Prior Exposure to Major Flooding Increases Individual Preparedness in High-Risk Populations

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Abstract

Introduction: July 2007 brought unprecedented levels of flooding to the United Kingdom. Health and financial implications were vast and still are emerging. Hydrological disasters will increase in frequency. Therefore, individual preparedness is paramount, as it may mitigate some of the devastating impacts of flooding. Literature on individual preparedness for flooding is scarce, so it is key that current levels of awareness, information gathering, and protective behaviors are investigated. It also is not clear whether being in a high-risk area or having recent exposure to flooding are motivational factors for preparedness.

Objectives: The objectives of this study were to: (1) ascertain whether prior experience with flooding is a strong motivational factor for preparedness for future flooding episodes; and (2) assess preparedness in populations at high risk for flooding.

Methods: A prospective questionnaire survey was sent to individuals living in two towns in the United Kingdom, Monmouth and Tewkesbury. Both towns are deemed to be at significant risk for flooding, and Tewkesbury was severely affected by the July 2007 flooding disaster. Data were obtained from these two populations and analyzed.

Results: A total of 125 responses (of 200) were returned, and demographic data indicated no major differences between the two populations. The number of protective behaviors was higher from participants from Tewksbury (flood risk and exposure; $p = 0.004$). Participants from Tewkesbury were more likely to be aware of living in a flood-risk area and of the emergency systems present in the area, and feel prepared for future episodes of major flooding ($p = 0.03$, $p = 0.005$).

Awareness of living in a flood risk-area increased the likelihood of being knowledgeable about emergency systems and adopting protective behaviors ($p = 0.0053$, $p = 0.043$). However, feeling prepared for future episodes of flooding was not associated with a strong increase in knowledge gained to prepare for flooding or having an increased number of protective behaviors.

Conclusions: Awareness of being at-risk for flooding is vital for self-protective behavior. Both awareness of risk and recent exposure are motivational for flood preparedness. Recent exposure to flooding increases awareness, but it is unknown how long this effect will last. Recent exposure increases the preparedness of individuals for major flooding 18 months after major flooding and, if it continues, will help mitigate the devastating health, financial, and social effects of major flooding.

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Introduction

Globally, the risk of damage from flooding has increased dramatically over the last decade, and the summer of 2007 provided the United Kingdom with examples of severe flooding to the extent that had not previously been encountered. More than 40 counties were affected, but Lincolnshire, Gloucestershire, Nottinghamshire, and South Yorkshire were hit by severe flooding. This was reported to be secondary to a combination of heavy rain and very high ground water levels.[1] Thirteen individuals lost their lives as a direct result of the unprecedented levels of flooding, and the long-term health effects are yet to be discovered. Currently, >5 million properties in England and Wales are in areas deemed at being at-risk of significant flooding, and the predicted forecast is not rosy, predicting up to a four-fold increase in localized flooding by 2080.[2,3]

The consequences of severe flooding can be far-reaching. Once the newspaper and media coverage has ceased, it often is easy to forget the resulting mid- to long-term effects of flooding. Damage to property often takes a long time to repair, and has financial and logistical consequences (especially if mid- to long-term relocation is needed). Ten months after the floods of the summer of 2007, 4,750 households still were in temporary accommodation with no immediate plans for return to their flooded homes.[4]

Along with financial implications, health problems, both physical and mental, can be attributed directly to experiencing severe flooding. These can include gastroenteritis and otitis media, depression, anxiety, and other forms of psychological distress.[5,6] Mental health issues often are escalated by some of the social consequences of flooding, such as the loss of community and neighborhoods due to relocation and isolation from social networks.[7]

Individual preparedness is the main focus for this study, and it is important to stress that this comprises only one area of a complex network in reducing the impact of flooding. Local councils, the United Kingdom government, the Environment Agency, and many other groups are integral to overall emergency planning regarding flooding. Only with the interaction of all of the different groups, can the impact of flooding be mitigated and the damage costs reduced.[8]

Just as risk reduction for flooding is multi-factorial, individual preparedness for flooding also has many different aspects. These include: (1) the knowledge of living in a flood-risk area; (2) acting on this knowledge; (3) being able to gather information to help reduce the impact of flooding; and (4) development of physical protective behaviors to protect your home.

