Impact of flood characteristics on damage caused to UK domestic properties: the perceptions of building surveyors

Impact of flood characteristics on damage caused to UK domestic properties: the perceptions of building surveyors

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Abstract

Flood damage to domestic properties can be considered as a function of two key factors, that is the flood characteristics (e.g. velocity of flow, time duration, and nature of any suspended contaminants) and characteristics of the property (e.g. physical location, materials of construction, and ability to withstand floodwater forces). A thorough literature review identified that little or no consideration is given to the characteristics of the flood when assessing flood-damaged domestic properties. This indicates that the damage caused by floods is considered by many to be a simple problem to resolve, whereas in reality, it is a complex phenomenon, highlighting the need of research in this area. This paper presents the perceptions of 289 building surveyors regarding flood characteristics as part of a two-year research project to benchmark the assessment of flood-damaged domestic properties in the UK. Surveyors perceived the sewage, fasciae and contaminant content, and depth of the floodwater to be the most important factors to be considered in flood damage assessment. This was followed by the time duration and source of the floodwater. The velocity of the

floodwater was considered the least important factor. Findings also revealed that methods to determine these factors were primarily a function of individual subjective perceptions and often based on visual inspection of the floodwater alone. Definitive guidance is therefore needed in order to minimise variations in subsequent repair and reinstatement works.

Introduction

Due to climate change and unprecedented global warming, the risk of flooding in Britain is now significant and increasing with time (Hulme and Jenkins, 1998). The impact and magnitude of the problems caused by flooding are huge. There are five million people along with nearly two million homes; 185,000 business properties worth over £215 billion and agricultural lands worth over £7 billion at risk from flooding in England and Wales (Halcrow *et al.*, 2001; Harman *et al.*, 2002). The worst recorded coastal flooding in 1953 claimed 480 lives and an estimated £5 billion (at current prices) of damages (Crichton, 2003). Crichton (2003) argued that a similar flood today could lead to more deaths and insured losses of over £20 billion. The psychological damage caused by flooding is beyond quantification but can be equally as devastating as the physical damage. Although floods are an inevitable phenomena, their impacts could be minimised by appropriate actions prior to and after the flood. Knowledge of how to assess and subsequently repair flood-damaged domestic properties is highly important and would help home-owners, insurance companies, loss adjusters and repair specialist contractors to mitigate damage and return the property to its pre-flood condition as early as possible.

Stemming from this, a thorough review of the literature in the flood damage domain has been conducted (Proverbs *et al.*, 2000; Nicholas and Proverbs, 2002). The results suggested little consensus of opinion and ignorance of many factors regarding damage assessment procedures or ‘optimal’ repair methods. This indicates that the damage caused by floods is considered by many to be a simple problem to resolve, whereas in reality, it is a complex phenomenon. A conceptual model of flood damage was then established (Nicholas *et al*., 2001). The model identified that the damage caused by floods is a function of many variables that can be grouped under one of two headings: building characteristics and flood characteristics. Building characteristics include (i) the frequency of the dwelling being flooded, (ii) the materials the building is constructed from, (iii) the drying characteristics of the materials, and (iv) the condition of the building prior to being flooded. Flood characteristics are defined as (i) the depth of floodwater, (ii) the velocity of floodwater in contact with a particular dwelling, (iii) the contaminant (including sewage and fasciae) content of the floodwater, (iv) the duration of the flood, and (v) the source of the flood (e.g. river, stream, dam, sewer) which relates to the location of the dwelling.

This paper presents findings of building surveyors’ perceptions regarding flood characteristics as part of a two-year research project to benchmark the assessment of flood-damaged domestic properties in the UK. Data were collected from a UK-wide questionnaire survey of building surveyors and loss adjusters. The analysis was based on 289 completed questionnaires representing a considerable sample of experts involved in the repair of flood-damaged properties. A description of the flood characteristics now follows.

Flood characteristics: the scale and nature of the disaster

Damage caused by any disaster is highly dependent on the scale and nature of that disaster. Here, the damage caused to a property is dependent on the flood characteristics, in terms of depth, velocity flow, contaminant content and time duration.

Flood depth

Flood depth is often considered as the key factor influencing the scale of flood damage (DTLR, 2002). This is usually as a result of increased hydraulic pressure on the building's components and abrasion or scouring. The impact of flood depth on the damages incurred has been the subject of much research (e.g. Debo, 1982; Sorkin, 1982; Green and Suleman, 1987; McBean *et al*., 1988; Handmer and Smith, 1990; Minnery and Smith, 1996). Logically, as the depth of the floodwater increases, so does the cost of necessary repair works (Nicholas *et al*., 2001). The DTLR (2002) suggested that for very shallow flooding, where water does not rise above floor level, damage is unlikely to be significant for most properties. Damage increases significantly once water rises above the floor level and comes into contact with furnishings and personal belongings. Flood depths greater than 1 metre above floor level may damage the structure of the buildings. Typically, half a metre of floodwater within a modern semidetached house will result in an average cost of £15,000 to repair and around £9,000 to replace damaged belongings (the Association of British Insurers c.f. DTLR, 2002).

