The Ongoing Impact of Secondary Stressors on Businesses in Northern Ireland Affected by Flood Events

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Abstract—**Purpose**: The key aim of the research was to identify the secondary stressors experienced by businesses affected by single or repeated flooding and to determine to what extent businesses were affected by these stressors, along with any resulting impact on health. Additionally the research aimed to establish the likelihood of businesses being re-exposed to the secondary stressors through assessing awareness of flood risk, implementation of property protection measures and level of community resilience.

Design/methodology/approach: The chosen research method involved the distribution of a questionnaire survey to businesses affected by either single or repeated flood events. The questionnaire included the Impact of Event Scale (a 15-item self-report measure which assesses subjective distress caused by traumatic events).

Findings: 55 completed questionnaires were returned by flood impacted businesses. 89% of the businesses had sustained internal flooding, while 11% had experienced external flooding. The results established that the key secondary stressors experienced by businesses, in order of priority, were: flood damage, fear of reoccurring flooding, prevention of access to the premise/closure, loss of income, repair works, length of closure and insurance issues. There was a lack of preparedness for potential future floods and consequent vulnerability to the emergence of secondary stressors among flood affected businesses, as flood resistance or flood resilience measures had only been implemented by 11% and 13% respectively. In relation to the psychological repercussions, the Impact of Event scores suggested that potential prevalence of post-traumatic stress disorder (PTSD) was noted among 8 out of 55 respondents (15%).

Originality/value: The results improve understanding of the enduring repercussions of flood events on businesses, indicating that not only residents may be susceptible to the detrimental health impacts of flood events and single flood events may be just as likely as reoccurring flooding to contribute to ongoing stress. Lack of financial resources is a possible explanation for the lack of implementation of property protection measures among businesses, despite 49% experiencing flooding on multiple occasions. Therefore it is recommended that policymakers should consider potential sources of financial support or grants towards flood defences for flood impacted businesses. Any form of assistance should be made available to businesses at the earliest opportunity as there was no significant association between the time of the last flood event and the likelihood of experiencing PTSD symptoms.

Keywords—Flood event, flood resilience, flood resistance, PTSD, secondary stressors.

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I. INTRODUCTION

FLOOD events can have catastrophic implications for the local and national economy due to the almost inevitable disruption caused to the commercial sector [1]. The summer 2007 floods in the UK impacted approximately 48, 000 residential and 7, 000 commercial properties, thus highlighting that flood events have substantial implications for both homeowners and businesses [2]. Within the UK, it has been estimated that by 2080, the financial losses suffered by businesses as a result of flooding will cost the UK economy up to £42 billion annually [3].

Businesses can be affected either directly or indirectly by flood events. Direct impacts include financial issues such as damage to equipment, records and stock and also the costs associated with the necessary repair works. Indirect impacts include disruption to the supply chain and the resulting increase in insurance premiums [4]-[7]. It is essential to recognize that although the direct impact of a flood event may be small i.e. the business has not experienced extensive damage; nevertheless, the severity of the indirect impacts can often result in eventual business closure [4].

Multiple previous studies have examined the impact of flood events on the long-term health of residents [8]-[18]. However, very limited research is available to date which examines the health impacts of floods on business owners and managers, with previous research focus remaining mostly on awareness, preparedness and adaptation measures. Nevertheless, there is a growing recognition of the importance of identifying the impact of flood events on the health of individuals who have the overall day-to-day responsibility of running a business [3]. Further research is necessary in order to determine the long-term health impacts on business owners and managers which will inform emerging strategies and policy relating to flood warnings, flood response, post-flood support and flood alleviation. In order to improve understanding this paper examines the specific secondary stressors impacting business owners and managers who have experienced flood events and the role of individual and community coping mechanisms in alleviating the stressors. Demographic and flood impact characteristics are utilized to gain an understanding of risk factors which can increase the extent of the stressors experienced by individuals. The key contributions to the research field by this paper are that it develops the understanding of the secondary stressors impacting business owners and managers as a result of flooding, permits the ranking of these stressors in terms of

importance and additionally demonstrates the correlations between particular stressors. These findings can significantly inform and guide future policy as they firstly identify the key flood-related issues faced by businesses which may require specific agency or governmental support. Secondly the findings illustrate that particular stressors are likely to occur in combination and thus require collective action to minimize their potential impact.

The structure of the paper is as follows: Section II contains a review of the literature relating to the factors which have the potential to cause stress to business owners and managers who experience flooding; Section III outlines the research methodology utilized in the study, Section IV presents the key research findings of the study and Section V proposes future research needs in this area and the key policy recommendations and implications.

II. LITERATURE REVIEW

During the aftermath of a flood event, businesses often experience the emergence of a series of persistent problems such as difficulties relating to insurance claims. These ongoing problems are secondary stressors, which can be defined as "ongoing, unresolved factors indirectly associated with a defined prior event or events, which may result in emotional strain among affected individuals and act as obstacles in a return to what is perceived as normality" [19]. Secondary stressors can severely affect business continuity, often leading to extreme financial hardship, making it very difficult for the affected business to continue to function.

Examination of previous studies relating to the impact of flood events on businesses allowed the development of a list of "secondary stressors" which have the potential to negatively impact business owners and managers (Table I).

