An exploration of factors affecting the long term psychological impact and deterioration of mental health in flooded households

Jessica Elizabeth Lamond *, Rotimi D. Joseph, David G. Proverbs

Centre for Floods Communities and Resilience, University of the West of England, Coldharbour Lane, Bristol BS16 1QY, United Kingdom

A B S T R A C T

The long term psychological effect of the distress and trauma caused by the memory of damage and losses associated with flooding of communities remains an under researched impact of flooding. This is particularly important for communities that are likely to be repeatedly flooded where levels of mental health disorder will damage long term resilience to future flooding.

There are a variety of factors that affect the prevalence of mental health disorders in the aftermath of flooding including pre-existing mental health, socio-economic factors and flood severity. However previous research has tended to focus on the short term impacts immediately following the flood event and much less focus has been given to the longer terms effects of flooding. Understanding of factors affecting the longer term mental health outcomes for flooded households is critical in order to support communities in improving social resilience. Hence, the aim of this study was to explore the characteristics associated with psychological distress and mental health deterioration over the longer term.

The research examined responses from a postal survey of households flooded during the 2007 flood event across England. Descriptive statistics, correlation analysis and binomial logistic regression were applied to data representing household characteristics, flood event characteristics and post-flood stressors and coping strategies. These factors were related to reported measures of stress, anxiety, depression and mental health deterioration. The results showed that household income, depth of flooding; having to move out during reinstatement and mitigating actions are related to the prevalence of psychosocial symptoms in previously flooded households. In particular relocation and household income were the most predictive factors. The practical implication of these findings for recovery after flooding are: to consider the preferences of households in terms of the need to move out during restorative building works and the financial resource constraints that may lead to severe mental hardship. In addition the findings suggest that support with installing mitigation measures may lead to improved mental health outcomes for communities at risk.

© 2015 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

1. Introduction

The health and wellbeing of flooded communities can be detrimentally affected by the experience of flooding. In particular qualitative research suggests that symptoms of stress and mental disorder can be encountered in populations many years after the flood occurs (Tapsell and Tunstall, 2008; Carroll et al., 2010). Mental health disorders are considered at least as important as physical health impacts after flooding (Fewtrell and Kay, 2008; Carroll et al., 2010). However the nature and prevalence of mental health issues is highly variable and from the available evidence it is not possible to predict, with any certainty, where and how severely the need for mental health intervention will arise (Few,

2007; Tapsell et al., 2009). Organisations such as Public Health England and the Health Protection Agency call for more research that leans towards the measurement of long term need in previously flooded communities (Stanke et al., 2012). However the measurement of uplift in mental health disorders is complicated, for example by underlying levels of mental health disorder already present, and therefore the true assessment of increased need is difficult to achieve.

Mason et al. (2010) among others, have asserted that it is important to distinguish between natural, short lived reaction to a traumatic event and those reactions that may develop into a longer term disorder or cause for concern. However the majority of quantitative studies of stress and mental health disorders have focussed on measuring severe reactions of individuals a short time after a flood event. These studies have identified many different factors that can influence the prevalence of symptoms for example flood characteristics (Paranjothy et al., 2011; Collins et al., 2013);

* Corresponding author.
E-mail address: jessica.lamond@uwe.ac.uk (J.E. Lamond).

individual characteristics (Alderman et al.; Rosen et al., 2009); socio-economic factors (Collins et al., 2013); preparedness (Shultz et al., 2013); and duration of reinstatement activities (Azuma et al., 2013). Accordingly, while some factors are not within the control of authorities, such as the socio-economic characteristics of populations at risk, others can be more readily influenced. In particular actions to mitigate post flood experiences might be considered as crucial interventions by responders if they can be seen to have a large impact on long term mental health outcomes. This is particularly important in areas that are likely to be subject to repeated flood events.

Therefore this research seeks to explore the long term distribution of, and relationship between, different symptoms of stress and mental health in previously flooded communities. It also seeks to explore the impact of various factors, including post flood experiences, on the mental health and wellbeing of flood affected communities and individuals after several years has passed from the event itself. The underlying aim is to improve understanding of the importance of the recovery experience in mental health outcomes. In turn this could lead to improved provision of support and resources to those potentially most vulnerable to future mental health problems as a result of flooding and flood risk (Tapsell et al., 2009). In Section 2, previous research is explored in more detail in order to identify factors that may influence mental health outcomes, and develop the conceptual framework in order to design suitable representations of those factors for modelling. The following section describes the implementation of a postal survey of flooded communities. Results of the survey analysis are contained in Section 3 and finally the results are discussed in Section 4 and conclusions are drawn in Section 5.

2. Materials and methods

Data collection instruments, survey delivery and the design of a conceptual framework for analysis are described in the following sections. The conceptual framework was informed by the outcomes and findings of previous studies as described in Section 2.1. This was a necessary step given the large potential number of exposure, outcome and co-variate factors that could be included. The application of the framework and analysis is outlined in Section 2.2.

2.1. Development of framework for analysis, selection of outcome, exposure and co-variate measures

As previously noted, mental health impacts from trauma such as flooding span a spectrum from reported stress to depression and post traumatic stress disorder (PTSD) (Norris et al., 2002). Results from previous studies investigating the impact of flooding on mental health are summarised in Table 1 adapted from the review carried out by Alderman et al. (2012). This table illustrates the wide range of measured impacts (from 8.6% to 53% of the population exhibiting symptoms of some kind of psychological impact) and also the different countries, methods and timescales over which studies have been carried out. In particular it is notable that those studies carried out in the short term following a flood event tend to record higher rates of mental health disorder than those carried out some time afterwards, although it is clear that symptoms continue in some individuals for many years (Briere and Elliott, 2000). It is also apparent that minor psycho-social impacts symptoms are not measured or reported as frequently as more severe disorders.

