Title Page

Title: A systematic review of human behaviour in and around floodwater

Authors: Hamilton K [a], Demant D [b,c], Peden AE [d,e,f], Hagger MS [a,g,h]

Affiliations:
[a] School of Applied Psychology, Griffith University, Brisbane, Australia,
[b] Australian Centre for Public and Population Health Research, Faculty of Health, University of Technology Sydney, Ultimo, New South Wales, Australia
[c] School of Public Health and Social Work, Faculty of Health, Queensland University of Technology, Brisbane, Australia
[d] Royal Life Saving Society – Australia, Sydney, Australia
[e] College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Australia
[f] School of Public Health and Community Medicine, University New South Wales, Sydney, Australia
[g] Psychological Sciences, University of California, Merced, USA
[h] Faculty of Sport and Health Sciences, University of Jyvaskyla, Jyvaskyla, Finland

Keywords: systematic review; flood; behaviour; drowning; non-fatal drowning

Acknowledgements: Martin S. Hagger's contribution was supported by a Finland Distinguished Professor (FiDiPro) award (Dnro 1801/31/2105) from Business Finland. The study is supported by Royal Life Saving Society - Australia and Griffith University School of Applied Psychology partnership grant. The sponsors have no role in the design, methods, participant recruitment, data collection, analysis, interpretation, preparation of this manuscript, or the decision to submit this article for publication, and they do not have ultimate authority over any of these activities.

Correspondence to: Kyra Hamilton, Heath and Psychology Innovations (HaPI) research lab, School of Applied Psychology, Griffith University, Brisbane, Australia,
Email: kyra.hamilton@griffith.edu.au or hapiresearch@gmail.com

Figure/Table Titles:
Figure 1: *Flow diagram*
Table 1: *Characteristics of included studies*
Table 2: *Themes in identified literature*
Table 3: *Extraction of behaviour-specific data by study (alphabetically)*

Citation: Hamilton, K., Demant, D., Peden, A. E., Hagger, M. S. (2020). A systematic review of human behaviour in and around floodwater. *International Journal of Disaster Risk Reduction*. doi:10.1016/j.ijdrr.2020.101561

A systematic review of human behaviour in and around floodwater

Abstract

Flooding can have a major impact on people's safety and livelihood. Understanding people's flood-related behaviours may assist in the development of more effective strategies aimed at lessening the impact of floods including mortality and morbidity. This systematic review examined peer-reviewed literature published from January-1989 to April-2019 on human behaviour in and around floodwater to identify behaviour patterns as well as protective and risk factors. We extracted three main themes from a thematic analysis of included studies (N=54): activities and risk-taking behaviours (n=24); loss reduction, knowledge, and warnings (n=37); and diet and hygiene (n=4). This review had limitations which prevented definitive conclusions being made. What does seem apparent is the limited knowledge of the social psychological mechanisms that guide behavioural responses in a flood event. Further exploration of methods to improve preparedness, increase the likelihood of evacuation, and reduce 'risky' behaviour during floods is needed. Future studies should prioritise addressing these gaps to enhance the evidence-base for reducing the impact of floods including flood-related mortality and morbidity.

Introduction

Globally, flooding is one of the most common natural disasters (Doocy, Daniels, Murray, & Kirsch, 2013) and drowning is thought to be a leading cause of death during times of flood (Di Mauro, De Bruijn, & Meloni, 2012). The World Health Organization (WHO) estimates between 1980 and 2009, floods have claimed the lives of over 500,000 people around the world (World Health Organization, 2014). Reports into causes of death due to interacting with floodwaters have identified several factors impacting drowning risk during times of flood including accidental falls into water, being swept away by floodwater due to a lack of early warning or evacuation procedures, or deliberately entering floodwaters to recreate (Peden, Franklin, & Leggat, 2018; Peden, Franklin, Leggat, & Aitken, 2017). Driving into floodwaters is a leading activity immediately prior to flood-related drowning, a fact that has been highlighted in a number of countries (Diakakis & Deligiannakis, 2013, 2015, 2016, 2017; Fitzgerald, Du, Jamal, Clark, & Hou, 2010; Franklin, King, Aitken, & Leggat, 2014; Gissing, Haynes, Coates, & Keys, 2016; Hamilton, Peden, Keech, & Hagger, 2016; Hamilton, Peden, Pearson, & Hagger, 2016; Hamilton, Price, Keech, Peden, & Hagger, 2018; Haynes et al., 2017; Keech, Smith, Peden, Hagger, & Hamilton, 2019; Pearson & Hamilton, 2014; Peden et al., 2017; Pereira, Diakakis, Deligiannakis, & Zêzere, 2017; Salvati, 2018; Freddy Vinet, Boissier, & Saint-Martin, 2016).

There are also other behaviours that may increase risk of mortality or morbidity during times of flood including living on floodplains or near waterbodies prone to flooding (Apel, Aronica, Kreibich, & Thieken, 2009; Plate, 2002) as well as the behaviour in the lead up and immediately after a flood that can impact health and safety such as refusal to evacuate (Heath, Kass, Beck, & Glickman, 2001; Vorst, 2010) and flood-related infection and disease (Centers for Disease Control and Prevention (CDC), 2012; Watson, Gayer, & Connolly, 2007). These cascading crises (Kachali, Storsjö, Haavisto, & Kovács, 2018; Gianluca

Pescaroli, 2018; Serre & Heinzlef, 2018) after a flood event can have wide-ranging implications on flood preparedness, mitigation, and response, and point to the need for a better understanding of human behaviour during times of flood. This knowledge can help to inform strategies to improve behaviour and reduce flood-related mortality and morbidity as well as flood-related losses to property and livelihoods.

Human behaviour is vulnerable to crises and disasters and, as a consequence, such events bring about challenges for prevention efforts. Flood events can be considered a natural disaster (Pelling, 2003) which can develop into a crisis – "a situation in which important decisions involving threat and opportunity have to be made in a particular short time" (Shaluf, Ahmadun, & Mat Said, 2003, p. 24). For a reconceptualizing of the story of disaster and the term 'natural disaster' in terms of present-day trends and tendencies, see (Alexander, 2000; Blaikie, Cannon, Davis, & Wisner, 2005). Effective management of human behaviour in crises and disasters is important to reduce negative impacts and save lives. Ritchie (2008, 2009) considered three steps in the process of effective crisis and disaster management: (1) planning and preparedness activities before a crisis or disaster; (2) response to, or management of, a crisis or disaster as it occurs; and, (3) final resolution to a new or improved state after the crisis or disaster is over. This paper focuses on the second step, specifically focusing on understanding human behavioural responses as they occur in a flood event.

Although not all flood-related deaths and injuries are preventable (e.g., when individuals are unexpectedly inundated with water leaving no time to make decisions), where decision making is possible, individuals' behavioural responses in and around floodwater during a flood event may help to prevent flood-related incidents (Hamilton, Peden, Keech, & Hagger, 2018; Hamilton, Peden, Pearson, et al., 2016; Hamilton, Price, et al., 2018). Therefore, understanding human behaviour in and around floodwater is needed to help inform effective prevention strategies. This is because decisions informing people's

behavioural responses in floods are likely to be psychological in nature, involving a range of social and motivational factors (Hamilton, Peden, Keech, et al., 2016; Hamilton, Peden, et al., 2018; Hamilton, Peden, Pearson, et al., 2016; Hamilton, Price, et al., 2018). Once safety compromising behaviours in and around floodwaters can be identified, investigations into the mechanisms that guide these risky acts can be elucidated and interventions developed.

With extreme weather events predicted to result in increased frequency and severity of flooding over the coming decades as a consequence of global climate change (Doocy et al., 2013; Easterling et al., 2000; Patz, Engelberg, & Last, 2000), there is a need for more effective prevention strategies to prevent flood-related loss of life. Given that many fatalities in floodwaters are associated with behaviours that put one at risk (e.g., driving into floodwater, recreating in floodwater), and that deaths can be minimized through adoption of safety behaviours, identification of the social, environmental, and psychological factors that determine these behaviours is essential to inform the development of behavioural interventions and policy aimed at minimizing risk and reducing flood-related incidents.

In scoping the literature, it seems apparent that various factors may influence flood-related behaviours including intrapersonal variables such as demographics (e.g., gender, age) (Drabek, 2001; Salvati, 2018) and psychological factors such as attitudes and beliefs (Adomah Bempah & Olav Øyhus, 2017; Drobot, Benight, & Gruntfest, 2007); interpersonal variables (e.g., social support, social norms) (Tim, Pan, Ractham, & Kaewkitipong, 2017); and physical environmental variables such as flooded roads (Diakakis & Deligiannakis, 2013) or the more general characteristics of a flood such as velocity or ‘suddenness’ (Penning-Rowsell, Floyd, Ramsbottom, & Surendran, 2005). Integrating these various factors into a theoretical framework is the basis for an ecological model of behaviour. Ecological models of behaviour target multiple levels of influence; thus, individual, as well as social and physical environmental influences, are deemed to influence individual behaviour and are likely to

interact to promote or hinder behavioural performance (McLeroy, Bibeau, Steckler, & Glanz, 1988; Sallis & Owen, 2002; Stokols, 1992). Working within an ecological model requires the inclusion of all these levels of influence and is proposed to be what distinguishes potential contributions of ecological models from that of other intrapersonal and interpersonal theories (Sallis & Owen, 2002). The current study, therefore, adopts an ecological model of behaviour to better understand human behaviour during times of flood.

The overarching aim of this systematic review is to summarise the current literature regarding human behaviour in and around floodwater to identify behaviour patterns as well as protective and risk factors, to guide prevention. This study used the definitions adopted by Jonkman and Kelman (2005), namely that a flood is defined as the presence of water in areas that are usually dry. This includes both the flood characteristics of flash flooding and slow-onset flooding (Peden et al., 2017). In the following sections of the review, the methodological approach is outlined, including the selection criteria, search strategy, and inclusion/exclusion process. The results section outlines key findings from the included studies, organised under the following sections: activities and risk-taking behaviours; loss reduction, knowledge, and warnings; and, diet and hygiene. The discussion outlines gaps in the published literature across the same sections and highlights opportunities for further research to advance understanding of flood-related human behaviour and minimise loss of life and injury due to flooding. This review builds upon the findings of Becker et al's (2015) review of people's behaviour in and around floodwaters by taking a theoretical approach based on an ecological model of behaviour to improve understanding of human behaviour during times of flood, and updating the literature to April 2019 using a systematic review approach.

Method

The current review adopted published guidelines for narrative reviews (Shamseer et al., 2015; Stroup et al., 2000). A PRISMA checklist is provided as supplementary material (see Supplement 1).

Selection Criteria

Peer-reviewed literature published from January 1989 to April 2019 were reviewed, with data on human behaviour in or around floods or floodwater included in the study. Studies were considered for inclusion regardless of study design with the exception of systematic and non-systematic reviews. Studies discussing mitigation or recovery behaviours were excluded as well as studies commenting on behaviour during regular and expected flooding. Results were limited to the language skills of the authors (English and German).

Search Strategy

The authors developed a search strategy in cooperation with a specialist librarian and six databases (SCOPUS (contains Medline), PsychINFO, Web of Science, ScienceDirect and Risk Abstracts) were searched in April 2019 for relevant sources published using the following search terms:

Row 1: ‘behavio*’ OR ‘response’ OR ‘reaction’

Row 2: ‘flood*’ OR “water disaster” OR “natural disaster”. Research was limited to human research if a database allowed for such a limitation. Wildcards (e.g., * or #) were used, in the case of ScienceDirect British spelling was used. Bibliographies and reference lists of all included publications were also screened for additional references.

Review, Data Extraction, and Data Analysis

All citations were downloaded into citation management software (N=13,388). Once duplicates were removed (n=3,886), two research assistants independently from each other screened record titles and abstracts for all references. A total of 8,424 records were excluded

after title screening and a further 818 after abstract screening. Records excluded at the title screening stage commonly covered clearly unrelated topics such as soil erosion, psychological flooding behavioural therapies as well as software and IT-issues. A random sample of 10% (n=840) of excluded records at this stage were reassessed by author DD identifying no issues of concern. A full-text assessment of all remaining articles (n=267) was conducted independently by authors DD and AP. Author KH reviewed publications in cases of persistent differences in opinion regarding inclusion. A further 213 articles were excluded at this stage most commonly for discussing long-term mitigation behaviours taken after a flood (no behaviour in an actual flood) or due to not containing flood-specific data (n=52). Consensus was reached for the inclusion of all publications. Please refer to Figure 1 for a list of all reasons for exclusion. Subsequently, data from each article was extracted (see Tables 1, 2, and 3).

A narrative approach was chosen due to a lack of homogeneity in the selected studies, which varied strongly in sample size, study design, outcomes, and populations. Data presented in the included studies were extracted and categorised into themes (see Tables 1, 2 and 3), and consensus on the final interpretation of results was reached.

Results

Description of Included Studies

A total of 54 studies were included. Table 1 provides an overview of study characteristics. Most studies (n=19) were from Asia, followed by Australia (n=15), Europe (n=9), the United States (n=7), and Africa (n=3) with one study examining the United States and Europe. Most studies used surveys (n=21) or databases (n=14) for data collection, followed by qualitative interviews (n=8); the remaining ten studies used multiple data collection methods. The majority of studies (n=37) used floods as the main type of events, with 21 studies reporting on specific flooding events (e.g., 2011 Queensland, Australia

floods), followed by extreme weather events and disasters (n=6), cyclones/hurricanes/typhoons (n=5), flooded waterways (n=4), flooded roads (n=1), and damaging hydrogeological events (n=1). All studies have a cross-sectional or case-control design and as such classified as level IV (lowest level) evidence on the Australian National Health and Medical Research Council (2009).

Main Themes in Included Studies

Three main themes emerged during the analysis of included studies (see Table 2). A total of 24 included studies reported data on *activities and risk-taking behaviours* with most reporting data on entering floodwaters (n=23), followed by recreational activities (n=7), and general risk-taking behaviours (n=1). A total of 37 studies reported data on *loss reduction, knowledge, and warnings* with most reporting data on loss reduction behaviours such as evacuation and relocation behaviour (n=17), protecting property (n=14), rescuing others (n=8); followed by knowledge sharing and information seeking (n=12); and flood warning behaviour (n=7). Finally, four studies reported on *diet and hygiene*.

