. Another 14 (11%) were killed in double-fatality events, and 51(39%) in multiple-fatality events: that is, events where three or more people were killed. Seven events caused double fatalities and three events caused triple fatalities (see Table 19).

**Table 19**: Number of deaths and flash flood events in regard to single- versus multiple-fatality flood events

| **Deaths** | **No. Events** | **Total Deaths** | **% of total** |
|---|---|---|---|
| 1 | 65 | 65 | 50 |
| 2 | 7 | 14 | 11 |
| 3 | 3 | 9 | 7 |
| 4 | 2 | 8 | 6 |
| 5 | 1 | 5 | 4 |
| 6-10 | 1 | 8 | 6 |
| >10 | 1 | 26 | 20 |
| **TOTAL** | **80** | **130** | |

Two events caused four flash flood fatalities, both due to rains from ex-tropical cyclones: ex-TC Oswald, in January 2013 (four deaths in Qld), and ex-TC Debbie, in March 2017 (one death in Qld; three in NSW). [Other fatalities were caused by some of these events, by causal factors other than flash flooding: e.g., flooding (non-flash), gust and rain-related factors.] These results are summarized in Table 20.

Five fatalities were caused by an East Coast Low (ECL) in Caboolture, in 2015. Eight flash flood fatalities (as well as other non-flash flood fatalities) were caused by the June 2007 *Pasha Bulker* storm that occurred in the Sydney and Hunter region of NSW.

By far the largest multiple-fatality event was due to a series of severe storms in combination with monsoon troughs/ TC Tasha, following months of extensive and heavy rainfall, that occurred in SE Qld during January 2011: there were 26 flash flood fatalities in the area, including 19 in the Lockyer Valley, two in Rockhampton and two in Brisbane.

**Table 20**: Multiple-fatality events by jurisdiction and causal event, 2000-2017

| Event name | State/s | Causal event/s |
|---|---|---|
| Brisbane/ SE Qld Coast floods, March 2001 | NSW | storm (fierce) |
| Tamboon Inlet flood, February 2002 | Vic | breach of inlet to sea |
| Murwillumbah flash floods, March 2004 | NSW | tropical low |
| Biggenden floods, November 2004 | SE Qld | storm (heavy) |
| Melbourne flash floods, November 2004 | Vic | storm |
| Northern NSW flood, December 2004 | NSW | storm |
| Guanaba Creek flood, June 2005 | SE Qld | upper trough system + ECL |
| Hawkesbury/ Hunter flood, June 2007 | NSW | *Pasha Bulker* storm |
| Southeast Sydney flash flood, January 2008 | NSW | storm |
| SE Qld flash floods, January 2011 | SE Qld | extensive heavy rainfall then storm/ monsoon trough |
| Ex-TC Oswald floods, January 2013 | SE Qld | Ex-TC Oswald |
| Sydney, Hunter severe storms April 2015 | NSW | ECL |
| Caboolture flood, May 2015 | SE Qld | ECL |
| NSW/ACT ECL floods, June 2016 | NSW, ACT | ECL |
| Ex-TC Debbie flash floods, March 2017 | NSW, SE Qld | Ex-TC Debbie |

The five most fatal flash flood events covered in this study were examined more closely.

The 26 flash flood fatalities of the SE Qld January 2011 floods occurred across a wide area: Cherbourg, Grantham, Helidon, Murphys Creek, Postmans Ridge, Spring Bluff, Toowoomba, Dalby, Karrabin, Minden and Willawong (Durack). Half (13) of the deaths occurred in houses, where either the house was washed away or the decedent was swept out of the house. Nine of these occurred in Grantham, where a sudden wave of floodwater came through the town: a similar situation occurred in two other locations, causing two deaths in each. Four deaths occurred through the decedents attempting to evacuate via vehicle – all of them passengers and three of them in Grantham. Two other deaths occurred through an attempt to evacuate a home suddenly flooded by a wave of water by climbing onto a parked vehicle, washed away. Three deaths occurred through driving along flooded roads: two separate incidents where the driver was returning home and one where the driver was buying food. One decedent attempted to walk/ swim across a flooded watercourse *en route* to work, despite "road closed" signs and barriers being in place, and one jumped from a bridge into floodwaters (for recreation) despite warnings.