Measurement of the impact of flooding in prompting mental health issues is complicated by the underlying level of psychiatric

Table 1
Summary of results from studies of mental health and flooding (after Alderman et al.).

Author	Location	Study characteristics	Findings
Chae et al. (2005)	Korea (2002)	3–6 months post flood with control	PTSD 39.5% Anxiety 21%
Paranjothy et al (2011)	England (2007)	3–6 months post flood	PTSD 11.9% Anxiety 17.8% Depression 7.7%
Mason et al. (2010)	England (2007)	6 months post flood	PTSD 27.9% Anxiety 24.5% Depression 35.1%
Liu et al. (2006)	Hunan, China (various)	2.5 years post flood	PTSD 8.6%
Norris et al. (2004)	Mexico (1999)	Longitudinal study Levels at 6 month reported	PTSD 28%
Assanangkornchai et al. (2004, 2007)	Thailand (2000)	Longitudinal study Levels at 20 weeks reported	Generic mental health problems 40%
Heo et al. (2008)	Korea (2006)	18 months post flood pre flood control	PTSD 43.1% Mild depression 53.5%

disorders already present in the population. It is rare for studies to have access to detailed statistics regarding pre-flood mental health disorders; therefore the number of controlled studies is small. In the current study there is similarly no pre-flood measurement available. Co-morbidity of symptoms is also apparent, Norris et al. (2004) observed both PTSD and Mild depressive disorder (MDD) in populations affected by floods in Mexico and found that co-morbidity was substantial; therefore the study will need to be cope with potentially high cross-correlation between variables if more than one disorder is modelled. Therefore the study measured multiple psycho-social impacts, or outcome measures, with the intention of examining the prevalence and co-morbidity of symptoms.

Research has suggested that incidence of psychosocial impacts of flooding are also related to a number of factors, and studies by Few (2007) and Tapsell et al. (2009) are helpful in identifying potentially influential variables. The relationship between these factors and trauma symptoms can be quite complex and studies do not always agree on their relative importance or even direction of influence.

Among those factors with relatively consistent measured influence is low socio-economic status, seen to be related to higher levels of symptoms across multiple studies (Tierney, 2000). Female gender is also a strong predictor of reported symptoms (Tapsell et al., 2009), while some evidence exists that ethnic minorities suffer worse impacts (Norris et al., 2002; Tapsell and Tunstall, 2008). However for the current study with households as the unit of analysis gender and ethnicity are too complex to consider. Severity of exposure to a traumatic event is universally found to have a significant effect on post event outcomes (Bland et al., 1996; Norris et al., 2002; Tapsell et al., 2009). Indicators of severity are variously measured and can include emotional responses, such as fear of death, as well as objective measures, such as number of casualties or losses. These were considered inappropriate as the 2007 flooding was not of a severity to generate large numbers of human casualties. Other more relevant examples of flood severity indicators are presence of water in the home (Mason et al., 2010), injury, death of a relative, damage levels (Alderman et al., 2012) and direct, indirect, tangible and intangible losses (Norris et al., 2004). High levels of disruption and deterioration of living conditions post flood can also be related to an increase in psychosocial disorders (Norris et al., 2004; Mason et al., 2010; Whittle and

Medd, 2011).

Other influencing factors appear to be less clearly linked and relate to cultural, social, coping and personality factors. Support networks are hypothesised to be helpful in preventing the development of symptoms but indicators for the presence of support networks are not easy to find. For example, spousal support was seen as less helpful for women than for men (Tapsell et al., 2009) and this may be related to the social burden often placed on females as homemakers. The impact of religious counselling is likely to be highly subjective and linked to the strength of belief and standing within a community. In some cultures or for some age groups the expectation of not asking for help can make symptoms worse (Switzer, 1999; Maercker and Muller, 2004). Family and social structure may be highly important but difficult to measure on a consistent basis particularly when considering international comparisons or diverse ethnic communities.

Life stressors are important such as being a single parent, health issues and other stressful events co-existing with the trauma. Tapsell et al. (2009) suggests that this may explain the different findings related to age of an individual exposed to trauma. Some studies have demonstrated that middle aged adults are the most prone to mental health problems after disasters (Norris et al., 2002). Tapsell et al. (2009) suggests this is due to the flooding adding to the greater responsibilities they already face. This may more than outweigh the additional physical challenges faced by many older people as they are able to employ coping strategies and are more used to and adapted to accepting help. Finally Mason et al. (2010) suggest coping strategies and attitudes are important (Mason et al., 2010) with, for example, events seen to be accidents causing less distress than those seen as preventable. Therefore exposure factors and covariates were selected as follows:

2.1.1. Outcome factors

Severity of deterioration of mental health; frequency of anxiety when it rains; frequency of increase stress level; frequency of depression; frequency of sleeplessness; frequency of nighmares; frequency of flashbacks to the flood event; frequency of using alcohol; frequency of visit to the doctor's surgery; increase frequency of anger; frequency of tension in relationships; frequency of difficulty in concentrating on everyday tasks.

2.1.2. Exposure factors

Duration of flooding (hrs); flood depth; registered for flood warning; receipt of flood warning; action as a result of warning; cost of damage (reinstatement cost); need for relocation; length of relocation; implementation of sandbags; moved high value items to first floor; relocating kitchen to upper floor; implement airbrick and vent covers; implement waterproofing external walls; implement non return value; implement automatic airbrick and vent; implement doors and window guards.