Activities and Risk-taking Behaviours

Entering floodwaters. Several studies reported on correlations between drowning deaths and entering or crossing floodwater with motor vehicles or by foot, or swimming in floodwater. Included studies overall demonstrated that this behaviour of entering floodwater may be one of the most common factors associated with fatalities and injuries during floods. As an example, a study (Coates, 1999) from Australia using various databases to examine flood deaths from 1788 to 1996, showed that 28.3% (n=398) of fatalities were associated with attempting to cross a creek, river, or stream with most of these occurring on boats (n=131) or by walking, wading, and swimming (n=103). A further 10.2% (n=143) of fatalities were associated with an attempt to cross a road, bridge, culvert, or ford. A total of 131 fatalities occurred on boats; 125 occurred while walking, wading, or swimming in

floodwater; and 118 fatalities occurred in cars. Another study from Australia by Haynes et al. (2017) with overlapping time-frames reached similar conclusions reporting that attempts to cross bridges, causeways, crossings, culverts, ford, or watercourses during a flood are a major reason for flood fatalities. A qualitative study from India (Krishna, Ronan, & Alisic, 2018) focussing on the health and wellbeing of children during floods reported that parents generally perceive children to be at a higher risk during floods as they would enter floodwater to play with other children and engage in other dangerous situations during floods at times in which constant supervision may be difficult to achieve. Furthermore, parents have demonstrated high levels of willingness to enter floodwaters to provide for their families, particularly children.

Most studies (n=10) focused on the use of motor vehicles. In a case-control study after a flash flood in Puerto Rico (Staes, Orengo, Malilay, Rullán, & Noji, 1994), those in a vehicle during a flood had a significantly higher risk of mortality (OR=20.05, 95-%-CI: 4.2-131.8, $p<0.001$) compared to those not in a car – with the exception of using the car for evacuation purposes. FitzGerald et al. (2010) attributed 48.5% of drowning death in Australia with the use of motor vehicles, with most of these being associated with crossing waterways, similar to a United States study associating 43% (n=80) fatalities with cars (French, Ing, Von Allmen, & Wood, 1983). Another study (Peden et al., 2017) also attributed the majority of flood-related drowning death with non-aquatic transport (55.4%, n=71). A study by Zhong et al. (2013) reported that 24.2% (n=8) of fatalities associated with the 2011 Queensland, Australia floods were associated with vehicles entering floodwaters. However, other studies attributed significantly smaller proportions to the use of cars. Aceto et al. (2017) attribute only one fatality occurred in relation to travelling and transport compared to 14 injuries and 345 of those involved in their study. In a study (Chang, 2016) of flood-related fatalities in tropical cyclones in Taiwan between 2000 and 2014, out of 886 deaths with a known

location, 9 deaths (5 work-related, 4 non-work related) occurred in cars with a further 86 (40 work-related, 46 non-work related) fatalities occurring on roads and bridges. A further study (Jonkman & Kelman, 2005) reports that 32.8% (n=81) of flood-related drownings in selected European and American flood events occurred in vehicles as well as 5.7% (n=14) of physical injury.

Two studies concentrated on car accidents related to floods. In a study from Greece (Diakakis & Deligiannakis, 2013), more than half of all car crash fatalities related to flooding between 1970 and 2010 occurred after travelling across a waterway with most occurring in regional areas (70%) during night-time (46.7%) by locals (78.1%) on paved roads (41.5%). Another study (Yale, Cole, Garrison, Runyan, & Ruback, 2003) identified that the majority (82.5%, n=66) of car crashes in North Carolina, United States, during the 1999 storm Hurricane Floyd was directly associated with the storm, occurring after hitting a puddle or driving into floodwater, resulting in 27 motor vehicles being fully or partially submerged in water with 14 fatalities.

Studies also reported the willingness to and beliefs associated with entering floodwater with motor vehicles. A study (Franklin et al., 2014) among residents of Townsville, Australia showed that 38.5% (n=50) of participants were willing to drive through floodwater, mostly driven by unawareness of the risks associated with driving through floodwater (61.5%, n=80) as well as the need to reach a specific destination (36.9%, n=48), impatience (33.1%, n=43), an underestimation of the risk (30.8%, n=40), or the belief that the car would be able to get through floodwater (208%, n=27). In another Australian study (Gissing et al., 2016), 84% of all vehicles in Shoalhaven, New South Wales, were observed to drive through an officially closed flooded street. Two other studies (Hamilton, Peden, Keech, et al., 2016; Pearson & Hamilton, 2014) from Australia using the same dataset showed that participants believe that driving through floodwater can save time, help to reach a destination,

and was unlikely to result in injury or death. Participants also associated negative consequences with entering floodwater: becoming stuck or stranded, crashing, sustaining vehicle damage, being swept away, and encountering hidden hazards. However, the strength of association depended on the depths of floodwater with negative beliefs more likely to be associated with deeper floodwater whereas positive beliefs were more likely to be associated with shallow floodwater. Furthermore, the willingness to enter deep and shallow flooded waterways was positively associated with attitude, subjective norms, perceived behavioural control, and past behaviour. Willingness appeared to be negatively associated with perceived severity in deep but not in shallow floodwater whereas perceived susceptibility was not associated with willingness to enter floodwater. This is consistent with a qualitative study by the same authors (Hamilton, Peden, Keech, & Hagger, 2019) identifying a range of concepts affecting intentionally driving through floodwaters: the individual perception of the situation (e.g., pressure to arrive at the respective destination), the social and environmental context (e.g., other motorists entering floodwater), self-efficacy judgements (e.g., perceived skills and knowledge) as well as past experiences (e.g., reliable risk assessments in the past). Similarly, results of a study (Lu, Zhang, Peng, & Rahman, 2014) in Bangladesh show that 28% of inner-city residents are not changing their travel behaviour during a flood.

Other studies examined the correlation between walking through floodwater and fatalities or injuries. Ashley and Ashley (2008) reported that 9% of flood fatalities in the United States between 1959 and 2005 can be attributed to walking through floodwater with 43% of these entering floodwater to reach a destination. FitzGerald et al. (2010) report an even higher number attributing 16% of flood fatalities to swimming or wading across flooded waterways. Similarly, high values were reported for Europe and the United States in which 62 of 167 drowning fatalities occurred among pedestrians as well as 4 out of 29 physical traumas (Jonkman & Kelman, 2005).

This is consistent with a qualitative study (Few & Pham, 2010) in which 120 Central Province and Mekong Delta, Vietnam households reported that injuries through colliding with submerged objects are common after wading or walking through floodwater. Furthermore, a study (Shabanikiya, Seyedin, Haghani, & Ebrahimian, 2014) from the Quchan area, Iran, found most people were willing to cross floods on foot; however, there are differences and those older than 35 years were less likely to cross a flood on foot than those younger than 35 years (60% vs. 80%). Similarly, those who take flood warnings seriously, have experienced floods in the past, and are not a skilled swimmer were less likely to enter floodwaters than their counterparts. Education, sex, marital status, reasonable perception of flood risk, and knowledge about health consequences of entering floodwaters did not affect willingness to enter floodwater. However, a study from Nigeria (Ajibade, McBean, & Bezner-Kerr, 2013) reported that men are more likely to enter floodwater in dangerous situations to care and protect their family compared to women as a result of cultural expectation and gender norms. It was furthermore expected that unwillingness to enter flood water would result in significant financial losses in communities with already low socio-economic status due to an economy largely dependent on small businesses including food businesses (e.g., freshwater delivery), that are vital for the respective communities.

Recreational activities. The number of flood-related drowning deaths attributable to recreational activities such as swimming, camping, hiking, or surfing varied between studies and locations. In a study on flood fatalities in the United States between 1959 and 2005, only a small number of fatalities occurred during recreational activities such as hiking or camping; however, no specific numbers are mentioned (Ashley & Ashley, 2008). This is consistent with a 1983 study by French et al. (1983) which showed that only four (2%) cases of flood-related drowning in the United States between 1969 and 1981 could be directly associated with other recreational activities such as rafting or sailing.

Three studies (Fitzgerald et al., 2010; Haynes et al., 2017; Peden et al., 2017) from Australia with some overlapping data also showed meaningful differences in the proportion of flood-related drownings death that may be attributed to recreational activities. FitzGerald et al. (2010) report that a total of 19 (26.5%) flood-related deaths between 1997 and 2008 could be attributed to swimming and surfing. This number is significantly lower in Peden et al. (2017) who report that 7% (n=9) of flood-related drownings between 2002 and 2012 were attributable to swimming and recreating. Similarly, Haynes et al. (2017) report that 7% (n=121) of flood fatalities between 1900 and 2015 were attributed to swimming; however, it is important to note that this number also included those who swam to rescue another person. A further 98 people (5%) died while boating on the water, though it is not clear if this number also included work-related boating. In an Australian study by Franklin et al. (2014), 10% (n=13) of participants responded that they had swum in floodwater; however, it is unclear if this behaviour was exercised for recreational reasons.

Aceto et al. (2017) report that fishing and other recreational activities are responsible for one fatality (5%) during damaging hydrogeological events in the Italian Calabria Region between 2000 and 2014. Furthermore, 22 out of 154 injuries related to these events can be

related to fishing and recreational activities as well as 36 (2%) to general involvements in the events.

General risk-taking behaviour. Only one study (Said, Afzal, & Turner, 2015) examined risk-taking behaviour in general using survey and experimental elements. Findings showed that previous experience with floods did not affect risk-taking behaviour among a sample of participants from Punjab (Pakistan) and that participants who experienced a flood and lived in a designated flood cluster systematically tried to avoid risk.

Loss Reduction, Knowledge, and Warnings

Evacuation and relocation behaviour. Several studies examined evacuation responses (i.e., evacuated or not) to evacuation orders with different results reported depending on the country and specific type of event. A study (Adeola, 2009) among Hurricane Katrina (United States) survivors showed that 65.2% (n=390) evacuated voluntarily within 24 hours prior to landfall, with a further 11.5% (n=69) evacuating 12 hours prior to landfall and only a small number of participants (10.5%, n=63) found shelter within their town or tried to ride the storm out. Similarly, 60% of Brisbane, Australia residents evacuated during a flood in 2011 (Box, Bird, Haynes, & King, 2016). However, this number was significantly lower among pet-owning flood survivors of which only 34% (n=38) evacuated (Taylor, Lynch, Burns, & Eustace, 2015). During a flood in Lagos, Nigeria only 38.6% (n=387) of participants relocated, whereas 17.1% (n=171) did nothing and a further 44.4% (n=445) opted to stay and mitigate damage (Ajibade et al., 2015). Similarly, only 43.8% (n=121) were rescued/evacuated in the Kumamoto and Oita Prefecture, Japan flood (Kakimoto & Yamada, 2016). A meaningfully higher proportion of participants reported evacuating to a cyclone shelter (75.24%) in a study from Bangladesh (Alam & Rahman, 2014), followed by staying at their house (12.38%), seeking shelter in school buildings (5.74%) or choosing to raise embankments and dams instead (6.67%). The perceived

vulnerability of adolescent girls in public shelters was identified as the main reason for families staying home instead of seeking shelter elsewhere, particularly if no male family member is present.

Several studies also investigated potential predictors of and influence on evacuation behaviour. Consistent with generally high rates of evacuation behaviour, a study (Duclos, Vidonne, Beuf, Perray, & Stoebner, 1991) of flash flood survivors in France showed that the main concern after realising the danger of a flood was to seek safety (27%), similarly to a study conducted in Japan (Matsuda, 1990) in which 42.8% (n=107) stated that endangerment of life was the main reason to seek refuge as well as receiving an evacuation order (44.8%, n=112). This is consistent with another study in Japan (Kakimoto & Yamada, 2016) which reported that those who evacuated had a higher flood risk perception than those who had not evacuated (Scores: 1.41 vs. 1.03, $p \leq 0.01$); however, cause and effect are unclear. Furthermore, those who evacuated were more likely to inform themselves about river conditions and seek advice (Kakimoto & Yamada, 2016). A study (Haynes et al., 2017) on Australian flood fatalities between 1900 and 2015 showed that only very few fatalities occurred to those while being evacuated or rescued. A study from the United States (Drabek, 2001) looked at the impact on timely evacuation from workplaces and homes, reporting that the duration of impact had the highest effect on timely evacuation for both workplaces and their home. Further predictors identified for workplace evacuations where time in initial warning, gender, mandatory evacuation advisory at their home, manager's future risk perception as we as a mandatory evacuation advice for their workplace. Duration of impact, as well as time in initial warning, also affected timely evacuation at home; additional factors were magnitude of impact as well as emergent risk perception.

Adeola et al. (2009) report that the main influence on evacuation behaviour during Hurricane Katrina in the United States was persuasion from friends and families (28.9%,

n=173), followed by prior experience with hurricanes and floods (21.9%, n=131), personal intuition (14.0%, n=84), mandatory enforcement (12.2%, n=73), and mass media (9.4%, n=56). Only persuasion from friends and family was shown to have a significant influence in a logistic regression (B=0.219, p≤0.001). Furthermore, ethnicity and low socio-economic status were identified as leading to slow responses as well as a barrier to evacuation behaviours. A qualitative study (Adomah Bempah & Olav Øyhus, 2017) in Volta River, Ghana, communities showed that floods and other disasters are often perceived as acts of god leading to a lower intention to enact evacuation behaviours. Matsuda et al. (1990) reported that the main reason for not seeking refuge or to evacuate was that participants thought it would be safer to stay home (57.4%, n=194), followed by curiosity to see what will happen (43%, n=144) and initiating other behaviours such as mitigation (20.4%, n=69). The Haynes et al. (2018) paper also identified several reasons why participants stayed at home instead of seeking shelter with most participants assuming that it would be safe to stay at home (35%, n=114), followed by not believing that their property will be affected (22%, n=73), with other reasons being related to protecting or caring for their property, pets or dependent family members. Qualitative data from the same study is supportive of these findings.

