THE IMPACT OF FLOODING ON THE VALUE OF RESIDENTIAL PROPERTY IN THE UK

by
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A thesis submitted in partial fulfilment of the requirements of the University of Wolverhampton for the degree of Doctor of Philosophy (PhD)

January 2008

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Date………………………………………….

ABSTRACT

Flooding of residential property is a real and growing phenomenon in the UK causing short and long-term detriment of various kinds to its victims. The issue of potential decrease in value of those properties which are located on the floodplain, though much discussed in the media, has received scant attention in the UK research literature. An extensive literature survey has revealed a need for methodological innovation in the field of temporal impact of flooding and the inadequacy of the current paradigms for inclusion of insurance into flood modelling. A wide-ranging review of data sources, including discussion with industry experts, has identified the requirement to generate primary data on the availability and cost of flood insurance.

A novel framework has been developed for this research. This framework is an extension of the recent research in flood modelling and incorporates ideas from the wider house price analysis literature. Data collected via a questionnaire survey of householders has been combined with secondary data on property prices and flood designation in order to attribute any loss in property value to the correct vector of underlying flood status.

The output from this study makes a contribution to the understanding of the impact of flooding on house prices, allowing for better valuation advice. Empirical findings are that the understandable concerns of residential property owners at risk of flooding regarding long term loss of property value are largely unfounded. Price discounts are observed for some recently flooded areas but they are temporary Improved appreciation of the impact of claims and flood risk on the cost of insurance has also emerged. The insurance market was not found to be instrumental in reducing the price of property.

The output from the study also makes a methodological contribution in extending concepts relating to the relationship between flooding, insurance and house prices. This development is anticipated to facilitate refinement and updating of the empirical findings with reduced effort in the light of future events.

ACKNOWLEDGEMENTS

I am grateful to my supervisory team particularly my Director of Studies, Prof. David Proverbs who instigated this research and believed in my ability to tackle it. He has provided invaluable feedback on my efforts and been unfailingly positive and supportive. I would also like to thank Dr. Adarkwah Antwi whose thoughtful input in the early phases of the research helped shape its direction. To Dr. Felix Hammond who stepped in to replace Dr Antwi on the latter's departure to Ghana I am indebted for his fresh critical perspective which has greatly improved the presentation of the arguments.

I acknowledge the financial support of the School of Engineering and the Built Environment, University of Wolverhampton. I am grateful to colleagues within the school who have assisted me and asked challenging questions.

I am indebted to family and friends for their moral support and practical assistance. In particular I am grateful to Dr. Francesca Bumpus for patiently reading every chapter, and her advice on writing style.

I would also like to express my gratitude to those victims of flooding and other home owners who took the time to respond to the questionnaire survey. I acknowledge the assistance of many individuals within the Land Registry and Environment Agency who supplied data for the research.

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1.1 INTRODUCTION

Flooding is the most common natural hazard faced by populations worldwide causing the most fatalities and coming second only to windstorms in the cost of damage caused (Munich Re, 2004b). Floods can devastate communities and have a range of impacts short and long term upon their victims. Over £200 billion worth of assets are estimated to be at risk of flooding in the UK (Office of Science and Technology, 2003). The worldwide increase in frequency of extreme weather events has been reflected in the UK where, since 1998, there have been several severe flood events. The flood event of Easter 1998, coming as it did after a relatively dry period, sparked a renewed interest in the management of flood risk (Bye and Horner, 1998) which was reinforced by further flooding in 1999 and the widespread 2000 floods (EA, 2001, NAO, 2001, Clark et al., 2002). Forecasts of increased flooding due to climate change (Office of Science and Technology, 2003, Evans et al., 2004) and subsequent flood events in Boscastle in 2004, Carlisle and North Yorkshire in 2005 and the most recent summer flooding of 2007 have kept the flood issue high upon the political agenda.

The immediate effect of flooding on its victims in terms of loss of property and displacement from their homes is readily apparent. Dramatic coverage of emergency evacuations and the destruction of property are presented in the media (Pook, 2000, Thompson and Fitzwilliams, 2005, Humphreys, 2005). Surveys of flood victims document the wider impacts (Welsh Consumer Council, 1992, Ketteridge and Fordham, 1998, Samwinga et al., 2004). Less apparent but equally distressing to the victims are the longer term detrimental impacts such as health problems (Bennet, 1970, Welsh Consumer Council, 1992, Hajat et al., 2003, Reacher et al., 2004, EA/DEFRA, 2005). A key worry expressed by homeowners is that they may experience insurance problems and that enhanced awareness of flood risk due to media coverage, recent changes in disclosure and insurance regimes may cause depression in the price of flood-prone property (Welsh Consumer Council, 1992, Clark et al., 2002, Samwinga et al., 2004, EA/DEFRA, 2005).

The maintenance of property value is a key element in the sustainability of local communities (Bramley et al., 2004). It is of importance not only to property owners and their agents but also to local and national governments. If devaluation due to floodplain status leads to vacant and derelict property then local blight could ensue. In extreme examples the case could be made for clearing entire swathes of housing. However abandonment of existing localities to the elements is a policy matter and the increased pressure on building land due to housing demand makes such an event undesirable.

Knowledge of the extent and scale of the price effect of flooding will therefore be valuable for a number of purposes. Valuation professionals need to know what magnitude of discount to apply to previously flooded and at-risk properties when they come up for sale (Kenney et al., 2006). Furthermore the financial impact on the residential sector through the reluctance of consumers to purchase properties in floodplains is a concern to house builders (Hertin et al., 2003, Kenney et al., 2006). Mortgage lenders and insurance companies can make a more realistic estimate of capital at stake in flood risk property. Governments, national and local and their associated agencies with responsibility for flood defence policy and implementation need to understand the full financial implications of their decisions (Clark et al., 2002).

Among the most distressing of post-flood impacts is the physical displacement from home and community during reinstatement particularly if alternative accommodation is far removed from the home (Samwinga et al., 2004). Factors facilitating a quick reinstatement of flooded property will therefore assist victims in their recovery and can also help in maintaining community cohesion. In the ideal scenario flood victims would welcome secure and timely financial support for the recovery work as well as ready access to professionals experienced in the restoration of flood damaged buildings. An effective insurance market can provide both of these things. Insurance against flood damage can also provide benefit to the wider community in preventing blight and sustaining the local community.

Knowledge of the impact of flooding on the cost and availability of insurance and the way that this affects the value of property will be useful to property owners and their agents. Strategies to maintain insurance cover in the presence of flood risk will be valuable not only during their residence but also in the property transfer process. Commercial investors in property have also identified the non-availability of flood risk insurance as a key deterrent in property purchase (Kenney et al., 2006). However the debate about the role of insurance in flood risk management involves a much wider community. The presence of insurance is not an unalloyed good as has been extensively described by Kunreuther (1974), Clark (2002) and Crichton (2005), among others. Insurance can induce moral hazards in those able to prevent flood damage if it removes the incentive to do so. Recently authors have argued that, if this danger is recognized, it may be possible for insurers to take steps to prevent complacency amongst property stakeholders (Huber, 2004, Green and Penning-Rowsell, 2004).

1.2 RESEARCH CONTEXT AND JUSTIFICATION

Flood related research is a multidisciplinary field which ranges from the purely physical sciences aspect of short term flood prediction to the social science considerations such as studies of vulnerability. The current investigation is located broadly within the area of flood risk management but more specifically within flood impact measurement. The research area of flood risk management in the UK context has quite naturally prioritised the preservation of life, flood defence and emergency response (Fordham and Ketteridge, 1995, Penning-Rowsell and Wilson, 2006). Flood prevention and flood damage prevention are also a primary focus (EA, 2001, Hall et al., 2003, Entec, 2005).

A deep understanding of the full impacts of flooding is necessary in order to implement flood management policies in the best interests of all (Green et al., 1994). Research into the impact of flooding in the UK has focused mostly upon the costs to the insurer, government and society in general (Clark et al., 2002, Office of Science and Technology, 2003, Dlugolecki, 2004, EA/DEFRA, 2005). The damage to property, infrastructure and business has been studied in some detail by Penning-Rowsell and others (Green et al., 1994, Penning-Rowsell and Green, 2000, Penning-Rowsell and Wilson, 2006) in order to evaluate the cost benefits of flood management programmes. Some insurance industry funded research has been undertaken to examine the effect of flooding on the cost of repairing individual properties (Black and Evans, 1999a, Soetanto et al., 2002). Such research is designed to allow insurers to mediate claims and to assess their ultimate financial exposure to flood risk. An additional thread of research has been the longer term stress and health impacts on the flooded household (Bennet, 1970, Fordham and Ketteridge, 1995, Reacher et al., 2004, EA/DEFRA, 2005). Long term financial impacts of flooding upon the victims in respect of loss of capital value in their property and increase in insurance premiums, though much discussed in the media (Hughes, 2000, Stevenson, 2002, Brown, 2004) has received rather less attention in academic research.

The assumption that flooding will have an impact on property value is commonly held and makes intuitive sense but not yet proven for the UK (Clark et al., 2002). Conflicting theories suggest that a measurable impact of flooding on property value is not a foregone conclusion. Price theory predicts that the willingness to pay to avoid the disutility of flood risk should be reflected in property price discount, however behavioural decision theory suggests that consumers may ignore the risk of flooding during property purchase (Slovic, 1987) unless forced to do so. There have been two surveys of expert opinion on the impact that flooding may have on value of residential property in the UK (Building Flood Research Group (BFRG), 2004, Eves, 2004). The huge variation in responses, even from professionals working in the same market, is a remarkable feature of both studies. A further survey on the attitude of property stakeholders to commercial and residential development also found opinions varied widely (Kenney et al., 2006). The research highlights the lack of analysis of value implications of flood risk and reinforces the need to examine the relationship using actual transaction data.

Studies of the effect of flooding on property value and insurance exist for the US, Canada, Australia, New Zealand and France. These studies demonstrate widely different measured effects but agree on the importance of insurance in determining value loss. Different insurance regimes exist across countries with the UK being unique in the inclusion of flood cover under standard household policies (Gaschen et al., 1998). In general where insurance is studied the analysis is based on published state insurance rates and takes no account of the fact that the majority of homeowners fail to insure unless forced to do so (Babcock and Mitchell, 1980, Harrison et al., 2001). There is a division in the literature between studies of a particular flood event, for example Tobin and Montz (1997) and studies of designated floodplain location, for example Shilling et al (1989). The temporal nature of the value effect of flood differs depending on which approach is taken. Impact of a flooding incident is seen to decrease with elapsed time after the event, designation, conversely, leads to permanent effects.

In relation to the aims of this investigation there is an absence in the existing research of a consensus view on the likely impact of flooding on house prices in the UK. There are also gaps in the dearth of transaction based research into the effect of flooding on house prices in the UK, and in the lack of a theoretical framework to include the influence of insurance costs on the value of houses.

1.3 STUDY AIMS

The main aim of this research is to investigate and measure the impact of flooding and the risk of flooding on the value of residential property in the UK.

A subsidiary aim of this research is to investigate the impact of flooding and flood risk on the cost and availability of insurance and whether insurance issues are a determining factor in any loss of property value.

1.4 RESEARCH PHILOSOPHY

This study touches upon multiple fields of study including natural environment, built environment, risk management, economics and finance. Even a cursory glance at the literature reveals that practitioners from all these fields have studied the impact of flooding on property. The motives and methods have varied accordingly and from a problem centred perspective all bring valuable insights to bear. However, competing and complementary theories of behaviour have failed to provide guidance to valuation professionals and property managers for their practical purposes. In specifying a particular national market for this research the objective is to place the research in an evidence based real world context and to generate concrete estimates of market reactions. The philosophy of this thesis is therefore pragmatically pluralistic and will incorporate a broad literature review.

1.5 INITIAL RESEARCH STRATEGY

Achievement of the stated aim of measuring flood impacts clearly demanded a quantitative element within the research strategy. Simply to build a conceptual model would not fulfil the research aims. However, within the research there was a tendency to mix in other methods in accordance with the pragmatic research philosophy.

Incorporating expert opinion, questionnaire comments and textual analysis into the design and interpretation of quantitative data provides a deeper understanding of the problem than statistical analysis alone. The initial research strategy was therefore to investigate the wider context of flooding, house price and insurance literature via a survey of the published research. In this way a conceptual model of the impact of flooding on the value of property could be developed. The strategy then involved estimation of the model parameters using UK data. Throughout the development phases of the research the availability of data to test conceptual models was therefore considered of crucial importance. A bias towards a quantitative approach was present from the outset and purely theoretical or qualitative approaches were eschewed.

1.6 OBJECTIVES OF THE STUDY

To achieve the aims of this research the objectives will seek to address the identified gaps in the current research in the following way.

1. A comprehensive review of relevant literature will be undertaken to identify any consensus in the previous analysis of the impact of flooding upon property value and the relationship between flooding, insurance and property value. The review will also encompass methodological approaches with the intention of identifying appropriate methodologies for measuring the impact of flooding on property value and insurance cost.

2. A conceptual model will be developed, specific to the UK, of the impact of flooding upon property value. This conceptual model will incorporate the cost and availability of flood insurance.

3. Models of the impact of flooding on property value will be estimated. Data on property insurance will be collected and combined with the price models to explore the relationship between flooding, insurance and property value.

1.7 DELIMITATION OF THE STUDY

The study will concentrate on fluvial flooding, examples involving coastal flood risk, overland flow and water system failure are considered briefly during the empirical stage. The UK will form the context for the study during the literature review stage. However, because of the differing disclosure, regulatory regimes and property transfer process, during the empirical model building stage the study will focus on England and Wales. Domestic residential property only will be considered. For the purposes of the empirical analysis only transacted property will be included. Data for the study will be taken from the Land Registry price paid dataset, the Environment Agency web-based indicative flood plain map and a survey of homeowners. The further implications and limitations of these data sources will be discussed in Chapter 6.

1.8 ANTICIPATED BENEFITS OF THE STUDY

The financial effect of flooding and flood risk on property value in the UK has been a topic much loved by the media but neglected in academic research. This project aims to make a contribution within this clear gap in understanding. In order to increase understanding it has been necessary to develop a novel framework for analysis because the existing literature is not directly applicable to the UK market. The research will therefore make contributions in methodology and understanding as detailed below.

1.8.1 Methodological contribution

As detailed in Chapter 6, it has been necessary to take steps in model development in order to deal with the temporal variability in flood impact on property value, the data issues specific to the UK and the unique insurance regime in the UK. The temporal formulation can be applied in future research into the impact of flooding, or other natural hazards on the property market. Although the broader analysis framework was designed of necessity to address country specific problems the insight gained during development of the conceptual model into the potential actions of insurance in the property market may be relevant in other insurance markets.

A major advantage to the proposed methodology is that, in using repeat sales analysis, the costs of data collection are minimised, this makes it possible to revisit and extend the analysis with minimal cost. In a changing regulatory regime which may provide increasingly accurate and timely flood risk information, house buyers' perceptions of risk may well change. The ability to continue to track the impact of flooding is a desirable facility.

1.8.2 Contribution to understanding

The understanding of the effect of flood on property value will be improved in four ways by the study:

i) The spread of the effect of flooding on property value over time will be better understood. Valuation practitioners express the opinion that people forget about the risk of flood but have no firm grasp of the length of time that might take. In the proposed research several locations will be analysed and it may be possible to detect differences in recovery time depending on previous flood experience.

ii) The magnitude of the effect will be estimated from actual sales data. All previous estimates of sales impact in the UK have been based on expert opinion (Building Flood Research Group (BFRG), 2004, Eves, 2004). In the aftermath of a flood this can be highly coloured by media hype and in the context of relatively rare events such as flooding, the experience of the experts may be low.

iii) The impact of flooding on the cost of insurance for floodplain residents will be measured in a new way. Use of published rates or blind customer surveys in the specialist field of flood insurance is unlikely to reflect the true impact of living on a floodplain for the majority of customers. Floodplain residents have an incentive to shop around and can make personal negotiations with insurance companies to reduce costs (Which?, 2005). The questionnaire survey will give a unique insight into this issue.

iv) In the light of the output from the questionnaire survey it will be possible to investigate the impact of insurance cost on sales value for the UK market. The hypothesis that increased insurance cost for floodplain properties is having an impact on the value of property in the floodplain will be tested using transaction data.

1.9 ORGANISATION OF THE THESIS

The thesis will cover in detail the literature reviewed during this study. This literature was broadly sectioned into four strands each forming a chapter. The literature on flooding and its impact on the built environment is covered in chapter 2. In chapter 3 price theory and house price models are considered. In chapter 4 the lessons from the specific work on flood impact on property value are detailed. The property insurance market in the UK and the way in which insurance can be incorporated into house price modelling are the topics of chapter 5. This chapter draws on flood pricing literature as well as UK insurance literature.

Following from the extensive review chapters, conceptual model development is described in chapter 6. Chapter 7 lays out the practical steps necessary in the empirical analysis phase of the research based on transaction data from the UK property market. In chapter 7 the rationale behind the approach taken is summarised and the way in which the research aims will be addressed by the empirical research is explained.

Chapter eight presents a large collection of textual data about the study sites and the preliminary data analyses to obtain local price indices for each site. The remainder of the detailed analyses is split between two chapters. The analysis of questionnaire responses forming the bulk of chapter 9 whilst chapter 10 deals with the house price analyses and the combined model. Choice of model and model validation is also contained within chapter 10.

Chapter 11 presents the conclusions and recommendations of the study and suggests ways in which this research in its completed form will contribute to knowledge and where the strand of research might most profitably be developed.

1.10 SUMMARY

It has been shown within this chapter that flooding is an important issue, not just for the UK but worldwide. Flooding is an increasing phenomenon and the importance of increased research into the area of flooding will grow commensurately. Flood related research has included a substantial body of work relating to flood risk management and the measurement of flood impacts. Within this broad area the longer term financial implications of flooding for the UK homeowner are seen to be under researched. Better understanding of these long term impacts is argued to be useful for a wide range of property stakeholders but the gap in understanding cannot be completely addressed by a single research project. The clearly stated aims and objectives for this investigation are therefore designed to move towards a fuller understanding of the impact of flooding on insurance cost and property value for a limited range of flood types. The limits of the study and its context within flooding research have also been clarified. As described in section 1.8 the ongoing thesis will encompass an extensive literature review, conceptual model development and empirical analysis. The following four chapters constitute the review section commencing with a contextualising of the flooding literature concentrating on flood impacts in the built environment in the subsequent chapter.

Chapter 2 : FLOODING AND THE PERCEPTION OF RISK

2.1 INTRODUCTION

The inundation of water across areas that are normally dry constitutes a flood and has a wide variety of impacts (Gruntfest, 1995, Fleming, 2001b, Reacher et al., 2004, EA/DEFRA, 2005). As an extreme example, a tsunami may result in massive loss of life, land and possessions. At the other extreme, poor functioning of the internal plumbing system within a dwelling may result in an escape of water and minor damage to contents. Flood events differ in their severity and duration. In the UK for example tsunamis are not usually considered a likely threat but river flooding occurs regularly and coastal flooding can occasionally cause great devastation (Fleming, 2001b). It is also important to distinguish between the severity of a weather event and the severity of its impact on the human and built environment (Clark et al., 2002).

In the UK the incidence of severe weather events has increased in recent years (Munich Re, 2004a). The increase has been attributed to climate change and on this basis the intensity of events is projected to continue to accelerate (Office of Science and Technology, 2003). However, even without the increase in weather events the financial risk to property in the UK has increased due to the action of man. As discussed in Clark et al (2002) the vulnerability of the population has increased due to increased development in the floodplain and the neglect of flood defences. The impact of flooding in financial terms has also increased because of the increasing value of buildings and their contents (Penning-Rowsell and Green, 2000).

To some extent therefore the increased flooding problem is man made and mankind can take action to reduce its impact. The primary function of scientific forecasting of weather events is to enable society to take avoiding actions and to minimise the risk to persons and property (Arnell et al., 1984, Spence, 2004). The success or otherwise of such measures is crucial in determining the public perception of risk and the extent to which populations at risk of flooding will modify their behaviour (Ryland, 2000, Bruen and Gebre, 2001, Fleming, 2001a, Spence, 2004). In the UK flood defence policy has shifted from total reliance on hard engineering solutions to increased use of planning restrictions, resilient construction and adaptive behaviour (Fleming, 2001b, NAO, 2001, Oliver, 2007).

Whatever future construction practices may bring, the reality remains that for the foreseeable future, due to historical settlement patterns, a large population will remain at risk of flooding. The maintenance of those communities is in the interest of the wider population except in the extreme cases where frequent and severe flooding renders maintenance impractical. Understanding the economics of floodplain property involves an appreciation of global economic losses but also financial ones affecting individuals resident in the floodplain such as the increased cost of insurance and loss of property value.

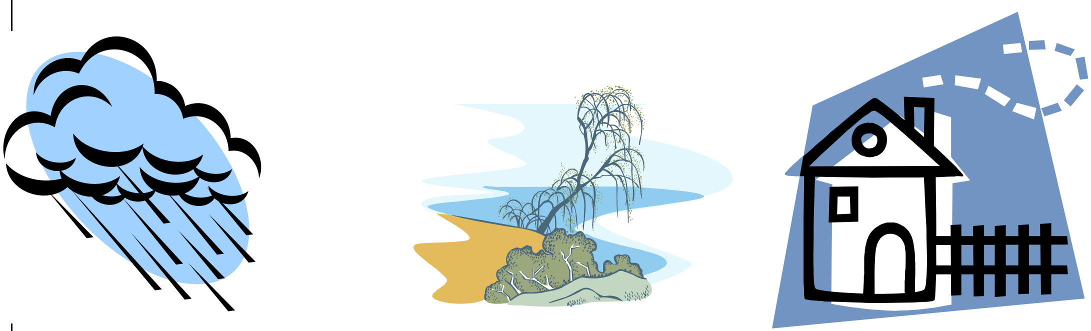
The empirical stage of this research focuses on one type of flooding in one national housing market. It is clear from the literature described in this chapter but also later in chapters 4 and 5 that the differences between types of events and the differing actions of governments in protecting and informing their populations renders specialisation in the measurement of the financial impacts of flooding necessary. However human response to hazard will have some common features and understanding these features, and the flood hazard in general will be crucial in interpreting the results of the empirical analysis and in determining the general applicability of the conclusions.

Section 2.2 describes the various types of flooding. Section 2.3 considers the likely increase in future flood risk. The impact of flooding in the built environment is described in section 2.4. Sections 2.5 and 2.6 consider the prediction of flooding from a scientific and public perception perspective. Section 2.7 examines the actions which property owners and other stakeholders can take in the knowledge of flood risk.

2.2 TYPES OF FLOODING

A flood is a great flow of water; an inundation; a deluge; a condition of abnormally great flow in a river (Chambers, 1993). But to an insurance company, to a farmer or to a householder the term flood may carry different meanings. In the flooding literature there are also many ways of categorising floods. Figure 2-1 shows Flemings source-pathway receptor model (Fleming, 2001b), an example of a useful representation for visualising the elements which distinguish between different flood incidents. A source might be heavy rainfall or high tides, a pathway might be a river or overland flood and a receptor could be a house, field or factory. In their guidance to the construction industry the Construction Industry Research and Information Association (CIRIA) have seven flood mechanisms which encapsulate the way in which flood water can affect development sites (Lancaster et al., 2004).

In the UK, for residential property, all types of flood are normally covered by domestic house insurance. Therefore the flood type and so the distinction between types is not of critical importance to the householder as it might be were their insurance cover dependent upon it. However, for the researcher, it is important to be aware of the differences in definition of flooding when comparing estimates of the cost of floods because some types of flooding are more controllable or preventable than others. For the purposes of this research a much simplified grouping of flood types is practical while recognising that many flood events may combine more than one type. The categorisation used below encapsulates the CIRIA mechanisms and is consistent with the Environment Agency (EA) definitions of the flood events of 2000 cited in National Audit Office (2001).



SOURCE ------------→ PATHWAY -----------→ RECEPTOR

Source - The initial condition that can lead to a hazard and subsequent risk being realised.

Pathway - The means by which the source can impact a receptor.

Receptor - The target which will be threatened by harm from the hazard.