All eight flash flood fatalities caused by the June 2007 *Pasha Bulker* storm in the Greater Hunter area of NSW were associated with vehicles driving through or near floodwaters: a family of five perished when their car was driven over a collapsed section of road into a creek; a couple drowned when their 4WD was washed off a bridge *en route* from home to shops; and a passenger *en route* home from work was swept down a stormwater drain after exiting the car.

All five flash flood fatalities caused by the ECL, 2015, in Qld were associated with vehicles driving through or near floodwaters in Morayfield/ Burpengary: a family of three perished when their car was swept off a flooded bridge and, moments later, the driver of a 4WD ute drowned when the vehicle was swept off in exactly the same place (the two children also in the car were saved). All decedents were moments from their home. At another location, a car driver was swept off a flooded bridge: the driver's partner was saved.

All of the four flash flood fatalities caused by the ex-TC Oswald rains of January 2013 were associated with vehicles driving through or near floodwaters: two overseas contract farm workers *en route* to work in separate cars around 5am; one motorbike rider swept off a bridge around 9pm by a wave of floodwater caused by a passing semi-trailer and one wheelchair-bound passenger as a van approached a bridge at around 3am.

All four flash flood fatalities caused by the ex-TC Debbie rains of March 2017 occurred during the night. Three were in the Northern Rivers area of NSW: one was swept away whilst attempting to reach home on foot; one collapsed whilst trying to protect a home from floodwaters and one had refused to heed a warning to evacuate a caravan, which was swept off its base. A further fatality occurred near Gympie, Qld, when the decedent attempted to visit a friend's place on foot.

Two other recent multiple fatality events are mentioned here. At approximately 5pm on 5 June 2016 three males were swept away by floodwaters in separate incidents whilst trying to drive across causeways: two in NSW and one in the ACT. In at least one instance the road had been partially blocked by barriers. The vehicles involved included two utes. In the second incident, in the early hours of 20 April 2015, three people drowned in their homes in Dungog: two males aged 70-79 and one female aged 60-69. The female, a former SES member, was aware of the flood and had in fact warned others but did not want to leave her home without her pet dog.

## Multiple- versus Single-/ Double- fatality event actions

The activity of most of the decedents who died in multiple-fatality flash flood events has been described. The data was next analysed to see if there was any difference in what people were doing at the time of or just before death in relation to whether they died during a multiple-fatality as opposed to a single- or double-fatality event. The fields in Table 21 have been compiled from a few different coding tables – activity prior to death, location of fatality (details), and reason behind action prior to/ at time of death – and so the data from any one decedent could appear in more than one of the table rows.

Of those who were attempting to cross a causeway/ watercourse/ crossing etc, most (69%) died in a single- or double-fatality event and so did most (63%) of those undertaking this activity via vehicle (either in or exiting it).

The vast majority of people who died whilst engaged in an activity in/ near a stormwater drain (100%) or in water (attempting rescue or for a joyride) (90%) did so during a single- or double-fatality event, as did those recreating (96%) [please note that the data from most of the same decedents will appear in more than one of these categories].