Protecting property. The protection of private or common property is one of the most common behaviours exercised during floods (Few & Pham, 2010). Neal et al. (2011) examined emergent behaviours during a flood in Kingston upon Hull, United Kingdom and reported that residents were likely to engage in activities that were not their responsibility such as building sandbag walls to protect common or other residents' property. Most other studies, however, focussed purely on the protection of private property. These behaviours include draining water away from homes with buckets (38.6%, n=333) in flood-prone villages in Lagos, Nigeria (Ajibade et al., 2015); raising items (65%), sandbagging homes (13%), clearing drains (8%), or relying on flood resilient buildings (7%) in the 2011

Brisbane, Australia floods (Box et al., 2016); and engaging in general preventative behaviour (21%, n=49) after a flood warning in the Italian region of Cesenatico (De Dominicis, Fornara, Ganucci Cancellieri, Twigger-Ross, & Bonaiuto, 2015).

Other studies have reported similar behaviours; however, the application of behaviours varied between studies. Duclos et al. (1991) reported that saving personal belongings as the main concern of the 8% of flash flood survivors in Nimes, France, followed by preventing water from entering the house/removing water (7%). Small scale mitigation behaviours were much higher in Maitland and Newcastle, Australia with 84% and 86% of residents lifting contents higher to prevent flood damages (Molinari & Handmer, 2011). A German study (Thieken, Kreibich, Müller, & Merz, 2007) reported that the majority of participants did not undertake emergency measurements after a flood warning as it was perceived to be too late to take measurements (65.1%, n=185) or because nobody was home (18.8%, n=52). Those who did undertake emergency measures to protect their property reported a wide range of measures including putting moveables contents upstairs (55%), parking vehicles in a flood-safe space (55%), safeguarding documents and other valuables (52%), and protecting the building against inflowing water (50%); other reasons include disconnecting appliances or protecting against damages from oil, gas or electricity supplies.

In a study in Pakistan (Said et al., 2015), only a small minority of participants residing in a designated flood cluster undertook mitigation action (mean: 0.20, SD: 0.40) with more people believing that ‘nothing works to protect against flood losses’ (mean: 0.33, SD: 047). This is in contrast to a study from the Mekong Delta, Vietnam, (Chinh do, Bubeck, Dung, & Kreibich, 2016) in which a large proportion of participants reported to have undertaken emergency measurements to protecting business and private property including moving furniture (60%, n=227; 68%, n=326), vehicles (24%, n=91; 25%, n=120), other valuables (48%, n=181; 50%, n=240), and products (58%, n=219) as well as generally flood-proofing

their home or business. Similarly, participants in a study from Ghana (Adomah Bempah & Olav Øyhus, 2017) described that mitigation actions are rarely taken due to the perception of natural disasters being 'an act of god'. Only one study commented on the potential risk of undertaking protective behaviours; Haynes et al. (2017) stated that 9% (n=168) of all flood-related deaths in Australia between 1900 and 2015 can be attributed to rescuing people, property, or pets.

Rescuing others. A study (Duclos et al., 1991) on flash flood survivors reported that saving their own lives and those of others were one the most common major concerns (19%) after participants realised the danger of the situation. This study also showed that people were most likely to be saved by members of the public such as their neighbours (40%, n=20) or family members (20%, n=10) rather than trained emergency services personnel such as firefighters (12%, n=6), the Red Cross (10%, n=5), or the army (8%, n=4). However, another study (F. Vinet, Lumbroso, Defossez, & Boissier, 2012) from France suggests that family members, particularly partners, may also pose a risk– many fatalities occurred in couples (n=22) whereas only five fatalities of just one partner dying were registered. The authors hypothesised that the wish to die as a couple might influence behaviour to evacuate and to rescue. Interviewees in a study conducted in Nigeria (Ajibade et al., 2013) perceived men to be more likely to enter floods to protect their family and rescue others than women due to societal expectations regarding gender norms.

A total of four people died while trying to rescue another person with two people injured during damaging hydrogeological events in the Italian Calabria region (Aceto et al., 2017). Ashley and Ashley (2008) reported that 9% of all fatalities during floods in the United States between 1959 and 2005 occurred while walking through floodwater of which 16% were related to rescuing another person, while French et al. (1983) reported a total of 6 (3%) deaths occurred during the rescue of another person in flash floods in the United States

between 1969 and 1981. In an Australian study (Haynes et al., 2017), 168 (9%) people died while rescuing people, property, or pets between 1900 and 2015. Jonkman and Kelman (2005) reported that 0.8% (n=2) of all deaths occurring in a series of non-systematic flood events in the United States and Europe occurred during a rescue attempt as well as one (0.4%) physical trauma.

Knowledge sharing and information seeking. People use a variety of sources to seek and share their knowledge during or immediately prior to a flood. For example, a study conducted by Krishna et al. (2018) in Tamil Nadu, India, found that children were commonly used to transport information between neighbours in small villages despite being perceived to be at higher risk during natural disasters. During the 2011 flood in Brisbane, Australia, most participants sourced their information from friends, families, and neighbours (39%); followed by the local government (22%), personal experience (13%), the media (7%), and others (20%) (Box et al., 2016). Bird et al. (2012) investigated the use of Facebook® as a medium of knowledge sharing during floods in Australia and overall found that both Government accounts as well as community-led Facebook® groups were perceived to be trustworthy with information perceived to be accurate and up-to-date. Almost all participants (99%) perceived the information provided in community Facebook® groups to be useful and joined these groups particularly for area-specific information for their communities (65%). Another study from Australia (Haynes et al., 2018) also found that social media platforms to be important factors in sharing and receiving knowledge during floods, particularly in regards to area-specific information.

Kakimoto and Yamada (2016) provided a more detailed analysis showing that residents of the Kumamoto and Iota Prefectures, Japan made a significant difference between information sourced depending on the type of information needed, with most people relying on themselves to gain information regarding river conditions or the weather (70% and 32%,

respectively), while relying on neighbours for seeking general advice (6%) and information regarding evacuations (25%). Other important sources for information regarding river conditions and weather were television or radio (12%/22%), and relatives and fire volunteers for information regarding general advice (11%/10%). Internet-based sourced and emails were the least sought-after source of information.

Participants in a Finnish study (Haataja, 2014) perceived information and knowledge received through radio broadcasts to be more up-to-date and relevant than official warnings. Mobile phones were seen as devices of potentially limited use during disasters as these are dependent on being charged and network connection which may not be possible during disasters; phones may also be on 'silent mode' making it difficult to communicate with others. However, they were nevertheless perceived as a good medium of communication and information through social media despite face-to-face communication with neighbours, friends and family being preferred; this personal contact was not expected from authorities.

Studies from Thailand have shown that internet-based information sources, particularly social media, may be beneficial in providing accurate and localised information (Allaire, 2016; Kaewkitipong, Chen, & Ractham, 2016). Bangkok, Thailand residents, for example, put more trust in information sought via social media compared to other online sources (87% vs. 66%) and showed a 37% reduction in flood losses per household compared to those not using social media as a source of information. Interviews with Thai officials have also shown that social media can be useful for information collection by authorities (Kaewkitipong et al., 2016). Another study from Thailand (Tim et al., 2017) confirmed the important role of social media during floods as a source information and social support, as well as a medium of communication. Participants agreed that information provided through social media is highly valuable due to its timely manner and focus on specific areas. Thai officials again perceived social media as a valuable tool to collect data during a natural

disaster and to better allocate resources. The potential value of social media during floods was also reported in a Malaysian study (Aisha, Wok, Manaf, & Ismail, 2015) in which participants reported to use WhatsApp®, Twitter® and Facebook® to seek and share knowledge and information with WhatsApp being perceived to have the highest value (mean: 3.57, SD: 1.45) followed by following newsfeeds on Twitter® or Facebook® in general (mean: 3.19, SD: 1.42) and following celebrities and politicians (mean: 2.59, SD: 1.36). However, social media only accounted for 4.3% of the variance in satisfaction from information sharing with WhatsApp® being the only significant predictor.

Only one study (Ahmad, Zani, & Hashim, 2015) analysing predictors of knowledge sharing among flood victims could be identified. In this study, among Malaysian flood victims, self-efficacy, social support, and social recognition were identified as significant positive predictors of knowledge sharing, whereas reciprocity did not predict willingness to share knowledge. Similarly, only one study examined how knowledge sharing directly affects behaviour. A qualitative study from Neal et al. (2011) among those affected by floods in Kington upon Hull, United Kingdom showed that behaviour during floods, particularly residents' willingness to exercise emergent behaviour, depends greatly on the rate of information transfer.

Flood warning behaviour. Systems aimed at warning populations of impending floods are installed in a number of countries. Bin Osman et al. (1994) conducted a survey among 35 households in flood-prone areas in the Kampung Morten Settlement, Malaysia, and found that, in a hypothetical flood warning, the majority of people will keep watch (42.9%, n=15), followed by doing nothing (20%, n=7), evacuate premises (17.2%, n=5), consult others (11.4%, n=4), temporary floodproofing measures (5.7%, n=2), and moving valuables/properties (2.9%, n=1).

Other studies examined behaviour after actual flood warnings. In a study (Molinari & Handmer, 2011) in two regions in New South Wales, Australia, respondents showed high rates of action after a flood warning was issued. Almost all participants (99%) took action to reduce flood loss including evacuation and a large majority lifted contents to an upper area (84-86%) and sought further information (76%). A more detailed study (G. Pescaroli & Magni, 2015) from the flood-prone area of Cesenatico, Italy, showed that the main behaviour taken after a flood warning was to warn others (20%, n=66), followed by seeking further information (23%, n=54), measures of protection (21%, n=49), doing nothing (18%, n=41), and seeking shelter (3%, n=7) or evacuate (2%, n=5). A study (Drobot et al., 2007) conducted in Austin and Denver, Unites States, showed that flood warning attitudes may have a significant impact and can prevent engaging in dangerous behaviour such as driving through floods. However, a study (Yale et al., 2003) on crash-fatalities in North Carolina, United States, during Hurricane Floyd showed that people still exercised risky behaviour after receiving a flood warning.

A study from Australia reported that (evacuation) orders and warnings are often not perceived as helpful by participants, potentially explaining why no action is undertaken; for example 28.84 (n=87) strongly disagreed that they understood if their property was likely to be affected whereas 35.82% (n=107) did not receive the evacuation warning with enough time. Similar reasons were identified in a study conducted in Germany by Thieken et al. (2007) in which most participants who did not undertake emergency measures after a flood warning argued that it was ‘too late to do anything’ (65.1%, n=185) followed by not being at home during the time (18.3%, n=52), not perceiving emergency measures as relevant (8.8%, n=25) and underestimating the seriousness of the impending flood (5.3%, n=15); all other reasons were mentioned by less than five percent of participants.

Diet and Hygiene

Four studies reported dietary and hygiene behaviour during floods in low-income countries. Few et al. (2013) reported that participants in Vietnam hold the belief that diarrhoeal disease is more common in flood season and adjust their dietary behaviour accordingly by drinking more rainwater rather than river water. A qualitative study (Goudet, Griffiths, Bogin, & Selim, 2011) in the Dhaka Slums, Bangladesh, reported that mothers are often underweight during flood periods resulting in an inability to produce sufficient maternal milk. Children's diets were often substituted with inappropriate or malnutritious food due to an absence or unaffordability of nutritious food and fresh vegetables during floods. This is consistent with another qualitative study from Bangladesh (Akhter et al., 2015), reporting the absence of nutritious food and fresh vegetables during floods as well as the absence of firewood and clean water. Finally, a study from India (Krishna et al., 2018) reported a lack of fresh and nutritious food during floods leading to a higher vulnerability of children during floods and an increase in risky behaviours such as entering floods to provide children with sufficient food and water.

Discussion

Globally, flooding is a common natural disaster, with drowning thought to be a leading cause of death. As much flood-related mortality and morbidity is preventable and often the result of individuals' behavioural responses in the flood event, gaining a better understanding of people's flood-related behaviour is important so that prevention strategies can target these behaviours and the underpinning mechanisms that guide these risky acts (Ruin, Lutoff, & Shabou, 2017). This is also true of the after-effects of flooding, described as cascading crises (Kachali et al., 2018; Gianluca Pescaroli, 2018; Serre & Heinzlef, 2018), where impacts are often felt long after the initial flood event has concluded, although this study does not address this step in the management of human behaviour in crises and

disasters. Rather, this study focused on understanding human behavioural responses as they occur in a flood event in which behaviours are commonly a response to the characteristics of a flood (Penning-Rowsell et al., 2005). This systematic review identified 54 studies on human behaviour in and around floodwater, including behavioural patterns as well as protective and risk factors. Key themes were identified as well as knowledge gaps in the existing literature where further evidence will support efforts to prevent mortality and morbidity associated with floods.

Activities and Risk-taking Behaviours

A total of 24 studies that reported data on activities and risk-taking behaviours associated with floods were identified. Most reported data on entering floodwaters in vehicles or on foot, although recreational activities (e.g., surfing, boating) were also identified but the number of studies were small and findings less consistent. The more consistent evidence for behaviours associated with entering into floodwater suggests strategies are urgently needed that focus on individuals' decisions to engage in acts (e.g., driving into floodwater, walking into floodwater) that may put them at risk. As identified in this review, behavioural research is emerging that explores the psychological motivations behind risky flood-related behaviour, specifically driving into (Hamilton, Peden, Pearson, et al., 2016) and avoiding driving into floodwaters (Hamilton, Price, et al., 2018). This research demonstrates that social psychological factors (e.g., attitudes, social norms, self-efficacy) are important to consider in designing interventions aimed at affecting individuals' behavioural decisions in floods, and that sex-specific targeting of messages may also be important to consider (Hamilton, Peden, et al., 2018). For example, research on changing people's beliefs and motives toward driving into floodwaters through the use of a video infographic in Australia (Hamilton, Peden, et al., 2018) found that, at one-month follow-up, positive changes in beliefs were present in females but not in males. While females are at risk from flood-related incidents, males account for a

higher proportion of fatalities associated with entering floodwaters than females (Peden et al., 2017). Male norms and cultural factors, such as the need to protect (Ajibade et al., 2013), may explain why men more often enter floodwater than women. The current literature, however, is too scant to draw conclusions about sex specific differences, or indeed conclusions about demographic factors in general (e.g., age, socio-economic status, education level), in relation to flood-related behaviours and, thus, more research is required.