Figure 2-1 : Source Pathway Receptor model, (after Fleming, 2001b)

2.2.1 Coastal and estuarine flooding

Flooding from the sea at the coast is caused by extreme tidal flows which can occur due to three main mechanisms (Institute of Hydrology, 1999): high cyclical tides due to the gravitational effects of astral bodies (astronomical tide level); increase in water level due to low barometric pressure and wind (surge); swelling waves due to the wind speed and direction (wave action). Sea defences are often in place to defend against the normal level of such mechanisms but flooding may often occur when several of the mechanisms combine, an individual extreme occurs in an individual mechanism or the defences fail.

In the UK widespread coastal flooding occurred in 1953. It derived from a combination of a high spring tide, a deep atmospheric low over the North Sea and northerly gales. Three hundred people lost their lives and twenty four thousand homes were flooded (EA, 2003b).

The extension of this coastal flooding inland via estuaries is mainly dependent on the tidal flow factors above but may be further complicated by high river levels. A phenomenon known as tidelocking may occur if, due to high tides, the estuarine defences do not allow for draining of high river flows into the sea. Flooding may then occur behind sea defences even though they have not been overtopped.

2.2.2 Fluvial flooding

Flooding from rivers and streams is usually caused by heavy or prolonged rainfall. The resultant runoff overwhelms the natural water courses and exceeds their capacity for transmitting water downstream. Rapid snow melt may also generate the runoff levels which cause fluvial flooding but in the UK this is less common. The state of the so called natural water course may also be a contributing factor to this type of flooding as may upstream defence strategies. Managing the flow of water through the river network and floodplains can be a central and strategic government role.

Fluvial flooding is often predictable during periods of prolonged rainfall but if intense rainfall for a wide catchment is directed into a narrow watercourse as occurred in Boscastle in August 2004 (Doe, 2004) flash flooding may occur too fast for monitoring systems to generate warnings. Groundwater saturation also has a part to play during very prolonged rainfall. The ability of the surrounding countryside to allow soak-away to the water table is compromised and so the majority of the water must be discharged through the water courses.

The 2000 flood event was mainly due to prolonged heavy rainfall saturating the ground and overwhelming the watercourses. More than 10,000 properties were flooded some up to five times (NAO, 2001).

2.2.3 Overland flooding

Overland flow (sometimes known as pluvial flooding) is water flowing over the surface of the ground that has not entered a natural drainage channel. It can occur almost anywhere but is most likely to be of particular concern in topographical low spots (Lancaster et al., 2004). Most commonly, overland flow is the result of intense rainfall exceeding the infiltration capacity of the surface onto which it falls. This could be because the surface is impermeable due to it being man made or due to drying out during a summer drought. Surfaces can also become impermeable because of saturation due to a prolonged wet period. Overland flow is most common in areas with steep terrain or in substantially urbanised environments where it can often be linked to failure of drainage systems.

2.2.4 Failure of artificial water systems

Flooding can result from the failure of artificial water systems because the systems are poorly designed and flow exceeds the design capacity or because they are poorly maintained and become blocked or compromised in some other way. Flooding of this type may contain high levels of debris as sewers are often involved or affected. Flooding can also occur from pump failure, from reservoirs or canals. Water system failure is a large problem in the UK as described in Crichton (2005), and because of the likelihood of foul water is particularly unpleasant and costly. Internally or externally flooding can be caused by domestic supply failure such as burst pipes but these incidents are fairly circumscribed in scope.

Most of the flood prone sites studied in the empirical phase of this research suffered their last inundation in the autumn 2000 floods or are typically at risk of fluvial flooding. One site is at risk of coastal flooding but the 2000 incident was due to failure of a pumping station. This site was included to provide a contrast to the main body of data.

2.3 CLIMATE CHANGE AND THE INCREASE IN FLOOD RISK

As mentioned above, flood frequency and the frequency of other severe weather events have increased in the preceding decade. There have been periods in the past when flood frequency has accelerated, which have prompted government intervention in the flood insurance market (Arnell et al., 1984). The distinguishing feature of the present wet period is that flood frequency is predicted to continue to increase over the foreseeable future due to climate change (Office of Science and Technology, 2003, Stern, 2006). This presents new challenges for the built environment as the hazard frequency increases. However even without increased frequency of flooding the impact of flood is set to rise because of human actions: Recent development within floodplains has ensured that increasing numbers of properties are put at risk of flooding (Crichton, 2005); flood defence effectiveness had declined during the relatively dry decades of the 1970s and 1980 (Clark et al., 2002); lifestyle changes have increased the financial amount at risk from the same flooding scenario as householders invest more heavily in their homes (Chagnon et al., 2000).

2.3.1 Climate change predictions

Climate change is a global phenomenon. Increasingly, changing weather patterns are convincing researchers that human behaviour is having an impact on the temperature of the planet. Over the last 100 years, for example, the temperature in the UK has risen by 0.6 degrees Celsius (IPCC, 2001). International symposia and summits thrash out solutions to this perceived threat to our environment because it is widely recognised that this is a global problem requiring international cooperation for the development of robust solutions (Stern, 2006).

Predictions of future climate change depend crucially upon assumptions of future economic activity. The Intergovernmental Panel on Climate Change (IPCC) third assessment report (IPCC, 2001) has produced scenarios on future carbon emissions which range from 980-2190 giga tonnes of carbon per year. This translates into temperature increases of 2-4.5 degrees Celsius over the next century (Hadley Centre, 2003). Global precipitation levels are predicted to rise at the same rate, with every degree of temperature resulting in a percentage rise in rainfall (Hadley Centre, 2003). The recently published Stern report (Stern, 2006) concluded that action to offset the impacts of climate change is an international imperative and outlines ways this might be achieved. The Met. Office (Hadley Centre, 2003) estimates suggest that whatever action is taken some warming is inevitable due to current carbon dioxide levels.

Climate change has implications for the frequency and severity of flooding incidents. Forecasts for the UK (UK Climate Impacts Programme (UKCIP), 2007) suggest that the country will suffer wetter winters and increasing numbers of intense rainfall events. Higher rainfall will lead to prior wetness and a higher temperature will lead to higher mean sea levels and faster snow melt (Fleming, 2001b). For other regions of the world the rise in temperature is projected to result in increased drought and water shortages. Coupled with these climate shifts there is an expectation that the worldwide incidence of severe weather incidents such as hurricanes will rise (Stern, 2006). The consensus among climate models appears to be that there will be an increase in flooding incidents in the future.

When the increase in rainfall is coupled with lifestyle factors the expected growth in people at risk of flooding will grow from 1.6 million to 3.5 million in the 2080s. Estimated annual damages rising from £1 bn to £21 bn (Evans et al., 2004). Estimates of people and households affected by the increased flooding are crucially affected by assumptions about the population under threat. Assumptions about population growth, spread of development within and outside the floodplain and the building and maintenance of flood defences are necessary. Governments can influence the spread of development and the construction of flood defences thereby reducing future flood development. For individuals, the problems with using climate change predictions lies in their uncertainty. As pointed out by Nielsen (2006) the extent to which adaptation to climate change should be undertaken depends on the cost of adaptation and the certainty of the projections of climate change. What is lacking from the literature however, are detailed predictions of weather behaviour on the scale that can allow individuals to make decisions about the construction of their immediate environment (Nielsen, 2006).

From the existing models of climate change we can conclude that there is likely to be an increase in flooding incidents worldwide and particularly in the UK. While the scale and timing of this increase is unclear, however, the detailed implications of climate change are not quantifiable. This has implications for the behaviour of property stakeholders as will be discussed further in the next sections. However, as described below, the case for studying flood impact does not depend on the acceptance of the growth in flood risk. The distress, disruption and expense incurred at the current frequency of events is sufficient justification.

2.3.2 Development in the floodplain

Populations have traditionally settled next to rivers. For an agrarian economy it makes sense to cultivate the fertile floodplain and to utilise natural watercourses for irrigation, water supply and transport. In the industrial society the advantages of riverside living still outweigh the risk of flooding. In the developed world during the current technological age with widespread infrastructure there is not a compelling need to select a floodplain for development. Equally it is within the ability of mankind to build flood impervious homes or to defend homes to a very high standard. The decision to build on the floodplain or not becomes a response to government policy and financial considerations versus lifestyle factors.

Smith and Tobin (1979) illustrated the increased concentration of urban populations on previously flooded land and regarded floodplain invasion as the most significant factor in growing flood risk at that time. Crichton (2005) contends that the Association of British Insurers (ABI) agreement to cover flood risk for all domestic dwellings in the UK has led to increased development in the floodplain, greatly exacerbating the flood risk. This is considered an undesirable outcome especially as the reduced price of floodplain land often leads to it being used for low cost social housing, putting at risk those least able to stand the financial burden of flood risk. The Environment Agency (EA, 2001) view is that development on the floodplain is undesirable for several reasons. Clearly siting more buildings in the floodplain increases the population in the floodplain and places the new residents at risk. The development may also increase flood risk for the whole floodplain by decreasing the soak-away potential for the developed land. Furthermore actions taken to offset increased flood risk at the development site such as construction of flood banks may have impacts upstream or downstream of the development, thereby increasing the risk of flood elsewhere.

Alternatively there are factors which mitigate against the siting of all new development away from the floodplain. The government communities plan identified targets for the redevelopment of previously developed, brownfield sites rather than new land.

Planning Policy Guidance (PPG) 3 means that many proposed redevelopment sites are situated in the floodplain (Entec, 2005). It is also desirable to locate new development close to existing ones in order to increase housing density, a government target from PPG3. The price of land on the floodplain may also be a factor in favour of floodplain development. The proposed Thames Gateway project is a case in point: high density housing is planned close to the Thames. An estimated 86,000 new dwellings could be built in the Thames floodplain by 2015 (Crichton, 2005, Entec, 2005).

In the UK domestic building development is subject to planning constraints administered by local authorities. Systems within England, Wales, Scotland and Northern Ireland vary in detail because of differing local arrangements and legislation. The relevant guidelines relating to flood risk in England is Planning Policy Statement (PPS) 25 (Department of Communities and Local Government, 2006), in Wales the relevant guidance is contained in Technical Advice Note (TAN) 15, in Scotland SSP 7 and in Northern Ireland PPS15. These guidelines differ in detail but all dictate that development is subjected to flood risk assessment and that planning permission can be refused on the basis of unacceptable flood risk. The Environment Agency fulfils the role of advising on the flood status of a proposed development site in England and Wales (Wynn, 2005). This in effects limits the development on floodplains but does not prevent it. Local authorities can ignore the advice from the Environment Agency as they have done in 1 in 4 cases (Wynn, 2005, ABI, 2005c).

It has been estimated by the ABI (2005c) that over 1,000 planning applications for new developments have been approved against EA advice in the three years up to October 2005. However this is a great improvement on the situation in 2000, when, according to Crichton (2005), there were over 3,000 cases where Environment Agency advice was ignored. The most recent estimate by the Environment agency (EA, 2007) is that 96% of planning decisions of which they are informed about the outcome were decided in line with their advice. This still resulted in 110 known developments being approved against their advice. Other developments were permitted with appropriate mitigation measures being adopted. Wynn (2005) in a survey of planners and developers concluded that planners and developers were aware of and sympathetic to the aims of the planning guidelines. However in practice, the perception that slow Environment Agency advice will delay developments deters planners and developers from entering into consultation. Late response from the agency was also given as a primary reason for decisions running contrary to Environment Agency advice.

In short, despite regulations limiting the amount of development on the floodplain, it is perceived to be necessary to permit a certain amount of floodplain development. It is for the built environment professional to seek to minimise the increase in flood risk posed by a new development and to ensure that key infrastructure and vulnerable groups are not put at increased risk. Development on the floodplain should be planned to be sustainable and should take account of the "precautionary principle" that cost effective planning against the risk of flood should not be postponed because of uncertainty about the risk (Entec, 2004). Financial considerations which should not be ignored in this context are: first that the risk to their new properties is within the acceptable level set by the ABI as insurable or they will create insurance problems for any future residents; second, in the event of a flood whether the value of the properties will be damaged to such an extent as to leave purchasers unable to move because of negative equity.

2.3.3 The role of flood defence

The purpose of flood defence is to reduce the risk of flooding, to protect property and safeguard life (NAO, 2001). To many minds the natural response to increasing flood risk is to improve and increase the structural flood barriers protecting valuable property. During the 2000 flood event, although an estimated 10,000 properties were flooded, 280,000 were seen to be protected against flooding by existing defences (EA, 2001). However, it is clear that defences may be overtopped by an extreme event exceeding the design specification of the defence (Fleming, 2001b). Clark et al (2002) suggest that before the 1998 floods, funding for flood defences had been neglected and many were performing to below specified protection levels. Pressure from flood groups and the insurance industry has led to an increase in the budgets for flood defence in recent years.

Flood defences can be permanent, for example sandbanks or flood walls, but they can also be temporary barriers, put up when forecasts predict flooding is imminent. Demountable defences are used to defend the Frankwell area of Shrewsbury (Shropshire County Council, 2004) and pallet barriers have proved successful in Ironbridge and elsewhere (Worrall, 2004). Personal defences systems such as sand bags, door and window guards and skirts can be used on individual properties (Bowker, 2007).

Fleming (2001b) refers to flood management rather than flood defence. Strategies such as introducing storage areas into the system, for example the Lincoln washlands, channel enlargement or flood diversion channels. These methods require greater accuracy of flow volume prediction and continuous investment in monitoring (Smith and Tobin, 1979), and become more feasible as understanding of flood sequences increases. Finally flood warnings and evacuation plans can reduce significantly the risk to life and property (NAO, 2001).

Within England and Wales, the body responsible for overseeing matters relating to flood defences is the Environment Agency. Included in this role are advisory roles to planning authorities, surveys of flood defences, monitoring flood risk and assessing ways in which risk may be reduced. The Environment Agency controls the deployment of the bulk of the total expenditure on flood defences in England and Wales. In Scotland the body shouldering the responsibility is the Scottish Environment Protection Agency. The official position of the Environment Agency is that flooding can never be prevented entirely (Oliver, 2007). We must make space for it in urban design. The floodplain is the natural space for such storage because inherent in its use are additional leisure, ecological and aesthetic advantages which are not present in underground tanking.

It might be thought that the construction of flood defences would always reduce the losses due to flooding. Smith and Tobin (1979) however point out that often the construction of defences allows development in what are now regarded as safe areas. The result of a catastrophic flood will consequently affect far more property and can more than offset the gains made by protecting the original settlement. This effect, known as the levee effect, means that flood defences reduce the costs due to regular anticipated flooding but increases the flood loss burden overall unless development is prevented behind the flood defence.

If defences are built and then poorly maintained as has been suggested to be the case in the UK then the impact of the levee effect is further heightened. The increased development behind defences coupled with defences not performing to design standards will increase the impact of all flood events. Analysis by Smith and Tobin (1979) suggests that the avoidance of the levee effect could be a driving principle behind current flood alleviation schemes which concentrate more on warnings and temporary defence systems rather than permanent engineered structures.

2.3.4 Lifestyle factors

Exposure to flood hazard is a key element in the assessment of flood impact. Flooding in an uninhabited area is not a disaster for homeowners or their insurers. In analysing the trends in disaster losses, Pielke (2006) concluded that the overwhelming driver in increased disaster losses in the US was societal change and development. Also in the US, Changnon et al (2000) observed that the increase in insurance claims following severe weather events was largely driven by societal changes, increase in wealth and increased concentration in hazard prone areas. Similar conclusions have been reached elsewhere, for example by Crompton et al for Australia (2006), for Cuba (Muir Wood et al., 2006) and for China (Qian, 2006). For the UK, Cowley et al (2002) observed that while the UK Retail Price Index has run at 2-3% in recent years, the consumption of household goods index has outrun it at 6%. People own much more and their goods are more expensive to replace. Carpets have replaced hard flooring and electronic and electrical appliances abound, mainly concentrated on the ground flood of dwellings.

The increased costs of flooding observed in recent flood events in the UK and the projections of further cost increases can therefore be seen to be a combination of increased risk, exposure and vulnerability. Within the context of present flood risk management policies the likelihood is that, despite increased spending on flood defence and planning guidelines designed to reduce floodplain development a significant proportion of residential property will remain at risk from flooding. The next section examines the various impacts of flooding within the built environment, describing many of the costs associated with these impacts.

2.4 THE IMPACT OF FLOODING IN THE BUILT ENVIRONMENT

As discussed above, flood risk is comprised of hazard, exposure and vulnerability. Damage occurs when hazard and exposure combine and a flood event impinges on urban areas. The amount of damage suffered by that built environment is then a function of its vulnerability. In understanding flood risk, therefore, the ways in which floods can damage buildings and, equally, the way this damage can be minimised is central.

Flooding can cause damage in several ways within an urban setting. There is a threat to personal safety in the ingress of water to normally dry areas, where escape from buildings via boats, helicopters or other emergency vehicle is often necessary. In a high velocity flood, people may be swept away or drowned before emergency services can reach them. Physical damage to buildings and their contents is another primary impact. Flood waters also impede transport, covering roads and railways. This causes disruption to commercial and domestic life. Essential services such as electricity and water supplies can also be cut off causing discomfort in addition to health and safety hazards. In the years following a flood there are many longer term, more intangible impacts of flooding such as financial hardship for flood victims and stress related problems. The various forms of damage are summarised in Table 2-1.

Table 2-1 : Forms of loss (after Penning Rowsell et al, 2005)

Form of loss	Tangible	Intangible
Direct	Damage to buildings	Loss of archaeological merit. Loss of treasured possessions.
Indirect	Loss of productivity. Increase in travel expenses	Inconvenience, Health impacts

Losses can also be categorised as economic losses from the standpoint of national or regional government or financial losses from the perspective of direct stakeholders in property. This section focuses on the direct and indirect impacts on buildings and their stakeholders in keeping with the theme of the current investigation.

2.4.1 Damage to buildings

It is a widely expressed truism that the type, depth, velocity and duration of a flood will have a large effect on the damage suffered by a building and its contents. Kelman and Spence (2004) describe in detail possible actions of floods on buildings categorising the effects into: hydrostatic actions, such as lateral pressure from flood depth differential between inside and outside a building; water damage to non-resistant materials and capillary rise; hydrodynamic actions including velocity of flow causing turbulence or wave action; erosion, movement of soil for example undermining foundations; buoyancy, uplift due to buoyancy reduces the lateral force required to move a building;

debris and non-physical actions such as contamination with chemicals, nuclear or biological agents. Kelman and Spence (2004) argue that many of these actions will vary greatly within a given flood and between neighbouring properties, as for example the impact of large debris such as oil tanks and cars may have catastrophic impacts on one property leaving others unscathed.

There is a general consensus that different types of flooding will result in different forms of damage. For example flash flooding such as occurred in Boscastle in Autumn 2004 or in North Yorkshire in summer 2005 tends to be associated with high velocity and debris content (Doe, 2004). This leads to a high level of structural damage to buildings affected by the flood. In contrast the regular slow rise flooding such as is suffered by residents of Shrewsbury and York has a much lower velocity of flow. Preparedness of the occupants for a flood can also dramatically affect the damage caused by a flood (Thieken et al., 2006). Research evidence to back up these widely held views is somewhat sketchy however. There is a lack of understanding of flood damage which leads to a great deal of uncertainty in estimates of future flood damages (Kelman and Spence, 2004).

In the UK, for cost benefit study purposes, economic damage can be calculated via the manual of assessment techniques (Penning-Rowsell et al., 2005). These manuals are based on depth of flooding and building type. Green et al (1994) concludes that international studies demonstrate that depth of flooding is the most critical variable for urban flooding. Comparisons across developed countries have shown that the unit loss curves are very similar for shallow floods affecting residential property. In a survey of loss adjusters and surveyors Soetanto et al (2002) discovered that amongst those dealing with the problem of flooding on a regular basis the contamination and depth of water were considered the most important factors affecting damage.

However the focus upon flood depth may simply be a reflection of the fact that depth of flooding is the most easily measured aspect of a flood as Soetanto et al (2002) observed. Assessments of flood damage are usually made after the flood and to determine the velocity or contaminant in the flood water is more problematic once the flood water has receded. Recent work by Black and Evans (1999b), by Merz et al (2004) and by Kreibich et al (2005) attempt to include other variables into the analysis such as type of construction and flow velocity.

Research into the impact of floods on buildings in the UK has been carried out by the Buildings Research Establishment (BRE Scottish laboratory, 1996), University of Wolverhampton (Soetanto et al., 2002), Middlesex University Hazard Research Centre (Penning-Rowsell and Green, 2000), the National Flood School (Netherton, 2006) and H R Wallingford (Tagg, 2006). In the USA recent experimental work has been carried out by Tuskgee University (Aglan et al., 2004) into flood resistance and resilient materials. Much of the work is directed towards recommendations of suitable material for flood resilient construction and for effective reinstatement. A summary of findings can be found in a recent report for the Department of Food and Rural Affairs (DEFRA) (Bowker, 2007). However the research tends to focus on submersion in static flood water rather than velocity and debris impacts.

Anticipation of damage, unrecoverable losses and the expense of reinstatement are thought to be part of the explanation of any discounting in the value of floodplain property as discussed in section 3.2. Prediction of the cost of flooding, or research into reducing this cost could have a dramatic influence on the valuation of flood risk implied in such discounting.

2.4.2 Damage repair

For the UK, repair of flood damaged domestic dwellings since the 1960s has been facilitated by the previously universal availability of flood insurance cover (Huber, 2004). This ensures that the majority of home owners will be able to rely on building professionals to reinstate their houses. Emergency services are clearly a first line of defence during the flood helping to pump water from dwellings and installing temporary defences. Teams from many agencies and council operatives will help to strip out damaged belongings in the immediate aftermath. It has been recognised, however, that the correct action immediately following a flooding incident may limit damage (Kelman and Spence, 2004) and so many insurers will attempt to get loss adjusters into a flooded area the day after a flood (Barham, 2004). Victims of a flood are not always content with the service they receive from their insurers as evidenced by reports into the Towyn floods of 1990 (Welsh Consumer Council, 1992), in Warwickshire Trading Standards (Warwickshire Trading Standards, 1998) and in Samwinga et al (2004). Advice on what to do when flooded is available from a multitude of sources for example Office of the Deputy Prime Minister and the Association of British Insurers.

Research into the needs and demands of flood victims has been carried out by Samwinga et al (2004) who concluded that these needs and expectations are little understood and hardly researched. The divisive impact of aid to the uninsured versus insurance claims is explored by Fordham and Ketteridge (1995).

For the insurance industry Black and Evans (1999a) estimated the average cost of reinstatement to be £22,000 for buildings and £13,000 for contents on average. The process of collating claims information from a variety of insurance companies for this study focussed the researchers attention on the poor collection of information by claims handlers and called for a standardised report for flood damage.

Research in the area is ongoing in the UK by the H R Wallingford research organisation on behalf of the Building Research Establishment (Tagg, 2006), Sheffield Hallam University (Lambert, 2006), University of Wolverhampton (Samwinga et al., 2004) and the National Flood School (Netherton, 2006). Achieving excellence in the sphere of flood repair may contribute to the maintenance of property value and spares the property owner a great deal of the stress and anxiety attendant on flooding of their home.

Standardisation of the repair of buildings is a theme of the work of Proverbs and Soetanto (2004) and of the Flood Repair Forum who have issued guidelines for the repair of flood damaged buildings (Flood Repairs Forum, 2006). There is much knowledge available about the impact of flooding on different building materials, and the best ways to treat the drying and restoration process. This knowledge is held within several specialist flood repair companies but a large proportion of flood reinstatement is performed by generalist builders who may have limited understanding even of such basics as efficient drying of a building and contents. Experience of the Carlisle flood victims (Hendy, 2006) has made it clear that in practice there is still great variability between the best and the worst in terms of reinstatement. Guidelines and standards are helpful in such cases in disseminating the best practice to a wider group of builders.

One of the more contentious issues in flood repair is the inclusion (or not) of resilience in the reinstated building. Clark et al (2002) point out that it is not in the interests of insurance companies to finance resilient repair because customers are not tied in to long term relationships with their insurer and a rival company may gain lower risk customers at their expense. Loss adjusters acting in the short term interest of their insurance companies often recommend the cheapest reinstatement method rather than the best or most resilient (Proverbs and Soetanto, 2004). Where resilient repair is offered as an option it is generally not taken up unless the property has been subject to repeated flooding. Many authors have called for regulation in this matter, Crichton (2005) observes that the Scottish executive has the powers to force resilient reinstatement in flood damaged buildings. Resilient reinstatement is perceived to reduce the cost to insurers and the ABI (2006) have produced guidance as to the benefit of resilient reinstatement for standard properties. Many of these alterations would be cost effective after just one flood incident.