**Table 21**: Numbers and proportions of fatalities by action/ reason of decedent against the deadliness of the flood event, 2000-2017

| **Deadliness of flash flood event** | **>3 killed** | | **1-2 killed** | | **Total** |
|---|---|---|---|---|---|
| **Action/ Reason of decedent** | **No.** | **%** | **No.** | **%** | |
| Attempting to cross a causeway/ watercourse etc | 22 | *31* | 48 | *69* | **70** |
| Attempting to cross a causeway etc - via vehicle | 21 | *37* | 36 | *63* | **57** |
| Engaged in an activity in/ near stormwater drain | 0 | *0* | 11 | *100* | **11** |
| Engaged in an activity in water (rescue, joyride etc) | <5 | *50* | 9 | *90* | **10** |
| In/ on house or structure | 20 | *100* | 0 | *0* | **20** |
| Attempting to evacuate (from home; work; vertically) | 8 | *89* | <5 | *11* | **9** |
| Taken by surprise: no attempt at/ very late evacuation | 11 | *100* | 0 | *0* | **11** |
| Recreating | <5 | *4* | 23 | *96* | **24** |
| Working | 0 | *0* | <5 | *100* | **<5** |
| *En route* to/ from recreation/ non-essential shopping | 5 | *19* | 21 | *81* | **26** |
| *En route* to/ from work | 7 | *88* | <5 | *12* | **8** |
| *En route* to/ from other destination | 12 | *67* | 6 | *33* | **18** |
| *En route* to/ from unknown | <5 | *21* | 15 | *79* | **19** |
| ***Total number killed in flash floods of this nature***[1] | ***51*** | ***39*** | ***79*** | ***61*** | ***130*** |

[1] This row is not the sum of the preceding rows: the fields comprising them were drawn from more than one coding table; thus data from any one decedent could appear more than once

All 20 people who died whilst in, near or on their house (or another structure) did so in multiple-fatality events, as did all 11 taken by surprise (with no attempt at or very late evacuation) and most (89% of) people who died whilst attempting to evacuate.

All four people who died whilst working did so in single- or double-fatality events.

The 43 (61% of) people who died whilst *en route* to any destination (i.e., carrying out business as usual) did so in multiple- (>3-) fatality events. Looking in more detail at those *en route*, of those who were *en route* to or from work, seven (88% of) people died during multiple-fatality events: however, 21 (81% of) people who were *en route* to or from recreation, visiting or non-essential shopping died during single- or double-fatality events.

## Severity of flood event versus actions

Similar to the above, the data was analysed to see if there was any difference in what people were doing at the time of or just before death in relation to the severity of the flash flood event.

The fields in Table 22 have been compiled from a few different coding tables – activity prior to death, location of fatality (details), and reason behind action prior to/ at time of death – and so the data from any one decedent could appear in more than one of the table rows.

The severity code Low/Bank full was combined with Minor/Moderate to give Low-Mod; the code of Major/ Extensive/ Serious was renamed as Major and the codes of Severe/ Disastrous and Record/ Highest known/ Unprecedented were combined to give Severe/ Record.

**Table 22**: Numbers and proportions of fatalities by action/ reason of decedent against the severity of the flood event, 2000-2017