The impact of individual preparedness on mitigating the effects of flooding is difficult to ascertain, but Kron *et al* believe that "given a basic level of protection...this group is the one that can reduce material losses most effectively".[8] According to the UK Environment Agency, there are a number of simple activities that could reduce the impact of flooding on a house and the financial and social consequences of flooding.[9] It is logical to believe that preparedness for flooding at an individual level would improve outcome. Measures such as knowing how or where to gather information prior to and during a flood, may help with the implementation of evacuation procedures. Preparedness also could minimize the financial, social, health, and emotional difficulties post-flood, e.g., moving treasured possessions out of harms way and keeping important documents in a safe place. Such measures may facilitate a faster return to normal activities. There is strong literary evidence that effective preparedness is beneficial in other scenarios, such as healthcare and disaster planning.[10–12] Indeed the International Commission for the Protection of the Rhine estimates that "protective adaptation by households can reduce monetary damage by up to 80%".[13]

Only a few previous studies have examined the issue of individual preparedness for flooding. The assessment of individual preparedness for flooding is vital if improvements are to be made in overall disaster preparedness. Following the dramatic Tokai flood disaster, Takeo *et al* used a retrospective method to assess preparedness prior to the flood.[14] Their criteria for individual preparedness included obtaining flood insurance and checking an available hazard map of the area. As part of a large study of flood preparedness in the UK, the Environment Agency examined protective behaviors by asking participants what they would do in the event of major flooding. This was a scenario-based questionnaire, and participants were asked to consider various actions.[2,15] However, retrospective preparedness data collection and scenario-based questions only go so far, and it is important to gather more objective pre-disaster data on individual preparedness for flooding. To the authors' knowledge, the knowledge of emergency systems and the number and types of physical protective measures implemented by individuals has not been studied previously, and would be important for inclusion in emergency planning for floods. It also is not known whether preparedness for future flooding events is influenced by prior exposure to flooding.

It is difficult to ascertain whether past exposure to flooding increases individual preparedness, as the literature is contradictory. Thieken *et al* simply state that the "pure knowledge of living in a flood-prone area stimulated the acquisition of information about self-protection".[16] However, prior exposure also may have an opposite effect, and may create a falsely optimistic bias (assuming that future flooding would be no worse than prior events), and it often is difficult for individuals to predict and perceive risks accurately and make appropriate decisions.[14,17] From their scenario-based and focused qualitative data, Burningham *et al* concluded that there was no association between experience of flooding and preparedness for flooding.[2]

This study focused on preparedness of individuals for flooding. The purposes of the study were to: (1) ascertain whether prior experience with flooding is a strong motivational factor for the development of preparedness measures for future flooding episodes; and (2) assess preparedness in populations at high-risk of flooding. The study will assess actual physical measures put in place to reduce the personal risk for damage from flooding, and to improve final outcome, as well as individual knowledge of emergency systems in-place.

Methods

Preparedness was assessed in two distinct ways, first, by examining adaptive protective behaviors in respect to major flooding, and second, assessing individuals' knowledge of emergency systems already in place.

Study Population

This study was a prospective, quantitative survey. Two population groups were identified and compared. The first group lives in a flood-prone area and the second group lived in a high-risk flood area and recently had been affected by flooding. The UK Environment Agency produces flood risk maps that stratifies the risks for a particular area for flooding. These were used to locate the areas included in the study. The two areas chosen for study were the towns of Tewkesbury and Monmouth. These are situated in areas classified to be at "significant" risk of flooding, which were quantified by the Environment Agency, as having a 1.3% annual rate of severe flooding and compares to a UK average of 0.1% risk. Despite topographical differences in the areas selected, the towns have a similar flood risk, which should reduce the variability in respect to preparedness for flooding. The two populations both were at "significant" risk of flooding, but the town of Tewkesbury was affected severely by flooding in July 2007, and houses from this town formed the Flood Exposure Group of the study.

In order to gain the most representative population data, an area random sampling method was used. All houses were within 300 meters of a significant water course known to be at a high-risk for flooding. A questionnaire was mailed to houses within the flood-risk area.