2.1.3. Covariates

Respondent age; household income level; occupation of the main income earner; number of people living in the household.

Furthermore a useful conceptual framework for analysing the relationship between variables and mental health is suggested by the work of Parker et al. (1987), Tapsell et al. (2009) and Shultz et al. (2013). This framework proposes that influencing factors on trauma impacts, particularly health impacts, can usefully be characterised in relation to the disaster cycle. Factors can therefore be grouped into impact phases for analysis and this may be helpful in reducing the incidence of co-linearity in the data and also may aid interpretation of findings. In accordance with this thinking, therefore, this research uses a framework of grouping variables into pre-existing conditions, flood characteristics and post event experiences as shown in Table 2 below.

The statistical analysis proceeds in three stages. First understanding of the prevalence and co morbidity of symptoms is developed through descriptive and correlation analysis. Spearman's Rho correlation analysis thereby informs the selection of the appropriate outcome variable(s) for the regression model. Second correlation of the selected outcome variable with exposure and covariate variables for each stage of the disaster cycle is carried out to select candidate variables for the regression model. Finally the candidate variables from these three correlation analysis are combined in a holistic final model.

2.2. Data collection methods

The study used a cross sectional postal questionnaire from a sample of owner occupied households that had experienced flooding of their homes during the 2007 floods in England. The survey questions relating to psychosocial impacts formed part of a larger questionnaire designed to elicit the willingness of owner occupied households to pay to avoid these and other intangible impacts of flooding and the financial benefits to homeowners of investing in measures (Joseph et al., 2014). Therefore it was not appropriate to use extensive questions or diagnostic instruments to collect information on psycho-social impacts. The household was taken as the unit of analysis and respondents were required to assess and report the deterioration in psychological health for their household as a whole. The survey received ethical approval from the Ethics committee of the Faculty of Environment and Technology of the University of the West of England.

Statements about typical psycho-social impacts (described above in Section 2.1.1) were derived from reported impacts in the literature and information on the severity of deterioration of mental health on households was gathered using a five-point Likert scale ranging from 'extreme impact' to 'no impact'. A weighting was allocated to each severity; where "extreme impact'=5, 'high impact'=4, 'moderate impact'=3, 'marginal impact'=2, 'no impact'=1. Similarly, information was gathered on

Table 2
Mapping of survey variables influencing the likelihood of experiencing mental health disorder after flooding with flood stage.

Pre existing conditions	Features of the stressor event	Post event stress and coping strategies
Respondent age	Did you receive flood warning	Relocated
Household income level	Did you do anything as a result of the warning to prevent damage?	Relocation time
Occupation of the main income earner	Actual reinstatement costs	Registered for flood warning
Number of people living in the household	Flood depth in each property	Implement of sandbags
	Duration of flooding (hrs)	Moving high value items to first floor
		Relocating kitchen to upper floor
		Implement airbrick and vent covers
		Implement waterproofing external walls
		Implement non return value
		Implement automatic airbrick and vent
		Implement doors and window guards

the frequency of specific psychological symptoms related to flooding such as depression. A five point Likert scale ranging from 'always' and 'never' was used. A weighting was allocated to each of the options; where "always"=5, "very often"=4, "sometimes"=3, "rarely"=2 and "never"=1.

Questions also addressed covariates and exposure factors (as described in Sections 2.1.2 and 2.1.3) such as income level; flood experience; and actions taken before and after a flood such as flood warning, and mitigation. Depth, duration and actual re-instatement cost data was collected from claims records. Table 2 summarises the way in which these variables were mapped against the disaster cycle phases within the conceptual framework.

There has not been an evaluation of immediate post-flood impact within the studied areas, the nearest approximation are the two UK studies of communities flooded in the same (2007) event. In the absence of pre-flood or post flood control information the respondents were asked to rate the deterioration in their households mental health rather than the absolute level. The expectation was that: the incidence of extreme mental disturbance would be relatively low and certainly lower than the previous UK studies; the proportion of households affected might be higher than the proportion of individuals; and self reporting might lead to over estimation of the clinical levels of mental health disturbance. However relative levels of different symptoms and their correlation with flood factors would be robust to the method chosen.

The survey locations were selected from amongst the locations flooded during the 2007 flood event, the selection criteria was based on the need to represent the widest possible variation both geographical and flood typology while retaining minimum numbers of affected properties within each selected site. Only sites with greater than 50 affected properties were included in the survey in order to facilitate data validation, in particular to check whether there were any geographic differences in responses, which can be most reasonably carried out with multiple properties in each location. Participants were selected through the use of an insurance claims database via a census sample of available addresses in the database. Fig. 1 shows the distribution of the surveyed locations. As this was dictated by the locations of flooded households the sample, it was not designed to be representative of national socio-demographic patterns. However as they are not used to infer national figures, but rather to explore relationships between variables this is not seen as a major issue for the interpretation of findings.

Postal questionnaire surveys are synonymous with low response rate (Creswell, 2003, 2009). However it was decided that the postal method was necessary for this research due to the nature of information required, which would require respondents to cast their mind back to the past flood event. Prior to embarking

Fig. 1. Map of survey locations.

on nationwide survey, the questionnaire was piloted to test the intended method for data collection and test respondents' understanding of the questions. The pilot questionnaire survey was administered among two sets of homeowners; those that had previous flood experience and those that had no flood experience. A total of 20 survey questionnaires were issued and respondents were asked to evaluate the layout, question design and content of the questionnaire after completing the main questions. The evaluations revealed that majority of the questions were well understood, this conclusion was reached based on the comments provided by the respondents. However, questions on the awareness and implementation of the adaptation measures to properties were found to be confusing. Following the completion of pilot study, these questions were modified based on the feedback received.