Velocity of floodwater

The velocity of floodwater is strongly related to the distance from the flood source and hence the depth of floodwater. Xu *et al*. (1998) demonstrated that the further the distance from the flood source, the less the floodwater velocity and consequently, the less the ability of the floodwater to transport quantities of solid matter. Furthermore, deeper floods have an increased velocity and on recession can have a natural tendency to 'wash out' suspended particles of deleterious matter as the floodwater level recedes (Nicholas *et al*., 2001). Generally, it is well accepted that the greater the floodwater velocity, the greater probability of structural damage.

Floodwater contaminants

It is also important to consider floodwater contaminants when assessing flood damage because these may:

- influence the water absorption characteristics of the building materials used;
- influence the drying time of materials;
- transport embryonic forms into the building's structure that are difficult to remove without saturation or sterilisation, and which may become a danger to occupiers' health; and
- significantly influence repair costs through the work involved in the removal of physical deposits (Nicholas *et al*., 2001).

The nature of floodwater contaminants may range from sewage from blocked drains to chemicals from garages or commercial premises. Once floodwater recedes, a layer of contaminated silt is left behind. Here, thorough cleaning is essential to ensure that the dwelling is free from germs and fit for operatives to conduct any necessary repair works and for occupants to live healthily in their dwelling (Gautam, 1980; Holt *et al*., 2000). In cases of flooding from the sea, saltwater can lead to corrosion of metallic fittings such as metal ducting and switch boxes, and steel reinforcement in reinforced concrete. It is estimated that saltwater flooding can increase flood damage repair costs by around 10 percent (the Association of British Insurers c.f. DTLR, 2002). It is clear that contaminant content will influence repair methods and cost. However, literature suggests that at present flood damage assessment generally ignores factors relating to contaminant content. Due to this, the true impact of contaminants in floodwater and the damage caused to flooded properties is not presently known (Nicholas *et al*., 2001).

Duration

The duration that the floodwater is in contact with the building is also a key factor determining the level of damage. Generally, the longer the duration of the flood, the more damage it will cause to the building. This is mainly due to the fact that the structures of many UK properties are made of porous solid materials, such as bricks, blocks and concrete. Hence, the longer the flood duration, the greater the amount of floodwater absorbed by the buildings' materials; hence prolonging subsequent drying and repair works.

Methodology

A questionnaire was designed to capture building surveyors' perceptions of flood characteristics. Respondents were first invited to indicate details of their employer, working area, job title and experience in assessing flood-damaged properties. Then, they were asked to rate the importance of several flood characteristics when assessing flood damage, on a four point scale ranging from 1 'not considered' to 4 'very important'. Additionally, methods used by practitioners to determine the flood characteristics were also investigated. Here, multiple options were provided and respondents invited to select one or more of those deemed appropriate. These methods were extracted from interviews with flood damage repair specialist contractors. Additionally, respondents were invited to indicate any other methods not included.

One thousand and eight hundred members of RICS Residential Faculty were initially targeted. Additionally, members of the Chartered Institute of Loss Adjusters were targeted via an invitation to participate in the survey published in the January 2002 edition of the Loss Adjuster magazine. These strategies yielded a response of 289 completed questionnaires which were subsequently used as the basis of analysis.

Analyses were conducted using *Microsoft Excel* and *SPSS*. Levels of experience in terms of the length of time involved in the assessment of flood-damaged properties and number of properties previously surveyed were best collected in the form of ranges because this form allows easier recall (Fellows and Liu, 1997). Each range was then assigned a numerical value representing ordinal data. Levels of importance which could be regarded as ordinal type variables, were converted into a Likert scale from 1 indicating 'do not consider when making a damage assessment report' to 4 indicating 'very important'. Pearson's correlation tests were performed to investigate the relationships between levels of experience and levels of importance for various flood characteristics. Although there is an argument that treating Likert scale-based data at this level of measurement as an interval scale is a violation of parametric test assumptions, there is an equally strong argument for doing so due to the advantages gained, as exemplified by Labovitz (1967).

Methods used to determine flood characteristics by practitioners were also converted into numerical format representing a nominal type variable. The description of the respondents now follows.