Loss Reduction, Knowledge, and Warnings

A total of 37 studies were found reporting data on loss reduction, knowledge, and warnings with human flood-related behaviour. Effective response actions, such as evacuation and relocation, are key to saving lives during floods (Adeola, 2009). However, people's response to evacuate is varied and may depend on the country and type of event. For example, rates of evacuation in flood events in developed countries (e.g., Australia) seem to be higher than those in developing countries (e.g., Nigeria) (Ajibade et al., 2015; Box et al., 2016). Some research has identified potential factors that might influence evacuation behaviour including pet ownership (Taylor et al., 2015), safety (Duclos et al., 1991), endangerment of life (Matsuda, 1990), higher risk perceptions (Kakimoto & Yamada, 2016), and persuasion from friends and family (Adeola, 2009). The latter finding is consistent with evidence suggesting that flood information is garnered more readily from proximal sources such as friends, family, and neighbours than from more distal sources such as government or media (Box et al., 2016; Kakimoto & Yamada, 2016).

Although findings from the current review, due to study focus and selection criteria, are too scant to draw definitive conclusions on those factors that might affect evacuation behaviour, a recent systematic review on evacuation during natural disasters provides further insights (Thompson, Garfin, & Silver, 2017). In their review, and consistent with this review, the authors found risk perceptions was a consistent positive predictor of evacuation, along

with several demographic factors, prior evacuation behaviour, and having an evacuation plan. Furthermore, findings from the current review were also too scant to draw definitive conclusions on those factors that might affect knowledge sharing. Despite this, it seems important to note that flood knowledge information and awareness and appropriate flood evacuation actions are needed at the community face-to-face level to have greater impact, although non-traditional flood information sources (such as social media) should not be dismissed and these new technologies as a source of information provision are emerging as being effective in providing accurate information (Aisha et al., 2015; Allaire, 2016; Bird et al., 2012; Kaewkitipong et al., 2016; Ruin et al., 2017; Tim et al., 2017). Regardless of the method of information delivery, future research should draw on behavioural psychology methods to design a set of consistent messages shown to be effective in communicating knowledge about flood risk and the need to evacuate.

Protecting property and rescuing others were other common behaviours that are exercised during floods. Mitigation actions (e.g., raising items, placing sandbags) to protect personal and common property are common human behaviours during floods and perhaps grounded in the classic fight-or-flight response which is generally regarded as the prototypic human response to stress (Box et al., 2016; Neal et al., 2011). In line with the fight-or-flight response, such actions in some cases can prevent evacuation (Haynes et al., 2017), and thus, increased chance of loss of life. What remains unclear are the processes that guide individuals' decisions to protect their property versus evacuate; future research should try and unpack these cognitive processes. Rescuing others is also a potentially risky behaviour that can result in loss of life, particularly among untrained members of the public (Ashley & Ashley, 2008; French et al., 1983; Haynes et al., 2017; F. Vinet et al., 2012). These acts are perhaps driven more by emotional responses to save others, which is evident in studies that show people are more likely to be saved by proximal others, such as neighbours and family

members than by distal others such as firefighters and the Red Cross (Duclos et al., 1991). Given the loss of life and potential for injury as a result of rescuing others and the emotional turmoil of wanting to save loved ones, more research is needed to understand how rescuing decisions are reached in these high-stress situations.

Diet and Hygiene

Flood-related human behaviours extend beyond loss of life or property loss. This review identified two studies that highlighted the impact of flooding on diet and hygiene. While one study focused on the need for safe drinking water for flood-prone communities in Vietnam, the other highlighted the dietary impact on mothers (and their babies) of food supply that is disrupted due to flooding. Both studies highlight the broader impacts of floods on human behaviours. These findings suggest that systems to mitigate the effects of flooding go beyond preventing death, serious injury, and property loss, which was beyond the scope of this review to unpack and should be further investigated.

Limitations

This systematic review was limited by the examination of peer-reviewed literature in English and German languages only, and a focus on behavioural responses during time of unexpected rather than expected flood events. Thus, other steps in the process of effective crisis and disaster management such as planning and preparedness activities before a crisis or disaster, and final resolution to a new or improved state after the crisis or disaster is over, were not investigated (Ritchie, 2008, 2009). Evidence included in this review may also be a limitation. Some of the included publications missed important, basic information such as the time-frame of data collection or the sample size (see Table 1). Furthermore, most publications included in this review relied on data gathered by surveys and databases. Cross-sectional surveys are regularly considered to be the lowest quality of evidence in health research (National Health and Medical Research Council, 2009), and are, among others,

prone to selection and participation bias. The effects of participation bias may be even stronger in studies conducted during or shortly after a natural disaster. Stressful life events may also heighten the risk of recall bias. Similarly, database research may not identify all relevant cases for a study as a result of faulty and/or missing entries. Additionally, this review did not specifically aim at exploring impacts on flood behaviour of specific populations such as vulnerable groups (e.g., people living with a disability or linguistic minorities).

Conclusion

This systematic review identified a range of human behaviours in and around floodwater during a flood event, with common themes being activities and risk-taking behaviours; loss reduction, knowledge, and warnings; and diet and hygiene. This review also had limitations which prevented definitive conclusions being made. What does seem apparent is the limited knowledge of the social psychological mechanisms that guide behavioural responses in a flood event. This knowledge is important to gain given flood damages to society also include psychological consequences (Tapsell, 2011). Further exploration of methods to improve preparedness, increase the likelihood of evacuation, and reduce 'risky' behaviour during floods is needed. Future studies should prioritise addressing these gaps to enhance the evidence-base for reducing the impact of floods including flood-related mortality and morbidity.

References

Aceto, L., Aurora Pasqua, A., & Petrucci, O. (2017). Effects of damaging hydrogeological events on people throughout 15 years in a Mediterranean region. *Advances in Geosciences, 44*, 67-77. doi:10.5194/adgeo-44-67-2017

Adeola, F. O. (2009). Katrina cataclysm: Does duration of residency and prior experience affect impacts, evacuation, and adaptation behavior among survivors? *Environment and Behavior, 41*(4), 459-489. doi:10.1177/0013916508316651

Adomah Bempah, S., & Olav Øyhus, A. (2017). The role of social perception in disaster risk reduction: Beliefs, perception, and attitudes regarding flood disasters in communities along the Volta River, Ghana. *International Journal of Disaster Risk Reduction, 23*, 104-108. doi:10.1016/j.ijdrr.2017.04.009

Ahmad, M., Zani, N. M., & Hashim, K. F. (2015). Knowledge sharing behavior among flood victims in Malaysia. *ARPN Journal of Engineering and Applied Sciences, 10*(3), 968-976.

Aisha, T. S., Wok, S., Manaf, A. M. A., & Ismail, R. (2015). Exploring the use of social media during the 2014 flood in Malaysia. *Procedia - Social and Behavioral Sciences, 211*, 931-937. doi:10.1016/j.sbspro.2015.11.123

Ajibade, I., Armah, F. A., Kuuire, V. Z., Luginaah, I., McBean, G., & Tenkorang, E. Y. (2015). Assessing the bio-psychosocial correlates of flood impacts in coastal areas of Lagos, Nigeria. *Journal of Environmental Planning and Management, 58*(3), 445-463. doi:10.1080/09640568.2013.861811

Ajibade, I., McBean, G., & Bezner-Kerr, R. (2013). Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. *Global Environmental Change, 23*(6), 1714-1725. doi:10.1016/j.gloenvcha.2013.08.009

Akhter, Syeda R., Sarkar, Ratan K., Dutta, M., Khanom, R., Akter, N., Chowdhury, M. R., & Sultan, M. (2015). Issues with families and children in a disaster context: A qualitative perspective from rural Bangladesh. *International Journal of Disaster Risk Reduction, 13*, 313-323. doi:10.1016/j.ijdrr.2015.07.011

Alam, K., & Rahman, M. H. (2014). Women in natural disasters: A case study from southern coastal region of Bangladesh. *International Journal of Disaster Risk Reduction, 8*, 68-82. doi:10.1016/j.ijdrr.2014.01.003

Alexander, D. E. (2000). *Confronting catastrophe: New perspectives on natural disasters*. New York, United States: Oxford University Press.

Allaire, M. C. (2016). Disaster loss and social media: Can online information increase flood resilience? *Water Resources Research, 52*(9), 7408-7423. doi:10.1002/2016wr019243

Apel, H., Aronica, G. T., Kreibich, H., & Thieken, A. H. (2009). Flood risk analyses—how detailed do we need to be? *Natural hazards, 49*(1), 79-98. doi:10.1007/s11069-008-9277-8

Ashley, S. T., & Ashley, W. S. (2008). Flood fatalities in the United States. *Journal of Applied Meteorology and Climatology, 47*(3), 805-818. doi:10.1175/2007jamc1611.1

Becker, J. S., Taylor, H. L., Doody, B. J., Wright, K. C., Gruntfest, E., & Webber, D. (2015). A review of people's behavior in and around floodwater. *Weather Climate and Society, 7*(4), 321-332. doi:10.1175/wcas-d-14-00030.1

Bin Osman Salleh, K. (1994). Perception of and adaptation to flood hazard - a preliminary study. *Malaysian Journal of Tropical Geography, 25*(2), 99-106.

Bird, D., Ling, M., & Haynes, K. (2012). Flooding Facebook-the use of social media during the Queensland and Victorian floods. *Australian Journal of Emergency Management, The, 27*(1), 27.

Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (2005). *At risk: natural hazards, people's vulnerability and disasters*. London, United Kingdom: Routledge.

Box, P., Bird, D., Haynes, K., & King, D. (2016). Shared responsibility and social vulnerability in the 2011 Brisbane flood. *Natural hazards, 81*(3), 1549-1568. doi:10.1007/s11069-016-2145-z

Centers for Disease Control and Prevention (CDC). (2012). Early warning disease surveillance after a flood emergency--Pakistan, 2010. *MMWR Morb Mortal Wkly Rep, 61*(49), 1002-1007.

Chang, C. T. (2016). A preliminary study on mortality attributed to tropical cyclones in Taiwan 2000–2014. *Environmental Hazards, 15*(2), 178-187. doi:10.1080/17477891.2016.1167011

Chinh do, T., Bubeck, P., Dung, N. V., & Kreibich, H. (2016). The 2011 flood event in the Mekong Delta: preparedness, response, damage and recovery of private households and small businesses. *Disasters, 40*(4), 753-778. doi:10.1111/disa.12171

Coates, L. (1999). Flood fatalities in Australia, 1788-1996. *Australian Geographer, 30*(3), 391-408. doi:10.1080/00049189993657

De Dominicis, S., Fornara, F., Ganucci Cancellieri, U., Twigger-Ross, C., & Bonaiuto, M. (2015). We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. *Journal of Environmental Psychology, 43*, 66-78. doi:10.1016/j.jenvp.2015.05.010

Di Mauro, M., De Bruijn, K. M., & Meloni, M. (2012). Quantitative methods for estimating flood fatalities: Towards the introduction of loss-of-life estimation in the assessment of flood risk. *Natural hazards, 63*(2), 1083-1113. doi:10.1007/s11069-012-0207-4

Diakakis, M., & Deligiannakis, G. (2013). Vehicle-related flood fatalities in Greece. *Environmental Hazards, 12*(3-4), 278-290. doi:10.1080/17477891.2013.832651

Diakakis, M., & Deligiannakis, G. (2015). Flood fatalities in Greece: 1970–2010. *Journal of Flood Risk Management*. doi:10.1111/jfr3.12166

Diakakis, M., & Deligiannakis, G. (2016). Changes in flood mortality during the last 50 years in Greece. *Bulletin of the Geological Society of Greece, 47*(3), 1397-1406.

Diakakis, M., & Deligiannakis, G. (2017). Flood fatalities in Greece: 1970–2010. *Journal of Flood Risk Management, 10*(1), 115-123. doi:10.1111/jfr3.12166

Doocy, S., Daniels, A., Murray, S., & Kirsch, T. D. (2013). The human impact of floods: A historical review of events 1980-2009 and systematic literature review. *PLoS Currents Disasters*(APR 2013). doi:10.1371/currents.dis.f4deb457904936b07c09daa98ee8171a

Drabek, T. E. (2001). Disaster warning and evacuation responses by private business employees. *Disasters, 25*(1), 76-94. doi:10.1111/1467-7717.00163

Drobot, S. D., Benight, C., & Gruntfest, E. C. (2007). Risk factors for driving into flooded roads. *Environmental Hazards, 7*(3), 227-234. doi:10.1016/j.envhaz.2007.07.003

Duclos, P., Vidonne, O., Beuf, P., Perray, P., & Stoebner, A. (1991). Flash flood disaster-nîmes, France, 1988. *European Journal of Epidemiology, 7*(4), 365-371. doi:10.1007/bf00145001

Easterling, D. R., Evans, J. L., Groisman, P. Y., Karl, T. R., Kunkel, K. E., & Ambenje, P. (2000). Observed variability and trends in extreme climate events: A brief review. *Bulletin of the American Meteorological Society, 81*(3), 417-426. doi:10.1175/1520-0477(2000)081<0417:ovatie>2.3.co;2

Few, R., Lake, I., Hunter, P. R., & Tran, P. G. (2013). Seasonality, disease and behavior: Using multiple methods to explore socio-environmental health risks in the Mekong Delta. *Social Science & Medicine, 80*, 1-9. doi:10.1016/j.socscimed.2012.12.027

Few, R., & Pham, G. T. (2010). Climatic hazards, health risk and response in Vietnam: Case studies on social dimensions of vulnerability. *Global Environmental Change-Human and Policy Dimensions, 20*(3), 529-538. doi:10.1016/j.gloenvcha.2010.02.004

Fitzgerald, G., Du, W., Jamal, A., Clark, M., & Hou, X. Y. (2010). Flood fatalities in contemporary Australia (1997-2008): Disaster medicine. *EMA - Emergency Medicine Australasia, 22*(2), 180-186. doi:10.1111/j.1742-6723.2010.01284.x

Franklin, R. C., King, J. C., Aitken, P. J., & Leggat, P. A. (2014). "Washed away"—assessing community perceptions of flooding and prevention strategies: a North Queensland example. *Natural hazards, 73*(3), 1977-1998. doi:10.1007/s11069-014-1180-x

French, J., Ing, R., Von Allmen, S., & Wood, R. (1983). Mortality from flash floods: a review of National Weather Service reports, 1969-81. *Public Health Reports, 98*(6), 584.