| **Flood severity** | **Low-Mod** | | **Major** | | **Severe/ Record** | | **Total** |
|---|---|---|---|---|---|---|---|
| **Action/ Reason of decedent** | **No.** | **%** | **No.** | **%** | **No.** | **%** | |
| Attempting to cross a causeway/ watercourse etc | 41 | *59* | 20 | *29* | 9 | *13* | **70** |
| Attempting to cross a causeway etc - via vehicle | 33 | *58* | 17 | *30* | 7 | *12* | **57** |
| Engaged in an activity in/ near stormwater drain | 9 | *81* | <5 | *19* | 0 | *0* | **11** |
| Engaged in an activity in water (rescue, joyride etc) | 6 | *60* | <5 | *30* | <5 | *10* | **10** |
| In/ on house or structure | 0 | *0* | 0 | *0* | 20 | *100* | **20** |
| Attempting to evacuate (from home; work; vertically) | 5 | *28* | 5 | *28* | 8 | *44* | **18** |
| Taken by surprise: no attempt at/ very late evacuation | 0 | *0* | 0 | *0* | 11 | *100* | **11** |
| Recreating | 19 | *79* | <5 | *17* | <5 | *4* | **24** |
| Working | <5 | *75* | <5 | *25* | 0 | *0* | **<5** |
| *En route* to/ from recreation/ non-essential shopping | 17 | *65* | <5 | *15* | 5 | *19* | **26** |
| *En route* to/ from work | <5 | *25* | <5 | *38* | <5 | *38* | **8** |
| *En route* to/ from other destination | 8 | *44* | 5 | *28* | 5 | *28* | **18** |
| *En route* to/ from unknown | 9 | *47* | 9 | *47* | <5 | *5* | **19** |
| Attempting to rescue people | <5 | *20* | 0 | *0* | <5 | *80* | **5** |
| Attempting to rescue pets, livestock, property | <5 | *29* | <5 | *14* | <5 | *57* | **7** |
| **Total number killed in flash floods of this severity**[1] | **63** | ***48*** | **28** | ***22*** | **39** | ***30*** | **130** |
| ***Total number of flash flood events of this severity*** | ***53*** | ***65*** | ***17*** | ***21*** | ***12*** | ***15*** | ***82*** |

[1] This row is not the sum of the preceding rows: the fields comprising them were drawn from more than one coding table; thus data from any one decedent could appear more than once

Despite most (63, or 48% of) deaths having occurred in low to moderate severity flood events, in the following activity types, the greatest proportion of deaths have occurred in severe/ record/ disastrous flood events amongst those:

- in or on a house or structure – 100%
- attempting to evacuate (from home or work, or attempting a vertical evacuation at home) – 44% (with the remainder divided equally amongst major and low-moderate floods)
- taken by surprise, with no attempt at/ very late evacuation – 100%
- attempting to rescue people – 80% (but low numbers– just four out of five)
- attempting to rescue pets, livestock or property – 57% (but low numbers– just four out of seven)
- *en route* to/ from work – 38% – equal with those that died through this activity in major floods(but low numbers– just three out of eight)

In low-moderate floods, most fatalities occurred when people were:

- engaged in an activity in/ near stormwater drain – 81%
- recreating – 75%
- working – 75% (but low numbers– just three out of four)

The majority (59%) of people attempting to cross a causeway/ watercourse perished in low-moderate events, with 29% dying in major events and 12% dying in severe/ record events. Very similar proportions were seen amongst those attempting to cross a causeway/ watercourse via vehicle.

# DISCUSSION

The defining characteristic of flash flooding is the lack of time between warning and onset of the event. Warning systems have improved and emergency response and management agencies have conducted campaigns to increase understanding and awareness of the flood hazard by the general public, but people are still dying in flash floods.

The majority of flash flood deaths occur outside of homes and businesses and are associated with individuals attempting to cross a watercourse. These results indicate that it is dangerous to be outside in flood-liable areas during flash flood events, and that people should be encouraged to shelter indoors if they have no way of making a flood-free escape from a flood-prone area. In severe events, however, there is a clear risk of fatalities occurring within buildings. Individuals who die within their buildings are, in the majority, over the age of 49 (70%) and are fairly evenly spread amongst those capable of independent action (40%), physically and or mentally disabled (30%) and affected by drugs or alcohol (30%), with some decedents affected by both of the latter. This would suggest that emergency services should identify those buildings and people that are most at-risk during flash floods so that early evacuation can be encouraged before flash flooding occurs.

The majority (54%) of deaths occurred as people attempted to cross floodwaters. With 53% of those deaths occurring within 0-2km of an individual's home it can be seen that, in circumstances where properties are built on floodplains or near watercourses subject to flash flooding, there is a significant risk to life as a consequence of people entering floodwater within their local area. Thus, building flood-resilient houses does not completely reduce safety risks: no matter how sturdy the building is, people may still become flash flood victims by entering floodwaters within their local neighbourhood.