Characteristics of the respondents

Figure 1 presents the nature of respondents' organisations. Most of the respondents (59.7%) were working for loss adjuster firms. This is not really surprising given that loss adjusters are the persons very much involved in the assessment of properties after the events of disaster including flooding. Almost one-quarter of the respondents (23.3%) were working for surveying consultancy practices. Eight percent classified their organisations as consulting engineers. Six percent were working for damage repair specialists. The remaining 8.6%

classified their organisations as estate agents/housing associations (3.1%), environmental services (1.7%), Local Authorities (1.7%), insurance companies (1.4%), and architectural practices (0.7%). The total percentage was not 100 percent since respondents were allowed to categorise their organisations into more than one category where appropriate. Although the majority were loss adjusters, as a whole, the views of the respondents could be deemed to represent various organisations involved in the assessment of flood-damaged properties.

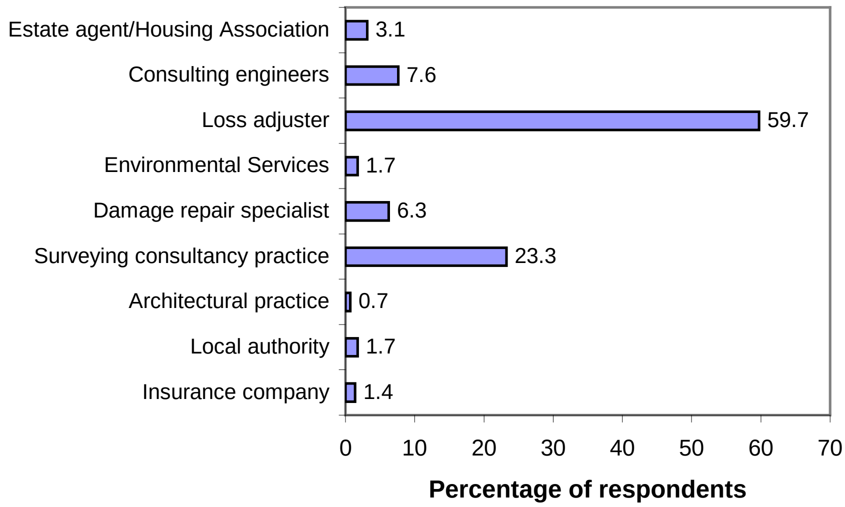


Figure 1 Respondent organisations

Figure 2 exhibits the operating regions of the respondents' organisations. Almost half of the respondents (48.9%) were working in the South-East region of the UK. About one-fifth (18.0%) were working in the South-West. As a whole, the sample was dominated by respondents working throughout England and Wales, while few were operating in Scotland.

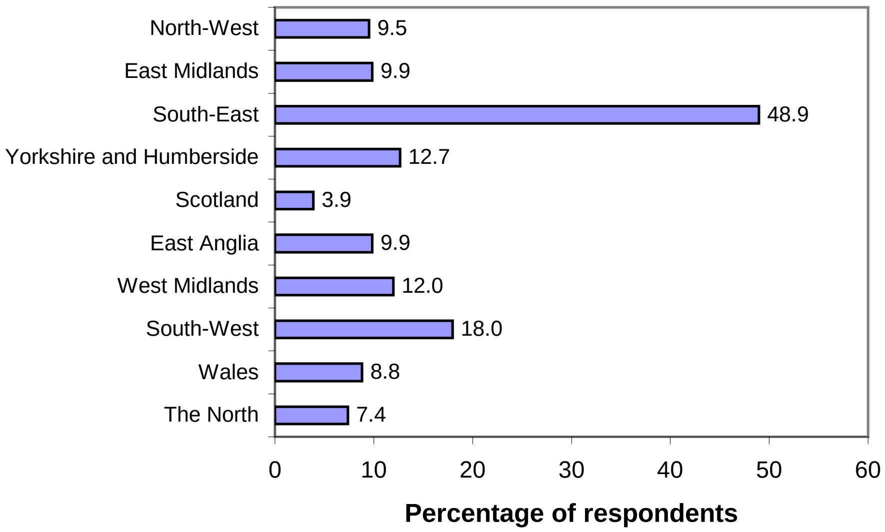


Figure 2 Operating regions of the respondents' organisations

Figure 3 shows the respondents' levels of experience in terms of the number of years in assessing flood-damaged properties. Most respondents (74.0%) had been assessing flood-damaged properties for more than 5 years. The mean was 3.12 and the median was 3.00 (i.e. ranging from 10 to 15 years). These indicate that respondents have extensive experience in the assessment of flood-damaged properties and their views can be deemed as those of experts in this domain.