TABLE I
SUMMARY OF RESEARCH EVIDENCE RELATING TO IDENTIFICATION OF SECONDARY STRESSORS

Secondary stressors identified
Flood damage (goods/equipment/property) [4]-[6], [20]-[28]
Prevention of access/closure [4]-[6], [20], [22], [26]
Loss of income/trading/debt [4]-[7], [20]-[23], [26]-[28]
Loss of services (gas/electricity/water/communications [20], [23], [25]
Insurance (increased premiums/no insurance/difficulties with pay-outs) [4]-[6], [21], [23], [25], [26]
Inadequate financial assistance [4], [7], [25], [27], [28]
Repair to property and equipment & clean-up charges [4]-[6], [20]-[22], [24], [26], [28]
Fear of future flooding [20], [26]-[29]
Length of time of closure [4], [21], [25]
Loss of customer base [4], [23], [25]
Security/looting concerns [4], [25], [27]
Lack of help from government agencies [4], [5], [7], [26], [27], [28]
supply chain (deliveries to and from business) [4], [5], [20], [21], [23], [26]
Unrecoverable rent/ rates/ cost of temporary premise/ legal charges [21]
Employees: Lost working hours/ compensation/ difficulty travelling to work [4], [5], [6], [20], [21], [23], [25], [26]

Only one of the identified previous studies had attempted to rank the stressors in order of importance, which involved re-

sampling the study population on three occasions over a 22 month period [25]. It was noted that the rating allocated by the study participants for the majority of the stressors decreased with time and the individual ranks also changed. Businesses were primarily concerned with fear of reoccurring flooding, loss of services, customer base and employee issues. However, six months later flood damage had replaced the concerns regarding customer base. The majority of secondary stressor rankings increased in the second survey and then decreased in the third survey, with the exception of insurance which steadily decreased and inadequate financial assistance which originally decreased, then increased again [25].

Small businesses have an important role in the prosperity and growth of local communities [7]. However, the impact of flood events on small businesses can be particularly devastating, as they often do not have access to the human and financial resources necessary for recovery and are less likely to have flood insurance [4], [5], [25]. Previous studies have additionally suggested that small businesses are more vulnerable as they often underestimate flood risk, are less likely to be preparedness for flooding and tend to suffer significantly greater losses than larger businesses [4]-[7]. Small business owners and managers tend to encounter more frequent and substantial stresses than those in larger businesses, thus it is important for future research to focus on exploring the psychological impacts [5].

TABLE II
INDIVIDUAL COPING MECHANISMS UTILISED BY BUSINESSES

Individual coping mechanisms identified
Flood warning [21]
Flood insurance [4], [6], [21], [23], [24], [26], [29]
Temporary flood installations e.g. sandbags [5], [21], [24]
Permanent flood installations (flood resistance measures) e.g. non-return values [6], [21], [24]
Flood resilience measures [6], [21], [24]
Temporary business premise [21]
Purchasing emergency equipment [4], [21]
Data backup [4]-[6], [21]
Flood action plan/flood risk assessment [21], [23], [29]
Research information regarding potential flood protection measures [24]
Raised storage for water sensitive objects/relocating items upstairs [6], [24]
Moving business vehicles to higher ground [24]
Keep an emergency flood kit in case of evacuation [24]
Lifting/removing equipment, goods and records [5], [24]
Disconnect utilities i.e. electric, gas and water [24]
Use water pumps/ensure property drains are kept clear [24]

Although preventing a flood event from occurring is beyond the ability of individuals, limiting the effects of such an incident is not impossible through the employment of individual and community coping strategies [5]. Coping strategies can be defined as "the approaches that an individual employs to deal successfully with a crisis" [28]. In relation to flood events, coping strategies can be utilized by individual businesses to minimize flood impact on single properties or employed by a group of businesses to limit the impacts at community level. The type of coping strategies selected by

businesses is likely to depend on business size, business tenure, flood experience, and perception of flood risk [6]. Table II demonstrates the range of individual coping strategies employed by businesses in previous studies. As it is not financially viable for community-level flood alleviation schemes to protect every flood-risk property, it is essential to encourage the uptake of individual structural and non-structural property-level flood protection measures by businesses in order to mitigate flood impact [6].

Previous studies relating to flood-impacted businesses did not tend to focus on business community coping strategies, although it was noted that flood-affected business suppliers joined together to enhance post-flood recovery and some businesses joined community flood networks [22], [24]. An additional study identified that research participants felt that communities were more helpful in the aftermath of a flood event when compared with assistance from public service organizations [20]. A collective approach in relation to flood resilience among the business community currently seems to be limited [23].

With regards to the health impacts of flood events on business owners and managers, the majority of advice and guidance currently available relates to the immediate health risks during flood events and associated with post-flood clean-up [30]-[32]. The review of the literature was only able to identify two studies which had examined the long-term consequences for business owners and managers [20], [27]. One study examined the relationship between mental health recovery and economic recovery, which concluded that mental health recovery tended to be dependent primarily on time since the event, rather than on economic recovery [27]. The second study examined the health challenges, both physical and mental experienced by farmers following a flood event, with results indicating that 85% had experienced stress, 85% had felt anxiety and 6% had experienced depression [20].