Haynes *et al* (2016) give a detailed discussion concerning education, incentives and structural interventions to reduce flood deaths resulting from persons entering floodwaters via vehicle or on foot, failing or being unable to evacuate and those who live in high hazard areas.

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# APPENDIX 1: CODING OF FATALITIES

The data for fatalities caused by flash floods in Australia was analysed in relation to informing the understanding of circumstances surrounding the fatalities and how this information could best be utilised to inform policy development for the preservation of life during flash flood events.

## LOCATION OF THE DECEASED

The jurisdiction (state or territory) in which the fatality occurred was noted. For this study the focus was NSW fatalities but, for comparison, we have included those from Victoria, the Australian Capital Territory and from South-East Queensland. In addition, the drainage basin was noted.

## SEVERITY

Data was categorized according to flood severity (minor, major, record etc), where it was possible to determine. The ranking used by the *PerilAUS* Floods Database was followed. This ranking had been determined in the early history of *PerilAUS* in order to make the best use of the descriptive terms employed in media articles where there was insufficient BoM data:

- Low/ bank full
- Minor-moderate
- Major/ extensive/ serious
- Severe/ disastrous
- Record/ highest known/ unprecedented

## TIME

The year, month and date of the fatality was recorded, as well as the approximate hour:

- Early morning (night)
- Morning
- Noon
- Day
- Afternoon
- Evening
- Night

## DEMOGRAPHICS

Division into age and gender groups allowed the analysis to consider whether certain groups possess a heightened vulnerability and how this has changed through time.

The occupation of the decedent was noted. This included:

- Professional rescue/ emergency services
- Recognized rescue/ emergency volunteer (e.g., SES)
- Armed forces
- Carer (i.e., full- or part-time carer for another person)

- On the land (farmer, grazier etc)
- Miner
- Labourer
- Engineer
- Water-related occupation
- Railway (driver, fireman, labourer etc)
- (Other) travels for work
- (Other) indoor occupation
- Mixed indoor/ outdoor occupation
- (Other) outdoor occupation
- N/A – child/ student if stated or if 14yo or younger
- Pensioner/ retired
- Unknown

In addition, the role played by the decedent during the course of the fatal incident was noted. This included:

- Civilian
- Civilian – ad hoc volunteer (rescuing people or moving debris etc)
- Emergency manager/ responder; recognised volunteer (e.g., SES, CFA)
- Work related to the flood, not an emergency responder (e.g., repairing damage)

## CAUSE OF DEATH

This covered an assessment of the actual cause of death: that is, whether the death was caused by drowning or by an indirect impact resulting from the flash flood: for example, an injury from flood debris or from a heart attack. Categories included:

- Drowning
- Exposure
- Injury: hit by flood debris; came into contact with a rock; etc
- Drowning/ injury/ exposure (this category was utilized in cases when, for example, the decedent had been washed away and the cause of death could not be attributed solely to drowning – that is, cause of death could have been a combination of drowning plus injuries sustained by flood-borne debris during the course of being washed down-river)
- Injury: flood- or rain-induced building collapse
- Injury: flood- or rain-induced landslide/ washaway
- Injury: vehicle accident
- Injury: Tree/ tree limb fall
- Heart attack; overexertion; shock; collapse
- Electrocution: fallen power lines etc
- Missing presumed dead

## CIRCUMSTANCES OF FATALITIES

Information about where people were, what they were doing and why they made these decisions is crucial in gaining an understanding of why these deaths occurred. This element of analysis looks in detail at how people responded to the flash flood threat. However, deciding whether people had sufficient warning or were sufficiently prepared – even in those cases where complete coronial records were available – is problematic. We have categorised people's decision-making using several coding schemes.

he varying levels of detail available for each case sometimes required a small number of assumptions to be made, which made coding a balance between the need to maximise the usefulness of the information extracted without diminishing the accuracy of the interpretation of the data. Those fatalities for which there was not enough information available to make a judgment were labelled as unknown. The categories are as follows:

## ACTIVITY PRIOR TO DEATH

- Attempting to cross bridge/ causeway/ culvert/ ford/ road
- Attempting to cross floodwaters [paddock; town; on road]
- Engaged in an activity near the water (bank/ bridge)
- Engaged in an activity in/ near a stormwater drain
- Engaged in an activity in the water (rescue, swimming, joyride etc)
- Engaged in an activity on the water (boat)
- Engaged in an activity not near usual watercourse (e.g., in house, driving through town etc)

## DETAILS OF LOCATION OF FATALITY

This category determined where the deceased was i.e., were they outside in a flooded watercourse, other floodwaters or inside or on a house or structure.

- Outside – near/ on/ in watercourse, i.e., natural or man-made watercourse, including dry creek beds and storm drains etc (on foot or in a car)
- Outside – near/ on/ in floodwaters (e.g., paddock; town) (on foot or in a car)
- In a house/ structure – destroyed
- In a house/ structure – not destroyed
- On a house/ structure – destroyed (also includes people who may have climbed on a car they had not been travelling in to escape water)
- On a house/ structure – not destroyed (also includes people who may have climbed on a car they had not been travelling in to escape water)

## REASON BEHIND ACTION PRIOR TO DEATH

This category defined people in terms of what they were doing (attempting to cross a watercourse or engaged in an activity in their home etc) and why they were doing it (attempting to evacuate, *en route* to work or home, recreating, looking after livestock etc).

- Attempting to evacuate from home
- Attempting to evacuate from place of work
- Attempting to evacuate from other
- Attempting vertical evacuation
- Taken by surprise - No attempt at evacuation/ Very late evacuation i.e., got caught as they stepped out the door or near their house etc
- Being rescued/ evacuated
- Awaiting a planned rescue/ evacuation
- Waiting to see/very late evacuation
- Refused to be evacuated
- Sheltering from storm / very late evacuation
- Working
- *En route* to home from work
- *En route* to work from home
- *En route* to home from school
- *En route* to school from home
- Collecting children
- Collecting others
- Recreating
- *En route* to home from recreation/ visit / non-essential shopping
- *En route* to recreation/ visit / non-essential shopping from home
- Carrying out repairs / maintenance due to flood damage etc
- *En route* to home from other destination
- *En route* from home to other destination
- *En route*
- Collecting provisions
- Getting help
- Attempting to rescue people
- Attempting to rescue/ retrieve property – household / car
- Attempting to rescue/ retrieve property – livelihood
- Attempting to rescue/ retrieve pets etc
- Attempting to rescue/ retrieve/ care for/ work with livestock etc
- Attempting to retrieve flotsam

## REASON BEHIND ACTION AT TIME OF DEATH

This "duplicate" coding scheme was used to capture people whose reason/ action changed during the event: for example, those who were driving to work (reason behind action prior to death) but became stuck and were being rescued (reason behind action at time of death). Categories are the same as that of the *Reason behind action at time of death* coding scheme.

## CAPACITY AND AWARENESS

Understanding the level of awareness of the flood risk, any warnings received or visible signs and capacity to take action is crucial in terms of interpreting why people took a particular course of action and how policy and practice can best be amended to have the greatest impact. Although the available information is necessarily limited, we have tried where possible to categorise people's decision-making.

The varying levels of detail available for each fatality sometimes required a small number of assumptions to be made. This made the coding a balance between the need to maximise the usefulness of the information extracted without diminishing the accuracy of the interpretation of the data. For example, unless otherwise stated all those who entered floodwaters in order to perform a rescue or continue their journey were coded as "Awareness category 2: knew there was a flood but depth, speed, debris took them by surprise". It is likely that a majority of those who were entering floodwaters at night were not aware and therefore this data is presented in relation to the timing of the event and potential visibility.