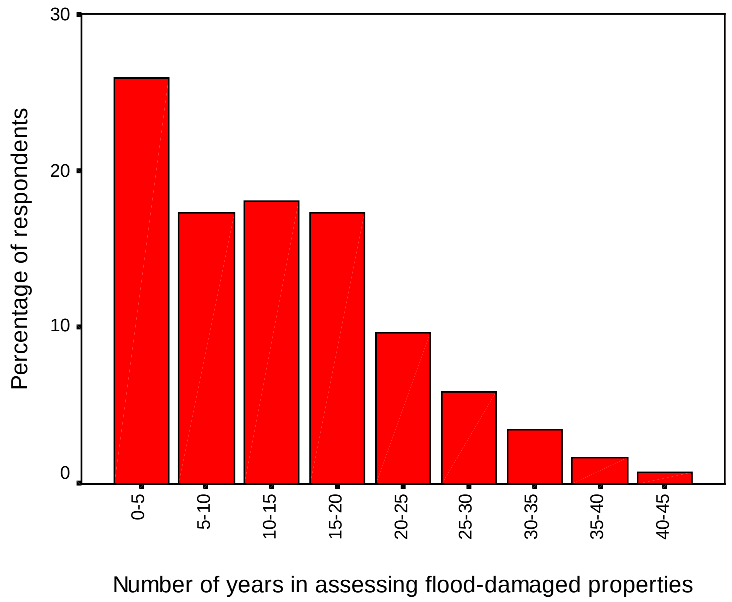


Figure 3 Respondents' levels of experience in terms of number of years in assessing flood-damaged properties

Table 1 presents mean, median and mode for these. An increase in the number of properties surveyed over the three time spans was expected, however, the results indicate an acceleration in the number of properties surveyed by respondents over the last two years. Generally, the results suggest that respondents were experienced flood damage assessors. It is worth noting that some respondents (13.9%) had surveyed more than 226 flood-damaged properties in the last ten years indicating a very extensive level of experience in this area.

Table 1 Mean, median and mode of the respondents' levels of experience in terms of number of flood- damaged properties surveyed over the last two, five and ten years respectively

Duration	Mean	Median	Mode
Over the last 2 years	3.95	3.00	3
Over the last 5 years	5.33	5.00	5
Over the last 10 years	6.44	5.00	5

Note: The numbers mean the following:
1 = 1 property surveyed
2 = 2-4 properties surveyed
3 = 5-10 properties surveyed
4 = 11-25 properties surveyed
5 = 26-50 properties surveyed
6 = 51-75 properties surveyed

Assessments of the flood characteristics

Figure 4 presents the respondents' perceived importance of the flood characteristics including contaminant content, velocity, duration, sewage and fasciae content, source of the floodwater and floodwater depth. Table 2 summarises the importance of these characteristics. Based on the mean importance, the characteristics were then ranked.

Sewage and fasciae content of floodwater was considered the most important characteristic, followed by contaminant content, depth, duration, source and velocity of floodwater. The mean, median and mode of contaminant content and depth of floodwater were the same and therefore assigned the same rank. Generally, respondents regarded the characteristics to be of importance since the means indicated importance levels between 3 and 4. That is, most respondents deemed the characteristics to be 'important' or 'very important', with velocity of floodwater being the exception.

On closer examination of Figure 4 and Table 2 (specifically the means and modes), conceptually, flood characteristics could be classified into three groups. The first group comprises sewage and fasciae, contaminant content, and depth of floodwater representing ‘extremely important’ flood characteristics where most respondents classified them as ‘very important’. The second group includes duration and source of the floodwater which were perceived generally as ‘important’ characteristics, including some respondents classified them as ‘very important’. The third group includes velocity of floodwater which was deemed as an ‘important’ characteristic, including a reasonable number of respondents who perceived it as ‘little important’. This suggests that the ‘content’ and ‘depth’ of floodwater are considered the most destructive and costly. Two possible reasons may help explain why velocity was found to be the least important characteristic. Firstly, assessors of flood damage are not normally in the premises when the disaster occurs and therefore do not visually assess the impact. Secondly, the flow velocity of most UK floods is somewhat lower, than for example floods due to *Tsunami* and therefore velocity is not considered very destructive to properties.

Table 3 shows a correlation matrix investigating the relationships between respondents’ levels of experience and their perceived levels of importance towards flood characteristics. There were strong evidence (i.e. at 1% level) of positive relationships between the importance of contaminant content, duration, source and depth of the floodwater, and the number of properties surveyed over the last 2, 5 and 10 years. This suggests that experts with more experience consider contaminant content, duration, source and depth of the floodwater to be more important. Furthermore, there was some evidence (at 5% level) of the relationship between sewage and fasciae content, and the length of experience and number of properties surveyed over the last 5 and 10 years.