2.4.3 Indirect losses

Not all consequences of a flood within a built environment are felt in the physical damage done to the buildings themselves. Buildings perform a function and during a flood and in the reinstatement period, they can frequently be prevented from performing that function. Financial loss arising from the disruption of the normal activity of a building can be considerable. Green (1994) points out that indirect losses from a flood will be dependent upon the severity of the event and are likely to be correlated with the direct damages for that reason. The duration of the flood event will also be important, particularly for trading losses or manufacturing disruption.

However, indirect costs may be suffered by businesses and residential properties not actually flooded (Penning-Rowsell and Wilson, 2006). For example costs may be incurred in successfully defending against inundation or a business which was not flooded but which had restricted access during a flood event lost business. For domestic properties loss of amenities are more likely to be an issue. For example, interruption of electricity supply may cause hardship and financial loss from the damaging of freezer contents. These may be small losses for the individual but if multiplied across a large city such as in Carlisle 2005 or wide areas of the electricity network as threatened by the 2007 summer floods the totals could be considerable. In analysing indirect costs therefore a wider population area must be considered than for direct damage costs.

When considering commercial premises the flow of all losses and counterbalancing gains which may be experienced by nearby buildings which are not damaged is complex. The scale at which losses are evaluated, household, local economy, regional or national will determine how important these indirect losses will appear to be (Green et al., 1994). Business losses after flooding are under researched and contain far greater variability than residential losses (Green et al., 1994, Gissing, 2002). Indirect losses for businesses due to flooding have been considered by Gissing (2002), Penning Rowsell et al (2005) and by Crichton (2006). In the UK, the average cost of a business interruption claim was £35,000 in 2005 (Crichton, 2006). On average businesses lost 50 working days but there was great variability in outcomes (Crichton, 2006). Crichton (2006) points out that only 8% of businesses received warnings of imminent flooding, and that after the flood 25% of businesses would consider moving their premises. Small businesses can take up to two years to recover from floods, many do not have interruption insurance and some do not survive. The Association of British Insurers state that having an emergency plan in place is crucial as 80% of businesses without such a plan do not recover even when insurance is in place (ABI/NFF, 2006). If the home is used for running a small business then a flood in the home may contribute to business failure.

Disruption of road transport and essential local services can also be costly involving re-routing of journeys, the financial implications of which can be addressed via the cost benefit studies often carried out when roads are constructed (Green et al., 1994). Cost of deploying the emergency services, cost of damage avoiding action and medical treatment can also be considerable (Penning-Rowsell and Wilson, 2006).

However, this investigation is concerned with domestic dwellings which primarily provide shelter and a base for domestic life. Much of the indirect impact of a flood for a residential property owner will be intangible as it affects their quality of life and will be covered in section 2.4.3. If it is necessary to relocate during a flood and subsequent restoration then housing costs can amount to a substantial expense that may often be covered by insurance. Extra transport costs, and increased living expenses resulting from the inaccessibility of the normal amenities of home are harder to quantify and will probably be borne by the flood victim. Loss of house value could be regarded as an indirect loss from flooding pertaining solely to the home owner and their financial backers if the loss was caused by the flood. Increased cost of insurance could also be regarded as an indirect loss from flooding if it stemmed from making a claim due to flooding. It is likely that all of these domestic indirect costs will be related to the severity of the flood and the duration of the recovery or restoration of the family home. This implies that, as mentioned before, these indirect costs should, in theory, be correlated to the direct damage costs. Accepted wisdom has been that indirect damage costs are unlikely to exceed direct damage costs, however from the perspective of the insured householder the indirect costs of property loss value and insurance cost increases may be uppermost in their minds as they are uninsurable and therefore borne by them directly.

2.4.4 Intangible effects

To the victim of flooding the economic damages described above are not always the most distressing aspect of a flood. There are many other impacts which are hard to quantify in monetary terms. The most tragic of these, loss of life, is happily an infrequent occurrence in UK floods. Green et al (1994) considered intangible effects in order to seek ways to minimise them and also to find methods by which they could be incorporated into the assessment of flood alleviation schemes. A subsequent theme of the work of the Flood Hazard Research Group including Tapsell and Tunstall (2003) has examined the issues surrounding vulnerability of human populations within the built environment.

Intangible losses can be subdivided into direct, such as loss of life due to drowning or exposure during the flood and indirect losses such as illness suffered in the aftermath. Health effects may be further subdivided into physical and psychological. Stress and worry can then generate physical problems. Studies of health impacts have been carried out by Bennett (1970) and by Reacher et al (2004).

A survey of flood victims was carried out by the EA and DEFRA (2005) into the intangible effects of flooding. They concluded that the degree of physical and psychological health impact of a flood could be measured using questionnaires. The impact was related to the depth of flooding and also socio-demographics of the victims. Post flood events such as difficulties with reinstatement also contributed to these negative health effects. An average monetary value of £200 per household was derived from this research.

The tendency of intangible impacts to vary with the flood victim is further explored by the literature. Long term psychological damage is felt by some victims but not all (Tapsell and Tunstall, 2003). The difficulties with under insurance are covered by Priest et al (2005), the tendency of the underprivileged to suffer worse consequences by Fordham and Ketteridge (1995). Puvachoeran (2003) researched into the social vulnerability index via a survey of Lewes flood victims. Samwinga et al (2004) held in depth interviews with flood victims which revealed a variety of concerns summarised in Table 2-2.

From this table it is clear that a lot of complex fears and stresses affect the flood victim, four years after the flood many victims were still able to articulate them in great detail. Particularly germane to this thesis are victims' expressed concern about loss of insurance cover or increased insurance cost and also of reduced demand for their property at resale leading to property devaluation.

Table 2-2 : Homeowners experience after flood damage to their property (after Samwinga et al, 2004)

DIMENSIONS	DESCRIPTIVE STATEMENTS
Economic Aspects	Financial – expenses associated with living in temporary accommodation.
	Insurance Cover Fears – fear of potential premium rises and/or refusal by insurers to extend cover.
	Property Value – fear of potential reduction in property value and/or demand.
	Loss of Property – some of which may not be replaceable.
	Loss of Earnings – associated with staying off work to oversee repair work.
Emotional Issues	Fear of flooding – in the aftermath of a flood event.
	Leaving home – upheaval associated with leaving in alternative accommodation.
	Loss of Memorabilia – things which may be of sentimental value and irreplaceable.
	Fatigue – associated with cleaning up and repair work
	Reaction to flooding – included Disbelief, Shock, Surprise, Devastating, Stressful, Worried, 'Get on with Life'.
Service-Related	Service Experience – how their service providers dealt them with and how well their needs have been met.
	Communication – consistent, timely and information and/or advice.
	Loss of Control – while the repairs are being carried out
	Temporary Accommodation – proximity to home, comparability.
	Speed of Return to Property.
	Confidence in service providers – makes easy for homeowners' to get on with other aspects of life while repairs are ongoing.
	Fairness – how fair the homeowner perceives the settlement to have been
Social Aspects	Family support network – helps to cushion the impact of the catastrophe.
	Children – families with children experienced more difficulties in day to day running of household.
	Friends support network – another source of help for flood victims
	Community Spirit – may be fostered when a neighbourhood empathises
	Situational Issues – other personal circumstances such as family tragedies can compound the stress felt by flood victims.
	Homeowners' Characteristics - Individual characteristics may have a bearing on coping with the flood and its aftermath.
	Experience of Flooding –previously flooded homeowners find it easier to cope next time
	Personality – each homeowner is different and will cope differently in crisis
	Vulnerable Groups such as the Infirm, Elderly people – had unique requirements and some found it difficult to cope with the resulting upheaval.
Physical Aspects	Flood characteristics – e.g. floodwater depth, contamination, amount of floodwater, and duration of flooding, define the nature of the flood event.
	Extent of damage – extent of property damage and whether or not its insured.
	Flood warning – how much warning homeowners had before the flood.
	Flood Timing or Season – holiday time can be particularly distressing.

Loss of property value was also identified as a concern after the Towyn floods (Welsh Consumer Council, 1992) and in the EA/DEFRA survey (EA/DEFRA, 2005). Anticipated loss of value is an additional worry for flood victims and may lead to them feeling physically trapped, because unable to sell and move on, in an environment in which they no longer feel safe.

2.5 SCIENTIFIC MEASUREMENT AND PREDICTION OF FLOOD HAZARD

The effective management of flood risk depends on a good understanding of flood hazard. At a policy level flood prediction can assist in the efficient allocation of funds for construction and maintenance of defences or flood warnings. Property stakeholders will use hazard estimates to decide on the siting of property and their plans with regard to flood management. More crucially, during a flood event, accurate predictions of the likely peak level of flooding can minimise loss to property and life. However as described below, in many cases the estimation is problematic and forecasting lacks the certainty or detail needed by decision makers.

2.5.1 Flood measurement

Flood height markers are a familiar sight; fluvial floods are often described according to their height above normal river levels. For example: a history of Shrewsbury floods shows that the 2000 flood event was the worst since 1946 at 5.25 metres above normal levels according to the gauge board at the Welsh Bridge (Shropshire County Council, 2004). Measurement of the flood peak can be achieved by examination of tidemarks on these gauge boards.

The weather systems which cause flooding are also carefully recorded, radar and satellite imagery, rain gauges and so on track the weather routinely for the Meteorological office. For example: detailed records of the weather events leading up to the catastrophic flooding of Boscastle in 2004 are explained in Doe (2004). Flow within rivers is also measured routinely and is used in flood forecasting as described below. Hydrological records of flooding for the UK are held in the National Water Archive hosted by the Centre for Ecology and Hydrology (CEH Wallingford, 2006). However as noted by the Institute of Hydrology (1999) and described above there is a lot more to a flood event than the maximum peak at gaugeboards and flow within the normal river bed. The state of the catchment prior to flooding, the extent of flooding, velocity, level of contaminants and debris will all contribute to the level of damage inflicted by a flood. Records of these other aspects of flood events are less consistent than the records of heights, the level of effort expended probably depending to some extent on local agencies, the manpower available and the length of pre-warning. In the case of a major flood, priority is given to rescue and mitigation activities rather than recording.

Tidemark evidence, verbal accounts, analysis of damage and debris can all play a part in reconstructing the flood event (Doe, 2004). In recent years in England and Wales the Environment Agency has collected aerial photographic evidence of the extent of flooding. Details of historic flood events from textual sources are available from the Chronology of British Hydrological Events, hosted by the University of Dundee (Black and Law, 2004). The recording of flood history can therefore best be described as piecemeal.

2.5.2 Flood prediction

Prediction of flooding is necessary in order to plan for future flood defence strategies but also in real time to advise potential victims of likely severity. Real time models are vital for warning systems and can prompt floodplain residents to take avoiding action, preventing some losses. For a slow rising fluvial flood, warning systems can be very effective, although the balance between warning too frequently and not warning enough can be difficult to manage. For the purposes of this research, however, it is the long term modelling of future flooding rather than the real time modelling of floods as they happen that is of most interest. These are more likely to affect a long term decision such as a house purchase.

Much of the flood estimation and subsequent prediction carried out in the UK has been based on the 1999 flood estimation handbook (Institute of Hydrology, 1999). The large volume of data necessary for reliable flood frequency estimation is made very apparent within this publication. Methods for using data from one site to estimate returns on a different site are necessary because of the paucity of data available. This collection of best knowledge and practice has since been modified and improved upon by subsequent authors.

Common currency among flood frequency prediction is the notion of returns rates. Return rates for a flood event refer to the average long term interval between floods of a particular magnitude. For example a 1 in 100 year flood has a 1 percent chance of occurring in any one year. The construction of a return period for an event can lead to confusion however especially if practitioners from different disciplines study the same flood. Doe (2004) describes the autumn 2004 Boscastle event as having three possible return cycles depending on which type of analysis is used. The short run of reliable flood measurements relative to the return period of a serious flood means that accurate return period assessment can be problematic. To this end much research into the reconstruction of historic events has been directed (Black and Law, 2004).

An additional complication to the prediction of future flooding is the uncertainty of future predictions of weather systems. Stationarity of climate conditions is an inherent assumption in models using historical flow records to predict the future (Werrity et al., 2002, Green and Penning-Rowsell, 2004). As discussed above, climate change is expected to impact upon future flooding as rainfall events are predicted to become more intense. The use of historic records to generate return periods cannot easily take this anticipated change in weather patterns into account. As rainfall intensifies 1 in 50 return period floods may become 1 in 25 year events.

A detailed analysis of alternative flood prediction methodologies is beyond the scope of this thesis. Wheater (2002) covers the various types of model and their strengths and shortcomings. However it is instructive to examine the accuracy and precision capabilities of commonly used models for the UK. Reed (2002) concludes that flood frequency estimation is an uncertain business which must be reinforced with the judgement of the practitioner. In the UK flood frequency predictions are generally based on event analysis which require gross simplification (Wheater, 2002). Detailed measurement of catchment and flood areas are not required and therefore predictions are not detailed enough to predict flood risk for individual properties.

Fleming (2001b) outlines many areas of improvement needed for the realistic projection of flood forecasting. In particular the over-reliance of statistical analysis of past events rather than hydro-dynamic modelling of river catchments is highlighted. Bradbrook et al (2005) points out the prohibitive cost of widespread river catchment modelling.

2.5.3 Floodplain mapping

Mapping of the floodplain is the practical outcome of flood frequency prediction which is most relevant to property stakeholders. Typically the floodplain will be divided into broad risk categories based on the expected return rate of a flood affecting that area. Property owners, developers, lenders and insurers can establish the risk to their investments or make decisions about the areas in which they will live. A major recent development in the UK has been the publication of indicative floodplain maps by the Environment Agency (2006a) on the internet. A massive project was undertaken to make the maps more consistent and reliable. A new digital elevation map was generated and new software was employed to automate the flood estimation procedures used in the past (Bradbrook et al., 2005). Inevitably some smoothing and simplifying assumptions are involved in gaining consistent estimates on a national scale (Bradbrook et al., 2005).

Public access to the best available information about flood risk could have far reaching implications for the behaviour of floodplain residents or potential floodplain residents. However the use of this information for individual properties is not recommended by the Environment Agency, who suggest contacting the agency to get a full picture of individual flood risk. In addition the maps only cover coastal and fluvial flooding which can lead to false complacency if residents ignore the risk of pluvial and other flooding. For example it is estimated that 30-50% of flood insurance claims after the autumn 2000 floods were from properties outside any floodplain (Crichton, 2005).

The reputation of the maps among floodplain residents and the insurance industry is that they are not accurate enough to determine risk (Munich Re, 2004a). Norwich Union commissioned their own land survey in an effort to improve on the Environment Agency estimates (Munich Re, 2004a). However data on flood defence positions has not been made available from the Environment Agency and so the majority of insurers use Environment Agency risk categories along with their own records to determine premium (Crichton, 2005). Green and Penning-Rowsell (2004) warn against using the Environment Agency floodplain maps for insurance purposes because there are so few catchments where reliable estimation can be made, particularly where there is most interest in their accuracy namely urban catchments.

2.5.4 Prediction of flood impact

Separate from the prediction of flood extent and velocity is the further step of estimating the impact of the flood on the built environment. Top level estimates of the number of properties within the ambit of a given flood flow are useful in determining priorities for flood defence spending. In the UK, output from the Environment Agency flood models are combined with census data and commercial databases of the location of property (Evans et al., 2004). Economic damage is then estimated from depth damage functions produced by Penning-Rowsell et al (2005). These damage curves estimate the economic loss defined as the value of goods lost. These kinds of estimates may well underestimate the insurance burden of flooding because they do not include all costs covered by UK insurance policies. Black et al (1999a) has used insurance records to estimate equivalent damage curves for the financial impact on insurance companies.

Research in this area is moving away from simple depth damage curves towards more complex functions incorporating flow velocity and contaminants (Thieken et al., 2006) as discussed in section 2.4 or to better understanding of the affected built up area and the flows within it (Flood risk management research consortium, 2007). Other areas of sophistication could include the type of properties, construction type and any resilient features of the properties. As an example: the current global estimation techniques cannot distinguish between a house with raised construction and one without because floor levels are not recorded on a routine basis. The difference in cost between a raised property and a standard one would usually be quite substantial.

In a similar way to the forecasts of flooding these forecasts of the impact of flooding are based on statistical averages, not suitable for use in estimating costs for a particular property at risk. An individual will have knowledge about the construction, type and contents of their own home. To construct an estimate of likely flood damage, however they would also need to be able to judge the likely depth of flooding. Environment Agency indicative flood maps do not give this information. An individual property owner might require a professional impact survey to gain a realistic view of future expected damage costs. This lack of quality in public information will naturally have an impact on public perception of risk as discussed in the following section.

2.6 PUBLIC PERCEPTION OF RISK

In order to take action in respect of flood risk whether in purchasing flood insurance or deciding against investing in the floodplain it is necessary for an individual to perceive a risk. How the floodplain population is alerted to the risk of flood, how much they trust that information and how concerned they become about the risk should have an impact on the way they behave. Awareness of risk is the first step towards risk avoidance. The individual may then seek out further information about the risk and use that knowledge together with underlying personal biases to form a perception of the danger to themselves and their property. This will of course vary from individual to individual (Grothmann and Reusswig, 2006). Public perception of risk has been shown to be a complicated matter, not necessarily predictable from experts' assessment of risk or affected by new evidence which contradicts their pre-conceptions (Slovic, 1987, Barnett and Breakwell, 2001, Brilly and Polic, 2005).

2.6.1 Awareness of risk

The ways in which awareness and preparedness can be raised among at-risk populations has been much debated in recent years in the UK (Bye and Horner, 1998, BMRB, 2002, Richardson et al., 2003) as an important part of putting into place adequate public information campaigns and warning systems. The results of surveys of both flooded and "at-risk" populations reveals that there is complacency among floodplain residents. Awareness of flood risk was included in the evaluation of the intangible costs of flooding (EA/DEFRA, 2005). The report was based on a survey of properties in locations flooded in 1998 and 2000. Only 24% of residents were aware of the risk of flooding before the recent events but awareness post flood had risen, just three years later when 86% were aware of the risk. In 2002 the Environment Agency research into the effectiveness of flood awareness campaigns among residents at risk of flood (but not necessarily recently flooded) found that 95% agreed that flooding is a serious issue but only 45% thought it affected them (BMRB, 2002).

It is worth considering in which ways the floodplain population become aware of the risk of flood to their property. For potential purchasers in the UK there is currently no regulation which forces the disclosure of flood risk information (Building Flood Research Group (BFRG), 2004). Common sense may indicate the advisability of a flood risk assessment if the property is located next to a watercourse but many properties at risk of flood are not so situated. Discovery will be by chance, local knowledge or due to the thoroughness of their conveyancing professionals or possibly through insurance problems.

Once resident the householder may become subject to the Environment Agency awareness campaign. Word of mouth, local knowledge and media campaigns will play a part. The home owner may have problems getting insurance due to flood risk. Alternatively the resident may remain in ignorance until they become the victim of a flood. For Example, in 1998 very many flood victims were completely surprised by the flood in Bewdley (BBC, 1998).

2.6.2 Sources of information

Once aware of flood risk the most obvious source for information about the nature and extent of that risk is the Environment Agency. An individual letter detailing the risk to property is available from the agency at a price. The agency will also give a risk category and place a resident on the flood warning register. For some catchments quite detailed surveys are available, for others information is more sketchy.

When asked about which organisations provide information about flooding 20% mentioned the Environment Agency (BMRB, 2002) while 29% mentioned local council/local authority. Local media are cited as the primary warning mechanism in the event of a flood.

Unless the individual is very determined and willing to search local archives or willing to fund a professional survey, the most reliable source of alternative information is word of mouth from local residents (Thrush et al., 2005). This will be particularly true in areas frequently flooded where the floodplain residents will have a good idea about depth of flooding and local topography (Richardson et al., 2003).

2.6.3 Perception of risk

Given the same information, however, the interpretation of risk by individuals will vary widely (Barnett and Breakwell, 2001). Clark et al (2002) point out the ability of floodplain residents to completely ignore the risk of flood. Bruen and Gebre (2001) cite many examples of floodplain residents being surprised by flooding and blaming mis-management of rivers, reservoirs and locks for floods which are, in fact, due to unprecedented weather systems.

Conceptualising risk can be difficult for the lay population. For the UK, Richardson et al (2003) describes a program of research including case studies and surveys to investigate the link between flood awareness, communication and perception of risk.

They conclude that the use of the language of probability can be a confusing factor. Return rates are often taken to mean that there will be a specified length of time between each flood. People also focus on frequency of the event rather than the potential harm a flood could cause. An additional outcome of the research programme is the division of at-risk resident by flood experience and attitude to flooding ranging from the unaware to the fully aware but unconcerned. They recommended the use of comparisons with other risks for example the risk of fire in order to contextualise the probability information.

The construction of flood defences can give false confidence to residents (Bollens et al., 1981, Pynn and Ljung, 1999) given that the designed defence can be lower than historic high flood levels. When defences are overtopped by events outside the designed protection they are perceived to have failed (Bruen and Gebre, 2001). It is very important to remember that once defences are breached or overtopped the water will revert to its natural pathways and may recede more slowly than before.

People underestimate the damage a flood will do if they have not experienced one (Pynn and Ljung, 1999, Bruen and Gebre, 2001). The fact that many domestic insurance claimants prove to be underinsured (Hiscox, 2006) demonstrates that they may not have a good feel for the cost of replacing their possessions.

2.7 ACTION OF PROPERTY OWNERS IN THE PRESENCE OF FLOOD RISK

Given the recent flood history in the UK and worldwide with significant media attention one might anticipate a behavioural change in those resident in the floodplain. The hypothesis underlying the current research is that there may be an impact on the price of domestic property but this is not proven within the UK. The evidence available about actions of floodplain residents points both ways with contentment shown by some floodplain residents whilst others, particularly in the immediate aftermath of flooding are moved to take collective action. Property owners are rightly concerned about the disruption and stress caused by flooding (EA/DEFRA, 2005) but also have financial concerns about reinstatement costs, increased insurance premiums and loss of property value (Welsh Consumer Council, 1992, Samwinga et al., 2004).

2.7.1 Propensity to insure

Where flood insurance is available as a separate policy or an option, the propensity to buy flood insurance can be seen as a willingness to offset flood risk (Ehrlich and Becker, 1972, Macdonald et al., 1987) and by extension an expression of the acceptance that flood risk exists. The picture is not straightforward however, good understanding of the local insurance market is necessary in interpretation of coverage levels. Insurance regimes vary internationally as detailed in Gaschen (1998) affordability may deter purchase or alternatively insurance may be compulsory if purchase finance is required.

For example, in the US flood insurance is managed under the National Flood Insurance Program (NFIP) and insurance is mandatory for flood victims who have previously claimed disaster relief and also for those requiring government backed finance. Burby (2001) noted that several studies of flood insurance have estimated coverage of around 20%. He contrasts this with insurance against fire which is held by 95% of the population. A survey of North Dakota residents examined the reasons given for not purchasing insurance in advance of a recent flood. Half of respondents cited three factors as “very important” in their decision not to insure: conservative flood estimates, belief in dikes and flood control devices and belief that the flood would not damage the home. Even when obliged to purchase insurance in the wake of disaster relief payments, Shaw (2004) found that 41% do not purchase cover, principally because it is too expensive.

In Germany extended elementary all risks cover is included in only 3.5% of domestic insurance policies (Schwarze and Wagner, 2004). Availability of emergency relief and private donations are seen to weaken the incentive to insure and to implement preventative measures. In the area affected by the 2002 Elbe flood the figure was much higher. Prior to the flood 50% held insurance and after the flood this increased to 70% (Kreibich et al., 2005). Kreibich suggests this is due to the fact that the former East German householders had flood insurance bundled into their normal policy.