Gissing, A., Haynes, K., Coates, L., & Keys, C. (2016). Motorist behaviour during the 2015 Shoalhaven floods. *Australian Journal of Emergency Management, 31*(2), 25-30. Retrieved from <Go to ISI>://WOS:000381423000006

Goudet, S. M., Griffiths, P. L., Bogin, B. A., & Selim, N. (2011). Impact of flooding on feeding practices of infants and young children in Dhaka, Bangladesh Slums: What are the coping strategies? *Maternal and Child Nutrition, 7*(2), 198-214. doi:10.1111/j.1740-8709.2010.00250.x

Haataja, M. (2014). Citizens' communication habits and use of ICTs during crises and emergencies. *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments, 10*(2), 138-152. doi:10.17011/ht/urn.201411203314

Hamilton, K., Peden, A. E., Keech, J. J., & Hagger, M. S. (2016). *Driving through floodwater: exploring driver decisions through the lived experience.* Paper presented at the European Health Psychologist, Aberdeen, United Kingdom.

Hamilton, K., Peden, A. E., Keech, J. J., & Hagger, M. S. (2018). Changing people's attitudes and beliefs toward driving through floodwaters: Evaluation of a video infographic. *Transportation Research Part F, 53*, 50-60.

Hamilton, K., Peden, A. E., Keech, J. J., & Hagger, M. S. (2019). Driving through floodwater: Exploring driver decisions through the lived experience. *International Journal of Disaster Risk Reduction, 34*, 346-355. doi:10.1016/j.ijdrr.2018.12.019

Hamilton, K., Peden, A. E., Pearson, M., & Hagger, M. S. (2016). Stop there's water on the road! Identifying key beliefs guiding people's willingness to drive through flooded waterways. *Safety Science, 89*, 308-314. doi:10.1016/j.ssci.2016.07.004

Hamilton, K., Price, S., Keech, J. J., Peden, A. E., & Hagger, M. S. (2018). Drivers' experiences during floods: investigating the psychological influences underpinning decisions to avoid driving through floodwater. *International Journal of Disaster Risk Reduction, 28*, 507-518. doi:10.1016/j.ijdrr.2017.12.013

Haynes, K., Coates, L., van den Honert, R., Gissing, A., Bird, D., de Oliveira, F. D., . . . Radford, D. (2017). Exploring the circumstances surrounding flood fatalities in Australia — 1900–2015 and the implications for policy and practice. *Environmental Science & Policy, 76*, 165-176. doi:10.1016/j.envsci.2017.07.003

Haynes, K., Tofa, M., Avci, A., van Leeuwen, J., & Coates, L. (2018). Motivations and experiences of sheltering in place during floods: Implications for policy and practice. *International Journal of Disaster Risk Reduction, 31*, 781-788. doi:10.1016/j.ijdrr.2018.07.011

Heath, S. E., Kass, P. H., Beck, A. M., & Glickman, L. T. J. A. j. o. e. (2001). Human and pet-related risk factors for household evacuation failure during a natural disaster. *153*(7), 659-665.

Jonkman, S. N., & Kelman, I. (2005). An analysis of the causes and circumstances of flood disaster deaths. *Disasters, 29*(1), 75-97. doi:10.1111/j.0361-3666.2005.00275.x

Kachali, H., Storsjö, I., Haavisto, I., & Kovács, G. J. I. j. o. d. r. r. (2018). Inter-sectoral preparedness and mitigation for networked risks and cascading effects. *30*, 281-291.

Kaewkitipong, L., Chen, C. C., & Ractham, P. (2016). A community-based approach to sharing knowledge before, during, and after crisis events: A case study from Thailand. *Computers in Human Behavior, 54*, 653-666. doi:10.1016/j.chb.2015.07.063

Kakimoto, R., & Yamada, F. (2016). Autonomous evacuation and local community. *International Journal of Disaster Resilience in the Built Environment, 7*(4), 374-387. doi:10.1108/IJDRBE-07-2014-0055

Keech, J. J., Smith, S. R., Peden, A. E., Hagger, M. S., & Hamilton, K. (2019). The lived experience of rescuing people who have driven into floodwater: understanding challenges and identifying areas for providing support. *Health Promotion Journal of Australia, 30*(2), 252-257. doi:10.1002/hpja.181

Krishna, R. N., Ronan, K. R., & Alisic, E. (2018). Children in the 2015 South Indian floods: community members' views. *European Journal of Psychotraumatology, 9*(Sup2), 1486122. doi:10.1080/20008198.2018.1486122

Lu, Q. C., Zhang, J., Peng, Z. R., & Rahman, A. B. M. S. (2014). Inter-city travel behaviour adaptation to extreme weather events. *Journal of Transport Geography, 41*, 148-153. doi:10.1016/j.jtrangeo.2014.08.016

Matsuda, I. (1990). Refuge-seeking behavior during rain-induced disaster: in the case of four districts damaged by Typhoon Number 10, 1986. *Geographical Reports - Tokyo Metropolitan University, 25*, 237-247.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health education quarterly, 15*(4), 351-377.

Molinari, D., & Handmer, J. (2011). A behavioural model for quantifying flood warning effectiveness. *Journal of Flood Risk Management, 4*(1), 23-32. doi:10.1111/j.1753-318X.2010.01086.x

National Health and Medical Research Council. (2009). *NHMRC additional levels of evidence and grades for recommendations for developers of guidelines.* Canberra, Australia Retrieved from https://www.nhmrc.gov.au/_files_nhmrc/file/guidelines/developers/nhmrc_levels_grades_evidence_120423.pdf

Neal, R., Bell, S., & Wilby, J. (2011). Emergent disaster response during the June 2007 floods in Kingston upon Hull, UK. *Journal of Flood Risk Management, 4*(3), 260-269. doi:10.1111/j.1753-318X.2011.01110.x

Patz, J. A., Engelberg, D., & Last, J. (2000). The effects of changing weather on public health. *Annual Review of Public Health, 21*, 271-307. doi:10.1146/annurev.publhealth.21.1.271

Pearson, M., & Hamilton, K. (2014). Investigating driver willingness to drive through flooded waterways. *Accident Analysis and Prevention, 72*, 382-390. doi:10.1016/j.aap.2014.07.018

Peden, A. E., Franklin, R. C., & Leggat, P. A. (2018). The flood-related behaviour of river users in Australia. *PLoS Currents Disasters, 10*.

Peden, A. E., Franklin, R. C., Leggat, P. A., & Aitken, P. (2017). Causal pathways of flood related river drowning deaths in Australia. *PLoS Currents Disasters*. doi:10.1371/currents.dis.001072490b201118f0f689c0fbe7d437

Pelling, M. (2003). Paradigms of risk. In M. Pelling (Ed.), *Natural Disaster and Development in a Globalizing World* (pp. 19-32). London, United Kingdom: Routledge.

Penning-Rowsell, E., Floyd, P., Ramsbottom, D., & Surendran, S. (2005). Estimating Injury and Loss of Life in Floods: A Deterministic Framework. *Natural hazards, 36*(1), 43-64. doi:10.1007/s11069-004-4538-7

Pereira, S., Diakakis, M., Deligiannakis, G., & Zêzere, J. L. (2017). Flood mortality in Portugal and Greece (Western and Eastern Mediterranean). *International Journal of Disaster Risk Reduction*. doi:10.1016/j.ijdrr.2017.03.007

Pescaroli, G. (2018). Perceptions of cascading risk and interconnected failures in emergency planning: Implications for operational resilience and policy making. *International Journal of Disaster Risk Reduction, 30*(Part B), 269-280. doi:10.1016/j.ijdrr.2018.01.019

Pescaroli, G., & Magni, M. (2015). Flood warnings in coastal areas: how do experience and information influence responses to alert services? *Natural Hazards and Earth System Sciences, 15*(4), 703-714. doi:10.5194/nhess-15-703-2015

Plate, E. J. (2002). Flood risk and flood management. *Journal of Hydrology, 267*(1), 2-11. doi:10.1016/S0022-1694(02)00135-X

Ritchie, B. W. (2008). Tourism disaster planning and management: From response and recovery to reduction and readiness. *Current issues in Tourism, 11*(4), 315-348. doi:10.1080/13683500802140372

Ritchie, B. W. (2009). *Crisis and disaster management for tourism*. Clevedon, United Kingdom: Channel View.

Ruin, I., Lutoff, C., & Shabou, S. (2017). Anticipating or coping: Behaviors in the face of flash floods. In F. Vinet (Ed.), *Floods. Volume 2 - Risk managment* (pp. 259-275). Oxford, United Kingdom: Elsevier.

Said, F., Afzal, U., & Turner, G. (2015). Risk taking and risk learning after a rare event: Evidence from a field experiment in Pakistan. *Journal of Economic Behavior & Organization, 118*, 167-183. doi:10.1016/j.jebo.2015.03.001

Sallis, J. F., & Owen, N. (2002). Ecological models of health behavior. In K. Glanz, B. K. Rimer, & F. M. Lews (Eds.), *Health Behavior and Health Education* (pp. 185-209). San Francisco, United States: Jossey-Bass.

Salvati, P. P., O; Rossi, M; Bianchi, C; Pasqua, A. A.; Guzzetti, F. (2018). Gender, age and circumstances analysis of flood and landslide fatalities in Italy. *Science of the Total Environment, 610-611*, 867-879. doi:10.1016/j.scitotenv.2017.08.064

Serre, D., & Heinzlef, C. (2018). Assessing and mapping urban resilience to floods with respect to cascading effects through critical infrastructure networks. *International Journal of Disaster Risk Reduction, 30*, 235-243. doi:10.1016/j.ijdrr.2018.02.018

Shabanikiya, H., Seyedin, H., Haghani, H., & Ebrahimian, A. (2014). Behavior of crossing flood on foot, associated risk factors and estimating a predictive model. *Natural hazards, 73*(2), 1119-1126. doi:10.1007/s11069-014-1124-5

Shaluf, I. M., Ahmadun, F. l.-r., & Mat Said, A. (2003). A review of disaster and crisis. *Disaster Prevention and Management, 12*(1), 24-32. doi:10.1108/09653560310463829

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., . . . Stewart, L. A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BRitish Medical Journal, 349*. doi:10.1136/bmj.g7647

Staes, C., Orengo, J. C., Malilay, J., Rullán, J., & Noji, E. (1994). Deaths due to flash floods in Puerto Rico, January 1992: implications for prevention. *International journal of epidemiology, 23*(5), 968-975. doi:10.1093/ije/23.5.968

Stokols, D. (1992). Establishing and maintaining healthy environments: Toward a social ecology of health promotion. *American psychologist, 47*(1), 6.

Stroup, D. F., Berlin, J. A., Morton, S. C., Olkin, I., Williamson, G. D., Rennie, D., . . . Thacker, S. B. (2000). Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *Jama, 283*(15), 2008-2012. doi:10.1001/jama.283.15.2008

Tapsell, S. (2011). Socio-psychological dimensions of flood risk management. In G. Pender & H. Faulkner (Eds.), *Flood risk science and management*. Oxford, United Kingdom: Wiley-Blackwell.

Taylor, M., Lynch, E., Burns, P., & Eustace, G. (2015). The preparedness and evacuation behaviour of pet owners in emergencies and natural disasters. *Australian Journal of Emergency Management, 30*(2), 18-23. Retrieved from <Go to ISI>://WOS:000381421400005

Thieken, A. H., Kreibich, H., Müller, M., & Merz, B. (2007). Coping with floods: preparedness, response and recovery of flood-affected residents in Germany in 2002. *Hydrological Sciences Journal, 52*(5), 1016-1037. doi:10.1623/hysj.52.5.1016

Thompson, R. R., Garfin, D. R., & Silver, R. C. (2017). Evacuation from natural disasters: a systematic review of the literature. *Risk analysis, 37*(4), 812-839.

Tim, Y., Pan, S. L., Ractham, P., & Kaewkitipong, L. (2017). Digitally enabled disaster response: the emergence of social media as boundary objects in a flooding disaster. *Information Systems Journal, 27*(2), 197-232. doi:10.1111/isj.12114

Vinet, F., Boissier, L., & Saint-Martin, C. (2016). *Flashflood-related mortality in southern France: first results from a new database.* Paper presented at the E3S Web of Conferences.