The study was approved by the School of Care Sciences Ethical Filter Committee at the University of Glamorgan. The questionnaires were anonymous and only the names of the towns, not individual addresses, were used for data collection.

Measures

Participants were provided with a cover letter outlining the justification and the reasons for the study, and suggested where and how to get further information. All answers were confidential, and participation in the study was voluntary. One questionnaire was mailed to each household, and the demographic questions were aimed at the head of the household. The questionnaire took 5–10 minutes to complete, and a stamped, addressed envelope was included for returning completed questionnaires.

The questionnaire was composed of three subsections. The first section was basic demographic information. Participants were questioned about their age, gender, ownership status of their property, number of occupants, and number of years that s/he was resident at their property.

The second part of the questionnaire concerned the adoption of protective behaviors against damage from a flood. This involved two areas. The first was their knowledge of where and how to operate valves or switches for the three basic utilities; gas, electricity, and water. Second, the participants were questioned on their adoption of physical behaviors that would be needed in the event of a flood. These included behaviors such as keeping a supply of bottled water, sandbags, flood boards, and plastic covers for airbricks, as well as a list of important contact numbers and owning a basic first aid kit. The list of these protective behaviors was compiled using literature that had been produced by the Environment Agency in November 2007, "Preparing for a Flood: Practical Advice on What to do to Protect You and Your Property".[9]

The third part of the questionnaire concerned knowledge of their emergency systems. This was assessed by questioning the participants' knowledge of how to obtain information (from the UK government) concerning flooding, and the measures that could be taken to reduce flood damage. Specifically, participants were questioned on their knowledge of and whether they had signed up to the UK government warning helpline, "Floodline".

Participants also were questioned on their knowledge of the flood warning system. In the UK, there are four nationally recognized flood levels: (1) flood watch; (2) flood warning; (3) severe flood warning; and (4) all clear.[18]

Finally, participants were questioned about their awareness of living in an area that was at significant risk for flooding, and whether they felt prepared for future flooding that could affect their property. A Likert scale was used assessed the participants' feelings of preparedness.

Data were processed using Microsoft Excel [Microsoft, Inc., 2003, Redmond WA] and SPSS version 12 [SPSS, Inc., Chicago, IL]. Statistical analyses were performed, involving both descriptive and comparative statistics. It was assumed that both groups were comparable and had a normal distribution. It is envisaged that the basic demographic information will be of value with direct comparison between the groups, but also it was hoped that population subgroups would be identified that would facilitate further subgroup analysis. Chi-square and independent *t*-tests were used to compare populations.

A pilot study of 10 questionnaires was conducted to provide feedback and check for validity of question wording. The questionnaire also was drafted using the University of Glamorgan Ethical Filter Committee.

Results

One hundred twenty-five responses (from 200 distributed questionnaires) were returned—a response rate of 62.5%. There were 53 (53%) responses from the flood risk group (Monmouth) and 72 (72%) responses from the flood-risk and flood-exposure group (Tewkesbury).

Demographic Data

The two population groups were well matched. There were no significant differences in the age and gender ($p = 0.625$, $p = 350$). There also were no differences in home ownership status or the number of house occupants ($p = 0.777, p = 0.660$). Only the number of years living at the current property had statistically significant differences.

Adoption of Protective Behaviors

Protective behaviors of individuals to minimize flood damage are ranked by total quantity in Table 2. The "presence of a list of important contact numbers" (Monmouth 68%, Tewkesbury 67%) and "keeping important documents above the ground floor" (Monmouth 64%, Tewkesbury 75%) were the most common protective behaviors. The least used protective behaviors were keeping a "supply of plastic covers for airbricks" (Monmouth 2%, Tewkesbury 22%) and keeping a "supply of door flood boards" (Monmouth 15%, Tewkesbury 40%). There was a marked increase in physical flood protection protective behaviors between the flood risk and exposure group (Tewkesbury), with a large increase in the number of households with sandbags available, flood boards, and plastic covers for airbricks.