In summary, the review of the literature relating to the secondary stressors experienced by business owners and managers impacted by flood events resulted in the proposal of 15 factors (Table I) which have the potential to cause stress due to flood experience. Additionally, the review of previous studies permitted the establishment of a list of individual coping mechanisms (Table II) likely to be utilized by business owners and managers to reduce the likelihood of a flood event causing property damage. The empirical research, which is described below, was then used to rank both of these lists according to the importance of the stressors and the frequency of use of the individual coping mechanisms. The literature review did not manage to sufficiently identify a list of community coping mechanisms utilized by businesses, thus the empirical data collection aimed to compose an inventory of these measures. Limited previous research has been undertaken relating to the long-term health consequences of flood events on businesses, thus this study sought to partially remedy that deficit.

III. RESEARCH METHODOLOGY

A. Survey Instrument

Following the literature review, a proposed list of key secondary stressors was developed which have the potential to impact persons in charge of businesses affected by flooding. A key aim of the questionnaire survey was to determine the extent of the impact of these stressors, thus respondents were requested to indicate to what extent they had been affected by each stressor as a result of flood events. A five-point Likert scale extending from 0 to 4 (0 = Not at all, 1 = A little bit, 2 = Moderately, 3 = Quite a bit and 4 = Extremely) was utilized. Additional questions relating to demographics and flood impact were included in order to identify trends. Further questions relating to flood risk awareness and individual and community coping mechanisms were employed to determine how persons in charge of businesses adapt to the ongoing repercussions of flooding.

The chosen measure to evaluate the impact on health was the Impact of Event scale (IES), a self-report measure, entailing a short list of 15 questions which assess the degree of distress associated with a particular event. The IES can be utilized to identify individuals at risk of developing post-traumatic stress disorder (PTSD) who are likely to require diagnostic follow up [33]. Study participants were required to rate their degree of distress in relation to each specific item, during the last seven days, via use of a Likert scale, extending from 0 to 3 (0 = Not at all, 1 = Rarely, 3 = Sometimes and 5 = Often). The scores on the scale can range from 0 to 75 and can be interpreted as outlined in Table III.

TABLE III
INTERPRETING THE IMPACT OF EVENT SCALE

Score	Consequence
0 – 8	No Meaningful Impact
9 – 25	Impact Event
26 – 43	Powerful Impact Event
44 - 75	Severe Impact Event

27 or more – There is a 75% chance that the respondent has PTSD
35 and above – Represents the best cutoff point for a probable diagnosis of PTSD [38]

Piloting of the survey instrument was conducted with a small number of individuals from non-academic backgrounds (n<10) which was essential in order to ensure that ambiguous questions were eliminated and overall reliability was increased [34]-[36]. The key amendment as a result of piloting was the decision to use the 15-item IES as opposed to the 22-item IES in order to reduce the burden on study participants and the timeframe required for completion. Previous studies have found both versions to be reliable and valid [37], [38].

B. Sampling Criteria and Techniques

Data collection in this study was conducted in Northern Ireland between February and April 2014. The inclusion criteria for the study were businesses who had been either directly or indirectly affected by flood events. Directly affected was defined as businesses who had experienced internal flooding of the premise, generally resulting in damage

to equipment and stock or to the building structure. Businesses who were indirectly affected had experienced external flooding only, which had caused issues such as prevention of access to the premise. A purposive sampling framework was therefore selected for the study as it was compulsory for the study participants to be businesses which had first-hand experience of flood events, allowing them to provide information on the ongoing impact of the event. As there was no accessible recorded data available relating to specific businesses affected by flooding in Northern Ireland, identification of the study population depended almost exclusively on use of snowballing sampling techniques and the use of secondary data such as newspaper articles and government reports. As it was impossible to identify the maximum study population, it was not possible to calculate a suitable sample size and consequently all the businesses that were identified as potentially previously impacted by flooding in Northern Ireland were requested to complete the survey.

In total, 134 businesses were identified as potentially impacted by previous flood events, which were then contacted and asked to participate in the research. 12 of the businesses had been affected by flooding but did not wish to participate in the study, while 67 had not actually been affected by flooding or had not been present at the time of the flood event. Therefore 55 completed questionnaires were returned at the end of the data collection.

C. Data Analysis

1. Descriptive Analysis

Questionnaire data was coded and analyzed via the use of the Statistical Package for Social Sciences (SPSS). Descriptive statistics were used for the purpose of demonstrating the sample characteristics inclusive of the data distribution [36], [39].

One of the key elements of the descriptive analysis was to rank the studied secondary stressors in order to determine the key factors causing ongoing stress to businesses. The Relative Importance Index has been previously effectively used in several flood related studies including ranking of factors that cause flooding, flood prevention measures and social impacts of flooding in order of perceived importance [40], [41]. Therefore it was decided it was an appropriate tool for this study. The five-point Likert scale utilized in the questionnaire was transformed to relative importance indices (RII) for each of the secondary stressors through use of the equation:

$$RII = \frac{\sum W}{A \times N} \qquad (1)$$

where W is the weighting allocated to each stressor by the study participants (ranging from 0 to 4), A is the highest weighing (in this case it was 4) and N is the total number of study participants [42].