In the UK, however, flood insurance is bundled into standard household policies implying that people are insured against flood by default if they are insured at all. Emergency flood relief in the UK is difficult to obtain since the government has a policy of not providing funds centrally. Insurance coverage is high in the UK, those who are uninsured tend to express a desire to have insurance but are prevented by low incomes (Joseph Rowntree Foundation, 1998). Figures are not available to compare the propensity of the floodplain population to insure versus the rest of the population nor is it clear whether floodplain residents are, in general, willing to accept flood exclusions from their policy in order to reduce premium costs. However, a British Market Research Bureau (BMRB) survey of property at risk of flooding (BMRB, 2006) revealed that one third of people had not taken the trouble to discover whether their insurance policy covered flood risk.

2.7.2 Damage avoidance strategies

Avoidance of flooding or minimisation of damage due to flood is a sensible reaction to flood risk. Knowledge about flood hazard has no significant effect on damage reduction unless knowledge is translated into actions. Damage limitation can be achieved via permanent measures such as installing pumps, elevated construction, shielding with barriers, waterproof sealing and resilient furnishings (Kreibich et al., 2005). Temporary measures can also be employed in cases where sufficient warnings are likely such as removing belongings to safety and installing temporary barriers.

It has been shown through surveys however that such rational behaviour is not carried out by a majority of the floodplain population. From the Environment Agency awareness campaign survey (BMRB, 2002) 57% agree that they will take action to reduce the impact of flooding but only 5% actually do. BMRB (2006) found that only 26% were even aware of the warning systems. EA latest estimates are that only 20% of at risk residents are on their flood warning database.

The EA/DEFRA survey (EA/DEFRA, 2005) found that flood protection measures taken by respondents who had been flooded included keeping alert for flood warnings

(50%), keeping irreplaceable items above the flood level (36%), keeping sandbags (25%), provision of flood guards/door boards (10%) and building walls or purchasing pumps (8%) spending on average £1,750. At risk residents who had not flooded were less likely to have taken flood protection measures.

In Germany the survey undertaken following the devastating Elbe flood in 2002 (Kreibich et al., 2005) revealed that belief in preventative measures actually declined following the flood. Perhaps this could be in part due to the destructive nature of the inundation, velocity and depth were so great that many normally effective measures would have failed to protect property. After the flood only 20% of households purchased water barriers. Forty percent had some kind of adapted interior fitting.

In the US Burby (2001) noted that less than 15% of property owners have actually taken action to improve their property in advance of flooding. In Canada, Babcock and Mitchell (1980) surveyed property owners in Cambridge, Ontario. They found that few people had done anything to reduce damage potential from flooding. Most of the evidence in the UK points to the fact that residents in the floodplain look to the Government as the prime force in controlling the risk of flooding and insurers to pick up the damage bill. Only those at risk of frequent flooding have the experience and knowledge to own the problem themselves.

2.7.3 Demands on government

After the 2000 flood event there was a groundswell of local action groups. These groups can form a very helpful advice function and can liaise with government and other bodies on behalf of flood victims in a coordinated way. A national body was set up, the National Flood Forum (NFF), to coordinate these flood groups (National Flood Forum (NFF), 2006). This enabled pressure from flood victims to be focussed and demands for increased flood defence spending ensued.

Within this forum a widespread perception appears to be that it is, ultimately, the role of Government to deal with the risk of flood. Engineered flood defences appear to be the preferred option (Gough, 2000, Bruen and Gebre, 2001). The reduction of flood risk by hard defences is, as discussed earlier, less popular with Government in the long term. In the short term, in the aftermath of the 2000 event, pressure from media, flood action groups and insurers led to increased flood defence spending. It may prove to be the case that this increase is unsustainable due to competing priorities in government spending. For example in August 2006 flood defence spending cuts were announced to roars of protest from the insurers (Dey, 2006) and the National Flood Forum.

2.7.4 Buying and selling in the floodplain

Long term attitudes about the sustainability of floodplain property can be expressed by the tendency to inhabit floodplain property. A real concern for residents is that the value of their property will be negatively affected by flood risk. The mechanism for discounting is not always clear however. One might expect that on the supply side, desire to vacate the floodplain would lead to an oversupply of property in the flood plain area. Low demand for this property might then lead to price discounting behaviour. On the other hand a rational buyer may be perfectly willing to buy in the floodplain subject to a discount that he considers appropriate to offset the risk of flood. The theoretical perspective is covered in detail in chapter 3.

Evidence to back up these theoretical positions is sketchy: A survey of Lewes residents (Puvacharoen, 2003) found that despite high awareness of flood risk and no plans to further defend the areas at risk, 91% of respondents were satisfied with their area of residence. Less than half of flood victims would even consider moving to an area with a lower risk of flood. Vulnerability surveys of previously flooded households reported in Green et al (1994) showed that while stress was experienced by some flood victims the population is remarkably resilient. Forty-five percent reported that they hardly worry abut future flooding, only 22% had spent money to stop water entering the property and only 17% of residents said when asked that they would move if they could. Babcock and Mitchell (1980) in Ontario, Canada studied both the actual and perceived differences in price between flood-prone and flood-free property. None of the residents mentioned flood risk as a factor when asked about influences on the selling price of their property. In Germany, moving to a safe area to avoid flooding was the least considered option in damage avoidance (5% of residents considering it).

Contradicting this positive picture is the fact that some empirical studies of the prices realised by floodplain properties reveal that discounting can happen. Many surveyors and investors believe that flooding can have a impact on value in the UK (Building Flood Research Group (BFRG), 2004, Eves, 2004, Kenney et al., 2006). Salthouse (2002) refers to large discounts suffered by flooded and designated at-risk properties and media attention on the likely impact of flooding on property could be a self-fulfilling prophecy. Following the 2000 floods, focus groups of new residents in two flooded locations were formed (Thrush et al., 2005). In Woking residents were angry that their property searches had not revealed flood risk and they felt that they would have chosen not to buy in that area had they known. New residents in Bewdley had some knowledge of flood risk but had not expected to be severely affected.

2.8 SUMMARY

This chapter summarises some of the copious literature on flooding events and flood risk globally and especially in the UK. Different types of flooding have been described and the particular flooding relevant to the current study defined. This study will deal principally with domestic properties at risk from fluvial flooding within the UK.

It has been shown in section 2.3 that the risk of flooding within the UK has increased in the past decade and that the scale of financial impact is potentially huge. The risk is forecast to continue to rise, not only due to climate change but also due to planned development and to lifestyle changes.

The impact of flooding within the built environment has been explored, three main types of loss are described, direct, indirect and intangible losses. These are all of concern to researchers and a brief summary of research into these impacts has been presented. The demonstrated gaps in the current understanding of flood impacts and the best way to reduce them may have implications for the behaviour of property stakeholders.

The scientific measurement and prediction of flooding within the UK is described in section 2.5. The research in this area has been driven mainly by the need to make decisions at a national and regional scale about flood defence spending. As a consequence there is a lack of the detail necessary for making good decisions about flood risk for a particular property. This also has implications for the researcher in estimating features of the at-risk population. In essence this population remains unknown.

Finally this chapter deals with the awareness of flood risk, perception of that risk and subsequent behaviour of the floodplain resident. This is a central concept for the intended research. It can be seen that previous literature advances inconsistent evidence that therefore cannot predict the behaviour of the floodplain resident in respect of property transactions. Existing studies produce conflicting evidence of the ability of floodplain populations to ignore flood risk set against empirical data which shows discounts experienced by sellers in the floodplain. The following chapter examines the economic theory underlying possible discounting behaviour in greater depth.

Chapter 3 : THEORETICAL MODELS OF HOUSE PRICES

3.1 INTRODUCTION

The central aim of this research is to investigate the impact of flooding on the value of UK residential property. For the purposes of this thesis the primary measurement of property value employed will be the transacted price because in a competitive market economy price is the most common and accessible expression of inherent value. A consideration of price theory, the underlying economic theory behind market pricing is therefore germane to the research. To understand the way in which aversion to flood risk could potentially be expressed through housing price it is necessary to understand both the theoretical value implications of flooding and the practical mechanism by which this value impact could be expressed in the market price. The specific market in this instance is the residential property market for England and Wales. In line with the underlying research philosophy of an empirical evidence based approach, the quantification of the potential impact of flooding will require the use of a statistical estimation methodology. To that end an appreciation of the merits of widely used modelling methodologies in estimating potential discount due to flood risk will be critical.

This chapter therefore addresses price theory as it relates to housing and the valuation of disamenities in section 3.2. The current market for housing in England and Wales is covered in section 3.3. The heterogenous nature of the housing product is then considered in section 3.4 and sections 3.5-3.8 describe ways in which the heteregenous housing product can be dissected into its component parts. In keeping with the pragmatic approach of this investigation, different approaches will be considered which have been commonly used in the literature relating to valuation of environmental amenities. In section 3.9 the strengths and weaknesses of the approaches are discussed.

3.2 PRICE THEORY RELATING TO HOUSING

The theory of house price movements falls into both the fields of macro and micro economics (Bourne, 1981). Macro economics deals with the actions of supply, demand and pricing at a national or international level and considers the action of governments and global organisations such as banks in influencing the way in which large populations behave. This theory explains the growth or decline in national house prices against the cost of borrowing, supply of housing and national demographics. Microeconomic theory or price theory is more useful in explaining the choices individuals make in choosing one property against an alternative given the constraints of income, travel options and family needs. It is within this second sphere of understanding that the present study mostly fits. The supply of new housing at risk of flooding is a macroeconomic matter dependent upon the supply of land appropriate for residential development at a national level and the funds available for installing and maintaining community flood management. However the price of new and existing floodplain property relative to property not on a floodplain is driven by the individual purchase decisions of house buyers and their unique assessment of the relative amenities and disamenities of living on a floodplain. This study will be comparative, examining prices within local housing markets rather than attempting to predict the movement of the housing market as a whole. The results of this study, however, could be used in a macroeconomic sense in predicting the impact of government action for example flood defences on local wealth. Therefore the relevant theory for application in the current investigation is price theory as propounded most notably by Friedman (1976).

At its most fundamental level price theory is the study of the economic problem of the allocation of scarce resources among competing interests (Watson and Getz, 1981). Price theory predicts that individuals or organisations will act in their own best interests in maximising benefits to themselves according to their perception of costs and benefits. The price of a good or service is a proxy for the value or utility of that good or service to an individual, organisation or government. The price placed upon a good or service can therefore give information about the value of a good and can induce changes in behaviour when the value of one good or service varies in respect of an alternative. Price theory can be normative in predicting what should happen when supply or demand for a good changes or it can be positive, that is it can interpret changes in prices and the supply and demand and explain the link between them. Price theory can be expressed in the form of economic models which present a simplified version of the complex relationships which accompany any economic activity and predict movements in one aspect of interest based upon movements in another. Increasingly economists are expressing price models in forms which can be tested via statistical analysis of real life data thereby testing the power of the theory to predict market movements.

An underlying concept in price theory and price models is the rational behaviour of individuals and organisations in evaluating the alternative options open to them and acting accordingly. The consumer evaluates the utility or want-satisfying power of a commodity and chooses the option with maximum utility. This assumption is both a strength and a weakness for price theory, the strength lies in the ability to build consistent models of behaviour. The weakness lies in the truth or otherwise of the assumption. Modern psychology predicts that consumers do not behave in a rational manner and yet models based upon this assumption can often predict markets behaviour very well (Watson and Getz, 1981) and be simple and elegant. Why this should be so is a vexed question and beyond the scope of this thesis, presumably, where the models predict well, sufficient numbers of individuals behave in a manner which looks rational, perhaps due to convention and usage, to make the models work for practical purposes. The pragmatic stance adopted herein is to build the model on the assumption of rational behaviour and to test the models with data. After all, one role of the statistical estimation of various parameters of theoretical price models is to subject the simplification to evidence and assess how well the theory predicts reality.

Other simplifying assumptions, not necessarily central to price theory but often used in economic models of markets as though they were, are the notions of perfect competition with complete information. In a perfectly competitive market transaction costs are assumed to be zero, all parties have instant access to the information they need to make an accurate assessment about value. In this ideal scenario with willing buyers and sellers, price and value can be regarded as the same but in practice there are no property markets where this is the case. The following section considers the residential property market in England and Wales and it can be seen that the operation of the property transfer impedes the action of competition.

The above riders notwithstanding, economic theory would predict that a possible discount of the price of residential property due to floodplain location might accrue from multiple sources stemming from the multiple impacts of flooding on property described in section 2.4. Four principal sources are listed below:

1. Primary flood damage will reduce the habitable living space making the property less desirable to live in. The discount a rational consumer will apply for this would be the expected cost to them of restoring the property to pre flood condition over the lifetime of their ownership. This cost could simply be the actual cost of restoration but where insurance or aid is available cost to the homeowner could be less or even more than actual restoration cost.

2. A prospective buyer may consider discounting for evacuation costs in the expectation that they may have to relocate whilst repairs are made. A rational discount will include the tangible expenses of relocation and extra travel expenses. It could also include the less tangible elements of the disruption of the house as a primary social space giving access to convenient schooling and leisure activities.

3. Emotional wellbeing can suffer in the event of a flood. Health risks, stress impacts, loss of irreplaceable items due to flooding or the fear of flooding constitute a further disutility of floodplain living. The value homeowners place on these quality of life attributes could also lead to discount in floodplain property.

4. Long term investment and financial security is a very serious issue in the purchase of homes. For many UK residents the home is the most significant financial investment they will ever make. Many homeowners anticipate that their property will appreciate in value allowing them to either move up the property ladder or realise capital for other ends for example retirement income. The expected long term return on investment and short term borrowing power may be seen to be reduced by the impact of climate change. Buyers may place a discount on the value of floodplain homes due to this perceived investment weakness.

In the UK, as discussed extensively in chapter 2, the lay person can hardly be expected to evaluate any of these costs: experts struggle to do so. Anticipated damage depends on expected flood frequency, expected flood depth, structural property details, reliability of flood warnings and so on. Large uncertainties surround the estimates of many of these factors. Cost of disruption will be highly dependent on the individual and their lifestyle and vulnerability and preparedness. Even the cost of insurance is difficult to determine and subject to change. The less tangible elements such as health impacts and long term investment potential require highly subjective judgements which will vary widely across potential purchasers. A normative estimate of the expected discount in residential property price due to flood risk would be difficult to estimate and would have very large uncertainty bounds due to the uncertainty and imprecision surrounding direct damage estimates and the subjective nature of the other factors.

It is therefore important to employ another advantage of the statistical estimation of parameters of price models that is to establish the average market valuation of an amenity which cannot be predicted from theory. This function is particularly important when the amenity has a large emotional or intangible element such as aesthetic appeal or status reinforcement rather than tangible elements such as number of fireplaces or presence of heating. The risk of flooding, it has been demonstrated above, falls within this category of attributes and therefore the empirical approach adopted within this thesis can be seen to be appropriate for the task.

3.3 THE HOUSING MARKET WITHIN ENGLAND AND WALES

Within the UK, property ownership is aspired to by the majority (Doling, 2006). Much has been written about the growth in the percentage of UK residents who own their own property over the 1980s partly due to the right to buy policy enabling council tenants to buy their homes (Shapiro, 2000, Bramley et al., 2004, Doling, 2006). The Barker review (Barker, 2004) concluded that pressures on the housing market in the ten years preceeding the report were due to the increase in the number of households and an under supply of new housing have resulted in an upward trend in house prices. To improve the housing market in England Barker (2004) estimated an extra 120,000 new homes per annum, over and above the expected rate of construction, would be required, almost double the expected level of increase. The tendency of mortgage lenders to increase the multiples of income available to borrowers has also lent fuel to this uplift. The official Land Registry price index for the period under study as shown in Figure 3-1 reveals that prices have more than doubled over the past seven years. Researchers have argued that the price surges originate in the South East and feed through into the rest of the country in a ripple effect (Alexander and Barrow, 1994, Cook, 2003). House price growth is seen to differ between regions and even within them (Wilson et al., 2002, Fleming and Nellis, 2003) .

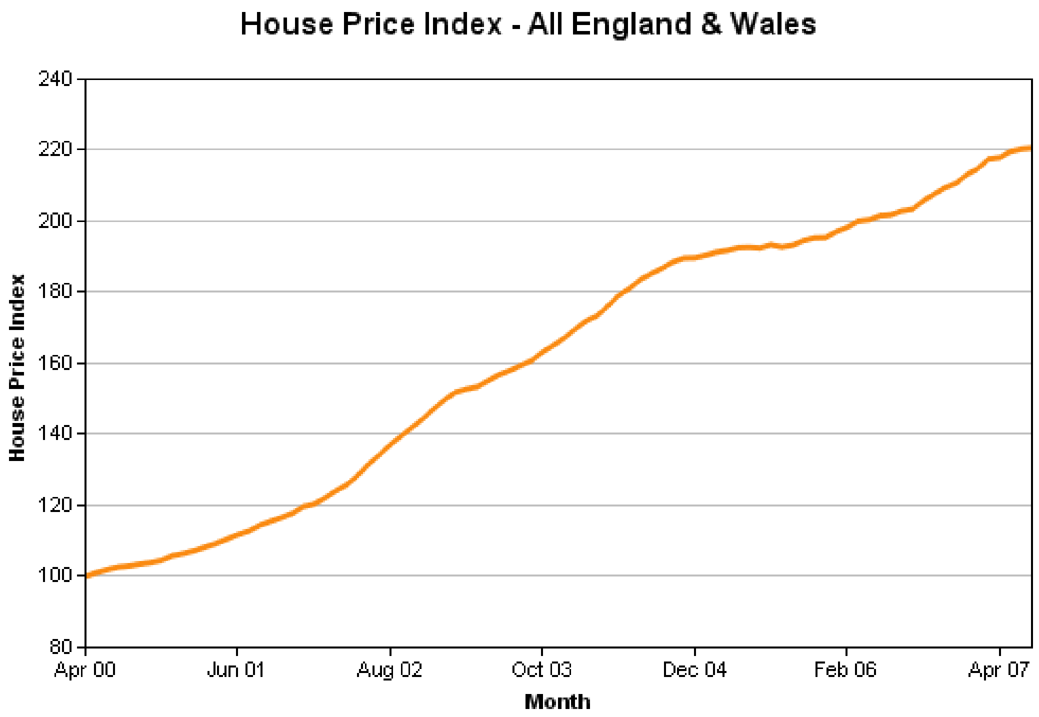


Figure 3-1 : Land registry price index (source Land Registry (2007))

Property may be sold as leasehold or freehold, most houses are sold freehold whereas flats are sold leasehold or commonhold (Communities and local government, 2007). Leases are usually set for 99 or 125 years and tenants have the right under the 1967 leasehold reform act and the commonhold and leasehold reform act 2002 to have their lease extended or to purchase the freehold under most circumstances, thus a short remaining term does not necessarily imply that a property will become unsaleable. Many leases may have a peppercorn rent but oblige the tenants to contribute towards the maintenance of common areas. Rights and responsibilities associated with a lease vary enormously (ODPM, 2007), therefore without detailed knowledge of the conditions of any lease it is not possible to value the freehold or assess impact upon the value of the property.

UK housing stock is very varied ranging from historic timber framed housing through brick and stone to modern modular construction. Properties subject to flood risk will fall into all categories of construction and age bands. Owning a second hand property is not generally seen as second rate although new properties which are sold with fixtures and fittings may suffer a discount on first reselling when those fixtures may not be included or may be devalued by age. Older properties are often subject to renovation whereby the condition of the property is raised nearer to modern standards so that the functional age may be different to the chronological age. For some buyers 'character' properties may command a premium price (Shapiro, 2000).

The purchasing process itself differs across the countries of the UK. Within England and Wales properties are advertised for sale by the vendor, or the vendor's agent, with an asking price and offers are invited. A vendor will accept one of the available offers, not necessarily the highest, and then the conveyancing process ensues. The buyer conducts searches and surveys and may then renegotiate the price, place conditions on the sale or withdraw their offer in the light of new information for example the presence of structural problems (Shapiro, 2000). At this point finance is usually arranged most often via a mortgage secured on the property. The lender therefore may also have information demands to ensure the security of their investment. This gathering of information is costly for the potential buyer, usually a solicitor is employed and the searches have a fixed cost associated with them, these costs cannot be recovered if the sale falls through. The mortgage lender will usually require the purchaser to insure the fabric of their new property and will often provide cover as part of the mortgage deal.

Critical to the potential discount in property price due to flood risk is the awareness of flood risk at time of purchase. Flood risk may be discovered at various stages during the process or not at all. Local knowledge, questioning of the vendor or agent or searching on the Environment Agency website may raise awareness before offers are made. At the moment a flood risk assessment may be requested at the search stage but is not a standard or compulsory search. If the buyer or their legal representative is not alert to the risks then the lender or the insurer may raise the issue. The percent of property owners alerted at various phases is unknown.

At the point of writing this system is changing with the introduction of seller's packs. These packs were designed in an attempt to shorten the conveyancing process, although experts disagree about whether they will achieve this aim, by providing more information in advance of offers and there has been a great deal of debate about the inclusion of flood risk information in these packs. This new system shifts some of the expense of information onto the seller and may affect the future relationship between the parties. At this point it is sufficient to note that there may be implications from any decision to introduce statutory disclosure of flood risk. These implications will be explored further in later chapters. None of the empirical data utilised involves seller's packs.

The process of price negotiation in the majority of residential property transfers in the UK involves more parties than the buyer and seller, usually there is involvement of a property agent, an independent surveyor and a lending institution. The relationship between the initial asking price, offer price and final contractual price is not clear and cannot be assumed to be consistent across property types or across sellers. Studies into the negotiation process are rare, since the necessary information is not collected by the majority of agents. One such study by Merlo and Ortalo-Magne (2004) based on the English property market observed that 1 in 5 sales fall through, the average time on the market is 11 weeks to offer and that the fall through of a sale does not usually result in a seller having to accept a lower price. Length of time on the market however was seen to have a bearing on final sales price relative to listing price. The experience of the agent in valuing similar properties will have a great bearing on the accuracy of their assessment of price. However, the agent could also be seen as a market maker in some senses, their opinion swaying the consumer's valuation of a property. In particular a property agent could be seen as an expert in the assessment of future potential for area or property improvement. Conversely, if an agent took the view that a particular risk, such as the risk of flooding, should depress property prices then his discounted valuation could become a self fulfilling prophecy or might result in floodplain property being kept off the market due to a perceived difficulty in selling.

It can be deduced from the above summary of some key features of the housing market for England and Wales that many of the assumptions inherent in economic models of choice will be breached. In common with property markets worldwide there does not exist a condition of perfect competition with complete information. The three most important features of the market for property in England and Wales as regards this investigation are the information asymmetry, with buyers not always aware of the flood risk status of their potential purchase, the involvement of financing institutions which, it has been suggested, may refuse to lend on properties at risk of flood and the strong growth in house prices which has the potential to mask the impact of flooding on the price of property.

3.4 THE NATURE OF THE HOUSING PRODUCT

Housing is a complex product which encompasses much more than the bricks and mortar and the land upon which a house stands. For the property owner a house performs a multitude of functions, apart from the primary one of physical shelter. A house provides an emotional base, a place of safety, storage for one's most treasured possessions. Owning ones own property provides financial stability, collateral, a long term financial investment, loan security. Perhaps even more importantly the location or neighbourhood in which your dwelling place is located provides a social milieu and defines an individual as belonging to an income bracket, race or religion, "townie" or "ruralite", "city slicker" or provincial. There is a great deal of prejudice surrounding housing location and property size and type (Shapiro, 2000) which translates into housing value over and above the rational, measurable attributes such as physical size and accessibility to necessary services.

Bourne (1981) describes the unique attributes of the housing product as fixed location, durability, slowness in responding to market pressures, complexity and diversity, exogenous influences, policy overlay, spatial externalities. These attributes may make housing markets operate in unexpected ways as they limit the supply side of housing to a relatively fixed combination of housing units in the short term. The supply side of the housing market is relatively inelastic to house prices in the short term because the supply of housing available to purchase from existing stock at any one time is dependent upon many factors other than the price. Since few consumers have multiple properties the sale of an existing house usually implies buying or at least renting another house. There is a circular nature to supply and demand because there are few substitutes to buying a house that satisfy the attribute of providing a dwelling place. The supply of new housing to the market is a slow process involving the planning and construction of dwellings which is a heavily regulated activity.