	Monmouth (flood risk)	Tewkesbury (Flood risk and exposure)	
Sample size	52	72	
Age (years)			
<20	0	0	
20–30	3	1	
31–40	4	4	
41–50	10	14	
51–60	17	26	
61–70	11	20	
>70	8	7	
			$p = 0.625$
Gender			
Male	21	36	
Female	32	36	
			$p = 0.350$
House owner status			
Own home	29	42	
Private treatment	15	21	
Council tennant	9	9	
Number of house occupants			$p = 0.777$
1	13	15	
2	25	38	
3	11	17	
4	2	2	
>4	2	0	
			$p = 0.660$
Years in current home			
Mean	10.7	7.4	
Range	1–20	1–31	
			$p = 0.043$*

Table 1—Population demographics *indicates statistical significance ($p < 0.05$)

	Monmouth (flood risk) %	Tewkesbury (flood risk and exposure) %
1. Presence of a list of important contact numbers	68	67
2. Important documents kept above the ground floor	64	75
3. Keep a torch with spare batteries	58	73
4. Ownership of first aid kit	55	76
5. Keep bottled water supply	19	39
6. Supply of sandbags	15	44
7. Supply of floodboards	15	40
8. Supply of plastic covers for airbricks	2	22

Table 2—Ranked percentage of positive responses to protective behaviors

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	Monmouth (flood risk) %	Tewkesbury (flood risk and exposure) %
Knowledge of location of gas cut off	66	76
Knowledge of location of electricity cut off	79	89
Knowledge of location of water cut off	77	83

Table 3—Knowledge of location of household utilities

The averages of the numbers of protective behaviors were higher in Tewskesbury (flood risk plus exposure) than in Monmouth (p = 0.004). The average of the number of protective behaviors adapted in Tewkesbury was 4.36, and the number of properties adopting ≥4 (out of total of 8) protective behaviors was 74%. This compared to a mean of 2.98 protective behaviors in Monmouth, with only 38% of properties adopting ≥4 protective behaviors.

Age was not associated with an increased likelihood for adopting protective behaviors (p = 0.803), nor was gender (p = 0.442). Property owners were more likely to take a larger number of protective behaviors, but this was not statistically significant (p = 0.294).

There was no statistically statistical difference between knowledge of the location of utility "cutoffs" between the two populations (Table 3). Overall, there was a high level of knowledge in Monmouth and Tewskesbury concerning the location these utility "cutoffs". There was no statistically significant difference between the genders (p = 0.301 electric, p = 0.418 gas, p = 0.93 water).

Participants were questioned on whether they had valid household and flood insurance for the property in which they lived. There was no difference in the rates of household insurance, with 87% of participants in Monmouth and 88% in Tewkesbury having valid household insurance. However, there was a difference in households with valid flood insurance with a far greater percentage of participants in Tewkesbury (flood risk and exposure group) having flood insurance (61% Tewkesbury to 40% Monmouth).

Knowledge of Emergency Systems (Table 4)

Participants were asked about two emergency systems. With respect to both emergency systems, participants in Tewkesbury (flood risk and exposure group) were more likely to be aware of these systems. They also were more likely for have signed up to the UK government "floodline", although the difference was not statistically significant. Participants' knowledge about these systems is in Table 3.

Being aware of living in an area at significant risk of flooding (in either group) was associated with an increased knowledge of: (1) the UK government "floodline" (p = 0.0001); (2) national flood warning levels (p = 0.021); and (3) where to obtain further information concerning flooding from the UK government (p = 0.053).

Perception of Risk of Flooding and Feeling of Preparedness

Participants were questioned on their awareness of living in an area at high risk of flooding and how well-prepared that they perceived themselves to be for major flooding.

Recent exposure to flooding made the participants from Tewkesbury significantly more aware of living in an area at high risk of flooding (88% to 72% respectively: p = 0.03). Awareness of being at significant risk of flooding (in both groups) was increased in participants that owned their own home. Eighty-nine percent of homeowners were aware of being at risk for flooding, and this was statistically greater than was the number of participants who were renting (either from private or council landlords; p = 0.005).

This awareness of living in an area prone to flooding (in either population) increased the number of protective behaviors that participants performed compared to participants who were not aware of this fact (p = 0.043).

Feelings of preparedness for major flooding were assessed using an analog scale. There was a statistically significant difference between the two study populations (p = 0.005). Having had recent flood exposure and being at high risk of further flooding, the participants from Tewkesbury, were significantly more likely to feel prepared for future flooding with 57% feeling prepared or very well-prepared for future flooding. The Monmouth population also was at a high-risk for flooding (but with no recent major flooding exposure) felt less well-prepared with only 26% of the participants feeling prepared or very well-prepared.