2. Associations between Variables

Inferential statistics were utilized to assess the existence of associations between variables, including the use of One-way ANOVA and Chi Square. Whenever a statistically significant association is mentioned within the key findings, it was at least at the 95% confidence level (ρ <0.05).

3. Principal Component Analysis

Principal Component Analysis (PCA) was conducted using SPSS to determine the correlation structure of the secondary stressor variables. PCA is one of the most frequently used multivariate statistical techniques, where the main objectives are to: (1) extract the key data, (2) compress the size of the data set through retaining only the key data, (3) simplify the data set description and (4) analyze the correlation structure of the variables [43]-[45]. In order to accomplish these objectives, PCA involves the computation of new variables named principal components, which are acquired as linear combinations of the initial variables [43].

Before the PCA was conducted, a correlation matrix was created to check the correlations between variables. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity were then conducted to ensure the accuracy and reliability of the findings. The resulting KMO value of 0.748 and the Bartlett measure (ρ = <0.001) demonstrated that the data exceeded the suggested minimum standard that should be met before the conduction of a PCA [46].

Principal components were then created and retained, based on the Kaiser criterion. This involved extraction and interpretation of variables with an Eigenvalue of less than 1 [44], [45]. A varimax rotation was performed to allow for a more effective interpretation of the components. Variables which had an absolute loading greater than 0.5 were considered significant in line with previous studies [44], [45], [47].

IV. DISCUSSION OF RESEARCH FINDINGS

A. Sample Demographics

Table IV indicates the sample demographics. Approximately half of the respondents were business owners (50.9%) and the remainder were business managers (49.1%). In relation to business tenure, over half of the premises were owner occupied (56.4%) while less than half were rented premises (43.6%). The majority of businesses which participated in the study were micro sized businesses (76.4%).

B. Flood Impact

As illustrated in Table IV, almost all the businesses (89.1%) were directly affected by flooding i.e. they had experienced internal flooding. Regarding flood experience, 50.9% of the businesses had only experienced flooding on a single occasion, while 49.1% had experienced multiple flood events. The most recent flood event for almost three quarters of businesses (74.5%) had occurred within the last 5 years. In relation to flood depth, the majority experienced floodwaters of 0-6 inches (60.0%). It was found that business owners were significantly more likely to have experienced more severe flood events than managers i.e. greater flood depth (ρ = 0.017). A possible explanation may be that managers are not as concerned regarding the financial implications, compared to

business owners, whose livelihood may be at risk. Businesses which were flooded to a greater depth were significantly more likely to have had to close for a longer period of time in order to conduct necessary repair works ($\rho = 0.007$).

TABLE IV
SAMPLE DEMOGRAPHICS

Characteristic		Number of respondents	Percentage (%)
Respondent role	Owner	28	50.9
	Manager	27	49.1
Business tenure	Owner occupied	31	56.4
	Rented	24	43.6
Business size	Micro (<10)	42	76.4
	Small (11-50)	10	18.2
	Medium (>50)	3	5.5

TABLE V
FLOOD CHARACTERISTICS

Characteristic		Number of respondents	Percentage (%)
Flood Impact	Directly affected	49	89.1
	Indirectly affected	6	10.9
Flood experience	Once	28	50.9
	Multiple	27	49.1
Most recent flood event	0-5 years	41	74.5
	>5 years	14	25.5
Flood depth	Seeped in/under floor	3	5.5
	0-6 inches	33	60.0
	7-12 inches	12	21.8
Length of closure	Didn't close	24	43.6
	<1 day	11	20.0
	2-7 days	13	23.6
	1-4 weeks	4	7.3
	>1 month	3	5.5

With regards to length of time of closure, almost half of the businesses (43.6%) stated that they did not have to close due to flooding. The majority of businesses which did have to close, re-opened within one week of the flood event. Only 3 businesses were closed for more than one month.

C. Secondary Stressors

1. Ranking of Secondary Stressors

Table V contains the RII for each of the secondary stressors, accompanied by each stressors associated rank. The 18 stressors are arranged in descending order of rank, with the highest RII or lowest rank indicating the secondary stressors perceived as the most important by residents. The key secondary stressors perceived by residents were: flood damage (RII = 0.714), fear of future flooding (RII = 0.723), prevention of access/closure (RII = 0.709), loss of income/trading/debt (RII = 0.650), lack of help from government agencies (RII = 0.650) and repair to property and equipment/clean-up charges (RII = 0.636). The secondary stressors which achieved the highest rankings can be divided into the following categories: the financial implications of the flood event (flood damage, repair to property and equipment/clean-up charges and loss of income/trading/debt), the external factors which can limit business continuity (prevention of access/closure and lack of help from government agencies) and finally the stress relating to the possibility of flood reoccurrence (fear of future flooding). With the exception of "fear of future flooding",

none of the identified key secondary stressors are in agreement with the only identified previous study which ranked stressors, where the highest ranked stressors were: fear of reoccurring flooding, loss of services, loss of customer base and employee issues [25]. This disparity between studies could potentially be due to study location differences as this study involved both urban and rural businesses, while the previous study only considered an urban area.