The main survey questionnaire was issued to the 15 full study sites on the same date. Three weeks later a reminder postcard was sent to those who had not responded. The decision to issue a postcard instead of issuing another set of questionnaires was hinged on reducing possible upset for respondents and contact details were provided in case another questionnaire was required. Among the non responders, two respondents provided a reason of not being the occupant of the property at the time of the flood event. Further, a phone call was received by a lady on behalf of her mother-in-law that she was too old to complete the questionnaire. In total, 2309 questionnaires were distributed with 280 responses, representing a response rate of 12.1%, which is considered a reasonable return for an unsolicited postal survey.

The survey questionnaire was designed to gather information in two key areas including socio-economic demographics. Data analysis was carried out in SPSS based on variables from the survey and with reference to the flood stages in the form of descriptive statistics and correlation analysis. The exploratory analysis was carried out across several of the psycho-social impact categories and led to the selection of a binary logistic regression model based on self reported mental health deterioration described in Section 3.6.

3. Research results

Three phases of analysis are provided below: first descriptive statistics are presented to show the prevalence and distribution of psychological symptoms and reported mental health issues by respondents on behalf of their households. This is followed by a cross-correlation analysis of factors seen to influence mental health in the past. These factors are related to pre-existing factors such as household composition, event factors such as flood depth and post event factors such as displacement from home. Finally a binary logistic regression model is presented that explores the most significant correlations between long term mental health deterioration, social factors, event factors and post event coping and stressors.

3.1. Prevalence of reported mental health deterioration in households

Two thirds of the respondents reported no or marginal impact on household mental health (see Fig 2). The rest are about evenly divided between moderate, high and extreme impact of flooding on the deterioration of mental health.

A similar pattern is reported on the frequency of depression (Fig. 3) with two thirds reporting never or rarely suffering depression. However the numbers reporting frequently being depressed or always suffering depression are fairly low at 9.5% and 7.4% respectively.
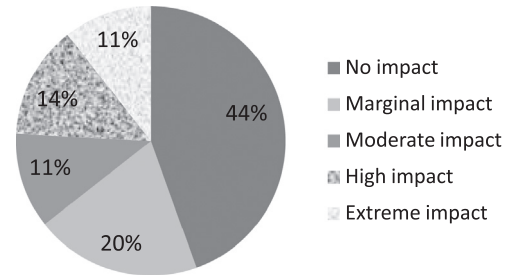

Fig. 2. Prevalence of different reported severities in deterioration of mental health following flooding.
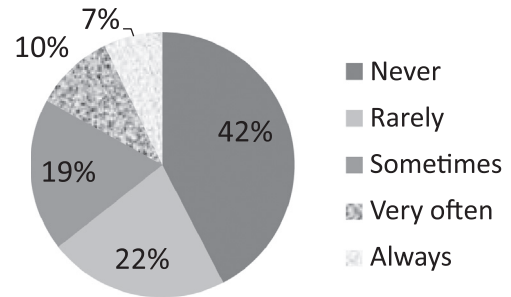

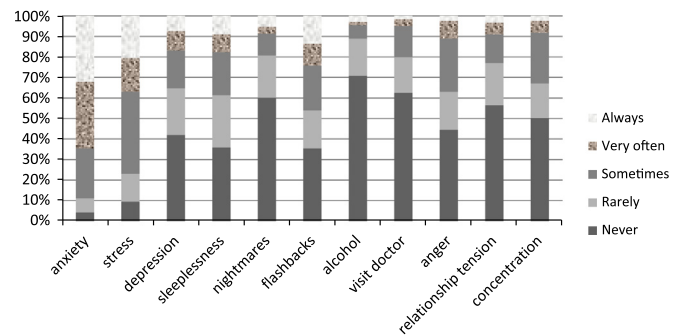Fig. 3. Prevalence of different frequencies of experiencing depression after flooding.

Fig. 4. Distribution of reported psycho-social symptoms six years after a flood among English households flooded in 2007.

Figs. 2 and 3 exhibit the expected trauma patterns that longer term psychiatric disorders are experienced by a minority of flood affected households. However as shown below other symptoms and anxieties are more regularly reported.

3.2. Distribution of reported symptoms of psychological impacts of flooding

The questionnaire explored many different symptoms that are seen to be indicative factors for psychological distress, ranging from social behaviours, feelings and symptoms and self reported disorders. Fig 4 demonstrates the percentage of households experiencing different symptoms.

Over 60% of respondents reported always or very often experiencing anxiety when it rains even though the flood was a long time ago. Less than 5% of respondents reported never experiencing anxiety. This is a legacy that demonstrates how universal human responses are to the ongoing threat of flooding and that risk of flooding is associated with rainfall in the minds of flooded households. The high levels of anxiety translate into increased stress for fewer households; under 40% reported always or very

often experiencing increased stress level. However, only 10% reported never experiencing increased stress levels. This suggests that the majority of previously flooded households still feel somewhat vulnerable and experience low level symptoms even 5 years after a flood event. Frequent flashbacks were experienced by fewer households (23% always or very often) however almost two thirds reported experiencing them if only rarely. Nightmares were less common with 60% reporting never suffering from them and less than 10% always or very often having nightmares. Sleeplessness and depression exhibited similar reporting patterns, with 18% experiencing them always or very often. The knock on effect of the anxiety and stress levels in terms of always or very often experiencing anger, relationship tension, loss of concentration or needing to visit the doctor or use alcohol was restricted to less than 40% for each symptom. These are still quite high levels, suggesting that the memory of flooding, within a significant number of flood affected households, endures and impacts on their wellbeing.