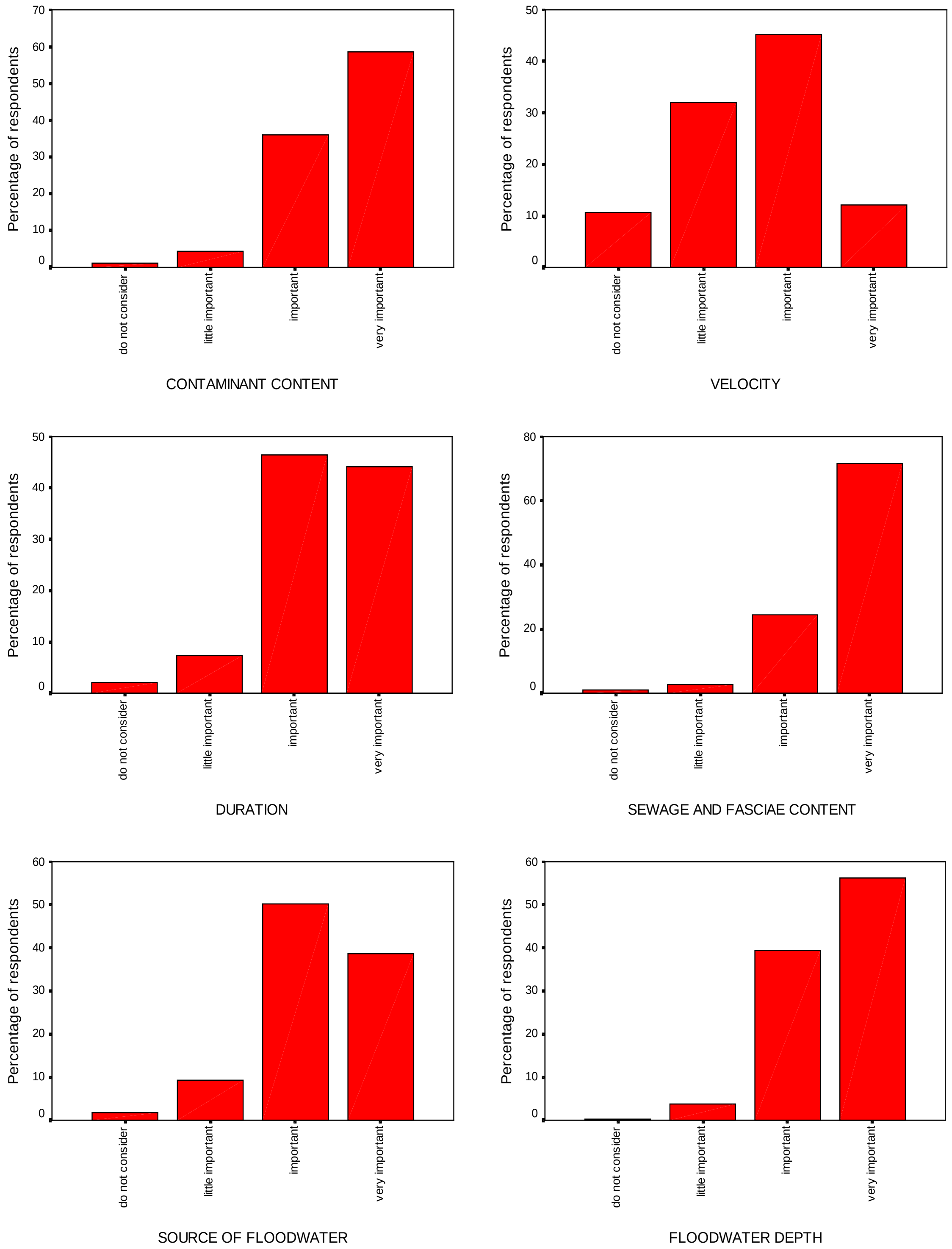


Figure 4 Importance of flood characteristics

Table 2 Mean, median and mode of the importance of flood characteristics

Flood characteristics	Mean	Median	Mode	Rank
Sewage and fasciae content	3.67	4.00	4	1
Contaminant content	3.52	4.00	4	2
Depth	3.52	4.00	4	2
Duration	3.33	3.00	3	4
Source	3.26	3.00	3	5
Velocity	2.59	3.00	3	6

Note: For mean, median and mode, the numbers mean the following:
1 = do not consider when making a damage assessment report
2 = little important
3 = important
4 = very important

Table 3 Correlation matrix between levels of experience and levels of importance

	Contam	Velocity	Duration	Sewage	Source	Depth
Duration in present job (yrs)	0.046	0.007	-0.042	0.021	-0.037	0.003
Length of experience (yrs)	0.071	-0.051	0.042	0.121*	0.037	0.049
Properties surveyed last 2 yrs	0.173**	0.072	0.214**	0.085	0.196**	0.164**
Properties surveyed last 5 yrs	0.191**	0.074	0.219**	0.103*	0.188**	0.147**
Properties surveyed last 10 yrs	0.194**	0.057	0.190**	0.107*	0.170**	0.140**

Note: * = Correlation is significant at the 5% level (one-tailed)
** = Correlation is significant at the 1% level (one-tailed)

Sources of information or methods to determine flood characteristics

Figure 5 presents the source of information and methods currently used by practitioners to determine various flood characteristics. Findings are discussed in the following paragraphs.