The complexity of the housing product warrants further consideration and it is the unique characteristic of the housing product which receives the most attention in the literature. At the most simple level each residential property consists of a unique bundle of characteristics, structural, locational and neighbourhood/environmental which determine its suitability for a particular purchaser. Shapiro (2000) states that the principal factors for determining the value of a residential property with vacant possession are: location; accommodation; nature of the unit; state of repair, appearance and quality of finish; the quality and quantum of the fixtures and fittings; the potential of the neighbourhood for improvement and the potential for the property to be improved and modernised and the plot size. These general headings group specific attributes some of which will only be important for particular styles of dwelling or buyers. Table 3-1 below lists some attributes taken from the property advertisement pages of a local property paper (Shrewsbury Chronicle, 2007). This is not an exhaustive or definitive list but it illustrates the range of attributes. Descriptions always mention structural features and sometimes mention accessibility to services particularly schools. Language portraying neighbourhood desirability is often used, usually phrased in a positive manner, although some descriptions such as ‘convenient’ may been seen as code for location on a busy road. These attributes are used by potential purchasers to select a subset of properties to view and should therefore include the most details which, in the opinion of the property agent, are the most important for buyers.

Table 3-1 : Commonly listed housing attributes in the UK

Structural	Number of bedrooms Number of bathrooms/cloakrooms/En-suite bathrooms Number of receptions Dining kitchen/fitted kitchen/luxury kitchen Utility room Entrance hall Type (semi, flat, detached, terrace, townhouse, attached, barn, bungalow) Ground floor/first floor/penthouse (of flat) Number of storeys Cellar/basement Garage/driveway/off-street parking/ allocated spaces conservatory Garden/Landscaped gardens/courtyard Grounds Outbuildings Fitted kitchen Central heating Double glazing Fishing and Mooring rights Spacious/ample/large Improved/extended Well maintained/immaculate/in need of modernisation/ development opportunity Modern/recently built/character/mature/period features No chain
Locational	Close to town centre/walking distance to town centre/central location Close to schools Close to amenities Close to bypass /easy access to motorway/access to transport links Easy commute to Adjacent park/ conservation area Riverside location Village location Good position Wonderful views
Environmental	Sought after area Highly desirable Prime location Popular location Convenient location Enviable location Cul-de-sac Small development Country home Wonderful setting Popular development Charming/Pretty/picturesque village Warden controlled/retirement community Gated community Quiet location Quiet rural location Private road

source(Shrewsbury Chronicle, 2007)

When modelling the price of housing there is a natural inclination to include all of these attributes which seem important to selling agents but of course some simplification is necessary to reduce the attributes to measurable variables. In chapter 4 and chapter 6 there will follow further discussion of the attributes used in previous studies of property value in the UK and elsewhere and the level of success in measuring them.

Final decisions to purchase, however, are based not only on listed attributes but upon many other considerations, some objectively quantifiable and others not. Housing is a classically differentiated good. In practice potential purchasers seek to maximise the utility of a property within a given budget and make compromises on the various features of a property such as size, age, condition to meet their specific, but not always explicitly specified, requirements.

The heterogeneous nature of housing is a major stumbling block in the application of classical price theory. One might attempt to segment the housing market in order to reduce the variability between types and quality of dwellings, but two issues render segmentation problematic. First a housing unit is ultimately unique at the very least in its physical location. Even within a modern housing estate with a limited pattern of houses to choose from or a terrace of ostensibly similar property, each property must nevertheless have a unique location. In most cases this may not change the value much, but in some instances, particularly when locational disamenities are the focus of study, locational factors may be crucial. Second even if groups of similar enough properties could be found and location controlled for, buyers do not segment the market in such rigid ways. While some buyers may be very specific or clinical in their specifications of physical characteristics, most will consider a broad range of equivalent options which will achieve their lifestyle requirements.

Because of these difficulties the use of models which focus on housing as a collection of attributes rather than as a housing unit has dominated housing literature for the past thirty years. The most common of these is the hedonic model described below which uses price data for large numbers of property attribute bundles to reveal the marginal price of each attribute. Other ways of valuing elements of housing are the experimental method, repeat sales and the contingent valuation method and are also described below.

3.5 HEDONIC MODELS

Price theory can be used to estimate the absolute demand for a given good or service dependent upon the price of that good. It can be extended to operate in competitive markets where consumers can choose to purchase one of a selection of equivalent goods or services dependent upon their relative prices and suppliers will provide a given quantity of the good or service in return for achieving the market price. Unfortunately for market analysts, in the field of consumer choice theory, perfect competition, the substitution of freely available equivalent goods dependent upon price, rarely exists. Competing products are rarely exactly equivalent or homogeneous except where they are commodities such as electricity. In most consumer markets companies will seek to differentiate their product in order to add value (even in commodity markets the notion of customer service can be used to differentiate suppliers). An extension of demand theory due to Lancaster (Watson and Getz, 1981) extends the notion of substituting products to the idea of substituting attributes. The consumption of a good or service contributes many attributes which may also be contributed by other goods or services not normally considered a direct substitute (Watson and Getz, 1981). One example of this might be the attribute of physical warmth which may be achieved by purchasing shelter, improving the insulation of already existing shelter, consumption of calories, physical activity, burning of fuel or donning of warm clothing. These purchases would not normally be considered related unless their common attribute, warmth generation, was identified. The analysis of the utility of a good or service may be improved by taking account of underlying attributes and the demand for these attributes over the consideration of the demand for a product. When a good is viewed as a bundle of these attributes, and if these attributes can be quantified, then its utility can be decomposed among the attributes by comparison with the demand for similar products whose bundle differs in some way. These competing products are known as heterogeneous because they have different levels of the underlying attributes. This is the basis for the theory of hedonic prices or implicit prices. Hedonic prices can often be derived normatively as for example the heat retaining attribute of double glazing could be valued as the cost of the electricity saved due to its installation. But some attributes can be more difficult to predict normatively and may require empirical analysis to extract them from the value of a good, an approach also known as revealed preference. Hedonic price theory has become dominant in the analysis of housing markets because housing is regarded as a classically differentiated product.

The hedonic model propounds that a differentiated good can be represented as a vector of attributes $(Z) = (Z_1, Z_2, \ldots Z_i, \ldots Z_n)$. Buyers (consumers) and sellers (producers) hold differing utility functions relating to the vector of attributes. At the point where the bid functions of the buyers willingness to pay for the vector of attributes and the offer function of the sellers acceptable minimum price meet the market clearing price function is determined.

$$P(Z)=P(Z_1,Z_2,\ldots Z_n).$$

Rosen (1974) specifies that the functional form for the price function is unknown but that it is unlikely to be linear over the whole range of attributes. Under assumptions of market equilibrium and structure the marginal implicit price (MIP) prices are the expression of economic benefit or loss for small changes in an attribute independent of the levels of other attributes. The MIP of an attribute can be estimated from the partial derivative of the price function with respect to that attribute.

$$MIP(Z_i) = \frac{\partial P(Z)}{\partial Z_i}$$

The marginal prices for a particular market may be estimated from observed prices and attributes drawn from the market. Some form of least squares regression is usually utilised with functional forms pre-specified. Non-parametric and assumption free estimations have also been applied.

Hedonic price models have been used within the housing market to quantify structural characteristics such as the number of bedrooms and presence or absence of a garden. Implicit prices for softer attributes have also been derived such as the proximity and ease of access to other goods and service. They have even been used to price the public good of providing amenities by examining changes in price on the provision of such goods. Hedonic models had been used for many years and in many markets before Rosen formalised the theory (Rosen, 1974). Initially it was utilised for mainly non-spatial goods of variable quality or attributes. Reference is usually made back to this seminal paper when hedonic studies of the housing market are carried out, but hedonic studies of the housing market preceded it, for example the Ridker and Henning study of air pollution (Ridker and Henning, 1967).

Rosen's paper is subtitled 'Product differentiation in pure competition' and, as discussed above, pure (or perfect) competition does not exist in the housing market. The paper also goes on to specify many conditions under which the theory is valid including notably that a state of equilibrium should exist. Housing markets are rarely in a state of equilibrium and in the current study where a large shock to the system (flooding) is hypothesised, this condition is likely to be breached. Nevertheless many authors have carried out hedonic studies and achieved sensible, reproducible and believable results. Freeman (1979) discusses the validity of the hedonic market for housing studies and concludes that there are in fact many theoretical objections to using hedonic models in studies of house prices, particularly studies which value an environmental good, about which information may be less than usually perfect, as part of housing attributes or when markets are changing. However, since all economic models are simplifications and misrepresent reality the judgement should be whether hedonic models are good enough representations to be useful. Freeman concludes that hedonic models can be very informative but that care must be taken to avoid anomalous results due to specification problems. He argues for validity from the weight of evidence when multiple studies across different locations produce similar results and urges that biases should be tested for as far as possible.

In respect of this current study the two major drawbacks of the hedonic method are the large quantities of data necessary to estimate unbiased models and the lack of temporal equilibrium. The small sample of properties at risk in any location is likely to make robust estimation of models problematic particularly in the light of the danger that omitted locational variables may be correlated to the flood risk.

3.6 EXPERIMENTAL OR DIRECT MARKET COMPARISON METHOD

A naturally intuitive approach to the problem of identifying potential discount due to flood is to directly compare similar properties within and outside the floodplain. This is the method of valuation most favoured by estate agents, direct market comparison backed up by gut feel (Clark et al., 1994). What did the last property in this street sell for? How does it compare with this one? Is there something special about this property that will command a greater price then the rest in this street. If a very specific question needs to be answered for a specific location the direct comparison method can be an efficient and simple approach. However a very good local knowledge is necessary to identify homogenous properties that differ in only the aspect of interest, the judgement of the analyst is replacing formal measurement of property attributes. An extension to this is to identify groups of properties that differ in several aspects and use experimental design methods to control for variables not of interest and evaluate variables of interest. An attractive feature of the method is that conclusions can be drawn fairly rapidly from small samples.

The experimental method will always be open to the criticism that the properties are not truly homogeneous because of the heavy reliance on the subjective judgement of the practitioner. The method does not rely on underlying price theory or economic model, building instead upon empirical observations of differences in realised prices in a local market at a given time. Extending the results of this kind of analysis to any other location or time frame is therefore highly risky.

For the purposes of the current investigation, it was recognised that repeat application of experimental of comparative valuation across multiple sites might build up a picture of the state of the property market and the discount due to flood risk. An example of the approach applied to a case study site in the UK can be seen in Lamond and Proverbs (2006). However, not all flood locations provide conveniently comparable property, and the level of detailed knowledge necessary to establish comparatives would preclude the breadth of locations envisaged in this research. Furthermore, without underlying hypothesis or a structured framework, it would be difficult to extend the applicability of any findings.

3.7 REPEAT SALES METHODS

Repeat sales models are used when house prices over a longer time period are to be examined. Serial sales of the same property can be used to measure changes in neighbourhood or environmental attributes that occurred between these sales. The repeat sales model has also been proposed as an alternative to price indices constructed using hedonic methods (Clapp and Giaccotto, 1992, Wang and Zorn, 1997, Leishman and Watkins, 2002a). This can be regarded as an extension of the hedonic model as follows :-

Starting from a variant of the explicit time variable hedonic model, as specified in Gatzlaff and Ling (1994) and others, in logarithmic form. The formula for price of house i at time period t is

Equation 1

$$\ln P_{i,t} = \sum_{j=1}^{J} \beta_j \ln X_{j,i,t} + c_t + \varepsilon_{i,t}$$

where

> β_j = a vector of coefficients representing the elasticity of price with respect to the matrix of locational and property specific explanatory variables, $X_{jit.}$
>
> $\varepsilon_{it,}$ the error term is distributed mean 0 and variance σ_e^2
>
> c_t a generalised logarithmic market growth term.

This adaptation of the standard cross-sectional hedonic model combines the data for adjacent time periods and then includes time as an independent variable. It is generally used to generate a price index where c_t is estimated from known prices and property characteristics.

Equation 1 can be applied to a subsequent sale of the same property at time t+k by simply substituting t+k for t.

$$\ln P_{i,t+k} = \sum_{j=1}^{J} \beta_j \ln X_{j,i,t+k} + c_{t+k} + \varepsilon_{i,t+k}$$

Then the growth in price of property i between time t and t+k is given by Equation 2 below:

Equation 2

$$\ln P_{i,t+k} - \ln P_{i,t} = \sum_{j-1}^{J} \beta_j \ln X_{j,i,t+k} - \sum_{j=1}^{J} \beta_j \ln X_{j,i,t} + c_{t+k} - c_t + \varepsilon_{i,\tau}$$

Property factors such as size and age of house are assumed not to change significantly in the small time between t and t+k. Thus Equation 2 reduces to:

$$\ln P_{it+k} - \ln P_{it} = c_{t+k} - c_t + \varepsilon_{i\tau}$$

The price index can be estimated from the prices alone by averaging across properties.

Repeat sales methods could also be considered as the ultimate in comparative or experimental models where properties are assumed to be identical because they are the same property. Clearly this assumption can never be held to be completely true because between serial sales home owners make improvements to their property and the property ages. Changes to the locational amenities can also occur between sales. Another possibility is that between sales consumer preferences have changed and that different types of property have become more or less popular as a result.

The use of repeat sales to evaluate the effect of environmental externalities has been advocated by Palmquist (1982) and Case et al (2006). The most useful advantages of the repeat sales method in respect of the current study is the reduction in effort necessary in collecting property details and the perception that with very small sample size, controlling for property attributes via hedonic modelling would be impossible. The major disadvantage of the repeat sales method for the current analysis is that the repeat sales method can only measure changes in growth patterns over the time period. Any long term capitalisation of flood risk which predates the analysis cannot be identified.

3.8 CONTINGENT VALUATION METHODS

Contingent valuation methods are indirect methods in that they do not rely on data from a market transaction. They are basically a survey of expert or not so expert opinion relating to the value of a good or service. Market players are asked what they would be willing to pay for a good or service or how much they would be willing to accept in payment for a good or service. The contingent valuation method is most appropriate when the good or service is not traded so no market exists as for example in the provision of public goods. It can also be used when a part of a good or service is not traded directly but as part of a package and so may be appropriate in housing markets. Contingent valuation methods are also useful when the data regarding trades within a market are not collected or are unreliable and it would be prohibitively difficult to collect reliable data.

Survey methods for the valuation of environmental goods were initiated by Ciriacy Wantrup (Cummings et al., 1986) in 1952 and began to be implemented in earnest during the 1970's when the seeds of contingent valuation were recognisably sown. From the outset, however, many issues and doubts about the reliability of contingent valuation have been expressed.

The problems with bias in estimation inherent in the contingent valuation method are well documented see, for example, Bishop and Heberlein (1979). Three major components of bias are gamesmanship, ill informed opinion and the tendency for respondents to do one thing and say another. Gamesmanship refers to the belief that responses to the survey may affect the market or public policy and therefore particular responses may sway things in favour of the respondent regardless of actual truth. Ill informed opinion refers to the fact that when actual decisions are made a great deal more thought and research will go into the choice, lack of experience of a situation also falls into this category. The tendency to do one thing and say another may have many root causes not least the raising of an issue which would never normally feature in a respondents thinking, the example of respondents reporting that they would refuse service to Chinese nationals (Bishop and Heberlein, 1979) when in fact Chinese nationals had obtained service from these respondents is a case in point. Raising concern over flood risk could be another. An example of this was seen in the survey of property owners in Ontario (Babcock and Mitchell, 1980). When asked about property value few mentioned flood risk but when asked directly about flood risk 90% indicated that flood risk had a negative effect. No evidence of actual adverse impact was observable from the sales data. Social pressures and presenting an acceptable point of view would also lead to respondents reporting a different behaviour to their actual one

The choice of respondents for a contingent valuation survey will be a crucial factor in its representation of reality. Brookshire et al (1982) compared contingent valuation to hedonic methods and did not reject the hypothesis that a bias of up 50% may be seen. More striking was the asymmetric effect of willingness to pay vis a vis willingness to accept. Those currently residing in the hazard area were willing to pay far less to move out of the hazard zone than those living outside the hazard area would expect to discount. The valuation of zone residents of their willingness to pay to relocate fell close to the hedonic valuation whilst the valuation by residents outside the zone was over 5 times as high.

Another interesting comparison was rendered from the cost benefit analysis of a flood control project in Roanoake, Virginia (Shabman and Stephenson, 1996) where four choice measuring estimates were available. Contingent Valuation methods were low when compared with hedonic estimates and with cost based analyses. One quarter of respondents refused to estimate a willingness to pay, expressing the belief that someone else should pay and 15% could not put a monetary value of reducing flood risk. When asked to vote for the project at the expense of increased local taxation in a referendum, those who expressed most willingness to pay were least likely to vote. It emerged that the majority of votes for the flood control project came from residents outside the floodplain and were a mark of civic solidarity with the flood victims.

Due to the expense of conducting house to house surveys, surveys of experts, often agents, are frequently resorted to. It is not really possible to say how this may impact upon the various biases inherent in the method although presumably agents should be better informed about market prices.

For the purposes of the current study the fundamental weakness of the contingent valuation method is that respondents are likely to be ill informed. There is a lack of experience in the majority of house purchasers and professional valuers in the UK with floodplain valuation. Rationalisation of the disamenity of floodplain location when prompted might result in an overestimate of the impact by the lay person (Babcock and Mitchell, 1980). They will fail to take into account the amenity value of riverside location which may in a real life situation outweigh the flood risk. Those with experience of valuing floodplain property may have a very different perspective. The timing of any survey in relation to flood events would have a major impact on estimates of price impact (Shabman and Stephenson, 1996).

3.9 SUMMARY

This chapter has examined the underlying price theory relevant to applications within the housing market. It has clarified that price is used to give information about the value or utility of a good or service to an individual or organisation. In this respect if there is a discount in the price of floodplain property it can be seen as a value put upon avoidance of the risk of flooding. The theoretical quantification of such a discount is seen to be impractical in the face of the uncertainty and subjectivity involved in the evaluation of costs and benefits. Later, in Chapter 5, the comparison of this willingness to pay to avoid flood risk via price discount and the willingness to pay via insurance cover will be discussed. This chapter has also outlined some relevant aspects of buying and selling residential property in England and Wales. It has been demonstrated that a state of perfect competition does not exist in the property market and that the unit of housing is not an appropriate entity for measuring the impact of flooding on the value of residential property. The chapter has therefore dealt with the ways in which the impact of housing attributes may be measured. All the approaches described above are seen to have strengths and weaknesses.

For the purposes of the current study the contingent valuation method is seen to have fundamental weaknesses in the lack of general experience with flood risk. The contingent valuation method will be excluded from further metholodogical consideration.

The analysis will therefore be based on market data and some form of revealed preference method. In choosing this approach, however, the use of data relating to property which is listed for sale or property which has actually sold will prove a limitation of the study. The analysis may underestimate the impact of flood risk on property value because floodplain properties most severely at risk may never come up for sale in anticipation of large devaluation.

In choosing between market based approaches, no methodology is seen to be wholly suited to the analysis of a floodplain property market which is geographically diffuse as is the case in the UK. Invalid assumptions inherent in the use of hedonic models in the housing market may be an issue particularly as measurement of flood impact will be attempted over a period when the public perception of that hazard is shifting in the light of recent flood events. Also the assumption that a continuous spectrum of housing bundles exist and are available to choose from could well be violated in the restricted housing markets in the location of a floodplain. The spatial nature of flood risk and the uniqueness of property locations means that the application of hedonic or comparative methods will be fraught with difficulties and require much detailed property level information. Repeat sales methods may offer a more elegant solution. These issues and the relative merits of alternative market based methods are explored further in the following chapter which reviews the literature relating to the impact of flooding on residential property value. It will be seen that all of the above methods and some novel variations of them have been employed in the past.

Despite the reservations about the invalid assumptions noted above, weight of evidence may be appealed to if multiple attempts to measure the impact are attempted and produce comparable findings (Freeman, 1979) Criticisms may be levelled at any single study of price impact of flooding that, for example a particular floodplain area grew or declined for reason unrelated to flooding. However the likelihood that multiple floodplain sites will be affected in the same way relative to non floodplain sites will be reduced to negligible in the light of multiple analyses of floodplain locations. To that end the study will attempt to analyse multiple floodplain locations in a structured way which allows for generalisation of findings.

Having in this chapter examined the theory underlying the use of several house price modelling techniques and concluded that there are strengths and weaknesses in all methods the next chapter will deal in detail with past studies. Chapter 4 will assess studies in flooding, whatever the method employed to assess whether the weight of evidence regarding the impact of flooding and flood risk on property prices has already been generated and summarises that evidence. The chapter will go on to assess other house price models in the hedonic field, and in the area of environmental disamenities, lessons will be drawn from these previous studies to aid the current research.

Chapter 4 : LESSONS AND FINDINGS FROM ANALYSIS OF EXTANT STUDIES

4.1 INTRODUCTION

Chapter 3 discussed the theoretical basis on which models of house prices may be constructed but although it drew somewhat from published studies, the results of extant studies were not considered. This chapter forms a more functional review of the literature incorporating summaries of results and discussion of the practical methodological issues.

The weight of evidence argument proposed by Freeman (1979) suggests that some indication of the impact of flooding on residential house prices might reasonably be gained via meta- analysis of existing studies. The expectation that populations react in similar ways to similar risks could lead to the belief that common results might be found internationally. This practice of using multiple studies in cost benefit analysis is gaining credence in the environmental field (McComb et al., 2006). To that end, section 4.2 summarises the findings of existing studies into the impact of flooding and flood risk on property value.

Section 4.3 considers other housing studies relating to UK housing markets, focussing on the valuation of amenities and diamenities, in order to develop a model specific to the UK market. Specific data issues are seen to exist within the UK which are not present elsewhere. It makes sense for a study within the UK market to concentrate on aspects of the housing market found relevant by previous UK studies.

International studies form the subject of section 4.4, insight may be gained from this literature into a wider range of investigations and methods. In particular this review contributes substantially to the understanding of the implications of selection and omission of key variables. Practical considerations regarding the use of different methodologies are also considered.

Section 4.5 summarises some of the specific methodological issues emerging from the literature review which must be addressed in the design of the methodology for measuring flood impact on residential property in the UK.

4.2 RESULTS OF INTERNATIONAL FLOODING STUDIES

The findings from studies from the developed markets of UK, France, US, Canada Australia and New Zealand are grouped below by country. Studies from elsewhere in Europe were sought but proved elusive. When interpreting the results from the research to date, and particularly its relevance to the UK it must be borne in mind that different disclosure regimes exist across the world and this seems to be partially reflected in different observed impacts. Potential purchasers may become aware of flood risk status at various stages of the buying process. At one extreme personal experience, or high media coverage, may ensure that all buyers are aware of local flood issues. At the other extreme sits the normal situation in the UK where there will be ad-hoc discovery of flood risk.

4.2.1 UK findings

Three UK studies (Building Flood Research Group (BFRG), 2004, Eves, 2004, Kenney et al., 2006) have surveyed experts in the property field regarding their opinions about the impact of flooding on property value, the property transfer process and investment decisions. Basically they are contingent valuation type studies with associated dependence on the experience of practitioners with flood risk valuation. The importance of the availability of flood risk insurance was highlighted in all three studies in particular for residential properties if financing was necessary. The findings of the three studies were broadly consistent but precise estimates of value impact were lacking. BFRG (2004) found the median discount for residential property to be 12-15% but the responses indicated a wide range of opinions among valuers even when working in the same market. Eves was reluctant to fix on an estimate of discount because of the variability, linking increased discount with increased severity of flooding. Kenney et al highlighted expectation of effective discounts in capital value of between 5-15% if insurance were available but stressed the lack of knowledge among the respondents. There was consensus that property values would recover after a flood event but there was no consensus on the length of recovery. There was consensus in that flooded properties may stay on the market longer than other similar properties, and that a slight discount for floodplain properties not previously flooded may be expected.

This extant research illustrates both the difficulty of the problem and the need for some guidance for valuers on the matter. It also follows from these studies that any consideration of the impact of flooding in the UK must consider the insurance angle. Another aspect stressed by Eves (2004) in particular is the positive value placed on riverside location, which acts in direct opposition to disincentive posed by the risk of flood.

4.2.2 French study

A hedonic study of the valley of the Canche, in the region of Nord-pas-de-Calais incorporating 15 towns and villages carried out by Longuepee and Zuindeau (2001) found largely insignificant responses to location within the flood zone. The area had recently been subjected to a major flood in 1995 and data relating to the four following years were considered. Two interesting aspects of this study were that, first, proximity to watercourses was tested separately from flood zone status and found to have a significant positive impact more than equal to the negative impact of being in the flood zone; and second, multiple flood zones were tested but the only negative impact (11% not significant) was found to be that of the outline of the actual flood, rather than the predicted flood zones.