3.3. Co-morbidity of symptoms

The co-morbidity of psychological symptoms is represented by the cross-correlation of symptoms. Analysis shows that symptoms are all significantly correlated (at the 1% level of confidence) with one another implying that households experiencing one symptom frequently are more likely to experience other and multiple psychological impacts on a regular basis. Typically individuals with the most extreme symptoms will exhibit many of the other ones with high levels of frequency. The high levels of co-morbidity imply that selection of a single outcome variable for regression modelling is a practical proposition as it is likely that similar factors will affect all the outcomes and also the co-linearity will be reduced. Severity of mental deterioration is selected as the outcome variable for further modelling.

A particular high correlation is exhibited (above 0.6) between: anxiety and stress; sleeplessness and depression; stress and depression; nightmares and sleeplessness; anger and increased tension in relationship; difficulty in concentration with anger and tension in relationship. Some of these may be expected in clinical terms, such as the association of depression with sleeplessness, others are socially linked such as higher expression of anger causing tension between household members and vice versa.

3.4. Factors affecting reported mental health deterioration

Table 3 shows that reported mental health deterioration is negatively correlated to household income. This implies that those with lower income levels are more likely to experience severe mental health deterioration after a flood. There are higher levels of

correlation between the household characteristic variables: occupation and age are related with older households having lower income, occupation and income are quite closely related. Older households tend to be smaller and larger households have slightly higher average income levels. This suggests that the measured impact of income on mental health deterioration may in some sense proxy for other socio-demographic factors.

Severity of mental health deterioration is also expected to be related to characteristics of the flood event including the direct damage caused. The data reveals that for this sample (see Table 4), flood depth is positively correlated with deterioration of mental health, and actions taken before the flood to decrease damage is negatively correlated with deterioration of mental health. This suggests the expected relationship of flood severity with mental health and also some indication that a feeling of control over damage or actual limitation of damage could boost mental resilience.

However, reinstatement costs are not correlated with mental health impact. One explanation for this could be that, for this sample, reinstatement costs are more related to property factors, such as the size of the property or value of the contents, rather than depth. Although correlation between depth and reinstatement cost is highly significant in statistical terms it is of a low order and reinforces the idea that flood severity is not the largest determinant of the cost of reinstatement among this sample. Receiving a flood warning was highly correlated to taking preventative action, however taking action was unrelated to reinstatement costs suggesting those actions were not instrumental in preventing economic damage to buildings. This could result in a lack of trust in mitigation measures that would lead to greater anxiety among previously flooded households.

Finally, Table 5 demonstrates that post flood stressors and coping actions are somewhat correlated with mental health deterioration. The need to relocate is most strongly correlated with mental health issues. The post-flood implementation of various resilience and resistance measures is also positively correlated with mental health issues. This could be driven by experiential learning in more severely affected households (both physically and mentally) to undertake measures in order to prevent recurrence of the damage and distress. Clearly there are some interactions between independent variables that would lead to a desire to build a holistic model to explain mental health deterioration in relation to a number of factors at once.

The correlations between installations of different protection measures demonstrate some tendency to install a suite of measures designed to keep water out rather than a single measure. This is reassuring because it is usually necessary to install more than one measure to achieve flood resistant protection. However, there are many examples of properties that appear to have implemented a partial solution.

Table 3
Correlation of severity of deterioration of mental health with pre-event population factors.

	Severity of deterioration of mental health	Respondent age	Household income level	Occupation of the main income earner	Number of people living in the household
Severity of deterioration of mental health	1.00				
Respondent age	−.05	1.00			
Household income level	−**.17****	−**.36****	1.00		
Occupation of the main income earner	.08	**.65****	−**.62****	1.00	
Number of people living in the household	.10	−**.24****	**.22****	−.16*	1.00

* Significant at 5%.
** Significant at 1%.

Table 4
Correlation of severity of severe mental health deterioration with flood event characteristics.

	Severity of deterioration of mental health	Did you receive flood warning	Did you do any-thing to prevent damage?	Actual reinstatement costs	Flood depth in each property	Duration of flooding (hrs)
Severity of deterioration of mental health	1.00					
Did you receive flood warning	−.07	1.00				
Did you do anything as a result of the warning to prevent damage?	−**.14***	**.45****	1.00			
Actual reinstatement costs	.12	-.03	.00	1.00		
Flood depth in each property	**.15***	.01	.05	**.21****	1.00	
Duration of flooding	.01	−.09	−.04	.13	**.34****	1.00

* Significant at 5%.
** Significant at 1%.

3.5. Factors associated with reported symptoms of psychological impacts

The prevalence of reported symptoms of anxiety and stress being experienced by households is much higher than the reported incidence of depression and mental health deterioration (see Fig. 4). Factors affecting the prevalence of these common symptoms are expected to be similar to those affecting rarer conditions.

Testing the same variables as for reported health deterioration it is apparent that once again household income is the most strongly correlated factor with reported anxiety and increased stress. flood event characteristics show no significant correlations with anxiety or increased stress. relocation time, a post flood factor, is correlated with stress but not with reported anxiety.

The strongest correlation for other reported symptoms such as sleeplessness, flashbacks and increased anger are all with relocation.