## CAPACITY TO RESPOND TO THE FLASH FLOOD EMERGENCY – PRIMARY

The coding for capacity involved categorising the data into those who were capable of independent action and those who were not because of a number of reasons.

These included a disability, inability to swim, under the influence of drugs or alcohol, looking after dependants and being encumbered with clothing and possessions. This code also recognised those who were likely to have followed the decision making of others such as passengers in a vehicle.

Unless otherwise stated the fatality was coded as "Capacity category 1: capable of independent action". However, many of those labelled in this way may well have been influenced by unknown factors. Furthermore it has been assumed that all drivers were capable of independent action: however, it is likely that they were influenced by passengers. All children who were with their parents or guardian were assumed to have followed the instructions of adults and were not in control of the decisions taken that led to their deaths. Children on their own who were less than 11 years old were coded in their own category. Following consultation with child disaster experts the age of 11 was considered to be the most appropriate age cut off although it is understood that children younger than 11 are more than capable of independent decision.

- Capable of independent action
- Physically and or mentally disabled or incapable
- Cannot swim
- Presence of drugs or alcohol in blood
- Made to follow the decision making of others (i.e., children who followed an adult's decision making; women who were told to take a certain action by their husband; passengers in a vehicle)

- A child or group of children on their own, age < 11
- Unfamiliar with the area (e.g., new resident; transiting)
- Encumbered with clothing, possessions or equipment
- Looking after dependents which affected ability to save themselves. Young, old, those with limited mobility etc

## CAPACITY TO RESPOND TO THE FLASH FLOOD EMERGENCY – SECONDARY

This coding scheme captures those who were, for example, a passenger in a car (Capacity - Primary) but were drunk/couldn't swim/disabled (Capacity – Secondary). Categories are the same as that of the *Capacity to respond to the flash flood emergency – primary* coding scheme.

## WARNINGS RECEIVED

- Had received an official warning relating to potential flood risk
- Had received an official warning to evacuate
- Had received an official warning to shelter in place
- Had received a warning from friends, family or bystanders relating to potential flood risk
- Had received from friends, family or bystanders to evacuate
- Had received from friends, family or bystanders to shelter in place/ evacuate vertically

## VISIBLE SIGNS OF THE FLASH FLOOD EVENT

- Obvious signs of floodwater and/ or rain
- No obvious signs of floodwater and/ or rain
- Emergency response personnel expediting

## AWARENESS OF THE FLOOD HAZARD

The data has been divided between those who were aware of the flood but did not expect to encounter it (e.g., walking their dog on the riverbank), those where the depth, speed and/ or debris took them by surprise (e.g., driving through floodwaters) and those who were unaware and taken by surprise (e.g., in their home when flash flooding hit).

- Knew there was a flood or imminent risk of a flood but did not expect to encounter it
- Knew there was a flood or imminent risk of a flood but depth, speed, debris and/ or stormwater drain took them by surprise
- Unaware and taken by surprise/ too little time to enact survival strategy
- N/A – child < 11 yo

## TRANSPORT OF THE DECEASED

This category determined whether the deceased was in a car or other form of transport and if they remained in or on the vehicle or tried to evacuate from the vehicle on foot. Categories included:

- On foot
- Swimming (incl. boogie board and inflated tyre etc)
- Carried by others
- In vehicle: car
- In vehicle: car; exited/ing
- In vehicle: 4WD
- In vehicle: 4WD; exited/ing
- In vehicle: utility (ute)
- In vehicle: utility (ute); exited/ing
- In vehicle: utility (ute) 4WD
- In vehicle: utility (ute) 4WD; exited/ing
- In vehicle: truck
- In vehicle: truck; exited/ing
- In vehicle: other e.g., motorbike, van
- In vehicle: train
- In vehicle (unknown type)
- On vehicle: push bike
- On boat (incl. makeshift: raft, canoe, dinghy etc)
- On rope/ cable/ flying fox
- N/A – in house / caravan