4.2.3 Australian findings

Eves (2002) studied the effects of flooding on the housing market in Sydney. It was concluded that in periods of flooding there is a discounting effect for flood-prone property, peaking at about 16%. As the gap between floods increases this discount ebbs away and flood-prone property catches up with its flood-free equivalent. Lambley and Cordery (1997) studied floods in Sydney and in Nyngan. In Sydney they observed some small and temporary impacts. In Nyngan, where the whole town was deluged, and where again the main effects were temporary, prices were depressed for about 6 months following the flood. There was some suggestion that a slight divergence in long-term growth between Nyngan and the control community could have been caused by memories of the flood. An examination of repeat sales of houses sold immediately following the flood at a depressed price and then resold shortly afterwards shows the action of opportunist entrepreneurs making gains well above expected returns, presumably after some investment in reinstatement. Faith in the long-term recovery in prices seems to be widespread and borne out in reality.

4.2.4 New Zealand findings

Montz (1992) studied the effect of flood events in three New Zealand communities. No precise estimates of impacts are presented, but the study concluded that all flood effects are temporary. In Pearoa a temporary dip was observed after the flood followed by a recovery. In Te Aroha the whole community experienced price decline in the wake of the flood, not just those properties flooded. Four years after the flood in Te Aroha the flooded properties had recovered more than the non-flooded. In Thames while there was no effect for a first flood, a second flood affected the whole market. Strangely the non-flooded properties seemed to suffer more discount from the second flood than the flooded properties.

In a further study of two of these communities Montz (1993) demonstrated that subsequent disclosure of flood risk via planning constraints had no effect on the value of properties.

4.2.5 US studies

In the US there is great interest in the designation of floodplains because in some areas of the country, where credit is required, flood insurance is compulsory and is subsidized by government (Burby, 2001). A summary of results from studies undertaken in the US is presented in Table 4-1. The studies vary between testing properties actually flooded and properties designated at risk of flooding. This can be a very important distinction. Actual inundation might be expected to heighten the concern of potential buyers, if they are made aware of it. Designation on the other hand may carry with it obligations on the future resident and may not correlate well with actual flood risk. In many cases the accuracy of categorisation is poor. For example in Houston, Texas (Skantz and Strickland, 1987) a flood occurred in 1979 and of the 33 studied properties that were actually flooded only 10 were in the 100-year floodplain. The research also differs in whether it tests for the temporary effect of specific events or looks at the long-term static effect of floodplain.

A study by the United States Army Corps of Engineers examined the hedonic studies previously carried out in the US (Chao et al., 1998) to achieve a confirmation that flood damage was capitalised into the price of houses in the floodplain. The study concluded that the case was far from proven. The authors rejected the option of further investigation using the hedonic method because of the heavy data requirements. Other results worth highlighting include a study by Tobin and Montz (1994) in Wilkes Barre, Pennsylvania that found a positive effect of flood in that the prices of flooded properties were higher after the flood, relative to non-flooded properties. This is similar to the effects that Montz (1992) discovered in New Zealand. The authors propose that this may be due to investment in the damaged houses resulting in improved quality in the flooded sub market. In Wilkes Barre it could also be attributed to the lack of alternative property. The Skantz and Strickland (1987) study observed no direct impact following a flood but saw, albeit weak evidence, that later insurance increases triggered a depression in house prices.

Table 4-1 : Summary of findings from US flooding studies

YR	AUTHORS	PLACE	FLOODPLAIN EFFECT
2006	Bin, Crawford, Kruse and Landry	New Hanover County North Carolina (coastal risk)	-11%
2004	Troy and Romm	California	-4.2%
2003	Bin and Polasky	Pitt County North Carolina	-8.3% post flood -3.7% pre flood
2001	Harrison et al	Alachua County, Florida	-2.9%
2001	Shultz and Fridgen	Fargo/Moorhead NorthDakota/Minnesota	-9%
1994	Tobin and Montz	Des Plaines, Illinois	No effect
1994	Tobin and Montz	Linda and Olivehurst California	-30% >10ft flood -10% 18" flood
1994	Tobin and Montz	Wilkes Barre, Pennsylvania	Positive effect.
1991	Speyrer and Ragas	New Orleans, Urban Suburban	-6.3% -4.2%
1990	Bialaszewski and Newsome	Homeworld Alabama	no effect floodplain location
1989	Shilling et al	Baton Rouge, Louisiana	-8% floodplain location
1989	Donnelly	La Crosse, Wisconsin	-12% floodplain
1987	Skantz and Strickland	Houston, Texas	No effect until after an insurance rate increase
1987	Macdonald et al	Monroe Louisiana	-8.5%
1979	Zimmerman	New Jersey	No effect
1976	Shabman and Damianos	Alexandria, Virginia	-22%

4.2.6 Canadian findings

The Canadian experience is somewhat different; floodplain regulation is weaker than in the US and is aimed at controlling development on the floodplain. Disclosure is not widespread and so perhaps it is not surprising that of seven studies quoted by Schaeffer (1990) only one found any significant discount. The Schaeffer (1990) study itself, based on a very small sample, produces confusing and inconsistent results. Three different methodologies are applied and the outcomes are dependent on the methodology. One approach yields no significant effects while the others show marginal price depression due to floodplain. The effect of subsequent designation is seen, against expectation, to raise the prices of designated property.

A survey of homeowners by Babcock and Mitchell (1980) seems to show that even in high-risk areas, and with homeowners, who had suffered flooding in the past, perception of risk is low and very few had purchased flood insurance. This was reflected in the house price data where no significant impacts were detected.

4.3 UK STUDIES OF OTHER AMENITIES AND DISAMENITIES

In the UK there have been a number of studies into the effect of locational externalities on the price of property. One of the main areas studied is that of the transport infrastructure. Forrest (1996) examined the impact of the MetroLink on house values around Manchester. Henneberry (1998) looked at the impact of light railway on the price of property in Sheffield and Gibbons and Machin (2005) used transport innovations to value rail access in London. Education value is another area of interest with schools being the subject of study by Cheshire and Sheppard (2004), Leech and Campos (2003) and Gibbons and Machin (2003). Other studies examining environmental amenities include Garrod and Willis (1992) studying the effect of woodland; Orford (2002), Day (2003) and Lake(1998) modelling a whole basket of influences via Geographical Information Systems including parks, views and noise pollution; Gibbons (2004) estimating the effect of property crime and Sims and Dent evaluating the impact of wind farms (Dent and Sims, 2007) and overhead power lines

(Sims and Dent, 2005). In most cases a hedonic or adapted hedonic model is used and, increasingly, large numbers of independent variables are essayed.

The most common included variables are listed in section 4.4 where a comparison is made with the international literature, they are on the whole structural. The way in which neighbourhood attributes are measured differs a lot more study to study which might explain why neighbourhood attributes feature less in the top ten. In UK studies the concept of neighbourhood is usually treated either with dummy neighbourhood variables or some variant of socio-economic variables such as census measurements of housing density or tenure. Derivatives of these census variables are also available in the form of classifications such as the ACORN neighbourhood categories and are used by two studies. Some authors, notably Day et al (2003) and Orford (2002) also include multiple distance measurements at varying levels of detail.

The availability of data is a major issue for housing studies in the UK (Costello and Watkins, 2002). Listings data such as that available in the US and Australia are not collected. The situation is slightly different across the countries of the UK with the register of Sasines in Scotland releasing housing transaction data but the Land Registry in England and Wales refusing to do so until very recently. Consequently most studies have used building society data or asking prices. A recent move by the Land Registry means that transaction value data is available but without associated property details. Data issues are explored further in chapter 6 but here it is noted that to gain complete market coverage of transaction information with associated property details would involve collating data from more than one source.

Interesting variations on the hedonic model are the use of repeat sales by Gibbons and Machin (2005). Use of a difference model removes the need to collect property characteristic data in the model. Leech and Campos (2003) use a block design to obviate the necessity of including all locational variables save the one of interest. These ideas are developed further in the methodology proposed below and were a valuable outcome of the UK literature survey.

There is a vast literature on the construction of price indices and on forecasting the property market at an aggregate scale, most of which is not relevant to the modelling of the small scale problem of flood modelling. Local price indices are of interest however and there are basically two schools of thought about their construction, namely the cross sectional hedonic and the repeat sales method. The Halifax building society is a leading proponent in the hedonic index field (Fleming and Nellis, 1986). Costello and Watkins (2002), Leishman and Watkins (2002b), Leishman and Watkins (2002a) and Lima and Pavlou (2007) deal with the estimation of local repeat sales indices.

Submarkets are considered by many authors, either in their own right (Jones et al., 2004, Meen, 2005) or as part of a wider study (Day, 2003). These are very interesting issues but the migration data available in the UK is not of sufficient detail to aid in the micro-analysis necessary for flooding studies.

4.4 METHODOLOGICAL REVIEW OF INTERNATIONAL HOUSING STUDIES

The focus of this section is a methodological assessment of alternative transaction based models in a practical sense. It draws upon past reviews of the area and considers in detail the question of selection of variables for analysis.

A review of hedonic models which included measures of environmental externalities was carried out by Boyle and Kiel (2001). The research conclusions stress the need to include all relevant measures of the externality, to include all other relevant variables and to look at the information pathways by which home owners assess the externality. Omitted variable bias can be a problem for hedonic studies and it is particularly important to consider those variables which might be correlated with the focus variable.

Butler (1982) reports the results of an experiment in omission of variables. In general the findings are that there is little detrimental impact on the predictive ability of such a model due to omission. It is the interpretation of coefficients that suffers but only in the case where the included variable is correlated with one or more omitted variables. At the same time Butler (1982) acknowledges that mis-specification of the model is inevitable. In modelling house price the researcher is at best making a local approximation to a much larger and more complex underlying relationship. Many different specifications may be equally appropriate approximations and there is no objective way to judge between them.

Consideration of appropriate variables to include in a model will often be pragmatic, based on availability and due to the expense of measuring environmental externalities it is rare that more than one will be included in a single study. A comprehensive analysis of hedonic studies of house prices was carried out by Sirmans et al (2005). The findings from 125 hedonic models were compared and the most frequently used attributes were tabulated as shown in Table 4-2. The total number of different variables included in these 125 studies numbered 357, of which 272 had been found to be significant in at least one study. The number of variables is made greater by the fact that the authors list different ways of measuring the same underlying concept such as lot size, log of lot size, lot perimeter. However the analyst must choose between these different ways of measurement as well as the basic concepts.

In this paper the authors also perform some meta-analysis comparing regional variation on responses throughout the US but this is of little relevance to the current study except to note that findings can vary across regions and are much more likely to vary across countries. It is also notable that some of the most commonly featured variables in past studies are unlikely to be relevant in the UK for example the presence of a pool or air conditioning. Furthermore, although there are a large number of candidate variables to be included in any hedonic model, there is little consistency among models. Only the top 20 variables are tabulated above but among these many are only included in 12 examples ie less than 10% of hedonic models include these variables. Many of the less featured variables appear in only one study.

Table 4-2 : The twenty characteristics appearing most often in hedonic pricing model studies (after Sirmans et al 2005)

Variable	Appearances	No. times positive	No. times negative	No. times not significant
Lot Size	52	45	0	7
Ln lot size	12	9	0	3
Square feet	69	62	4	3
Ln square feet	12	12	0	0
Brick	13	9	0	4
Age	78	7	63	8
No. storeys	13	4	7	2
No. bathrooms	40	34	1	5
No. rooms	14	10	1	3
Bedrooms	40	21	9	10
Full baths	37	31	1	5
Fireplace	57	43	3	11
Air conditioning	37	34	1	2
Basement	21	15	1	5
Garage spaces	61	48	0	13
Deck	12	10	0	2
Pool	31	27	0	4
Distance	15	5	5	5
Time on market	18	1	8	9
Time trend	13	2	3	8

Note: although some of these variables are the same and just measured differently, they are presented separately so readers can see how they are typically measured.

A similar analysis of the 16 UK hedonic studies considered in the literature review for this thesis has been carried out. Table 4-3 shows the top ten variables included in the sixteen UK housing studies analysed and it can be seen that the majority are structural. When this is compared to the international analysis it emerges that there are anticipated differences such as the replacement of air conditioning with central heating. Sirmans et al (2005) also provided summaries of the most commonly tested variables within various categories. The results for the environmental/natural category are shown below in Table 4-4 and it can be seen that views have been tested by a small minority of hedonic studies. The impact of view or lakeside location was almost always found to be positive. Views of one sort or another appeared 31 times including ocean and mountain views and proximity to stream. The overwhelming conclusion is a positive impact of view, only two cases failed to find significantly positive impacts. None found a negative impact. This is an example where Freeman's weight of evidence (Freeman, 1979) suggests that the presence of a view could be considered as a positive influence on the price of housing.

Table 4-3 : Top ten variables included in UK hedonic studies

Variable	Number of occurrences	In Sirman's top twenty
House Type	14	No
Presence of garage/double garage	14	Yes
Central Heating	13	No
Number of Bedrooms	10	Yes
Floor Area of property	10	Yes
Age	8	Yes
Number of bathrooms	8	Yes
Neighbourhood dummy	8	No
Central Business District distance	6	No
Garden	6	No

Studies included (Wabe, 1971, Fleming and Nellis, 1986, Pennington et al., 1990, Garrod and Willis, 1992, Forrest et al., 1996, Shinnick, 1997, Henneberry, 1998, Adair et al., 2000, Fletcher et al., 2000, Orford, 2002, Gibbons and Machin, 2003, Leech and Campos, 2003, Gibbons, 2004, Gibbons and Machin, 2005, Sims and Dent, 2005)

A good view is a nuisance factor for the proposed study because it is likely to be correlated with riverside location and therefore flood risk. One study which tested both negative and positive aspects of waterside living was Speyrer and Rajas (1991) in the US. They found that the positive effect of lakeside location was greater than the discount due to floodzone status. Bin et al (2006) also tested coastal view in a GIS methodology designed to disentangle view from flood risk and found large positive impacts of view.

Table 4-4 : Top four characteristics in the environmental/natural category from hedonic pricing model studies (after Sirmans et al, 2005)

Variable	Appearances	No. times positive	No. times negative	No. times not significant
Lake view	5	5	0	0
Lake front	5	5	0	0
Ocean view	4	4	0	0
"good view"	4	3	0	1

Studies which use methods other than the hedonic approach are not considered by Sirmans et al (2005) but include the repeat sales analyses favoured by Palmquist (1982) and Case et al (2006). Palmquist (1982) proposed the repeat sales methodology in order to reduce data demands in studying environmental effects. As discussed in Chapter 3 the repeat sales method can be regarded as a variant of the time variant hedonic model with the majority of characteristics held constant over time. The method is judged to be appropriate where there has been a change in the environmental quality of the properties which is not uniform and where the coefficients of an underlying hedonic model are constant over time. In comparing this simplified method with a hedonic regression for the same data the author concluded that the two methods produced comparable results. The assumption of constancy of hedonic coefficients over time, a necessary one if the repeat sales specification is to be used cannot really be tested without comparison data. However in the relatively short data sets available in the UK changes are less likely than in longer runs. There remains the possibility that the flood event itself has changed the underlying hedonic model dominating the utility function and diminishing or changing the importance of other attributes. For example riverside location might suffer a reversal of sign in the aftermath of a flood. The repeat sales model would attribute this effect to flood impact – it is debatable whether or not this would be a false attribution or whether a hedonic model would be able to satisfactorily disentangle these nuances. Case et al (2006) use a hybrid technique in their study of condominium prices. Hybrid techniques can remove the assumption of constant hedonic coefficients but, crucially, require more data on these attributes.

Leischman and Watkins (2002b) investigated the use of repeat sales indices on UK housing data. They constructed regional price indices using data available in Scotland from the register of Sasines. The study compared two methods of constructing the indices and benchmarked against average price indices. The relative merits of repeat sales versus hedonic models are discussed at length; in particular the advantage in terms of reduced data collection is highlighted. Previous studies have asserted that there may be bias introduced into repeat sales indices due to the subset of repeat sales being unrepresentative of the market as a whole. Either a positive bias due to the over-representation of development property (Steele and Goy, 1997) or a negative bias due to over-representation of low standard, frequently traded properties (Clapp and Giaccotto, 1992) might occur. However the conclusion is that repeat sales models can provide a sound basis for constructing indices of local markets. In the past, lack of data has meant that repeat sales models have been largely neglected in modelling UK housing markets. Recent developments at the Land Registry, however, have made the data more readily available and the Land Registry have launched a regional price index, based on the data (Lim and Pavlou, 2007).

Studies in the US have compared repeat sales, hedonic and hybrid methods and results are not conclusive. Gatzlaff and Ling (1994) however conclude that biases in the samples can occur, especially in short run data, but that in the longer term the methods produce very similar results. Comparison of the means of the repeat sub-sample with the total population can allay any worries about representation. In addition the model proposed below involves comparison of repeat sales populations. As noted by Gatzlaff and Smith (1993) in a study of the Miami metrorail, any sample bias will be the same for both control and test properties. Palmquist (1982) proposed the use of repeat sales models to measure the impact of environmental nuisance on the price of property with particular reference to noise pollution. The primary requirement is a change in the environmental quality of the properties which is not uniform among properties.

Montz (1993) used a form of repeat sales to examine flood effects in New Zealand. Ratios of prices before and after a devastating flood were modelled against depth of flooding and the number of quarters between sales. In the case of Paeroa, counter intuitive results were found: depth of flooding was positively related to price ratio. No significant effects were detected in the two other sites analysed. Market inflation was not dealt with explicitly, although from data presented elsewhere in the paper it would seem that prices had not appreciated a great deal in the time frame.

4.5 LESSONS DRAWN FROM PAST STUDIES

The above examples of research examining the influence of flooding on property value illustrate some of the issues that will face the proposed research in the UK. This section summarises those issues which are likely to be most relevant for the current research. Some of the problems will not be fully overcome in the study and will be borne in mind as limitations. For other problems, useful lessons are highlighted that can be applied in the research design.

4.5.1 The time varying nature of flood response

As time elapses after a flood event the memory of the event fades (Penning-Rowsell and Peerbolte, 1994). For some flood victims the trauma of flooding will remain with them indefinitely but for others the feelings will subside. For the community as a whole, turnover of property will ensure that the average experience with flood will also decline with time. The rate of forgetting will vary with the stability of the local area and can be affected by disclosure regulation or by the action of organisations such as the Environment Agency or local flood groups. The tendency of the community to forget about flood risk can be reflected in the value impact of flood as examples in the literature demonstrate.

BFRG (2004) in their questioning of surveyors enquired about the length of time to recovery of a flooded property. There was very little consistency in the responses, with some suggesting under a year and others anticipating longer than an eight year impact.

In Nyngan, Australia the whole town was inundated in 1990 at an estimated cost of $50 million (AUS) and subsequently the flood defences were raised to increase future protection. Lambley and Cordery (1997) compared the average house value in Nyngan with its flood free neighbour Gilgandra. For about 18 months following the flood there was a divergence in trends with the Nyngan property declining in absolute value. Two years after the flood, property values in Nyngan had recovered and caught up with their flood-free neighbour. An interesting facet of this study was the observation that trading in property never stopped and there was evidence of entrepreneur activity with houses bought at a discount just after the flood appearing again on the market within four years at a greatly increased price. Lambley and Cordery (1997) suggest that flooded property should not be sold in the immediate aftermath, residents should be encouraged to restore their property and sit tight for the recovery. Their research also confirms the fact that residents can place false confidence in defence works. Although the banks were raised this does not ensure total safety from future inundation.

Tobin and Montz (1994) have studied multiple flood sites and observed different rates of recovery. In one example, Linda and Olivehurst in California, the most severely affected properties had not recovered completely after ten years. It is interesting to note that in this instance some houses had not been reinstated and served as a visual reminder of the flood.

Firstly consider the case where a flood or new legislation imparts new information on risk to the market. The house buyers' perception of the relative desirability of properties in and out of the floodplain will change after the event. Harrison et al (2001) built three models, one before and one after the implementation of the National Flood Insurance Reform act in 1994 and one over the whole time period. They found that the price discount due to floodplain location doubled after the implementation, while estimates of other factors remained fairly robust across the time periods. The third model, utilising the whole time period and including a dummy for post implementation discount gave an even higher estimate post reform discount, however, this is no longer significant. Their results demonstrate the danger of using a global model, in this case detecting no significant effect from the legislation. Research should begin, if possible, by estimating pre and post flood and testing whether the models are significantly different. An alternative to using different models would be to use a model that allows for time varying effects. Tobin and Newton (1986) present theoretical profiles of the utility impact of flood on land values which are discussed and developed further in chapter 6.

4.5.2 The impact of age of property

In repeat sales analysis studies the ageing of property between sales is regarded as a nuisance factor. In the UK market, as discussed in chapter 3, the impact of the age of property on its desirability is not clear. The result from hedonic studies shows that the evidence on the impact of age is not consistent. Age was the most frequently included variable but the treatment of the variable was not uniform, neither were the findings. Clapp and Giacotto (1998) discuss the concept of age, noting the correlation between age and location, given that housing tends to be developed in tracts. They also observe that there may be a vintage effect where older housing may sell at a premium and that some studies do in fact observe positive coefficients for age.

In the UK age of house is highly correlated with its overall size (Wilkinson, 1973) and so may to a certain extent proxy for that variable. Older properties tend to be larger (ABI/BCIS, 2005) and on larger plot sizes. Average age of property in the UK is quite high (Bourne, 1981) and older housing will almost always have undergone some refurbishment resulting in modern amenities. Pennington et al (1990) observed that the age variable derived from building society data was not wholly continuous, tending to cluster around 25, 30 and 50 years. Pennington et al (1990) tried various formulations settling on a squared and cubed age variable based on significance in the regression model. Gibbons (2004) used age of property in hundreds of years and observed a significant positive effect. Forrest (1996) experimented with two different formulations for age in the study of an urban railway system. Use of age categories rather than a continuous age variable had very little effect on the estimation of the focus variables but showed a non-linear effect with houses post war (1945-69) proving less expensive than those pre-war (1915-1944) although the lowest value houses were pre 1915. For the present study small changes in the age of property will be ignored. The aging of property over the period analysed will be considered to be insignificant. An age category approach will be adopted in any hedonic specifications in order to allow for non-linear effects.

4.5.3 Data requirements

It is clear from the above analysis of previous hedonic studies that the estimation of a hedonic model which will adequately explain the discount due to flood status needs to involve a large number of candidate variables. Data on correspondingly numerous transactions would be required in order to estimate these models adequately. Previous flooding research has been carried out on samples ranging from just under one hundred (Bialaszewski and Newsome, 1990) to many thousands (Troy and Romm, 2004). Typically if flood designation is studied then more observations are available than if an actual flood is examined.

Collecting sufficient detailed data on properties in one location would be an onerous task. Given the geographical dispersal of floodplain property in the UK, and the necessity, identified in chapter 3 to analyse more than one location, this onerous task will be multiplied into a Herculean one. In the context of this study and with the limitation of time and resources inherent in a doctoral remit it would be impractical to attempt to develop multiple hedonic models. A methodology which reduces the burden of data must therefore be sought.

4.5.4 Dealing with market inflation

If a purely cross sectional hedonic model using observations sufficiently close in time is constructed then market inflation may be ignored. However in the study of floodplains both the paucity of data and the need to examine changing effects over time make the consideration of a longer time period desirable. Some method of dealing with inflation is therefore necessary, particularly in the light of the large house price inflation seen in the market for England and Wales in section 3.3. Methods employed in previous studies include discounting (Bin and Polasky, 2003), a time trend variable (Skantz and Strickland, 1987), dummy variables for each year (Speyrer and Rajas, 1991) and the use of a control group (Shabman and Damianos, 1976, Montz, 1993). All these methods have advantages and disadvantages. Time trend variables in linear models have the defect that they can only generate a steadily increasing (or decreasing) market; in real examples this is not very likely. Dummy year variables can allow for non-monotonic trends in house prices. Comparison against a control group requires very careful choice of the control group. Use of discounting raises the problem of which discounting factor to use, national price indices are not appropriate for local studies and local price indices are not always available and can be volatile. For this thesis local price indices will need to be constructed with the caution that the small sample sizes available could lead to volatility in the index.