Vinet, F., Lumbroso, D., Defossez, S., & Boissier, L. (2012). A comparative analysis of the loss of life during two recent floods in France: the sea surge caused by the storm Xynthia and the flash flood in Var. *Natural hazards, 61*(3), 1179-1201. doi:10.1007/s11069-011-9975-5

Vorst, H. C. M. (2010). Evacuation models and disaster psychology. *Procedia Engineering, 3*, 15-21. doi:10.1016/j.proeng.2010.07.004

Watson, J. T., Gayer, M., & Connolly, M. A. (2007). Epidemics after natural disasters. *Emerging infectious diseases, 13*(1), 1-5. doi:10.3201/eid1301.060779

World Health Organization. (2014). *Global report on drowning: Preventing a leading killer* Retrieved from Geneva, Switzerland: https://www.who.int/violence_injury_prevention/global_report_drowning/en/

Yale, J. D., Cole, T. B., Garrison, H. G., Runyan, C. W., & Ruback, J. K. R. (2003). Motor vehicle-related drowning deaths associated with inland flooding after hurricane floyd: A field investigation. *Traffic injury prevention, 4*(4), 279-284. doi:10.1080/714040485

Zhong, S., Clark, M., Hou, X. Y., Zang, Y. L., & Fitzgerald, G. (2013). 2010-2011 Queensland floods: Using Haddon's Matrix to define and categorise public safety strategies. *EMA - Emergency Medicine Australasia, 25*(4), 345-352. doi:10.1111/1742-6723.12097

Table 1: Characteristics of included Studies (n=54)

Reference	Country (area within country)	Year(s)*	Type of Study	Type of Event	Sample Size	Themes
Aceto (2017)	Italy (Calabria Region)	2000-2014	Database	Damaging Hydrogeological Events	3,211 (effected)	1.2, 1.3, 2.5
Adeola (2009)	United States	2005-2006	Survey, interviews	Hurricane (specific)	598 (survey) 25 (interviews)	2.3
Adomah Bempah (2017)	Ghana (Volta River Communities)	2010-2011	Interviews	Flood (specific)	60	2.3, 2.4
Ahmad (2015)	Malaysia	Unclear	Survey	Flood (specific)	108 (complete responses)	2.1
Aisha (2015)	Malaysia (East Coast)	2014/2015	Survey	Flood (specific)	507	2.1
Ajibade (2013)	Nigria (Lagos)	Unclear	Survey, in-depth interviews	Floods (general)	453 (survey) 36 (in-depth interviews)	1.3, 2.5
Ajibade (2015)	Nigeria (Lagos Coastal Areas)	2011	Survey	Flood (specific)	1,003	2.3, 2.4
Akhter (2015)	Bangladesh (Bhola & Shatkhira)	Unclear	In-depth interviews, focus group	Flood (specific)	4 (in-depth interviews) 24 (focus group)	3
Allaire (2016)	Thailand (Bangkok Area)	2012-2013	Survey, in-depth interviews	Flood (specific)	469 (Survey) 23 (in-depth interviews)	2.1
Alam (2014)	Bangladesh (Patharghata Upazila)	2013	Survey	Natural Disasters (general)	105 households	2.3
Ashley (2008)	United States	1959-2005	Database	Floods (general)	4,586 (fatalities)	1.2, 1.3, 2.5
Bin Osman (1994)	Malaysia (Kampung Morten Settlement)	Unclear (>1989)	Survey	Flood-prone Area	35 households	2.2
Bird (2012)	Australia (Queensland & Victoria)	2011	Survey	Flood (specific)	432	2.1
Box (2016)	Australia (Brisbane City)	2011	Survey, interviews	Flood (specific)	62	2.1, 2.3, 2.4
Chang (2016)	Taiwan	2000-2014	Database	Tropical cyclones	1,556 (fatalities)	1.3
Chinh et al (2016)	Vietnam (Mekong Delta)	2012	Survey	Flood (specific)	480 (households) 378 (small businesses)	2.4
Coates (1999)	Australia	1788-1996	Various databases	Floods (general)	2,213 (fatalities)	1.3
De Dominics (2015)	Italy (Rome & Vibo Valentia)	Unclear	Survey	Environmental risks general (Floods as the main event)	444	2.4
Diakakis (2013)	Greece	1970-2010	Database	Floods (general)	60 (fatalities, car accidents) 37 flood events	1.3
Drobot (2007)	United States (Austin & Denver)	Unclear	Survey	Flooded Roads	Unclear	2.2
Drabek (2001)	United States	1995-1997	Survey	Hurricanes and floods	406 employees from 118 businesses	2.3
Duclos (1991)	France (Nimes)	1988	Survey	Flash Flood (specific)	108 families (228 people)	2.3, 2.4, 2.5

Few (2010)	Vietnam (Central Province & Mekong Delta)	2006	Interviews (exploratory field studies)	Climactic hazards (floods)	48	1.3, 2.3, 2.4
Few (2013)	Vietnam (Central Province & Mekong Delta)	2006	Interviews (exploratory field studies)	Climactic hazards (floods)	120 households	3
Fitzgerald (2010)	Australia	1997-2008	Various databases	Floods (general)	73 (fatalities)	1.2, 1.3
Franklin (2014)	Australia (Townsville, Qld)	2011	Survey	Floods (general)	130	1.2, 1.3
French (1983)	United States	1969-1981	Database	Flash floods (general)	1,185 (fatalities)	1.2, 1.3, 2.5
Gissing (2016)	Australia (Shoalhaven, NSW)	2015	Observation	Flood (specific)	154	1.3
Goudet (2011)	Bangladesh (Dhaka Slums)	2008-2009	Survey, Observation, Interview	Flood-prone Area	18 (mothers), 5 (community health workers), 55 (children)	3
Haataja (2014)	Finland	2012	Focus groups	Flood-prone areas	21	2.1
Hamilton (2016)	Australia	2012-2013	Survey	Flooded Waterways (general)	174	1.3
Hamilton (2019)	Australia	Unclear	Semi-structured interviews	Flooded waterways (general)	20	1.3
Haynes (2017)	Australia	1900-2015	Database	Floods (general)	1,859 (fatalities)	1.2, 1.3, 2.3, 2.4, 2.5
Haynes (2018)	Australia (NSW)	2017	Survey, Semi-structured interviews	Floods (general)	330 (survey) 83 (interviews)	2.1, 2.2, 2.3
Jonkman (2005)	Europe & United States	Unclear	Various Databases	Floods (general)	247 (fatalities)	1.3, 2.5
Kaewkitipong (2016)	Thailand	2012	Social Media, Newspapers, in-depth interviews	Flood (specific)	56 (interviews)	2.1
Kakimoto (2016)	Japan (Kumamoto & Oita Prefecture)	2012	Survey	Flood (specific)	264	2.1, 2.3
Krishna (2018)	India (Tamil Nadu)	2016-2017	In-depth interviews, focus groups	Flood (specific)	48 (NGO staff and community members, interviews) 14 (focus groups)	1.3, 2.1, 3
Lu (2014)	Bangladesh	2013	Survey	Extreme weather events	998	1.3
Matsuda (1990)	Japan (Kanto & Tohoku Regions)		Survey	Typhoon (specific)	609	2.3
Molinari (2011)	Australia	2007	Case-studies	Flood (specific)	2	2.2, 2.3, 2.4

Neal (2011)	United Kingdom (Kingston upon Hull)	Unclear	Data-bases, interviews	Flood (specific)	Unclear	2.1, 2.3, 2.4
Pearson (2014)	Australia	2012-2013	Survey	Flooded Waterways (general)	174	1.3
Peden (2017)	Australia	2002-2012	Database	Floods (general)	770 (fatalities)	1.2, 1.3
Pescaroli (2015)	Italy (Cesenatico)	2011-2012	Survey	Flood (specific)	228	2.1, 2.2, 2.3, 2.4
Said (2015)	Pakistan (Punjab)	Unclear	Survey, experimental design	Flood (specific)	640 (survey), 384 (experiment)	1.1, 2.3, 2.4
Shabanikiya (2014)	Iran (Quchan)	2012	Survey	Floods (general)	159	1.3
Staes (1994)	United States (Puerto Rico)	1992	Case control	Flash Flood (specific)	17 accidents	1.3
Taylor (2015)	Australia	2013	Survey	Disasters (general)	352 pet owners	2.3, 2.5
Thieken (2007)	Germany	2003	Survey	Flood (specific)	1679	2.2, 2.4
Tim (2017)	Thailand (Bangkok)	2013	Interviews, focus groups	Flood (specific)	56 (interviews and focus group discussions)	2.1
Vinet (2012)	France	2010	Database	Floods (selected events)	76 (fatalities)	2.4
Yale (2003)	United States (North Carolina)	1999	Database	Hurricane (specific)	66 (crashes)	1.3, 2.2
Zhong (2013)	Australia (Qld)	2010-2011	Database	Flood (specific)	33 (fatalities)	1.3

* Time of data collection

Table 2: Themes in identified literature

Themes		No of Studies
1: Activities and risk-taking behaviours		24
1.1	Entering flood waters	23
1.2	Recreational activities	7
1.3	General risk-taking	1
2: Loss reduction, knowledge, and warnings		37
2.1	Evacuation and relocation behaviour	17
2.2	Protecting property	14
2.3	Rescuing others	8
2.4	Knowledge sharing and information seeking	12
2.5	Flood warning behaviour	7
3: Diet and hygiene		4
Studies (total)		54

Table 3: *Extraction of behaviour-specific data by study (alphabetically)*

Reference		Aceto et al. (2017)
Activity during event (n)	Sleeping	Fatalities: n=10 Injured: n=46 Involved: n=210
	Working	Fatalities: n=3 Injured: n=7 Involved: n=101
	Traveling/Transport	Fatalities: n=1 Injured: n=14 Involved: n=345
	Rescuing someone	Fatalities: n=4 Injured: n=2 Involved: n=27
	Fishing/recreational activities	Fatalities: n=1 Injured: n=22 Involved: n=36
Comment Data on activity during flooding event it not known for 829 cases during floods (total: n=1,950). Gender is known for all fatalities (19/19), but not for all injured (82/154) and involved (198/1,777) people.		
Reference		Adeola (2009)
Initial evacuation response, %(n)		Ride out storm or found shelter in town: 10.5%(n=63) Heeded lest minute mandatory evacuation: 7.0%(n=42) Voluntarily evacuated 12 hr prior to landfall: 11.5%(n=69) Voluntarily evacuated 24 hr prior to landfall: 65.2%(n=390) Other: 5.4%(n=32)
Influences on evacuation behaviour, %(n)		Personal intuition: 14.0%(n=84) Mass media: 9.4%(n=56) Availability of financial resource: 5.2%(n=31) Mandatory evacuation enforcement: 12.2%(n=73) Friends and relatives persuasion: 28.9%(n=173) Prior experience with hurricanes and flood: 21.9%(n=131) Others: 6.5%(n=39) Don’t know/not applicable: 1.8%(n=11)
Predictors of evacuation behaviour (logistic regression), %(n)		Influence (friends): B=0.219 (SE: 0.081), p<=0.001 Prior experience or not: B=-0.223 (SE: 0.800), ns Duration of residency: B=0.375 (SE: 0.225), ns Job status (employed): B=0.506 (SE: 0.432), ns Number of children in household: B=0.153 (SE: 0.127), ns Household income: B=-0.070 (SE: 0.993), ns Previous experience of same magnitude: B=-0.456 (SE: 0.443), ns
Reference		Adomah Dempah et al. (2017)
Local beliefs and perceptions, %(n)		Natural disasters are often perceived as acts of god, particularly in developing countries leading to lower intentions of mitigating risks or evacuation. However, previous experiences with floods appear to rationalise these beliefs and more specific reasons such as dam failures are attributed. Own actions and

	inactions are usually not perceived to attribute to flooding, resulting in limited mitigation behaviours.
Reference	Ahmad et al. (2015)
Predictors of knowledge sharing, β	Self-efficacy: β=0.259, p<0.01 Reciprocity: β=-0.054, ns Social support: β=0.308, p<0.01 Social recognition: β=0.320, p<0.05
Reference	Aisha et al. (2015)
Social Media Use, mean(SD) Scale: Use for information sharing and information receiving during flood (1, very untrue, to 5, very true)	WhatsApp: 3.57(1.45) Following newsfeeds on Twitter/Facebook: 3.19(1.42) Following celebrities/politicians on Twitter/Facebook: 2.59(1.36)
Effects and satisfaction of information sharing through social media	Accounted for 4.3% of the variance in satisfaction from information sharing with WhatsApp being the only significant positive predictor among social media.
Reference	Ajibade et al. (2013)
Entering flood waters, business activities and liveability	Unlikely to enter flood water resulting in a negative impact on small businesses impacting finances. Liveability is reduced by a lack of freshwater. Participants regularly chose to bathe outside of peak flood hours to avoid contamination and danger.
Entering flood water and rescuing other, gender effect	Men are more likely to enter flood waters in dangerous situations to care and protect their family including rescuing others. This is perceived to be rooted in a culture which expects men to take such risks.
Reference	Ajibade et al. (2015)
Behaviours during floods, prediction of flood impact, %(n), B(SD)	Nothing: 17.1%(n=171), reference Relocate: 38.6%(n=387), B=0.46 (SE: 0.21), p<0.001 Drain water with bucket: 33.2%(n=333), B=0.22 (SE: 0.21), p<0.001 Other mechanisms: 11.2%(n=112)
Reference	Akhter et al. (2015)
Behaviour-specific data (qualitative)	Nutritious food and fresh vegetables are absent or unaffordable during floods leading to changes in diet and subsequent malnutrition. The absence of firewood and clean water leads impacts negatively on health, particularly children's health.
Reference	Allaire (2016)
Social Media Use	Social media users consider online information significantly more reliable than those using other online sources (87% vs. 66%); social media offered more information in general and more localised information. Use during floods to seek information can lead to a significant reduction of 37% (USD 3,708) in flood losses per household.
Comment Loss reduction is based on nearest neighbour estimate	
Reference	Alam et al. (2014)
Responses during disasters (general), %	Take shelter in cyclone shelter: 75.24% Stay in house: 12.38% Stay in school buildings: 5.74% Raise embankment/dams: 6.67%