TABLE VI
RELATIVE IMPORTANCE INDICES OF SECONDARY STRESSORS

Secondary stressors	W	RII	Rank
Flood damage (goods/equipment/property)	157	0.714	1
Fear of future flooding	159	0.723	2
Prevention of access/closure	156	0.709	3
Loss of income/trading/debt	150	0.682	4
Lack of help from government agencies	143	0.650	5
Repair to property and equipment/clean-up charges	140	0.636	6
Insurance (increased premiums/no insurance/difficulties with pay-outs)	125	0.568	7
Length of time of closure	120	0.545	8
Inadequate financial assistance	97	0.441	9
Employees: Lost working hours/compensation/difficulty travelling to work	89	0.405	10
Unrecoverable rent/rates/cost of temporary premise/legal charges	86	0.391	11
Loss of services (gas/electricity/water/communications)	86	0.391	12
Supply chain (deliveries to and from business)	82	0.373	13
Loss of customer base	70	0.318	14
Security/looting concerns	38	0.173	15

2. Associations between Stressors and Other Variables

With regards to associations between secondary stressors and other variables, analysis concluded that respondents from businesses that had experienced internal flooding were significantly more likely to be more concerned regarding the following secondary stressors: Flood damage ($\rho = 0.000$), insurance ($\rho = 0.006$), inadequate financial assistance ($\rho = 0.017$) and repair to property and equipment/clean-up charges ($\rho = 0.001$). This would indicate that although businesses affected by internal flooding also experience external factors such as prevention of access/closure they tend to be more concerned regarding restoring their premise to its pre-flood state. Businesses that had experienced flooding more recently i.e. within the last five years, were significantly more likely to be more concerned regarding the loss of customer base ($\rho = 0.015$) and have fear of future flooding ($\rho = 0.047$). Businesses, which have experienced more recent flood events have fresher memories regarding the detrimental impacts on business continuity. It is necessary to harness flood memory when it is at its most vibrant to emphasise the need for the implementation of measures which will prevent the reoccurrence of those stressors [48]. Additionally businesses more recently affected by flooding were significantly more likely to believe that their business would be flooded again ($\rho = 0.006$).

When businesses were flooded to a higher depth, respondents were significantly more likely to be concerned

regarding: flood damage ($\rho = 0.013$), insurance ($\rho = 0.025$) and repair to property and equipment/clean-up charges ($\rho = 0.011$) i.e. the financial implications which hinder flood recovery. Businesses that had to close due to experiencing flooding were significantly more concerned regarding: loss of income/trading/debt ($\rho = 0.033$), insurance (ñ = 0.022), inadequate financial assistance ($\rho = 0.032$), loss of customer base ($\rho = 0.040$) and unrecoverable rent/rates/cost of temporary premise/legal charges ($\rho = 0.004$). These findings indicate that stress regarding property damage and repairs are no longer the primary concern when businesses have to close, rather at that point business owners and managers tend to worry concerning the implications of length of time of closure. Businesses which had to close their premise for a longer timeframe i.e. more than one day were additionally significantly more concerned regarding: supply chain issues ($\rho = 0.046$) which could relate to either the problem of prolonged flooding or the possibility of a deterioration in relations with suppliers. It is important to note that businesses which received a flood warning were significantly more likely to be concerned about the impact on insurance ($\rho = 0.006$). This would suggest that although receiving a warning provides businesses with an invaluable window of time to prepare for

potential damage, flood warnings can in some cases cause additional concern and worry. Smaller businesses were significantly more affected than larger businesses by a number of stressors: prevention of access/closure ($\rho = 0.006$), loss of income/trading/debt ($\rho = 0.000$), lack of help from government agencies ($\rho = 0.000$) and unrecoverable rent/rates/cost of temporary premise/legal charges ($\rho = 0.027$). All of these stressors relate to external factors, suggesting that although small businesses may manage to sufficiently conduct repairs and re-open their premise, they may need additional help to deal with factors that are outside of their control [4], [5], [25].

3. Principal Component Analysis

As demonstrated in Table VI, a Principal Component Analysis was conducted which resulted in four principal components which had a Eigenvalue greater than one, accounting for 70.6% of the total data variance. Two key components (Component 1 and Component 2) emerged from the analysis which accounted for 23.44% and 23.08% of the variance, respectively. The remaining components accounted for 15.63% and 8.44% of the variance. Table VII illustrates the secondary stressors which make up each component.

TABLE VII
EXTRACTION VARIANCE

Component	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance %	Cumulative	Total	% of Variance %	Cumulative
1 (Financial implications)	6.143	40.954	40.954	3.516	23.438	23.438
2 (External factors)	1.729	11.529	52.483	3.463	23.083	46.522
3 (Business closure)	1.487	9.914	62.397	2.344	15.625	62.146
4 (Fear of future flooding)	1.228	8.187	70.584	1.266	8.437	70.584