3.6. Main factors associated with longer term mental health deterioration

There is strong co-morbidity between reported mental health symptoms therefore the restriction of the dependant (outcome) variable to a single symptom will produce the most stable model, albeit with some loss of information about the differences between symptoms. Deterioration in mental health was therefore chosen as the dependant variable and it was represented as a binary variable. The binary variable was derived from the five point Likert scale severe (high and extreme deterioration) as against low (moderate, marginal and no impact) based on the pragmatic consideration of improving statistical power in the light of the sample size and number of candidate variables and the assumption that moderate, marginal and no impact are words associated with tolerable effects as opposed to high and extreme.

In this model the aim is therefore to find the factors most indicative of households that reported high to severe mental health deterioration as a result of flooding. The model used candidate variables that were found to be correlated to mental health deterioration in the analysis above. An iterative backwards selection method was employed to select the variables finally included in the regression model. The resulting model correctly categorises 80% of the households with a Nagelkerke R^2 or 0.45, implying that 45% of the variation in the data is explained by the model. The model is shown in Table 6.

The first aspect to note is that all the independent variables exhibit the expected direction of influence on mental health outcomes. This is in contrast to the bivariate correlation analysis that showed mitigation actions as positively correlated with mental health deterioration. A possible explanation of this is that, having accounted for severity (using depth and relocation) the positive aspect of taking mitigation action is revealed by the holistic model.

The model elasticities suggest that those on very low incomes are eight times more likely to report severe mental health deterioration than those on the highest incomes. Those that are relocated for over 6 months are almost 6 times more likely to report mental health deterioration than those not relocated at all. Implementing mitigation measures (other things being equal) reduces the incidence of severe mental health deterioration by four fifths and those flooded at less than 1 m depth are one third as likely to experience severe mental health deterioration as those with deeper than 1 m floods.

This indicates that, as previously highlighted, multiple characteristics are needed to predict mental health deterioration. Income and relocation are the most strongly predictive factors. Almost all households with severe mental health deterioration were relocated and all households in the lowest income bracket reported severe mental health deterioration. There are variables included in the model from each of the three flood stage categories and this supports the conceptual framework chosen for the analysis as it has assisted in selecting appropriate factors to include within the binary logistic regression model. These factors can then be considered as important when attempting to support households in the aftermath of a flood.

4. Discussion

In comparing the results of this study with previous studies, and particularly those based on UK populations, differences must be borne in mind such as the study being carried out more than 5 years after a flood and relying on self reporting of symptoms at a household level. This could lead to inaccuracies from lack of recall due to time elapsed; lack of understanding of the symptoms and responses of other household members; and the impact of intervening events (flood related or not). Mason et al. (2010) also highlight the tendency for self reporting of mental health disorder to give higher prevalence than use of clinical diagnostic tests.

The survey delivery was a postal questionnaire and this may lead to self selection bias with the most affected individuals taking the time to reply. While it is never possible to determine whether there is some bias and levels of symptoms reported as higher than the real situation. In this instance the tendency for only those affected with psycho-social symptoms to reply was minimised because mental health issues were not the only focus of the questionnaire. The evidence from Mason et al. (2010) and Paranjothy et al. (2011) also suggests that potential participation biases do not appear to influence prevalence estimates of mental health

Table 5
Correlation of severity of mental health deterioration with post flood stresses and coping strategies.

	Severity	Relocate	Relocation time	Flood warning	Sandbags	Moved items	Relocated kitchen	Airbrick and vent covers	Waterproof external walls	Non return value	Automatic airbrick and vent	Door and window guards
Relocated	.263**	1.00										
Relocation time	.166*	.777**	1.00									
Registered for warning	.148*	.156*	.046	1.00								
Implement of sandbags	.204**	.127	−.003	.405**	1.00							
Moving high value items	.278**	.119	.045	.276**	.356**	1.00						
Relocate kitchen	−.094	−.140*	−.117	−.063	−.069	.009	1.00					
Fit airbrick and vent covers	.028	.022	.090	.137*	.146*	.032	−.041	1.00				
Waterproofed external walls	.084	.062	.034	.042	.027	.092	−.016	.124	1.00			
Non-return value	.009	−.018	.044	.044	.020	−.004	−.027	.474**	.044	1.00		
Implement automatic airbrick/vent	.117	−.010	.046	.063	.049	.070	−.015	.218**	−.028	.461**	1.00	
Implement doors and window guards	.146*	−.007	.052	.166*	.138*	.107	−.027	.288**	.224**	.443**	.447**	1.00

* Significant at 5%.
** Significant at 1%.

Table 6
Results of binary logistic regression model of severe mental health deterioration against population, event and post event factors.

	B	Odds ratio exp (b)	Confidence Interval	
			Lower	Upper
Household income level Ref. above £55,000				
Less than £5000	2.09	8.06	1.4	47.0
£5000–£14,999	1.14	3.13	0.9	11.4
£15,000–£24,999	0.77	2.17	0.7	7.1
£25,000–£34,999	−0.06	0.95	0.3	3.3
£35,000–£44,999	0.32	1.37	0.3	5.6
£45,000–£54,999	−0.52	0.60	0.1	3.1
Took damage prevention during flood	−0.12	0.89	0.3	2.7
Depth less than 1 m	−1.1	0.34	0.1	0.8
Relocation duration Ref. no relocation				
Less than 3 months	0.23	1.26	0.1	16.6
3–6 months	0.72	2.06	0.7	6.4
Longer than 6 months	1.76	5.80	2.2	15.1
Moved high value items	−1.54	0.21	0.1	0.5
Implemented door and window guards	−1.27	0.28	0.1	0.8

deterioration. This is backed up by results from Alderman et al. (2013) where no over representation of directly impacted households was observed in their survey of flooded households in Brisbane. Furthermore there were no discernible patterns in response rate or responses that would indicate that only severely flooded or traumatised households replied. Finally, given that responses covered the entire gamut from no impact to extreme impact, the correlation analysis and regression results are robust to potential sample selection bias.