In determining contaminant content and sewage and fasciae content of floodwater respectively, more than half of the respondents (60.1 and 56.2% respectively) relied on visual inspection of the premises. The second most popular method was to employ independent consultants (37% for both characteristics). About one-third would obtain information by contacting the public health department of the Local Authority (24.9 and 35.9%), Water Authority (30.6 and 25.6%) and the Environment Agency (30.6 and 32.0%). Some (21.0 and 17.4%) would contact the Local Authority. Only few (4.3 and 4.6%) would utilise in-house laboratories, probably due to a lack of such facilities and the expense involved.

Visual signs of subsidence was the most popular method (77.0%) employed to determine the velocity of floodwater. Some respondents (28.0 and 23.3%) would contact the Environment Agency and Water Authority to obtain information.

The importance of local information and/or consultation with witnesses was highlighted in determining the duration of the flood with almost half of the respondents (46.5%) indicating an intention to seek local assistance. However, visual inspection of the flood was still the dominant method (57.0%). Additionally, various sources of information would be sought by some respondents including contacting the Environment Agency (26.4%), Water Authority (25.0%) and Local Authority (23.6%).

Similarly, various sources of information would be sought to determine the source of floodwater with visual inspection as the most dominant method (53.7%). About thirty percent of respondents sort assistance from the Environment Agency (36.4%), Water Authority (35.7%), Local Authority (28.3%), and local information/witnesses (27.9%). Additionally, independent consultants (19.1%) and Public Health departments of Local Authorities (15.5%) were also deemed as useful sources of information by some respondents. In-house laboratories were again less utilised (3.2%).