Extraction Method: Principal Component Analysis

TABLE VIII
ROTATED LOADINGS OF THE PRINCIPAL COMPONENTS

Component	Secondary stressors	Factor Loading	Variance explained (%)
1	Repair to property and equipment/clean-up charges	0.895	
	Flood damage (goods/equipment/property)	0.880	
	Insurance (increased premiums/no insurance/difficulties with pay-outs)	0.828	23.44
	Inadequate financial assistance	0.710	
	Loss of services (gas/electricity/water/communications)	0.580	
2	Loss of income/trading/debt	0.865	
	Prevention of access/closure	0.858	
	Lack of help from government agencies	0.724	23.08
	Supply chain (deliveries to and from business)	0.621	
	Unrecoverable rent/rates/cost of temporary premise/legal charges	0.546	
3	Loss of customer base	0.839	
	Security/looting concerns	0.826	15.63
	Length of time of closure	0.500	
4	Fear of future flooding	0.828	8.44

Extraction Method: Principal Component Analysis, Rotation Method: Varimax with Kaiser Normalization

The first component is marked by high loadings of five variables that relate to the financial implications for a business directly i.e. internally affected by flooding. The five attributes are: repair to property and equipment/clean-up charges (0.895), flood damage (0.880), insurance (0.828), inadequate financial assistance (0.710) and loss of services (0.580). Businesses directly affected by flood events often experience extensive damage to stock, equipment and the building structure itself. This damage can also include the loss of

essential services required to effectively run the business, including gas, electricity, water and communication lines. The extent of flood damage, which often depends on both the duration of the flood event and flood depth, tends to have a direct impact on the level of repair works required and their likely duration. The finances required to sufficiently restore properties to their pre-flood condition and cover the cost of other damaged items is often obtained via insurance. However, previous flood experience has the potential to

significantly increase insurance premiums, resulting in businesses having to contribute a significant excess in order to receive a payment or in some cases prevent businesses from receiving any form of cover for flood damage. Due to these issues, business owners and managers frequently become anxious regarding the lack of financial assistance available to assist businesses in recovering from flood events which often exacerbates other stresses associated with the event [5], [25], [28].

The second component, like the first component is comprised of five variables with high factor loadings: loss of income/trading/debt (0.865), prevention of access/closure (0.858), lack of help from government agencies (0.724), supply chain issues (0.621) and unrecoverable rent/rates/cost of temporary premise/legal charges (0.546). The attributes correlated with the second component all relate to the role that external factors associated with a flood event can play in contributing to loss of income/trading/debt. Businesses affected only by external flooding, despite not suffering any damage to property or equipment often experience significant trading repercussions as customers are prevented from accessing their premise due to floodwater outside their property or blocking roads necessary to reach the area. For businesses affected by internal flooding but still open for trade, this can be an additional financial strain. This issue is closely connected to supply chain difficulties as prolonged flooding can stop supplies which are essential for business continuity from reaching the premise. In the majority of cases, business owners and managers whose properties are inaccessible must still continue to pay rent and rates for their premise and in a bid to continue trading some individuals may choose to rent a temporary premise in order to ensure some form of ongoing income. However, this decision must be based on a balance of the additional cost of obtaining the second premise and the likely customer footfall which it will experience [4], [20], [21].

It is essential to reiterate that the first two components accounted for a similar percentage of the total variance, illustrating that external factors can be just as important in establishing the long-term impact on businesses as the direct financial repercussions.

The third component was marked by high loadings of factors associated with the closure of businesses due to a flood event: loss of customer base (0.839), security/looting concerns (0.826) and length of time of closure (0.500). The length of time that a business remains closed due to waiting for floodwaters to recede during prolonged flooding or in order to carry out necessary repair works can have a substantial influence on the likelihood of the business retaining its prior customer base. While a flood affected business is closed, customers often find a premise that is more conveniently located, has a greater range of products etc. and as a result they do not return once the premise re-opens. Consequently, in addition to re-opening costs, businesses often have to re-advertise their services and promote special offers in order to re-obtain a minimum footfall. An additional concern during the period of closure, particularly in areas where multiple

businesses have been severely affected by flooding, is the possibility of security or looting concerns which could potentially result in further damage to the property and the loss of additional stock and equipment [4], [25].

The fourth component, which accounted for 8.44% of the total variance, only contained one variable which had a factor loading above 0.5: fear of future flooding (0.828). This component is therefore a trivial factor as it does not have two or three attributes which load highly onto the component. This indicates that the component basically represents a single variable, thus this single loading factor does not provide any new information on the underlying combinations of variables or contribute to the aim of identifying grouping patterns [49], [50]. However, as the component had an Eigenvalue of 1.266 and the variable had a high loading score, it should be recognized that although fear of future flooding is not significantly related to the other secondary stressors, it is an important entity in itself and may cause substantial stress as a stand-alone issue. The principal component analysis therefore reinforces the findings of the RII which identified that fear of future flooding was a high ranking secondary stressor.

D.Awareness, Future Flood Risk and Flood Warning

In relation to awareness of flood risk, 38.2% of respondents were aware of the flood risk to the business property, while the majority of businesses were unaware of their flood risk (60.0%). This supports similar levels of flood risk awareness found in previous studies [5], [24].

Regarding future flood risk, just over one third of respondents felt that their business property was either unlikely or extremely unlikely to flood again (34.5%). Just over half of respondents (50.9%) felt that that future flooding was likely or extremely likely. The disparity in findings indicates the likely lack of knowledge among business owners regarding future flood risk and the need for the provision of information to businesses regarding their current flood risk.