Levels of severe mental health deterioration and depression are much lower than the levels reported by Mason et al. (2010) and somewhat lower than Paranjothy et al. (2011) but this is to be expected given the greater time elapsed from the flood event.

Paranjothy et al. (2011) and Mason et al. (2010) have both measured impacts in England and have looked at more than one measured impact. They observed vastly different rates of symptoms such as 8% depression measured in Paranjothy et al. (2011) as opposed to 35% in Mason et al. (2010) (Table 1). It is apparent that, despite both studies measuring psychological effects at around the same time-lag (3–6 months after the flood), the population sampled contained very different proportions of households that experienced flooding of their homes and those that did not. Since floodwater in the home was seen by Mason et al. (2010) to be the biggest determinant of differential mental health outcomes, it is clear that focusing on flooded households will tend to yield higher levels of psychological impact than studies of the population in general. The levels of symptoms found in this study are more similar to levels reported by Liu et al. (2006) 2.5 years after a flood in China. However at this distance from a flood event, the results tend to support Briere and Elliot's (2000) finding that trauma indicators can be seen in populations decades after experiencing traumatic events.

The finding that, out of several pre-existing socio-economic variables, mental health deterioration is most correlated with income confirms results, noted in Section 2, from previous studies. Research consistently finds socio-economic status to have an influence on health outcomes in the aftermath of flooding whereas other variables are less consistently found to be related to symptoms.

The need to relocate was most strongly correlated with mental health issues. This is an expected result as displacement from

home is one of the most stressful factors cited by flood affected households in literature (Association of British Insurers, 2010; Environment Agency/Department of the Environment Food and Rural Affairs, 2005) and also because the likelihood of relocation is related to severity of flooding. Therefore the broad findings from this study concur both with previous empirical studies and with expectation derived from analysis of those studies, and are credible in that respect.

Where this study differs from previous research is in measuring the impact of active coping strategies such as taking adaptive steps after flooding. Contrary to expectation these are positively correlated with negative mental health outcomes this has been interpreted as a cross-correlation effect of flood severity. However in the multi-dimensional regression model some mitigation activities were found to be associated with reduced mental health deterioration and in that respect the findings are novel and indicate the possibility that actions taken to encourage active coping strategies may assist in the long term mental health of flooded communities.

This study is limited in that it is focussed on one flood event in England and on households that experienced direct flood damage. Therefore if these results were used to estimate psycho-social impacts from flooding in the wider floodplain community (directly and indirectly affected) it would probably lead to over-estimation of distress. It is also a cross sectional study and cannot be compared directly to measurement of short term impacts for the same population.

While it is possible that the measure of relocation is in some way proxying for other measures of damage and disruption following flooding; it is clear that the impact of such disruption is long lasting and can contribute to mental health deterioration in households. Appropriate consideration could therefore be given to the mental health aspects of households while discussing the appropriate reinstatement processes. Due thought to the desirability of keeping vulnerable households in their home or nearby could reduce the levels of stress and anxiety experienced by household members.

5. Conclusions

In the households surveyed for this study several years after flooding large numbers reported moderate symptoms and smaller numbers reporting more extreme symptoms of mental health disturbance. Most households still experienced some anxiety and a minority experienced extreme symptoms of anxiety leading to the conclusion that flood events represent a long term threat to mental health that warrants some attention and potentially intervention.

Factors implicated in the severity of symptoms for the households in this study are household income, severity of the flood event and need to relocate afterwards. Other pre-existing household characteristics were found to have weaker effects. Coping strategies such as implementation of flood protection were associated with reduced mental health symptoms once other factors had been accounted for.

The association of income levels with reported mental health deterioration requires more investigation. It is not clear whether the association is due to resource constraints, (that could be removed in the aftermath of a flood to help low income households) or whether a more general lack of resilience, related to low income, is the underlying issue.

Furthermore the observed effect of post flood mitigation on mental health is strongly suggestive of experiential learning by flooded households being enhanced through the motivation to avoid future stress and anxiety. It would be valuable to explore this

in more detail particularly for those households that may be flooded again in the future.

Finally, although the alleviation of the mental health implications of flooding through clinical and support counselling services has been largely outside the scope of the paper, the findings imply that this is an area worthy of further investigation and guidance in order to reduce the long term mental health impacts in flooded communities.

Acknowledgement

References

Alderman, K., Turner, L.R., Tong, S., 2012. Floods and human health: a systematic review. Environ. Int. 47, 37–47.

Alderman, K., Turner Lyle, R., Tong, S., 2013. Assessment of the health impacts of the 2011 summer floods in Brisbane. Disaster Med. Public Health Prep. 7, 380–386.

Assanangkornchai, S., Tangboonngam, S., Samangsri, N., Edwards, J.G., 2007. A Thai community's anniversary reaction to a major catastrophe. Stress and Health 23, 43–50.

Association of British Insurers, 2010. Fighting Flood Risk Together. Association of British Insurers, London.

Azuma, K., Ikeda, K., Kagi, N., Yanagi, U., Hasegawa, K., Osawa, H., 2013. Effects of water-damaged homes after flooding: health status of the residents and the environmental risk factors. Int. J. Environ. Health Res. 24, 158–175.