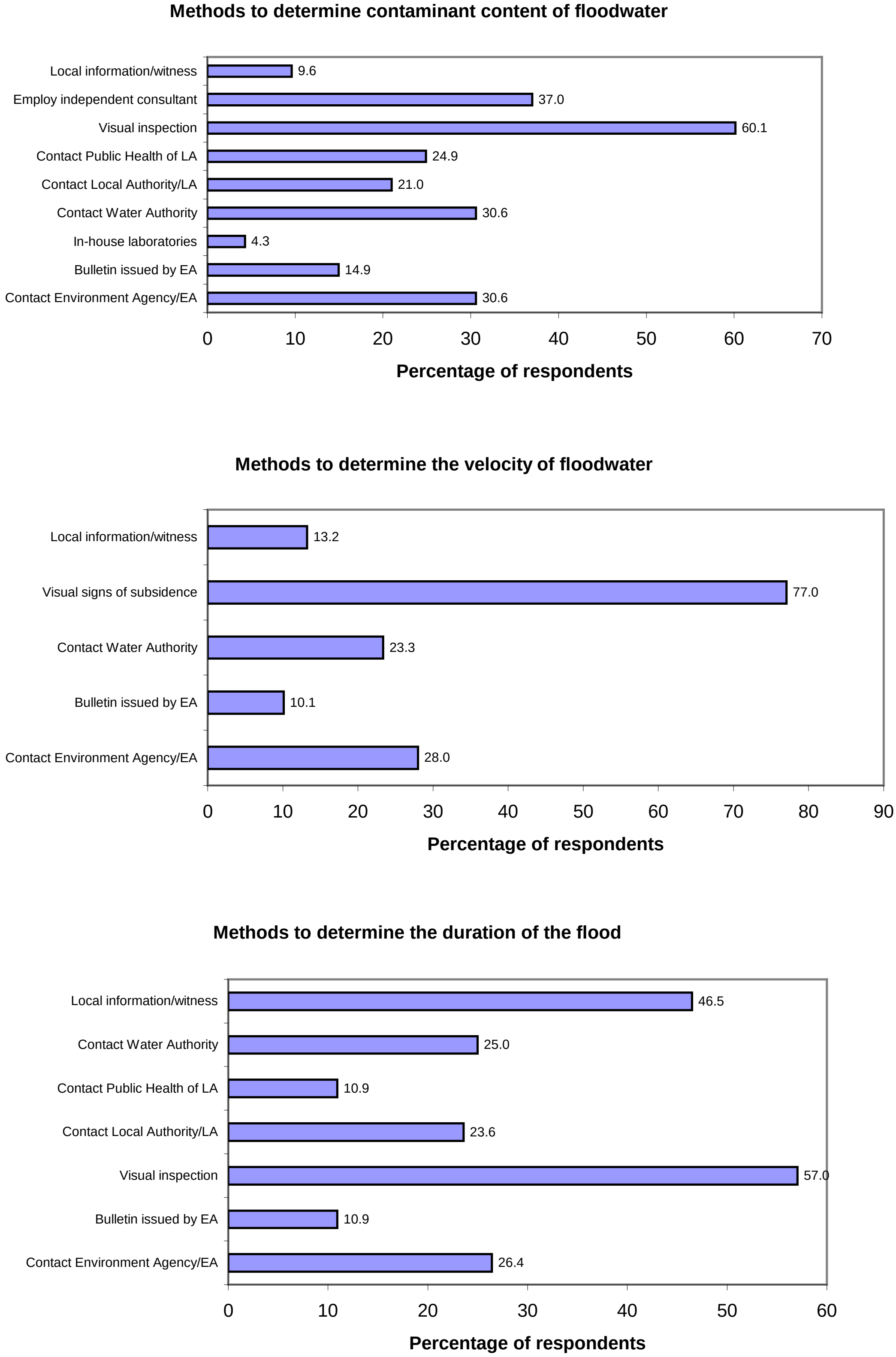
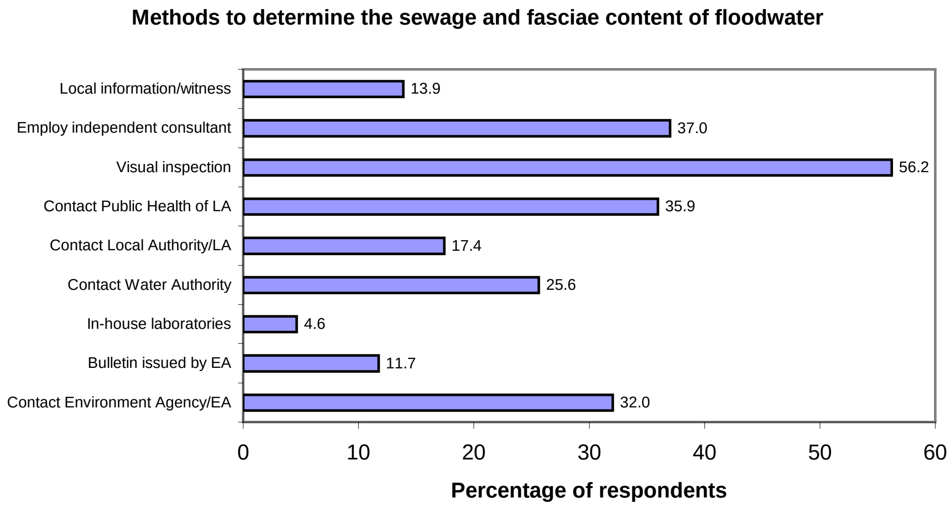
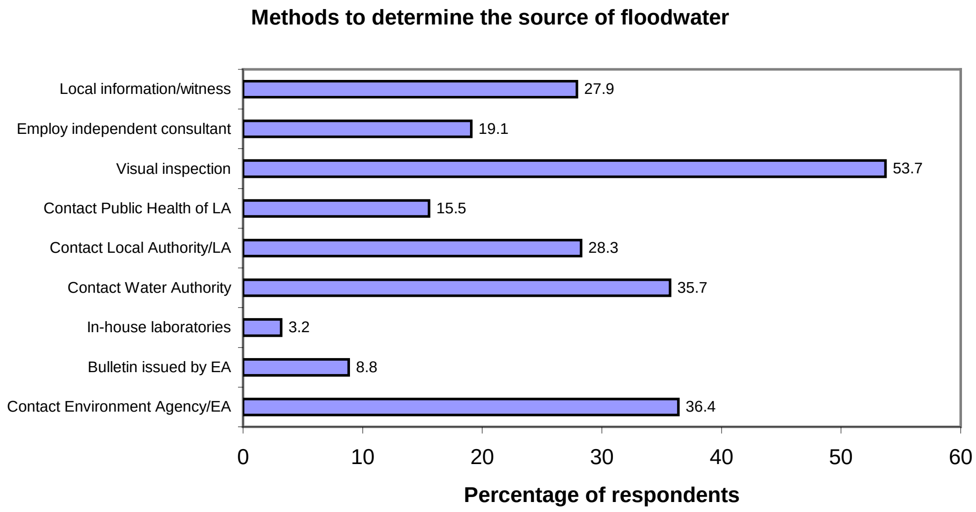