Only 16.4% (9) of businesses had received a flood warning; eight warnings were received via listening to the weather forecast, while one flood warning was from a family member. It should be noted that no flood warnings were received from government agencies. The majority of businesses in Northern Ireland do not tend to receive flood warnings, despite other areas successfully implementing the use of official government flood warnings [26]. The introduction of official warning systems and effective advertisement could result in a larger number of businesses receiving flood warnings. Respondents who received a flood warning were significantly more likely to implement a flood action plan/flood risk assessment as they had time to respond to the disaster ($\rho = 0.018$), while respondents who didn't receive a flood warning were significantly more likely to prepare a flood emergency kit i.e. ensure that they took their key documentation and other essential items with them during evacuation. ($\rho = 0.017$).

TABLE IX
INDIVIDUAL COPING MECHANISMS

Individual Coping Mechanism	Number of respondents	Percentage (%)
Insure property against flood damage	44	80.0
Ensure property drains are kept clear	33	60.0
Deploy sandbags and block entrances	31	56.4
Lifting/removing equipment, goods and records	30	54.5
Raised storage for water sensitive objects/relocating items upstairs	21	38.2
Data back-up	19	34.5
Flood emergency kit	19	34.5
Research potential flood protection measures	13	23.6
Staff training	11	20.0
Disconnect utilities	11	20.0
Moving business vehicles to higher ground	9	16.4
Flood resilience measures	7	12.7
Flood resistance measures	6	10.9
Flood action plan/Flood risk assessment	6	10.9
Purchase emergency equipment	6	10.9
Arrange temporary business premise	1	1.8

E. Individual Coping Mechanisms

As demonstrated in Table IX, the most common individual coping mechanisms employed by study participants were: insuring property against flood damage (80.0%), ensuring property drains are kept clear (60.0%), deploying sandbags and blocking entrances (56.4%) and lifting/removing equipment, goods and records (54.4%). The majority of individual coping mechanisms utilized by businesses in this study were significantly higher than noted in a previous study, with the exception of purchasing emergency equipment and the implementation of a flood action plan [21]. However, flood impacted businesses were still extremely vulnerable to being further impacted by these stressors in the event of a future flood event as only 11% and 13% respectively had installed flood resistance or flood resilience measures.

Businesses that were solely affected by external flooding were significantly more likely to move business vehicles to higher ground in either preparation for or response to flooding ($\rho = 0.043$). A likely explanation is that businesses affected by internal flooding were more occupied with preventing floodwater from entering their premise and relocating water sensitive items.

Businesses affected by reoccurring flooding were significantly more likely to deploy sandbags/block entrances during flood events ($\rho = 0.040$). This finding would indicate that sandbags are seen as a psychological measure of security by businesses, as in reality they only minimally assist in slowing the speed that water enters a property. Repeated flood experience did not increase the uptake of flood resistance or flood resilience measures among business owners and managers.

Businesses which have been flooded to a greater depth were significantly more likely to conduct staff training ($\rho = 0.025$) and research potential flood protection measures ($\rho = 0.000$). Businesses flooded to a higher level recognized the need for a quick response among staff during any future flood event in order to minimize damage. Increased flood depth increased interest in flood protection measures but did not result in implementation, perhaps due to financial constraints.

Businesses which had to close following a flood event were significantly less likely than those who did not have to close to have: a Flood action plan/Flood risk assessment ($\rho = 0.005$), implemented flood resistance measures ($\rho = 0.012$) or moved business vehicles to higher ground ($\rho = 0.024$). These findings indicate that lessons were learnt from previous flood experience and businesses did not want to experience business closure on a second occasion.

Businesses which had implemented flood resistance measures ($\rho = 0.019$) were significantly more likely to re-open within a shorter timeframe. Installation of measures such as flood gates and non-return valves tend to limit the level of floodwater entering a property and thus permits businesses to carry out minimal repairs and re-open swiftly.

Business size was a determining factor in the individual coping mechanisms employed by study participants. Larger businesses were significantly more likely to implement a flood action plan/flood risk assessment ($\rho = 0.031$), while smaller businesses were significantly more likely to engage in keeping property drains clear ($\rho = 0.001$), lift/remove equipment from the ground floor before or during flooding ($\rho = 0.040$) and purchase emergency equipment ($\rho = 0.006$). These findings imply that smaller businesses may underestimate flood risk or require additional assistance in adequately planning for flooding [4]-[7].

TABLE X
COMMUNITY COPING MECHANISMS

Community Coping Mechanism	Number of respondents	Percentage (%)
Helped clean up after flood	21	38.2
Checked on neighboring businesses	6	10.9
Helped with sandbags/flood defences	3	5.5
Collectively approached agencies	2	3.6
Formed/attended a flood resilience group	2	3.6
Helped move stock & equipment	1	1.8
Post-flood assistance	1	1.8

F. Community Coping Mechanisms

As demonstrated in Table IX, the key business community coping mechanisms collaboratively utilized by businesses were: helping clean-up after flood events (38.2%) and checking on neighboring businesses (10.9%). In general, incidents of community coping mechanisms were low among business communities, in agreement with a previous study [23]. There was no significant difference between business size and the employment of community coping mechanisms.