4.5.5 Choice of functional form

Where a regression model is used, many authors discuss the use of different functional forms. Theory does not predict a particular relationship (Rosen, 1974) and so the choice of form is an empirical one, often based on best fit. Linear and Log/linear are the most common selection, for example Bin and Polasky (2003) used a log transform for distance related variables based on the experience of other housing studies. Troy and Romm (2004) used a semi logarithmic model after examination of residuals from a linear estimation. In the flooding literature, where more than one form has been tried, the overall conclusions have not differed between models (Shilling et al., 1989).

Sirmans et al (2005) restates the three well recognised advantages of the log linear specification commonly quoted, namely that this reduces heteroscedascity, that the coefficients are readily interpretable as elasticities and that it allows for variation in dollar values of different characteristics. Log/linear model forms are shown in the theoretical developments quoted in this thesis as they are the most common. However the appropriate model form should be explored and, during the empirical phase, tests for heterogeneity and normality will be carried out before accepting the log/linear model.

4.5.6 Homogeneity of floodplain markets

The definition of a housing market for the purposes of comparative pricing analysis is usually based on a geographical area which the analyst perceives to be sufficiently homogeneous. This may not be an accurate picture of the market for housing, the possibility of submarkets should be considered because if they exist then building a single model of the whole market may not be an effective strategy resulting in poor estimation and reducing explanatory power. Substantive differences in the markets for floodplain and non-floodplain property could arise from differences in type of property. In New Zealand Montz (1993) found that the average physical attributes of floodplain houses differed from those outside the floodplain and therefore compared trends within sub markets. The characteristics of buyers may also create submarkets, they might be poorly informed individuals, cash buyers or buyers who are in the market for "development" or "investment" property. Troy and Romm (2004) for example found that hazard disclosure had a significantly greater impact on the price of housing in Hispanic neighbourhoods of California than in non-Hispanic communities.

MacDonald et al (1987) split their dataset to check the homogeneity of their test neighbourhood. They observed higher flood impacts on the price of property in one neighbourhood that consisted of higher priced properties. Research should consider likely sub markets to ensure that smoothing across sub markets does not affect significance testing but also to generate a deeper understanding of the underlying process. In this study investigation of different property types may be possible but it is unlikely that sufficient data will be available to carry out rigorous testing. It is hoped that by selecting small neighbourhoods in given flood locations homogeneity will be achieved but this cannot be guaranteed. This will be a limitation of the current research.

4.5.7 Collinearity

If the independent variables used in a predictive model are correlated to one another then they are described as collinear. This is a common problem in housing studies where, for example, lot size will be strongly related to house size. In particular as discussed above when estimating flood impact the nuisance variable of view might be strongly correlated with flood risk. In a hedonic regression model collinearity results in biased estimates of the partial regression coefficients; they cannot then be used for robust prediction. In choosing to eschew hedonic models for the major part of this empirical study it is hoped that the issue of collinearity will be avoided.

Most authors in this literature search have ignored or sidestepped the problem of collinearity, simply selecting the variables with the most explanatory power. Presumably the assumption is that there will not be much correlation between flood variables and the rest. Troy and Romm (2004) touch on the issue. Their model included a Hispanic/disclosure interaction term that demonstrated that the strength of the effect of disclosure varied with the percent of Hispanic residents. Hispanic concentration was highly correlated with floodplain location, they posit due to financing arrangements. Bialaszewki and Newsome (1990) tested whether multicollinearity had affected their results using stepwise regression and by examining the correlation between other independent variables and the flood variable. They concluded that it had not changed the outcome. Collinearity can be dealt with by a number of methods such as principal components analysis or residualisation, see Donnelly (1989) for an application of residualisation.

4.6 SUMMARY

The outcome of published analyses into the effect of flooding on property prices has produced a wide range of estimates. This is in part due to differing definitions of flood effect and also to the proximity of a flood event. The measured effect of flooding is also highly dependent on local issues such as frequency of flooding and availability of alternative housing. Some studies observed that there was no depreciation due to flooding. One counter-intuitive result is observed in which flooded houses increased in value relative to non-flooded. This could be explained by the impact of reinstatement resulting in betterment. The impact of flooding on property prices in the UK cannot therefore be predicted from extant studies.

However there is some consensus that the impact of a flood event on price declines over time as people forget about it and permanent capitalisation of flood risk into price is largely due to regulated disclosure of flood designation. None of the existing methodologies described in the literature are specifically designed to take account of an impact which varies over time. Most previous research either ignores the time factor or use snapshots at arbitrary time periods. An objective of the research programme which flows directly from the literature review will be to provide a strategy or methodology to deal with this anticipated feature of the data.

In the published research some form of hedonic modelling is the preferred methodology where sufficient data is available. Data limitations can heavily influence the choice of methodology. In the UK detailed data on property transactions is not as readily available as in other markets. This has led to the situation where all previous UK studies of flood impact on housing markets have used surveys to canvass expert opinion.

From the meta – analysis of previous studies of flooding and other housing studies it is clear that a great deal of time and expense can be expended in building alternative models which are equally as powerful in statistical terms. The choice of input variables to a hedonic model is generally pragmatic, limited to those variables which are readily available. For most studies of environmental amenities and disamenities the bulk of the effort expended in developing new data is expended in developing measurements of the variable under test. Within the UK market commonly utilised explanatory variables have been identified but no consensus exists about the relative importance of many of these variables or even the treatment of such common variables as age of property. Collecting the amount of data necessary to build and test several hedonic models of the price impact of flooding was concluded to be impractical and an alternative methodology will be sought. This review has identified repeat sales as a developing tool in the valuation of amenities. Repeat sales analysis, which has a much reduced data demand, will form the basis of the major empirical analysis within this thesis.

The UK studies highlighted river view as a positive driver for house price. This could be a severe nuisance factor for a study concentrating on riverside properties, by using repeat sales this nuisance factor will be held constant.

Availability and cost of insurance was also highlighted by the UK research into flood impacts on property value. All three studies mentioned insurance as a key issue and so it must be addressed within the current research. However the inclusion of insurance into either theoretical or empirical models is not a straightforward matter. The mechanism by which insurance could potentially influence property price is not clear. The next chapter is therefore devoted to the insurance issue.

Chapter 5 : FLOOD INSURANCE AND ITS IMPACT ON HOUSING VALUE

5.1 INTRODUCTION

One of the recurring themes within the modelling of the impact of flooding on house prices as summarised in Chapter 4 is the importance of flood insurance. It has been proposed that the cost and availability of insurance will have an impact on the value of property in the floodplain by many authors including Macdonald et al (1987), Harrison et al (2001), BFRG (2004), Eves (2004), Crichton (2005) and Kenney et al (2006). Ehrlich and Becker's (1972) self insurance theory has been used to predict a link between willingness to pay for flood avoidance via insurance and property price discount. For the UK market, surveys have suggested that the hypothesis could be valid but it has yet to be proven. Agreement as to its importance is present in the literature but the scale, direction and manner of its impact on house prices are not clear from theory or from previous studies. The inclusion in this thesis of a separate review of insurance literature relating to flood and natural perils cover is a reflection of this emphasis.

Of course, the importance of flood insurance extends well beyond its impact on house prices. Insurance against flooding can be a central plank in a national flood management policy, indeed can often incorporate state provision, and as such is subject to political as well as market forces. Flood insurance must be considered within the context of a wider flood management regime and the structure of the local insurance market will be very pertinent to the way in which insurance affects the housing transaction. Although it is not within the remit of this research to make judgements about the appropriateness of the current provision for householders in the UK it will be necessary to understand the way in which this provision shapes the actions of property owners and potential buyers within the floodplain market. This chapter therefore addresses two main themes: the unique UK flood insurance market and the wider international literature on flood insurance.

In section 5.2 the unique flood insurance regime in force in the UK is described and contrasted with other international regimes. The history and structure of the UK insurance market is then considered in section 5.3 and the market is summarised. This regime is currently in a state of flux in the aftermath of record levels of flood claims and this changing market and its implications are discussed in section 5.4. Section 5.5 is concerned with the wider insurance literature and the ways in which flood insurance may act theoretically on house prices highlighting previous empirical studies in the literature. In section 5.6 it is seen that these theoretical actions are not wholly appropriate in the unique UK flood insurance regime and that the data required to estimate such models is not publicly available in the UK.

5.2 FLOOD INSURANCE REGIMES

The maintenance of floodplain property is dependent upon the ability of the property owner to reinstate following a flood event. Affordable insurance against flooding or an adequate relief fund can provide the safety net necessary to effect that reinstatement. Different approaches have been taken internationally to provide cover for those at risk of flooding and other natural disasters and variations on schemes are continually proposed (Ryland, 2000, Bruen and Gebre, 2001, Schwarze and Wagner, 2004, Spence, 2004). These regimes form a central part of development policies regarding maintenance of floodplain property and further construction on the floodplain.

5.2.1 The UK regime

In the UK, for example, the government relies on private insurance companies to pick up a large part of the bill for repairing flood damage (Huber, 2004, Green and Penning-Rowsell, 2004). Flood cover is bundled into general property insurance, which is a fairly unique position worldwide. Private individuals have confidence, through household cover, that they will not suffer devastating financial loss in the event of a flood disaster. Mortgage lenders also use the protection that insurance provides to guarantee the value of property on which loans are secured. Property developers base their investment decisions on the understanding that those who will wish to purchase the development will be able to obtain loans. Clark et al (2002) argues that a period of low flood frequency and the historic insurance regime in the UK has resulted in widespread complacency and under-investment in flood defences leaving the UK property owner more than ever reliant upon insurance to mitigate the consequences of future flooding. As a result of the long term commitment by UK private insurers, level of cover in the UK is well above that of most other markets.

The UK system is fairly unique in providing such universal cover by default, in other countries the picture is very different (Gaschen et al., 1998, Michel-Kerjan, 2001, Paklina, 2003). Other approaches range from no cover, with victims relying on emergency aid, through optional separate flood policies or add-on options, to compulsory state run schemes. Cover can be provided exclusively by the private sector, exclusively by government or in partnership between the two. In this section some examples will be highlighted that relate countries mentioned in the empirical studies included in section 5.5 in order to contextualise the range of insurance regimes considered within this thesis.

5.2.2 International practices

In Canada flood cover is not included in the standard policy. It is possible to purchase a flood option from private companies at a high price. Penetration of insurance is low probably because the cost is prohibitive for the average homeowner (Gaschen et al., 1998). In some communities a policy of purchasing floodplain property and relocation to higher ground has been executed (Babcock and Mitchell, 1980).

In the US, the National Flood Insurance Program provides heavily subsidised basic cover in flood risk areas. There is an upper limit on this state cover and top up cover can be purchased from private companies. A great deal of thought and research has gone into the scheme and it is continuously monitored and updated to ensure that the maximum protection is afforded to likely flood victims. However this effort has been only partly successful. Burby (2001) covers the history of this scheme in some detail and summarises some key statistics. Penetration of insurance was estimated at 27% of floodplain residents in 1997 although accurate estimates are hard to make because of the uncertainty of estimates of flood risk. The damage caused by hurricanes Floyd and Dennis in 1996 exposed the fact that most damaged properties were not insured.

In Australia flood insurance is provided by private companies. Flood risk is divided into flash flooding and "mainstream" or riverine flooding. Flash flooding is often covered by standard insurance policies, but only a small number of insurers include mainstream flood cover as standard. Those that do include flooding either levy a significant premium increase or refuse cover altogether in high risk areas (Paklina, 2003). According to the Insurance Council of Australia, which is a body that represents private insurers, there are a number of key objectives that need to be achieved by local governments if insurers are to make cover more widely available. These measures include effective flood mitigation, accurate flood mapping, effective planning controls in flood prone areas and disclosure to residents in flood-prone areas (ICA, 2001).

In New Zealand the Earthquake Commission (EQC) provides cover via a national emergency programme that also covers other natural disasters (Paklina, 2003). All residential property owners who buy fire insurance automatically acquire ECQ cover up to a maximum buildings of 100,000 New Zealand Dollars (NZD) and personal effects up to NZD20,000 (OECD, 2003).

5.3 THE UK FLOOD INSURANCE MARKET

In the UK, flood insurance is contained within the standard general household insurance policy provided by private insurance companies. Buildings and contents insurance can be purchased separately or as a package, and flood cover is usually included in both buildings and contents policies. Insurance is not compulsory but buildings cover is normally mandatory where homes are purchased using mortgage finance. Government funds for flood mitigation have been diverted to damage prevention rather than grants to victims. Those householders who do not purchase insurance and do not possess the necessary means are dependent on disaster relief, emergency aid and loans to fund any reinstatement. For example in Towyn, North Wales, after a devastating flood in 1990, those uninsured and on income support could claim community care grants. Households not on income support and without insurance, for example the many retired people on state pensions, had to rely on money from the Mayors fund and discretionary grants from Colwyn Borough Council (Welsh Consumer Council, 1992).

5.3.1 The "Gentlemen's Agreement"

Until 2002 the universal availability of private coverage was the result of a "gentlemen's agreement" between the insurance industry and government. The agreement was entered into in 1961 in response to severe government pressure and by the end of the 1970s the majority of home insurance polices included flood risk as standard (Arnell et al., 1984). The main content of the agreement was that the insurance industry guaranteed to provide cover whatever the risk, and that the cover would not exceed 0.5% of the sum insured except in circumstances where regular flooding was seen to be inevitable (Huber, 2004).

The events of the last ten years have tested the accord between insurer and the government to the full. One of the problems with the agreement was that there was no mechanism for forcing government or individuals to take responsibility for flood risk reduction. A widely held view is that this has resulted in under-investment in flood defences by government and lack of planning by individuals residing in flood prone property (Clark et al., 2002, Huber, 2004, Green and Penning-Rowsell, 2004). Another problem is that the bundling of flood cover into general household cover makes it difficult for insurers to quantify the cost of flooding claims and to quantify their total exposure to flood risk. This may lead to liquidity problems for insurance companies if several severe flood events coincide (Huber, 2004).

5.3.2 The structure of the UK property insurance market

Since it is not possible to divorce the flood insurance market from the general property insurance market in the UK, it is necessary to consider the property insurance market as a whole. Euromonitor (2004) states that the market for domestic property insurance in the UK yielded £4.9 billion in premiums in 2003. The top five companies providing insurance in the UK held 63 percent of that market, while the top ten account for 85 percent. Aviva Plc, which owns Norwich Union (NU) and Commercial Union, is the largest player with 23 percent. There are many smaller players in the market. The domestic property insurance market is not always profitable; premium increases in recent years have been blamed on growth in weather related claims that have resulted in underwriting losses.

The Automobile Association (AA) surveys 39 different insurers in constructing its home insurance price index (AA, 2007). Figure 5-1 below shows the index for October 2007 and it is clear that despite the increase in flood and other weather claims the cost of household insurance has remained remarkably affordable. The increase in domestic insurance since the index commenced has been only 5%.

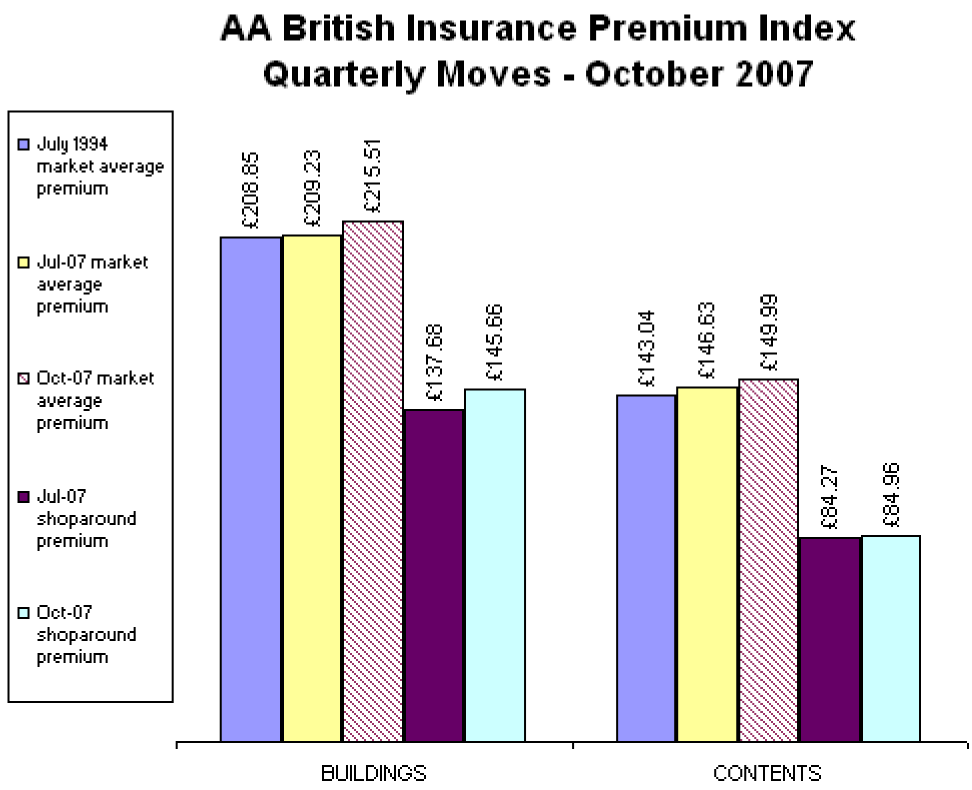


Figure 5-1 : AA premium index

The AA also makes available a comparison between the average quote and the "shoparound" quote and there is a wide discrepancy between the two. "Shoparound" is the average of the lowest three quotes. As an example in October 2007 the average difference in premium between market average and "shoparound" for buildings and contents insurance over the AA sample was 37 percent or £135. Policies differ in regard to which risks are covered but almost always include flood risk. This means that the homeowner seeking to purchase insurance has a bewildering range of choices at different price points. It would be difficult to predict with any accuracy, how much an individual might be paying for their insurance even with detailed knowledge of their circumstances.

Sixty one percent of UK households have buildings property insurance while 75 percent have home contents insurance (Euromonitor, 2004). Swiss Re, the reinsurance company gives a figure of 95 percent buildings insurance (Gaschen et al., 1998); the discrepancy may be accounted for by looking at owner-occupied households only. Most mortgagees hold buildings insurance as a loan condition and in the past this has tended to be held with the lenders insurer. The propensity to buy property insurance is heavily linked to income: 92 percent of households in the highest income quintile (the top 20%) have contents insurance while only 48 percent of the lowest quintile is insured. For buildings insurance the division is even greater with 87 percent of the highest quintile purchasing cover but only 26 percent of the lowest quintile. (Some of these may be insured via their private or local authority landlord) (Euromonitor, 2004). This implies that in a flood situation there will be a substantial uninsured sector particularly if the affected area is one of low average income.

Crichton (2005) suggested that this may well be the case as in the past cheap flood prone land was often utilised for local authority housing. Much of this property may have passed into private ownership under the "right to buy" scheme. Fordham and Ketteridge (1995) discussed three historic cases where lack of insurance was common: a case in Perth where the majority of flood victims were in local authority housing, the differential between the support offered to local authority tenants and private owners caused division in the community; Towyn 1990 where a large proportion of retired people living on state pensions were uninsured; and Paisley in 1994 where residents of Ferguslie Park could not get affordable insurance (due not to flood risk but theft and vandalism claims). After the flood emergency state handouts were necessary and this caused resentment in the wider community.

5.4 RECENT DEVELOPMENTS IN THE MARKET

Section 5.3 discussed the competitive and fragmented nature of the insurance market and showed that householders seeking cover will have a wide choice of companies and policy options. However for the floodplain resident recent developments in insurance markets may have added to the complexity of their insurance choice while narrowing their choice options. Changes in the pattern of weather claims over the past decade as discussed in section 2.3 have sparked a reassessment of the industry attitude to flood risk (Dlugolecki, 2004). In addition developments in the delivery of cover to the policyholder and greater provision of information on flood risk has impacts on the ability of the insurers to distinguish between properties. These developments have led to reported difficulties for floodplain residents in obtaining cover at a reasonable cost.

5.4.1 The impact of climate change

Weather related claims in general and flood claims in particular have grown substantially in recent years. Floods in 1998 cost insurers an estimated £500 million and in Autumn 2000 flooding of about 10,000 properties swallowed an estimated £1 billion of insurers money (Dlugolecki, 2004). Claims are estimated to have doubled over the five years to 2003 when compared to the previous five years. This trend looks set to continue: an ABI sponsored report by Dlugolecki (2004), for example, forecast an increase of 2-4% per year. River flooding in an extreme year was projected to cost an average £4.5 billion and coastal flooding in an extreme year could cost £40 billion by 2050. These scenarios compare unfavourably with the estimates of current premium figures in section 5.3.1, if premium income alone is considered it could take the industry ten years to recoup the cost of an extreme coastal flood, leaving aside all the other claims made on domestic property. The insurance industry has a duty to its shareholders to address these profitability issues via increased premiums or reduced exposure to flood risk.

5.4.2 ABI "Statement of Principles"

After the flood events of autumn 2000 a debate was initiated as to whether the insurance industry could continue to honour the inequitable "gentlemen's' agreement". The ABI sought to take a leading role in driving change and encouraging other stakeholders in the property market to bear more responsibility for flood management. New planning guidelines and pledges of higher government spending have resulted from the debate and at the time of writing the agreement remains largely intact having been renewed in 2002 and 2005 (ABI, 2002, ABI, 2005a). For most properties, those that are protected to the Department of Environment, Food and Rural Affairs' indicative minimum standard of 1 in 75 years, there should be no change, apart from perhaps raised premium, to the standard cover which they have enjoyed previously. Domestic and small businesses will find it equally easy to find cover.

Since the 2000 event many flood defences have been strengthened and more are planned to be strengthened based on Environment Agency assessments of the cost benefit of such capital works. Existing policies will be maintained in these areas in the expectation of a reduction in future claims. More importantly for research into property value the current insurers will insure new owners subject to satisfactory information about them. This promise implies that homes in high-risk areas can be sold, providing defences are planned, and encourages disclosure of the flood risk category during property transactions because insurers will switch the policy to the new owners in most cases.

Houses in the worst category, those where no defence improvements are planned, may face the situation that cover is withdrawn or maintained at a punitive premium rate. The ability to sell such property could be severely restricted.

In summary it would follow from the new statement of principles and would appear from media and anecdotal sources that, while for most home owners the "gentlemen's agreement" remains intact, the market is changing for those in the highest risk areas and that in the future insurance costs are to be more closely linked to flood risk. If insurers seize upon this agreement as a license to drop potentially expensive policies the next major flood event could result in severe hardship for its victims.

5.4.3 The move to direct distribution channels

One of the major recent changes in selling of insurance policies in the UK has been the move into direct selling. In the past the majority of owner occupied households purchased their buildings insurance along with their mortgage. The underwriting would be done en-bloc between the building society and their insurer. An implication of this situation was that many insurers had very little information about the properties they were insuring and therefore premiums were largely divorced from risk. Contents insurance has always been optional but for convenience many homeowners keep both policies with the same suppliers.

The advent of direct phone selling, most noticeably by Direct Line first began to challenge the mortgage lenders partial monopoly. Mortgage providers have the right to evaluate alternative buildings insurance policies taken by their mortgagees because they need to ensure that their investment is well protected. Some loans providers charge a reading fee to ensure that insurance is adequate on the property while others reserve the right to refuse a switch. Direct Line estimate that high insurance fees from tied policies cost the UK consumer £400m per year (Direct Line, 2002). The company has attempted to initiate changes in the law to outlaw the reading or switching fees associated with mortgage insurance, and had a policy of paying those fees for customers who switched to them. The Internet, with its associated ease of checking multiple policies has increased the trend away from mortgage tied insurance. Internet sites exist which will make comparisons between several insurers within minutes. Furthermore, online purchase out of office hours is possible.

An even more recent development has been the selling of insurance by supermarkets and utilities suppliers. The convenience factor and the discounts available for combining utility bills with insurance probably explain the popularity of this sector. Banks and building societies are also now targeting customers directly as insurance providers using their position of trust. Many of these new suppliers may be acting effectively as agents whilst others have set up or bought up their own insurance arm (Defaqto, 2003). These changes decouple the linkage between mortgage and insurance, although the eventual underwriters may remain the same. The changes have the potential to lead to more correlation between risk and premium as policies are undertaken on an individual basis rather than as block policies and insurers can obtain more detailed information about the property they insure.