Cultural and conditional behaviours of women during disasters (qualitative)	Staying with underage girls at home and move to appropriate shelters if male family members are present.
Comment Study primarily focuses losses and safety threats for women during disasters; however answers were given for entire households for behavioural variables.	
Reference	Ashley & Ashley (2008)
Walking through floodwater	9% of fatalities (16% of those to rescue some else, 43% to reach a destination within the floodwater)
Recreational activities	A small number of fatalities occurred during recreational activities such as hiking or camping.
Comment Gender and age is not known in 49% and 63% of the cases, respectively. Data often referring to figures with exact data points being unknown.	
Reference	Bin Osman (1994)
Reaction to a hypothetical warning of an impending flood β	Do nothing: 20%(n=7) Keep watch: 42.9%(n=15) Consult others: 11.4%(n=4) Temporary flood proofing measures: 5.7%(n=2) Move valuables/properties: 2.9%(n=1) Evacuate premises: 17.1%(n=5)
Comment The majority of the sample perceived floods to be a 'catastrophic' risk (n=21) or as 'dangerous' (n=14)	
Reference	Bird et al. (2012)
Reasons to join/look-up Facebook groups related to floods in Queensland or Victoria, %	For information on my community: 65% For information on my family's community: 42% For information on my friend's community: 39% To share information: 40% To offer help: 38% Out of curiosity: 22% Relayed information/knowledge back to family or friends: 97%
Level of trust in information provided in Facebook groups, %	Completely: 7% A great deal: 60% Moderately: 32% Not much at all: 1% Not at all: <1% Found information useful: 99% Found conflicting and/or inaccurate information: 39%
Perception of quality of information provided on Facebook by type or source	Accuracy of information: Government Facebook accounts were perceived to have the highest accuracy of information followed by government websites, community Facebook groups, media websites, community websites, and media Facebook accounts. Up-to-date of information: Facebook community groups were perceived to provide the most up-to-date information followed by government Facebook

	accounts and websites, media websites, media Facebook accounts, and community websites. Usefulness of information: Information provided in Facebook community groups was perceived to be the most useful followed by government Facebook accounts, government websites, media Facebook accounts, media websites, and community websites. Trustworthiness of information: Information from government Facebook accounts were perceived to be the most trustworthy followed by government websites, community Facebook groups with media websites, community websites, and media Facebook accounts having the same level of trustworthiness assigned.
Comment Most data are only presented in figures, percentages above are estimates by the review authors.	
Reference	Box et al. (2016)
Information source during flood, %	Friends/Family/Neighbours: 39% Local government: 22% Personal experience: 13% Media: 7% Other: 20%
Action taken during flooding, %	Raised items: 65% Evacuated: 60% Following warning advice: 42% Evacuation plan: 23% Sandbag home: 13% Evacuation kit: 13% Cleared drains: 8% Flood-resilient building: 7%
Comment Those with prior flood experience are more likely to take actions of any kind, and more likely to rely on their previous experience and local government as a source of flood information than those without prior experience. Total numbers are unclear.	
Reference	Chang (2016)
Location of death, n (work-related/non-work-related)	Bridge: 10/10 Canal/drainage: 7/1 Car: 5/4 Road: 30/46 Farm: 25/1 Higher floor/roof: 1/3 Basement: 1/36 Unspecific: 18/123 Sea: 69/3 River: 24/12 Indoors: 39/183 Outdoors: 195/92
Comment Significant missing data, i.e. location of death (indoors/outdoors) is unknown for 670 fatalities (43%).	

Reference	Chinh et al (2016)
Emergency measures taken during flood by small businesses/households %(n)	Save valuables: 48%(n=181)/50%(n=240) Move vehicle: 24%(n=91)/25%(n=120) Move furniture: 60%(n=227)/68%(n=326) Pump water out: 23%(n=87)/20%(n=96) Seal doors: 28%(n=106)/21%(n=101) Move goods/products: 58%(n=219)/n/a(-)
Reference	Coates (1999)
Circumstances/behaviour prior to death, %(n)	Unknown: n=807 Attempting to cross creek, river, stream etc.: 28.3%(n=398) - Walking, wading, swimming: 7.3%(n=103) - On horse: 6.0%(n=84) - In car/carriage: 3.6%(n=51) - On boat/makeshift boat: 9.3%(n=131) Attempting to cross road, bridge, culvert or ford: 10.2%(n=143) - Walking, wading, swimming: 1.6%(n=22) - On horse: 0.8%(n=11) - In car/carriage: 4.8%(n=67) In house or camp: 31.5%(n=443) - Attempting to escape flood: 4.1%(n=58) - Being rescued or evacuated: 0.3%(n=4) - Waiting for rescue: 16.5%(n=231) - Unaware of flood: 6.3%(n=89)
Reference	De Dominics et al. (2015)
Preventative behaviour, mean (SD) 5-point-Likert-scale	Attitude to enact preventative behaviour: Rome: 3.53 (SD: 0.52); Vibo Valentia: 3.69 (SD: 0.94), p=0.043 Intention to enact preventative behaviour: Rome: 3.11 (SD: 0.91); Vibo Valentia: 3.42 (SD: 1.01), p=0.001
Intention to enact preventative behaviour, hierarchical regression, β	Flood Risk perception: Rome: β=0.712; Vibo Valentia: β=0.563 Neighbourhood attachment: Rome: β=-0.006; Vibo Valentia: β=-0.010 Interaction: Rome: β=-0.035; Vibo Valentia: β=-0.147 R2: 0.52/0.27
Comment Paper describes two studies with the same questionnaire in the same regions. Extracted data is from the more detailed study 1.	
Reference	Diakakis & Delingiannakis (2013)
Timing of incident, %	Daytime: 35% Night-time: 46.7% Not reported: 18.3%
Area, %	Urban: 23.3% Regional: 70% Not reported: 6.7%
Road familiarity, %	Local: 78.1% Non-local: 14.6% Not reported: 7.3%

Road type, %	Paved road: 41.5% Bridge: 19.5% Artificial ford river crossing: 9.8% Natural ford crossing: 4.9% Unpaved road: 2.4% Not reported: 22%
Actions before incident, %	Travelled across waterway: 51.2% Driving or being parked when water rose unexpectedly: 24.4% Entering floodwaters to save someone: 7.3% Car crash influenced by floodwaters: 4.9% Entering floodwaters to recover vehicle:2.4 % Not reported: 9.8%
Comment Further subgroup analysis show nan overrepresentation of males and those aged 40 to 60 among fatalities. Total numbers for these figures are unclear.	
Reference	Drobot et al. (2007)
Flood warning attitudes, OR (SE, p)	Denver: 1.84 (0.40, p=0.13)/ Austin: 4.34 (0.51, p<0.01)
Flood danger knowledge, OR (SE, p)	Denver: 1.75 (0.27, p=0.04)/ Austin: 1.80 (0.35, p=0.09)
Flood experience, OR (SE, p)	Denver: 1.42 (0.24, p=0.13)/ Austin: n/a
Reference	Drabek (2001)
Impact on time of evacuation from work, standardised regression coefficients (β)	Duration of impact: 0.299 (p<0.01) Time in initial warning: 0.199 (p<0.01) Gender: -0.173 (p<0.01) Mandatory evacuation advisory (home): -0.128 (p<0.05) Manager's future risk perception: -0.121 (p<0.05) Mandatory evacuation advisory (work): -1.04 (p<0.05)
Impact on time of evacuation from home, standardised regression coefficients (β)	Duration of impact: 0.433 (p<0.01) Magnitude of impact: 0.274 (p<0.01) Time in initial warning: 0.234 (p<0.01) Emergent risk perception: 0.145 (p<0.05)
Reference	Duclos et al. (1991)
Principle concern of interviewees after realisation of danger, %	Go to safety: 27% Save own life or those of family members: 15% Save personal belongings: 8% Prevent water from entering the house or remove water: 7% Panic/anxiety: 4% Save persons other than family members: 4% Go back home: 4% Worry about family members: 4% Other: 6%
Rescued by, %(n)	Neighbours: 40%(n=20) Family: 20%(n=10) Firefighters: 12%(n=6) Red Cross: 10%(n=5) Army: 8%(n=4) Unknown civilian: 8%(n=4) Other: 2%(n=1)
Comment Samples sizes for principle concerns not available.	

Reference	Few et al. (2013)
Behaviour-specific data	60% of people believe that the incidence of diarrhoeal disease changed between seasons with most of these (53%) believing that it is more common in rain and flooding seasons due to lower water quality. Participants were significantly more likely to drink rainwater during rain seasons rather than river water. However, behaviour patterns vary greatly.
Reference	Few et al. (2010)
Behaviour-specific data	People try to be careful around floods but injuries are common as a result of wading through floods and collisions with submerged objects. Most interviewed households mitigate some of the damages and threats during floods: securing the building or parts thereof, clearing waterways and ponds, preparing boats for evacuations. Mitigation behaviours were initiated at the start of the storm seasons or prior to impending floods. Mitigation and behaviours during floods are significantly associated with access to information, education, and socio-economic positioning.
Reference	FitzGerald et al.(2010)
Activity prior to death, %	Use of motor vehicle (general): 48.5% Crossing waterways with vehicle: 39.7% Collapse of flooded waterway: 8.8% Swimming/surfing: 26.5% Swim/wade across waterways: 16%
Comment No details on circumstances available in n=5 cases. Total numbers for these figures are unclear.	
Reference	Franklin et al. (2014)
Behaviour around flood water, %(n) (total/male, female)	Driving through floodwater: 38.5%(n=50)/11%(n=22)/39%(n=78) Swum in floodwater: 10%(n=13)/23%(n=3)/77%(n=10)
Suggested reason for driving through flood water, %(n)	Not aware of danger or risk: 61.5%(n=80) Impatience: 33.1%(n=43) Invincibility/underestimating risk: 30.8%(n=40) Movement/reaching a destination: 36.9%(n=48) Car can handle it: 20.8%(n=27) Other: 3.1%(n=4)
Comment Further subgroup analyses show an overrepresentation of younger participants (18 to 35 years) engaging in high-risk behaviour. Suggested reasons identified in qualitative interview without prior options given.	
Reference	French et al. (1983)
Drowning circumstances, %(n)	Car related: 43%(n=80) Swept into water (at home/campsite/crossing bridge) : 43%(n=81) Rafting or sailing: 2%(n=4) Storm sewer: 1%(n=2) During evacuation (not involving cars): 2%(n=4) Performing a rescue: 3%(n=6)
Comment	

Subgroup analysis by characteristics not appropriate due to large amounts of missing data (gender, age,…)	
Reference	Gissing et al. (2016)
Driving through flood water (road closure), %(n)	84%(n=129)
Comment Drivers or large vehicles (e.g. trucks or four-wheel drives) were more likely to enter floodwater than those with wagon or sedan style cars. Males were overrepresented among those driving into flood water, though it is unclear if males were generally overrepresented in the sample.	
Reference	Goudet et al. (2011)
Behaviour-specific data (qualitative)	Mothers were often underweight during flood periods and, as a result, unable to produce sufficient maternal milk. Parents often resorted to substitute with inappropriate/malnutritious food for infants and young children. Nutritious food and fresh vegetables are absent or unaffordable during floods.
Reference	Haataja et al. (2014)
Information seeking behaviour	A strong interest in regular information during a natural disaster was reported by participants to enable appropriate behaviours during such events. The depth of information in official warnings and updates was perceived to be limited and arriving too slowly. Information received through other networks, such as radio broadcasts, was perceived to be more up-to-date and relevant to specific areas.
Knowledge and information sharing	Participants did not expect and personal contact for information sharing through authorities, but shared information themselves through personal networks, particularly neighbours and family in communication in face-to-face situations as well as through the use of mobile devices including social media. This is perceived to be helpful in the mitigation of damages to property and people during a natural disaster. However, mobile phones were also expected to be vulnerable as they need to be charged, may be muted and signals maybe lost.
Reference	Hamilton et al. (2016)
Beliefs associated with scenarios driving through flood water (20cms/60cms deep), mean (SD) on a 7-point Likert-scale	Save time: 4.65(1.73)/3.60(2.05) Reach my destination: 5.07(1.59)/3.37(1.78) Avoid injury or death: 4.64(1.80)/3.60(1.72) Become stuck/stranded: 3.71(1.86)/5.80(1.32) Crash: 3.30(1.77)/4.88(1.74) Sustain vehicle damage: 4.07(1.85)/5.88(1.21) Be swept away: 3.68(1.92)/5.60(1.35) Encounter hidden hazards: 4.84(1.62)/5.98(1.08)
Comment No specific data on actual willingness to drive through flood water.	
Reference	Hamilton et al. (2019)
Beliefs associated intentionally driving through flood water	Four themes emerged: Individual perception of the situation: - Pressure to arrive at the respective destination - Perception of situation in difference to warnings

	- Lack of clarity regarding situation-specific guidelines - Alternative are not sufficiently appealing Social and environmental context: - Social influences including social pressure, encouragement and a sense of security in the situation - Other motorists entering floodwater - Perceived environment/situational conditions Self-efficacy judgements: - Perceived skills and knowledge - Perceived ability to assess situation/risk and mitigate risk - Beliefs in vehicle efficacy Past experiences of driving through flood water: - Reliable risk assessment in past experiences - Ability to drive more safely - Perceived transferability of past experiences
Reference	Haynes et al. (2017)
Activity prior to death, %(n)	Attempting to cross - bridge/causeway/crossing/culvert/ford/watercourse: 45%(n=844) - floodwaters away from watercourse: 5%(n=84) Engaged in an activity - near the water (bank/bridge): 13%(n=236) - in/near stormwater drain: 3%(n=53) - in the water (rescue/swimming): 7%(n=121) - on the water (boating): 5%(n=98) - not near usual watercourse (e.g., home): 12%(n=228) Other: <0.5%(n=6) Unknown: 10%(n=189)
Evacuation behaviour, %(n)	Attempting vertical evacuation: 2%(n=41) Being rescued/evacuated: 2%(n=31) Awaiting a planned rescue/evacuation: <0.5%(n=5) Refused to be evacuated: <0.5%(n=8) Evacuating: 3%(n=46) Late evacuation: 1%(n=13) No attempt at evacuation (not aware): 4%(n=71)
Mitigation behaviour, %(n)	Carrying out repairs due to flood damage: 1%(n=21) Collecting provisions: 1%(n=925) Attempting to retrieve flotsam: 1%(n=9) Collecting people: <0.5%(n=3) Rescuing people, property, pets: 9%(n=168) Working, attending to livestock or livelihood: 6%(n=118)
Comment Data is overlapping with FitzGerald et al. (2010). Female victims were more likely to be engaged not near usual watercourses prior to death compared to males; all other differences were not meaningful. Males were more likely to be engaged in mitigation behaviours prior to death.	
Reference	Haynes et al. (2018)
Reasons for sheltering, %(n)	Stayed… to protect my house or property from looting: 7%(n=24) because I think it's safe to do so: 35%(n=114)

	because I didn't want to be dependent on emergency services: 3%(n=10) because I did not think my home or property would flood in this event: 22%(n=73) to wait and see what would happen: 16%(n=52) to wash down my property as the water receded: 12%(n=41) to protect my house or property from the floodwater: 14%(n=45) to care for pets or stock: 15%(n=49) because I felt it was too late to leave: 8%(n=25) because I had nowhere else to go: 8%(n=25) because I didn't know if the roads were flooded or not: 2%(n=7) because state emergency services, police or emergency services advised evacuation was no longer possible: 2%(n=6) because relatives, friends or neighbours advise me to stay: 2%(n=6) because my attempts to leave were unsuccessful: 3%(n=9) to care for a household member who was physically unable to leave: 2%(n=8) because it is physically difficult for me to leave: 4%(n=14) because I didn't know where to go: 3%(n=11) because roads were already flooded: 3%(n=11) because of my children: 1%(n=3) because I didn't know about the flooding, or had been advised that I would be safe: 2%(n=7) Average number of reasons reported per respondent: 2.72 Note: Qualitative interviews consistent with survey data
Perception of (evacuation) warnings and orders, Strongly disagree (1) to strongly agree (5), %(n)	I understood if my property was likely to be affected 1: 28.84%(n=87) 2: 15.36%(n=46) 3: 15.36%(n=46) 4: 13.48%(n=40) 5: 26.97%(n=81) Did not receive/don't know: n/a I understood when my property was likely to be affected 1: 37.59%(n=113) 2: 16.54%(n=50) 3: 16.54%(n=50) 4: 10.90%(n=33) 5: 18.42%(n=55) Did not receive/don't know: n/a Received evacuation warning with enough time 1: 35.82%(n=107) 2: 9.33%(n=28) 3: 9.33%(n=28)