Bland, S.H., O'Leary, E.S., Farinaro, E., Jossa, F., Trevisan, M., 1996. Long-term psychological effects of natural disasters. Psychosom. Med. 58, 18–24.

Briere, J., Elliott, D., 2000. Prevalence, characteristics, and long-term sequelae of natural disaster exposure in the general population. J. Trauma. Stress 13, 661–679.

Carroll, B., Balogh, R., Morbey, H., Araoz, G., 2010. Health and social impacts of a flood disaster: responding to needs and implications for practice. Disasters 34, 1045–1063.

Chae, E., Tong, W.K., Rhee, S., Henderson, T., 2005. The impact of flooding on the mental health of affected people in South Korea. Community Ment Health J. 41, 633–645.

Collins, T.W., Jimenez, A.M., Grineski, S.E., 2013. Hispanic health disparities after a flood disaster: results of a population-based survey of individuals experiencing home site damage in El Paso (Texas, USA). J. Immigr. Minor. Health 15, 415–426.

Creswell, J.W., 2003. Research Design:Qualitative, Quantitative, and Mixed Method Approaches. Sage Publication, Thousand Oaks, California.

Creswell, J.W., 2009. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3rd ed. Sage, London.

Environment Agency/Department of the Environment Food and Rural Affairs, 2005. The Appraisal Of Human Related Intangible Impacts Of Flooding. Environment Agency/Department of the Environment Food and Rural Affairs, London, Technical report.

Few, R., 2007. Health and Climatic hazards: framing social research on vulnerability, response and adaptation. Global Environ. Chang. 17, 281–295.

Fewtrell, L., Kay, D., 2008. An attempt to quantify the health impacts of flooding in the UK using an urban case study. Public Health 122, 446–451.

Heo, J.H., Kim, M.H., Koh, S.B., Noh, S., Park, J.H., Ahn, J.S., 2008. A Prospective Study on Changes in Health Status Following Flood Disaster. Psychiatry Investigation 5, 186–192.

Joseph, R., Proverbs, D., Lamond, J., 2014. Resilient reinstatement – what can we learn from the 2007 flooding in England? In: Brebbia, C., Proverbs, D. (Eds.), Flood Recovery Innovation and Response IV. WIT Press, Southampton.

Liu, A., Tan, H., Zhou, J., Li, S., Yang, T., Wang, J., Liu, J., Tang, X., Sun, Z., Wen, S.W., 2006. An epidemiologic study of post-traumatic stress disorder in flood victims in Hunan China. Can J Psychiatry 51, 350–354.

Maercker, A., Muller, J., 2004. Social acknowledgment as a victim or survivor: a scale to measure a recovery factor of PTSD. J. Trauma. Stress 17, 345–351.

Mason, V., Andrews, H., Upton, D., 2010. The psychological impact of exposure to floods. Psychol. Health Med. 15, 61–73.

Norris, F.H., Friedman, M.J., Watson, P.J., 2002. 60,000 disaster victims speak: Part II, summary and implications of the disaster mental health research. Psychiatry 65, 240–260.

Norris, F.H., Murphy, A.D., Baker, C.K., Perilla, J.L., 2004. Postdisaster PTSD over four waves of a panel study of Mexico's 1999 flood. J. Trauma. Stress 17, 283–292.

Paranjothy, S., Gallacher, J., Amlôt, R., Rubin, G.J., Page, L., Baxter, T., Wight, J., Kirrage, D., McNaught, R., Palmer, S.R., 2011. Psychosocial impact of the summer 2007 floods in England. BMC Public Health 11, 145.

Parker, D.J., Green, C.H., Thompson, P.M., 1987. Urban Flood Protection Benefits: A Project Appraisal Guide. Gower, Aldershot.

Rosen, C.S., Matthieu, M.M., Norris, F.H., 2009. Factors predicting crisis counselor referrals to other crisis counseling, disaster relief, and psychological services: a cross-site analysis of post-katrina programs. Adm. Policy Ment Health Ment Health Serv. Res. 36, 186–194.

Shultz, J.M., McLean, A., Herberman Mash, H.B., Rosen, A., Kelly, F., Solo-Gabriele, H. M., Youngs, J.G.A., Jensen, J., Bernal, O., Neria, Y., 2013. Mitigating flood exposure: reducing disaster risk and trauma signature. Disaster Health 1, 30–44.

Stanke, C., Murray, V., Amlôt, R., Nurse, J., Williams, R., 2012. The effects of flooding on mental health: outcomes and recommendations from a review of the literature. PLoS Curr. Disasters 4, e4f9f1fa9c3cae.

Switzer, G.E., 1999. Posttraumatic stress disorder and service utilization among urban mental health center clients. J. Trauma. Stress 12, 25–39.

Tapsell, S.M., Tunstall, S.M., 2008. "I wish I'd never heard of Banbury": the relationship between 'place' and the health impacts from flooding. Health Place 14, 133–154.

Tapsell, S.M., Tunstall, S.M., Priest, S., 2009. Developing a conceptual model of flood impacts upon human health, Integrated Flood Risk Analysis and Management Methodologies, FloodSite Report.

Tierney, K., 2000. Controversy and consensus in disaster mental health research. Prehosp. Disaster Med. 15, 55–61.

Whittle, R., Medd, W., 2011. Living with flood: understanding residents' experience of recovery In: Lamond, J.E., Proverbs, D.G., Booth, C.A., Hammond, F.N. (Eds.), Flood Hazards, Impacts and Responses for the Built Environment. Taylor CRC press, New York.