The results indicated that when the premise was owner occupied, the respondents were significantly more likely to check on neighboring businesses (p = 0.038). It has previously been suggested that business owners are more likely than business managers to be engaged in disaster preparedness as they have greater access to financial resources, however, another possible explanation is that business owners are more

likely than managers to be more integrated within the community [4].

TABLE XI
IMPACT OF EVENT

Score	Number of respondents	Percentage (%)
0 – 8	35	63.6
9 – 25	12	21.8
26 – 43	5	9.1
44 - 75	3	5.5

G. Impact of Event

The Impact of Event scores outlined in Table X found that more than half of respondents (63.6%) were not "meaningfully impacted" by the most recent flood event. This finding indicates that a large number of business respondents do not tend to develop symptoms of PTSD. Nevertheless it should be noted that only two of the study participants had experienced flooding within the last year, thus symptoms of PTSD which did develop in the immediate aftermath of the flood event may have subsided. In contrast, the most recent flood event was found to have a "powerful impact" on five respondents (9.1%) and a "severe impact" on three respondents (5.5%). This indicates that there was a 75% likelihood that 14.6% of the study participants have PTSD or at least some of the symptoms and consequently may require diagnosis follow-up [33]. The results fell within the range of the percentage of individuals who met the criteria for PTSD in previous studies, 8.6–24%, however, these studies had only considered residents; [51]-[55]. It should be emphasized that PTSD can have enduring consequences for flood victims, as it was noted that there was no significant relationship between the time since the last flood event and the resulting Impact of Event score. Therefore a maximum timeframe should not be assigned to the provision of post-flood support to businesses.

Respondents from businesses which had received a flood warning were significantly more likely to achieve a higher Impact of Event score ($\rho = 0.027$). These results emphasize that in some cases flood warnings can actually cause additional stress to affected individuals. A review of the accuracy and type of information provided in flood warnings might further clarify these findings.

Business respondents which insured their property against flood damage were significantly less likely to achieve a higher Impact of Event score: ($\rho = 0.001$), indicating that knowledge of having sufficient resources to conduct any potential flood-related repairs eased concern. However, businesses which undertook the following measures were significantly more likely to achieve a high Impact of Event score: researched potential flood measures ($\rho = 0.042$), implemented flood resilience measures ($\rho = 0.029$), implemented flood resistance measures ($\rho = 0.002$) and moved business vehicles to higher ground ($\rho = 0.048$). The findings indicate that preparing for flood events can actually cause additional strain, thus consideration of and provision of suitable information on the most effective flood prevention measures for specific areas might be beneficial for businesses.

Business respondents which achieved a high Impact of Event score were significantly more likely to be concerned regarding the following secondary stressors: flood damage ($\rho = 0.006$), loss of income/trading/debt ($\rho = 0.026$), insurance ($\rho = 0.004$), repair to property and equipment/clean-up charges ($\rho = 0.028$), lack of help from government agencies ($\rho = 0.022$) and supply chain ($\rho = 0.038$). With regards to the secondary stressor categories suggested following the application of principal component analysis, it would appear that financial implications and external factors are the stressors which are most likely to contribute to PTSD.

V. CONCLUSION

This paper sought to contribute to an important research gap by exploring the effect of flooding on business owners and managers. A list of secondary stressors with the potential to cause stress to persons in charge of businesses was developed, followed by empirical data collection which permitted the ranking of these stressors in terms of their relative importance. The identified key stressors related to fear of a future flood event and both the financial implications of flooding and external factors which additionally hinder business recovery. Principal Component Analysis reduced the secondary stressors into four key components: financial implications, external factors, the impact of temporary business closure, and fear of future flooding. Future flood policy and strategies aiming to reduce the impact of flooding on businesses should target actions towards these four components in order to alleviate the secondary stressors experienced by businesses.

In relation to individual coping mechanisms employed by businesses, the majority of measures used were reactive rather than proactive, particularly within the small business sector. Businesses with experience of reoccurring flooding were not any more likely to install flood resistance or flood resilience measures than businesses flooded on only one occasion. These findings suggests the requirement for a combination of the provision of advice and guidance regarding appropriate flood protection measures and the implementation of financial support such as flood defense grants in order to assist businesses in mitigating flood risk. Examination of community coping strategies among businesses found that very few businesses collaborate in relation to flood events. Current government policy in relation to flooding is seeking to encourage flood affected residents to work together in order to increase flood resilience. Similar strategies should be employed in order to inspire the development of business networks in relation to flood mitigation and alleviation. Smaller businesses were found to be disproportionally affected by flood events, emphasizing the particular need for post-flood support to be provided to smaller businesses in order to enhance the recovery process.

This study illustrated that business owners and managers are at a similar risk as residents to develop PTSD in the aftermath of a flood event. Suitable forms of national and local support should be investigated to assist businesses in dealing with both the financial repercussions and external factors

associated with flood events as these appear to be the issues that are more likely to result in health implications.

Further research is necessary within this field in order to develop the understanding of secondary stressors faced by businesses and the implementation of suitable measures to alleviate them. It would be beneficial to assess the difference in the stressors experienced by businesses located in urban and rural areas and any disparity in the use of coping mechanisms. Additionally it is felt that lessons could be learnt from other countries where more extreme flood events have occurred. Future studies are being developed to investigate these issues.

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