	4: 7.46%(n=22) 5: 16.04%(n=48) Did not receive/don't know: 22.01%(n=66) Received evacuation order with enough time 1: 40.45%(n=121) 2: 8.24%(n=25) 3: 7.49%(n=22) 4: 5.62%(n=17) 5: 10.49%(n=31) Did not receive/don't know: 27.72%(n=83) Note: Qualitative interviews consistent with survey data
Knowledge and information sharing through social media (qualitative)	Facebook and other social media apps were important factors in receiving detailed area-specific information, and allowed communication and knowledge sharing with others.
Comment Qualitative interview data also discusses individual incidents such as entering flood water to rescue individuals. However, it is unclear if and how such events are generalizable.	
Reference	Jonkman & Kelman (2005)
Vicinity of death by drowning or physical trauma, %(n)	Drowning (all: 67.6%, n=167): - as a pedestrian: 25.1%(n=62) - in a vehicle: 32.8%(n=81) - from a boat: 2.8%(n=7) - during a rescue attempt: 0.8%(n=2) - in a building: 6.1%(n=15) Physical trauma (all: 11.7%, n=29): - in water: 0%(n=0) - as a pedestrian: 1.6%(n=4) - in a vehicle: 5.7%(n=14) - from a boat: 0.8%(n=2) - during a rescue attempt: 0.4%(n=1) - in a building: 3.2%(n=8)
Inappropriate/high-risk behaviour	Unnecessary behaviour or high-risk behaviour is an important factor.
Comment While data on inappropriate behaviour was collected, this was not discussed in detail or presented in the publication. It is unclear how the data described is related to the study.	
Reference	Kaewkitipong et al. (2016)
Social media use	Social media (e.g., Facebook) was used extensively during the even to share and receive information on the evening prior to and during the floods. The technology was perceived to be useful but is currently not formally linked with other information sources such as government agencies limiting trustworthiness. Information was perceived as particularly useful pre- and post-event for preparation/mitigation and recovery. Social media was also perceived to be useful by authorities as a means to collect large amounts of data related to the intensity of the event.

Reference	Kakimoto & Yamada (2016)
Evacuated	Yes: 43.8%(n=121) No: 54.2%(n=143)
Source of information for river conditions/weather /evacuation/advice, %	Oneself: 70%/32%/n/a/n/a TV/radio: 17%/22%/4%/n/a Internet: 2%/3%/2%/n/a Relation: 6%/5%/2%/11% Neighbours: 12%/7%/6%/25% Fire volunteer: 3%/1%/3%/10% E-email: 0%/0%/1%/n/a
Flood risk perception, score (higher scores equal higher perception of risk)	Evacuated: 1.41, Non-evacuated: 1.03, t-value: 2.18, p<=0.01
Comment Those evacuated were significantly more likely to inform themselves about river conditions and more likely to get advice from neighbours and fire volunteers than those not evacuated. Those not evacuated were more likely to be informed about the weather via TV or radio.	
Reference	Krishna et al. (2018)
Behaviours of children and their parents during floods	Children were commonly utilised to transport information between families within villages. Children were perceived to be at high risk during evacuations and parents often entered flood waters with their children to evacuate often separating families during evacuation procedures which were not perceived to be appropriate for families with children. Children also had to be supervised at a heightened level compared to other times as these would enter flood water to play with other children and engage in other dangerous situations. Food and water, particularly for children, is limited during these times and parents are willing to enter flood water and put themselves at significant risks to provide their families and particularly children with sufficient food and water.
Reference	Lu et al. (2014)
Travel choice under flooding (total/coastal habitants/inland habitants), %	No change: 28%/30%/25% Trip cancelled: 22%/22%/22% Change of mode/route: 18%/19%/16% Change of destination: 19%/19%/17% Change time of day: 13%/10%/%20
Comment Data only presented as figures, percentages above are estimates by the review authors.	
Reference	Matsuda (1990)
Refuge behaviour, %(n)	Received evacuation order and evacuated: 53%(n=202)
Reasons for seeking refuge, %(n)	Life was in danger: 42.8%(n=107) Received evacuation order: 44.8%(n=112)
Reasons for not seeking refuge, %(n)	Stayed behind to see what would happen: 43%(n=144) Thought it was safer to stay at home: 57.4%(n=194) Should do something in a house: 20.4%(n=69)

Reference	Molinari & Handmer (2011)
Behaviour after flood warning, %	Looking for further information: 76% (Gippsland Region) Took action to reduce flood loss (incl. evacuation): 99% (Gippsland Region) Lifted contents to upper: 84 % (Maitland)/86% (Newcastle)
Comment Sample sizes of individuals are not available. Data is from different survey with different methodologies.	
Reference	Neal et al. (2011)
Emergent behaviour	After a need was identified during the floods emergent behaviour was exercised by officials as well as local residents to meet the demand. The more urgent a need is perceived the more likely local residents are to engage. Behaviour is driven by altruism and the rate of information transfer. Local residents engaged in a number of activities which fall outside their usual responsibilities: evacuations, care and support for neighbours, emergency medical assistance, building sandbag walls, and advising on obtaining benefits/talking to insurance companies. Behaviours exercised during the crisis positively contributed to community resilience.
Reference	Pearson & Hamilton (2014)
Full regression model of two scenarios (20cms and 60cms depth), standardised regression coefficients (β)	Attitude: 0.25, 95-%-CI:0.18-0.44, p<=0.001 / 0.22, 95-%-CI:0.13-0.42, p<=0.001 Subjective norm: 0.18, 95-%-CI:0.08-0.33, p<=0.01 / 0.34, 95-%-CI:0.27-0.55, p<=0.001 Perceived behavioural control: 0.37, 95-%-CI:0.25-0.49, p<=0.0 01/ 0.27, 95-%-CI:0.13-0.35, p<=0.001 Perceived susceptibility: -0.07, 95-%-CI: -0.20-0.05, ns / -0.04, 95-%-CI:-0.15-0.06, ns Perceived severity: -0.08, 95-%-CI: -0.22-0.03, ns / -0.12, 95-%-CI:-0.21-(-0.02), p<=0.05 Past behaviour: 0.15, 95-%-CI: 0.07-0.24, p<=0.001 / 0.10, 95-%-CI:0.01-0.22, p<=0.05 R^2: 0.80 (95-%-CI: 0.75-0.85) / 0.75 (95-%-CI: 0.70-0.82)
Comment Same data set as Hamilton et al. (2016). The confidence interval for R^2 (low risk model) in the publication is not correct. The correct value was provided by the authors.	
Reference	Peden et al. (2017)
Activity immediately prior to drowning, %(n)	Falls: 11.7%(n=15) Non-aquatic transport: 55.4%(n=71) Swept away: 17.2%(n=22) Swimming and recreating: 7.0%(n=9) Watercraft: 3.9%(n=5) Other: 4.7%(n=6) Unknown: 0%(n=0)
Comment Only data related to flooding is extracted. Data of one fatality appears to be missing.	
Reference	Pescaroli et al. (2015)
Behaviour after siren flood warning, %(n)	Warning of others: 29%(n=66) Research information: 23%(n=54)

	Measures of protection: 21%(n=49) Did nothing: 18%(n=41) Shelter: 3%(n=7) Evacuate: 2%(n=5)
Reference	Said et al. (2015)
Mitigation behaviour, mean	Lives in a designated flood cluster and …took mitigation action: 0.20 (SD: 0.40) … thinks nothing works to protect against flood losses: 0.33 (SD: 0.47) …takes mitigation measures now: 0.16 (SD: 0.36)
Risk taking behaviour	Participants with flood experience or not more or less likely to take risks than those with not flood-related experience. However, those who experienced floods and lived in a designated flood cluster are systemically avoid risk taking.
Comment The majority of all participants (78%) have experiences some flooding. A summary of the results of this experimental design are provided for efficiency reasons. Experiment followed an ordered lottery selection design.	
Reference	Shabanikiya et al. (2014)
Willingness to cross floods on foot by demographics, %	18-35 years of age/35+ years of age: 80%/60%, p=0.009 Male/Female: 25%/28%, p=0.544 Married/Unmarried: 87%/70%, p=0.053 Takes flood warnings serious/not serious: 62%/87%, p=0.001 Exposure to floods/no exposure: 62%/81%, p=0.022 'Proper' perception of flood threat/no 'proper' perception: 75%/72%, p=0.734 Skilled swimmer/beginner or unskilled: 86%/66%, p=0.006 College degree/no college degree: 67%/78%, p=0.123 Experienced loss due to flood/no loss: 79%/72%, p=0.325 'Right' knowledge about health consequences of floods/no 'right' knowledge: 78%/70%, p=0.231
Comment No total values for willingness to cross floods on foot were available. Numbers are not available. Values by gender are unusually low in comparison to all other variables.	
Reference	Staes (1994)
Driving through flood water	3 out of 23 fatalities were associated with driving through bridges already flooded.
Being in a vehicle (risk), OR (mortality)	OR=20.05, 95-%-CI: 4.2-131.8, p<0.001
Comment Gender and age is not known in 49% and 63% of the cases respectively. Data often referring to figures with exact data points being unknown.	
Reference	Taylor et al. (2015)
Evacuated, %(n)	Yes: 34%(n=38) No: 66%(n=75)
Other data is not presented by different types of natural disasters and is therefore not extracted.	
Reference	Thieken et al. (2007)
Reasons not to perform emergency measures after flood warning, %(n)	It was too late to do anything: 65.1%(185) Nobody was at home: 18.3%(52)

	I thought emergency measures wouldn't be necessary: 8.8%(25) I did not think the flood would become so severe: 5.3%(15) I did not know what to do: 3.5%(10) I was not capable of doing anything: 2.8%(8) I though emergency measures would be useless: 2.1%(6) Others: 1.8%(5) Not specified/not answered: 3.2%(9)
Emergency measures undertaken, %	Put moveable contents upstairs: 55% Drive vehicles to a flood-safe space: 55% Safeguard documents and valuables: 52% Protect building against inflowing water: 50% Switch off gas/electricity: 40% Disconnect household appliances/white goods: 35% Gas/electricity was switches off by public services: 22% Protect oil tanks: 12% Install water pump: 5% Seal drainage/prevent backwater: <5% Safeguard domestic animals/pets: <5% Redirect water flow: <5% Other measures: <5% Not specified: <5%
Comment Data for 'emergency measures undertaken' are only presented in figures, percentages above are estimates by the review authors.	
Reference	Tim et al. (2017)
Usage of Social Media to share knowledge and seek information (qualitative data)	Social media was used during the floods as a source of information, a medium of communication as well as source of social support. Social media was used extensively throughout the floods as a medium of communication not only between family members, neighbours and friends but also between authorities and unknown citizens to share information regarding floods and to seek information. Information received through these channels was perceived to be more up-to-date and to have a higher relevance due its specificity and area-relevance. Authorities perceived the use of social media to share information also as beneficial as monitoring social media allowed for faster and more in-depth collection of information regarding the current situation than traditional disaster response systems. It furthermore assisted in triaging emergency personnel more effectively.
Reference	Vinet et al. (2012)
Behaviour modification through relationships	A large number of fatalities (n=22) occurred in couples (relationships), only in n=5 was did one partner die. Authors hypothesise that the wish to die as a couple might influence behaviour. Being with a partner does not increase the chance to survive or to be rescued.

Awareness	Authors hypothesise that the large number of fatalities among elderly is also related to a lack of awareness rather than purely attributable to a lower levels of physical health and or strength.
Reference	Yale et al. (2003)
Submersion, %(n)	Fully or partially submerged in water: 29.3%(n=27) Not submerged in water: 70.7%(n=65)
Injuries and fatalities by degree of submersion (submerged in water/not submerged in water), %(n)	Fatally injured (drowning): 51.9%(n=14)/ 0%(n=0) Non-fatally injured: 0%(n=0)/ 41.5%(n=27) Not injured: 48.1%(n=13)/ 49.2%(n=32) Injury unknown: 0%(n=0)/ 9.3%(n=6)
Drowning fatalities by crash circumstances and degree of submersion (submerged in water/not submerged in water), %(n)	Total drowning: 15.2%(n=14) Hit puddle and went off road: n=2/n=0 Went off road in rain: n=0/n=0 Drove into water and stalled: n=10/n=0 Hit tree in road: n=0/n=0 Drove into collapsed section of road: n=2/n=0
Familiarity and warnings	All people who died knew the roads they were travelling on and all had received severe weather warnings
Reference	Zhong et al. (2013)
Circumstances of fatalities, %(n)	Swept away (flash flood): 54.5%(n=18) Vehicle entering water: 24.2%(n=8) Near flooded waterways by accident: 21.2%(n=7)
Comment The abstract refers to ‘15.1% of fatalities were caused by inappropriate behaviour’ – this figure is not discussed in the remainder of the publication.	

Figure 1: Flow Diagram