Participant ownership of their property increased the feelings of preparedness for major flooding, with 55% of homeowners feeling prepared or very prepared and 43% of house renters feeling very under-prepared or under-prepared, and this was strongly statically significant (p = 0.009). Increasing age was not associated with increased feeling of preparedness for major flooding (p = 0.492). There was a non-statistically significant association between feeling prepared for flooding and the number of adaptive behaviors and the knowledge gained concerning flooding (p = 0.532, p = 0.733, p = 0.930, respectively). Female participants were more aware of living in an area at high-risk for flooding than were the male participants, but this difference was not statistically significant (p = 0.064). However, this increased awareness among female participants was not associated with increased feelings of preparedness (p = 0.653).

Discussion

The objective of this study was to investigate the levels of preparedness and the protective behaviors aimed at reducing the impact of major flooding. In two high-risk populations, recent prior exposure to flooding increased the level of preparedness for future episodes.

Preparedness is multi-faceted, but starts with an awareness of living in an area that is at risk for an event, in this case, flooding. The data indicate that living in an area that recently was exposed to major flooding increases the awareness of the participants in that town to the possibility of further episodes of flooding. Participants who were aware of their increased risk for flooding were more likely to gain information on flooding and to be aware of the government flood-risk categories, regardless of their prior exposure to flooding.

		Monmouth (flood risk) n (%)	Tewkesbury (flood risk and exposure) n (%)
"Floodline" $p = 1.38$	Aware and signed up	13 (25)	25 (35)
	Aware but not signed up	18 (34)	29 (40)
	Not aware	22 (41)	18 (25)
Levels of flood warning $p = 0.001$*	Aware and knowledge of different levels	17 (32)	43 (60)
	Aware but no knowledge of meaning	20 (38)	25 (35)
	Not aware	16 (30)	3 (4)

Table 4—Knowledge of available emergency systems*

Assessment of flood risk by non-professionals is difficult, and evidence shows that generally, there is a poor correlation between expert assessments and lay assessments of flood risk.[19,20] Therefore, it is important that information is supplied by governmental (official) sources, and that people who live in high-risk areas are made aware of this fact, especially since increased awareness correlates with an increased number of protective behaviors.

Along with the willingness to gather information after becoming aware of being in a high-risk area, the process of putting this information into action is key to protecting property from flooding or at least reducing monetary damage. In the current study, awareness also correlated strongly with physical actions designed to protect the home or at least reduce monetary damage following flooding. There is no "gold standard" of preparedness for flooding apart from moving from the area, but the UK government's list provides a set of useful actions with the above design in mind. The strong correlation between awareness and protective behavior also is seen in the literature, as a correlation between property ownership and protective behaviors.[14,21,22]

Comparisons between the two groups yielded the most interesting results. Demographic data were similar between groups, which strengthens comparison although the authors acknowledge that two different communities will have small socio-economic differences that could influence results. However to the authors' knowledge, there never previously has been a direct comparison between two populations at high risk for flooding where one of the two has such recent exposure to major flooding. This recent exposure significantly increased knowledge gathering as well as the number of protective behaviors performed by participants. What is not known is how long this "protective effect" of increased preparedness is seen following exposure to flooding.

Although the combination of awareness, knowledge-gathering, and protective behaviors contributed to give the participants a greater sense of being prepared, this difference was not statistically significant. However, participants with prior exposure to flooding (Tewkesbury group) had increased feelings of preparedness. Feelings of preparedness also were increased in homeowners compared to participants renting their homes. There appears to be a double-edged sword to preparedness in a population with recent exposure. Exposure can provide the stimulus for preparedness, but can be seen as the standard to which other disasters will be set, and therefore, stem the need for excessive preparation.[2,23,24]

Conclusions

Recent exposure to flooding increased awareness of flood risk, adoption of protective behaviors, and ultimately, increased feelings of preparedness compared to a similar high-risk population. This increased preparedness has the potential to greatly reduce the impact of future flooding disasters.

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