Figure 5 Methods to determine flood characteristics





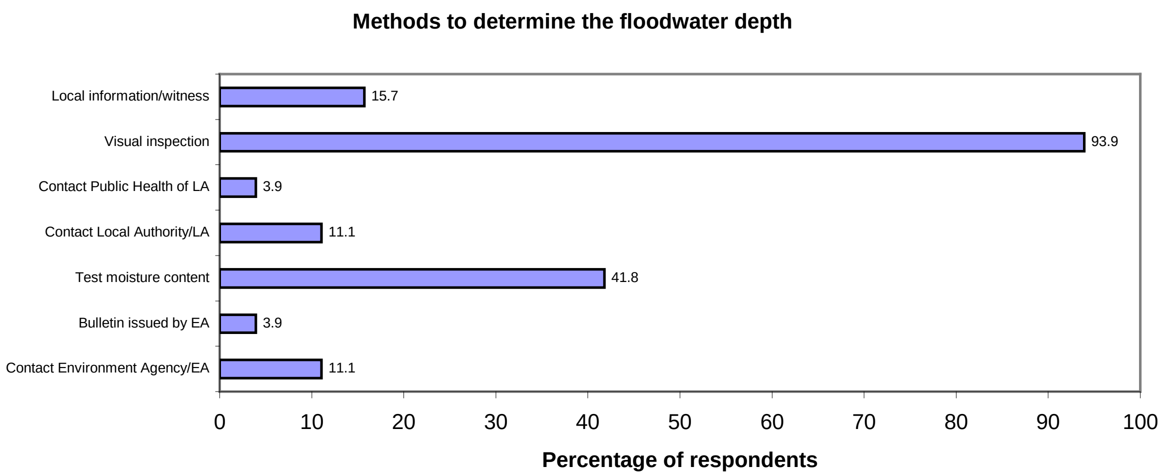


Figure 5 Methods to determine flood characteristics (cont.)

Almost all damage assessors (93.9%) would visually inspect premises to determine the floodwater depth. This is probably due to the presence of flood-marks on the walls of premises which may be easily recognisable after the flood has receded. More that forty percent (41.8%) would also test the moisture content of the building. Here, other methods were seldom utilised.

Generally, flood damage assessors relied heavily on visual inspections and hence independent judgements. In a similar vein, local information and/or witnesses were also important sources of information (although this was not an option provided in the questionnaire), particularly for determining the duration of the flood. This suggests that current assessment of flood-damaged properties contains subjectivity and may therefore be prone to variation. Further, it may be concluded that in the absence of hard evidence and hence the inability to obtain objective information, assessors would often tend to pursue other sources of information (e.g. from witnesses of the flood). This is particularly true for determining contaminant content, sewage and fasciae content, duration and source of floodwater. In contrast, current practice relies heavily on visual inspection to determine floodwater depth.

Conclusion

The results of a thorough review of the literature related to flood damage domestic properties indicated little consensus of opinion and ignorance of many factors regarding damage assessment procedures or ‘optimal’ repair methods. Further, it has been proffered that appropriate appraisal of flood damage should consider a plethora of factors classified into building characteristics and flood characteristics.

This paper has presented findings of a two-year research programme based on the assessment of 289 building surveyors regarding flood characteristics including contaminant content, velocity, duration, sewage and fasciae content, source and depth of floodwater. Their opinions were considered those of experienced flood damage assessors.

Generally, flood damage assessors regarded flood characteristics (with velocity being the exception) as ‘important’ or ‘very important’. Sewage and fasciae content of floodwater was considered the most important characteristic, followed by contaminant content, depth, duration, source and velocity of floodwater. Further investigation suggests that experts with more experience consider flood characteristics, with velocity of floodwater being the exception, to be more important. Regardless of respondents’ levels of experience, velocity of floodwater was perceived to be less important.

The results of analysis regarding the source of information and methods to determine various flood characteristics suggests that flood damage assessors relied heavily on visual inspections (i.e. independent judgements) and local information and/or witnesses. This suggests that current assessment of flood-damaged properties contains subjectivity and may therefore be prone to variation. Further, it may be concluded that in the absence of hard evidence and hence the inability to obtain objective information, assessors would often tend to pursue other sources of information (e.g. from witnesses of the flood). This is particularly true for determining contaminant content, sewage and fasciae content, duration and source of floodwater. In contrast, current practice relies heavily on visual inspection to determine floodwater depth.

These findings confirm the conclusion drawn from an earlier critical review of the literature, which found little consensus of opinion and ignorance of many factors regarding damage assessment procedures. Although flood damage assessors regard flood characteristics to be of importance, there is currently no definitive guide on how to determine these and therefore, they rely heavily on the subjectivity of visual inspection complemented with the use of local information and/or witnesses. Although these methods are practical and simple, they exhibit variations which ultimately result in varied repair recommendations for a similar flood-damaged property (Nicholas *et al*., 2001).

These findings provide a useful starting point for the development of definitive benchmarks of flood damage assessment which will allow assessment of the performance (in terms of time, cost, quality and perceived client satisfaction) of each possible repair strategy (Proverbs and Soetanto, forthcoming). Ultimately, this will yield a standardised repair strategy for a particular damage scenario which would help home-owners, insurance companies, loss adjusters and repair specialist contractors to minimise variations in subsequent repair and reinstatement works.

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