Direct sellers have changed the dynamics of underwriting. Their reliance on information technology using large customer databases to produce quotes automatically results in inflexibility. Customers whose circumstances require individual underwriting judgements are rejected. Some low cost providers are selecting "good risks" and thereby ruling out any households that live in the flood plain (Keynote, 2004). In 2002 Esure declared that they were positioning themselves as the number one provider for low risk policyholders and alerted the media to the worry that some people would find it difficult to insure their homes. Esure estimated that an annual saving of £30 per policy could be made by excluding high flood risk houses from their cover (Stevenson, 2002). For phone and Internet underwriters, the refusal to insure houses in flood risk areas has become a common stance.

5.4.4 Flood risk mapping

In addition to the greater incentive to price flood policies effectively there is also improved information now available for insurers to quantify the risk of flood as described in section 2.5. The Environment Agency has developed flood risk maps within England and Wales for coastal and riverine flooding. A free internet based service for the general public is available that will give a risk rating based on postcode. The underlying maps were subject to a great investment to improve reliability in 2004 (Bradbrook et al., 2005), and a more detailed risk profiling service is available for insurers. Despite the acknowledged poor quality of the data in some areas the new flood maps are being used by some insurers. Royal Sun Alliance have developed an intranet system allowing underwriters to access flood risk information by full postcode (Crichton, 2005). Norwich Union has tried to take a lead in the area of flood mapping by commissioning their own UK height map and combining it with flood flow information to assess risk on an individual property basis. They have now made this information commercially available to others. As these initiatives feed through to the insurance community they enhance the probability that risk based pricing will become the norm.

5.4.5 Implications for flood risk properties

From the above analysis of market dynamics and official insurance industry statements there would appear to be implied consequences for owners of property at risk of flooding. It is possible that any property owner designated at risk of flood, however slight, may experience difficulty in obtaining insurance cover, could see an increase in insurance premium and may have to approach several companies before gaining a policy.

For those moderately or severely at risk, where cover is achieved in the full acknowledgement of flood risk, the cost of premium is likely to be increasing towards an actuarially fair rate which may be double their previous rate or more.

Some individuals inhabiting the most frequently flooded property outside the planned defence areas may find it impossible to gain cover. They may have to accept flood exclusion or excess charges which would exceed anticipated flood damage claims.

If these implied effects are reflected in real underwriting decisions there will be further implications for the floodplain resident associated with high premiums or lack of insurance such as the inability to raise finance against their property investment. The most relevant implication to the current research would be the inability to sell a property due to the high insurance cost or lack of insurance. The way in which this might operate is discussed in sections 5.5 and 6.5

However, the implied impact on insurance cost and availability has not been measured by any published academic study and remains open to debate. Market dynamics take time to feed through to actual premium costs and published policies are not always adhered to. The fact that published statements and market dynamics predict that premium costs will increase for the floodplain resident does not mean that they have already done so. For example in a Consumer Association survey of forty three insurers (Which?, 2005), nine insurers said they would automatically turn down new customers who had made a flood claim. However, of the remaining 34 companies, while most said they might exclude cover for future flooding they also indicated that they would insure on a case-by-case basis. The evidence for premium price increases is considered in section 5.6 below.

5.5 INSURANCE LITERATURE RELATING TO FLOOD INSURANCE AND ITS IMPACT ON PROPERTY VALUE

This section discusses some theories of insurance relating to the impact on property value. Insurance literature and risk management is a wide topic and so this review has pragmatically concentrated on models encountered in the narrow literature relating to flood risk and property value. This falls broadly into the utility model and borrows concepts from decision theory. However as shall be shown in section 5.6 much of the theory is not applicable in the UK market and so in-depth analysis is not undertaken.

5.5.1 Arguments from utility theory

The notion of handling the uncertainty of flood damage via utility theory and the impact of this upon property value has been extended to include the insurance dimension by MacDonald et al (1987) and others. In summary, the theory proposes that the purchase of insurance cover is an expression of willingness to pay for reduction of an unpleasant event, in this case the financial loss from flooding. When a property with high flood risk is sold, the discount in value (when compared to a similar, low-risk property) represents the amount an individual is willing to pay to permanently remove the risk of financial loss from flooding. The extension of the theory in the presence of insurance is that the reduction of the flood hazard can be alternatively effected by purchase of insurance or by removal from the floodplain, the utility of either strategy being equal. Under the restrictive conditions that insurance payments in the event of a flood cover the entire cost of flood loss, the expected amount that a householder would be willing to pay is equal to the present value of insurance premiums in perpetuity. If there is a difference between the two amounts, the theory proposes, this could be due to concern that insurance will not cover all the losses or compensate for emotional upheaval and other intangibles. Some authors suggest (Macdonald et al., 1987, Shultz and Fridgen, 2001) that these theoretical values could be used to calibrate or even substitute for measured property price impacts of floodplain location. They suggest this in the light of empirical results which are consistent with the theory.

However there are some contentious assumptions inherent in the above proposal, two of which are whether or not householders purchase insurance when it is available and whether property buyers are aware of insurance obligations and costs at the time of property purchase. According to Harrison et al (2001), where coverage is not compulsory and universal, discounted insurance should be seen as an upper bound of the value discount due to flood. The propensity of floodplain residents to buy flood insurance is discussed in section 2.7.1 and it is recognised that, on the whole, coverage is low. In section 2.6.4 the variability in perception of risk was also mentioned and in the next section they are further explored.

5.5.2 Decisions under uncertainty

If the willingness to purchase insurance is seen as the willingness to pay to avoid disutility associated with a given risk then the arguments above will be valid if all parties evaluate risk equally. However the gulf between the perception of risk by floodplain residents and the scientifically assessed or official risk designation has been recognised before in chapter 2. In the valuation of expected damage due to flooding both the expected incidence of flooding and the anticipated damage levels caused by a given flood can be subject to widely varying estimates from property stakeholders and insurers. Bin and Polasky (2003) observed an illustrative example of this gap in perception in practice: Hurricane Floyd resulted in an increase in the devaluation suffered by flood-prone property although the insurance premium did not change. The risk perception of the house-buying population was clearly affected by the hurricane whereas pre-event high insurance premiums had not been translated into devaluation.

In the UK a great deal of uncertainty about the risk of damage to property at risk of flooding exists not only in the minds of the general population but on the part of insurers. The choices of individuals under uncertainty, and in particular with respect to low probability high loss events, have been argued to deviate from the classic utility theory (Kunreuther, 1974, Camerer and Kunreuther, 1989, Kunreuther and Pauly, 2004). Multiple causes of such deviations are summarised in Camerer and Kunreuther (1989) including a threshold probability below which individuals ignore risk, and for most property in the UK the likelihood of a flood event would fall into this category. Asymmetric views of losses and gains, general optimism and availability of data are also quoted. Correspondingly numerous alternatives and modifications to utility theory are suggested in the paper but many have yet to be tested empirically. The purchase of insurance for low probability high loss events has been addressed by Kunreuther (2004). One major barrier in the uptake of insurance is proposed to be the cost of obtaining information and forming an opinion about the cost benefit of investment in insurance. The author also discusses the situation where insurers hold different information and thus charge different premiums and concludes that the necessity of searching among suppliers may be an added disincentive to insure.

In short if property owners choose not to insure then one major cause may be that they perceive that their risk of damage from flooding is lower than the insurance premium suggests. Equally if this is the case then their expected disutility from flooding is by definition lower than the actuarial estimate and their willingness to accept property value discount due to flood risk status will be correspondingly low. In this example discounted insurance premium will overestimate willingness to pay to relocate out of the floodplain.

Another major cause of not insuring may be the effort of evaluating the cost benefit of insurance. This may include financial and time investment in information gathering and mental and time investment in processing information. This effort would also be involved in valuing the disutility of floodplain location during property valuation, again implying that insurance discount will overestimate their willingness to pay.

Affordability of insurance premium in relation to absolute levels of wealth of an individual is another consideration in the propensity to insure. In the low income sector this is a major policy issue (Joseph Rowntree Foundation, 1998), largely outside the scope of this research. High cost flood risk insurance bundled with general property insurance may lead to larger numbers of individuals failing to insure and thus become a social policy issue. However, for the purposes of property valuation low income individuals might be regarded as unable to accept the discounted valuation due to flood risk, unless they are subsequently moving to another at-risk property. Thus their lack of ability to pay for insurance will be reflected in a low ability to accept discount. Once again implying that discounted insurance premium will overestimate property discount.

5.5.3 Empirical studies

Those authors who have compared the discounted premium to property devaluation (Macdonald et al., 1987, Shilling et al., 1989, Shultz and Fridgen, 2001) have generally found results which accord with utility theory. As an alternative to making assumptions about the relationship between insurance and property price, some authors have included a measure of insurance cost into a hedonic price model. Shilling et al (1989) included a combined insurance cost/flood dummy variable into a conventional hedonic model and compared this with a straightforward dummy variable for floodplain location. There was very little to choose between the two models and the impact of other variables did not change.

Speyrer and Ragas (1991) included insurance as a rate index in their model. The rate of insurance - the insurance cost divided by unit sales price - was expressed as a percentage of the average rate of insurance. In this way a semi-continuous variable can be constructed. The rate of insurance was substituted into the model in place of flood zone location. The impact of insurance rate index on price was found to be significantly lower than might have been expected from comparison with flood-zone dummy models of the same data. Direct comparison of the two models presented in the paper is not possible because different locational variables are included. The adjusted R^2 for the alternative models are very similar, and most of the estimates of elasticity for property structural variables are remarkably robust to the model form.

The problem with this sort of analysis in terms of attributing a causal relationship between insurance cost and property value is that the two different flood variables, zone status and insurance cost, are treated as interchangeable as indeed they largely are in the US. Since insurance rate is dependent on flood zone status and insurance costs are wholly determined by rate and assessed value, a cross-sectional hedonic model cannot be used to distinguish between the two effects of flood zone status and insurance cost.

Timing of market events can give information about causality that cannot be gauged from a purely cross-sectional model. Skantz and Strickland (1987) analysing two events, a flood followed a year later by an increase in insurance premiums, demonstrated that it was the insurance rate rise and not the flood event that sparked the reduction in price. An adaptation of events analysis from the world of finance was used. This method looks at the cumulative average forecast errors from a model estimated before a given event, the non-flooded subdivision performs in line with this previous model whereas the flooded properties show a systematic bias. This kind of analysis can yield interesting results if timing of specific events is well established and the impact of any coincident events can reasonably be disregarded or isolated.

5.6 PROBLEMS IN APPLYING MODELS WITHIN THE UK MARKET

It has been demonstrated above that assessing the impact of flood insurance is complex in general. There are two additional major obstacles in carrying out empirical studies of the impact of flood insurance on UK property which are due to the unique nature of the flood insurance market in the UK. The first is the fact of the bundling of flood insurance into standard policy implying that a deliberate choice about insuring the flood hazard is not taken by the policyholder. The second is the lack of data on the price of flood insurance. The first causes problems with the theoretical formulation, the second with the practicalities of estimation. These two difficulties are explained in greater detail below.

5.6.1 Theoretical difficulties

The inclusion of flood insurance into general property insurance in the UK has many implications. As mentioned in earlier in this chapter this means that for most purchasers, those who require a mortgage, general buildings insurance and therefore flood insurance will be compulsory. This implies that the cost of the risk of flooding will be spread over a wide population not just those at high risk of flooding. Even for those who can chose not to purchase insurance flood risk is unlikely to be the deciding factor in their eventual choice because flooding is just one of a large number of risks covered. The notion of insurance cost expressing a willingness to pay to avoid flooding is therefore not relevant.

If insurance cost is to be built into the value of property then it must be assumed that knowledge of this cost is available to all parties at the time of property price agreement. It is not clear whether or not this is the case for the UK property transaction. There is no statutory requirement for disclosure but it is possible that the process of obtaining finance might amount to disclosure for practical purposes.

It might be possible to isolate the element of insurance premium relating to flood risk if there were a large flood risk loading on premiums in flood risk areas. Since insurance is mandatory for many purchasers and in practice domestic insurance coverage is high, if a loading factor could be established, it could be used to predict the amount a rational purchaser would be need to discount property value to offset this future expense. Unfortunately as will be shown in 5.6.2 it has not been possible to isolate a flood loading factor in the competitive UK market.

The alternative strategy of using the timing of insurance changes in the form of an events analysis type measurement is also inappropriate in the UK because it relies upon a single change in insurance rates. In the UK market price changes will be spread over time and may not be universal because of the competitive nature of the market so event timings are not discrete.

5.6.2 Availability of data

Perhaps because, in the UK, flood cover is provided by private companies there has been little publicly funded research into the cost, availability and take up rates of flood insurance. Anecdotal evidence is available about the increased cost of insurance in flooded areas: One property owner, moderately at risk of flooding and with a storm claim had received quotes varying from £819 to £400 from different insurers (Which?, 2005) despite explaining to each one that her house is built up several metres from the ground (compare this to an "average" premium of about £300). Excesses of £5,000 or even more are being applied to some high-risk properties (Crichton, 2005). Crichton (2005) also noted that the chairman of the All Party Parliamentary Group on Insurance and Financial Services, complained to the ABI that some constituents had suffered from increases in premium of up to 250%. Further evidence from Crichton (2005) citing Datamonitor, suggests that the average premium for a flood risk postcode is double the average household at £600.

There is very little formal and publicly available research, however, that quantifies the increased cost a flood victim can expect to pay for home insurance. Two sources that attempt to do so are Moneysupermarket.com (Modcock, 2003) and the Lewes flood action group (Lewes Flood Action Group, 2004). There is an important distinction in the approaches of these two studies. The first considers flood risk as defined by flood mapping, the second looks at the experience of properties actually flooded where, presumably, claims have been made and the insurer and insured have a joint history.

Moneysupermarket.com carried out a survey of insurance quotes for flood risk postcodes versus flood free ones (Modcock, 2003). They reported an increase of up to 60% but also said that by shopping around substantial savings could be made.

Lewes flood action group carried out a survey of 800 properties in the aftermath of severe flooding in 2000. The survey was carried out in 2002/2003 and most of the renewals should have been covered under the original "gentlemen's agreement" thus refusal should have been rare. Two hundred and fifty-four responses were received, a good response rate (not necessarily an unbiased one), which included both business and residential properties (not all commercial properties came under the "gentlemen's agreement"). Forty-five refusals of cover were reported, the majority of these refusals were for residential properties. Under the conservative assumption that all householders who had been refused insurance replied to the survey this represents 6% of the flooded properties, (18% of respondents). Just under half of the respondents reported significant changes.

While these results must be approached with caution they do represent the only systematic evidence about post flood insurance rates paid by householders. A conservative estimate is that 14% of policyholders suffered significant changes alternatively it may be that the figure is as high as 45%. The converse view is that over half of the flood victims who responded reported no substantial change. The survey does not record whether these properties remain uninsured or went on to gain cover from somewhere else.

The most important thing that these results demonstrate is the inconsistency displayed by insurers. It reinforces the desire to understand the insurance market from a consumer's point of view because knowledge of the policies of the various insurers and their national coverage rates will not tell us what the home owners in the floodplain are actually paying for cover. Crucially, if it is not possible to detect and measure a flood insurance premium loading due to flooding or flood risk then the hypothesis that increased premiums will have an impact on property prices cannot be tested.

5.7 SUMMARY

In the UK, flood insurance is included in the standard household policy. This is a fairly unique position worldwide. Most countries have a much smaller and more specialised flood insurance regime. The cover in the UK is provided by private companies and is protected by a statement of principles that ensures that most homes can get insurance. There are some properties that fall outside the agreement, notably new build and frequently flooded property with no prospect of new defences.

The increase in severe weather claims in the last decade has put severe pressure on insurers to raise rates for high flood risk areas. Competitive pressure within the wider domestic property insurance market makes the targeting of lower risk policyholders desirable. These factors and other recent developments are predicted to result in a closer link of premium to risk in all areas and particularly to flood risk.

There is very little research into the impact of these changes on the homeowner in flooded or flood risk areas. The available evidence suggests that, because insurers are pursuing different pricing policies, some policyholders are suffering large cost increases while others are not. A true measure of the increased insurance cost of flooding to homeowners can come only from the householders themselves. Therefore a survey of homeowners will be necessary in order to assess the scale of any increases in the cost of flood insurance and the prevalence of exclusion from flood cover. The survey design is presented in chapter 7.

The availability and cost of property insurance is an important factor in the sale of domestic property. Studies in the UK have identified that if insurance is not available the property transfer may be problematic. However, previous research has not established a causal model which explains the action of insurance on property value in the unique UK market. Theoretical models of utility predict that the purchase of insurance reflects the willingness of property owners to avoid the risk of flood. These models are not directly applicable in the UK for both theoretical and practical reasons. It will therefore be necessary to develop a new conceptual model for the action of the cost and availability of flood insurance in the UK market. This development is presented in chapter 6.

Chapter 6 CONCEPTUAL MODEL DEVELOPMENT

6.1 INTRODUCTION

This chapter presents the conceptual model developed in the light of the extensive literature review. This model has been developed to address identified shortcomings in previous studies but also to take account of specific difficulties within the UK market. The conceptual model includes three novel features: a time-varying repeat sales specification; new hypotheses about the action of insurance upon the property transaction; and the concept of the three dimensional nature of the flood status of a property. The hedonic specification adapted for flood impact measurement and for the UK market is presented in 6.2. The need for a time varying specification is described in 6.3 and the repeat sales formulation follows in 6.4. Section 6.5 describes the hypothetical action of insurance and 6.6 the three dimensional nature of flood status.

Estimation of the parameters of such a conceptual model is problematic in the UK market however. The issue of data availability is an enduring theme of the research as has been touched upon in sections 4.5.3 and 5.6.2. In section 6.6 the data issues are fully explored and the notion of increasing the available data by combining flood locations via a block design is outlined in section 6.7. Finally section 6.8 summarises the three models which will be estimated, one using only secondary data and the other two also incorporating the questionnaire data.

6.2 HEDONIC MODEL FOR THE UK MARKET

Using the theoretical hedonic framework for house prices as presented in Rosen (1974) and others a new adaptation for the UK market can be presented. Figure 6-1 shows a representation of the standard hedonic cross-sectional model adapted for the UK with the addition of flood status and insurance variables. The candidates for the raw independent variables for inclusion in the model have been used in hedonic studies of the UK housing market. Locational and environmental variables have been combined into "locational desirability" while the flood status and insurance cost have been clearly separated out. Variables impacting on the cost of insurance have been taken from the automated quote agents on the websites of insurance companies, from the BCIS rebuilding cost calculator (ABI/BCIS, 2005), from commentary in Doornkamp (1995) on the provision of subsidence insurance in the UK and from the categories used by the AA in conducting their premium index survey (AA, 2005). These have been confirmed as important through interviews with brokers and insurance company representatives.

The flood status variables are subject to an in depth analysis in section 6.6 because of the difficulty of inclusion within a standard framework. The hypothetical actions of insurance in the UK are discussed and it is seen that within the current framework, only one of these actions will be formally tested, although the others will be touched upon. A theoretical model is presented which will allow for combining the analysis of flood impact with the attribution of that impact to the separate elements of flood status.

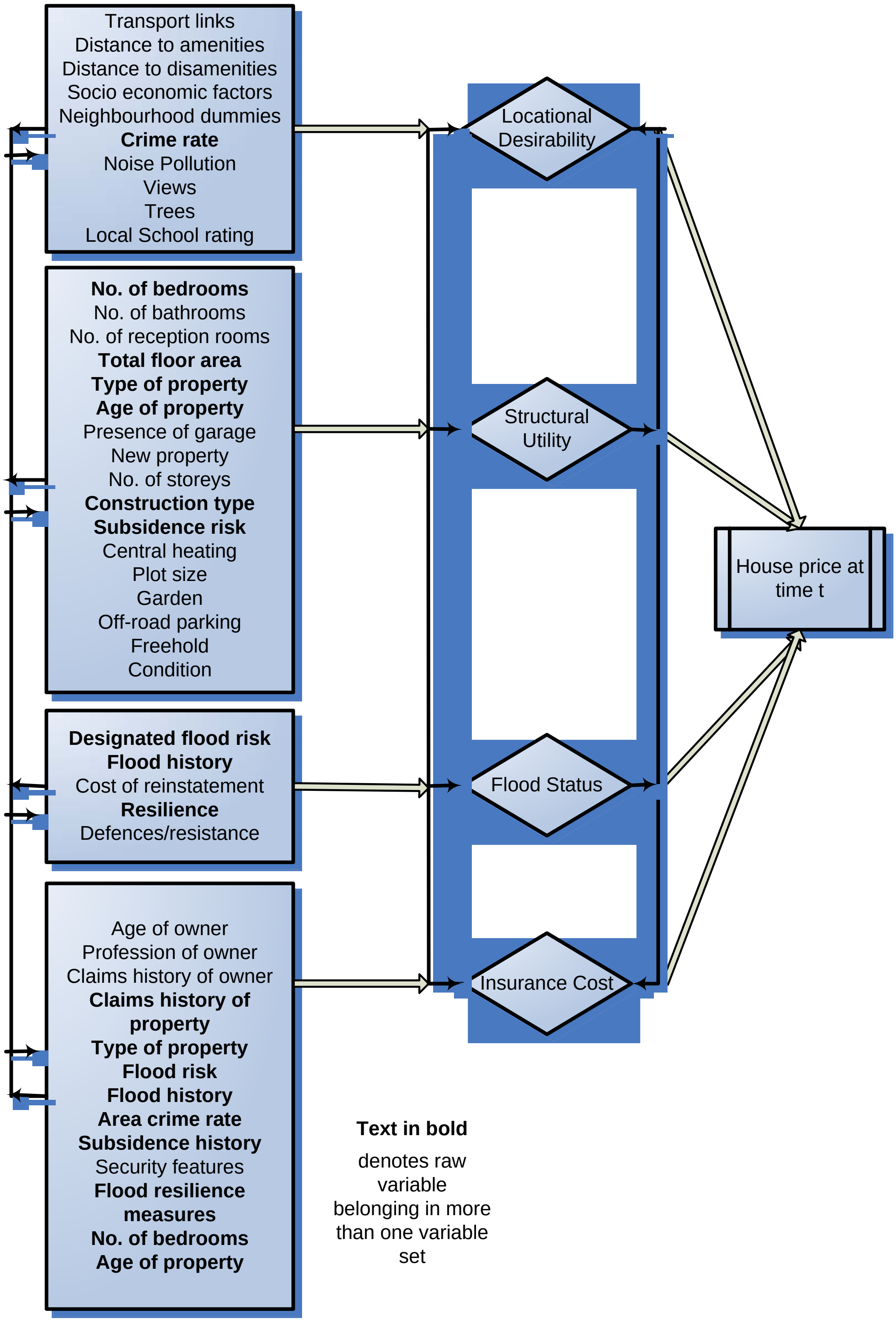


Figure 6-1 : Hedonic specification for the UK market including flood variables

6.3 THE REPEAT SALES SPECIFICATION FOR THE UK MARKET

Adaptation of the above hedonic specification to a repeat sales specification is possible using the comparison of serial sales of the same property. If a property's characteristics do not change between sales then the change in its price is due to one or more of the following factors: inflation; any major changes in locational variables such as installation of new transport links; and some random variability. In constructing repeat sales models it is necessary to assume that the valuation of amenities (other than the flood effect) does not change with time and the flood event. Palmquist (1982) tested for this assumption using a full hedonic model and repeat sales on the same area and concluded that assuming constant coefficients would not reduce the explanatory power of the model. However, in the UK flooding context, the burden of collecting the necessary data to perform this check is prohibitive.

Also inherent in the repeat sales approach is the assumption that property characteristics do not change between sales. Properties with large structural changes can be eliminated by examination of planning records but there is no readily available measure of property condition. In the analysis of flood damaged property, the condition in which a property is sold is a key variable; one might expect that any property that sold up to six months after a flooding incident will be sold in a poor condition. Properties sold after reinstatement might well have improved condition. The absence of condition information will be an issue for the study. In interpreting the results of the analysis this omission must be borne in mind.

Figure 6-2 shows the way in which a repeat sales specification of the full hedonic model in Figure 6-1 reduces the variable set.

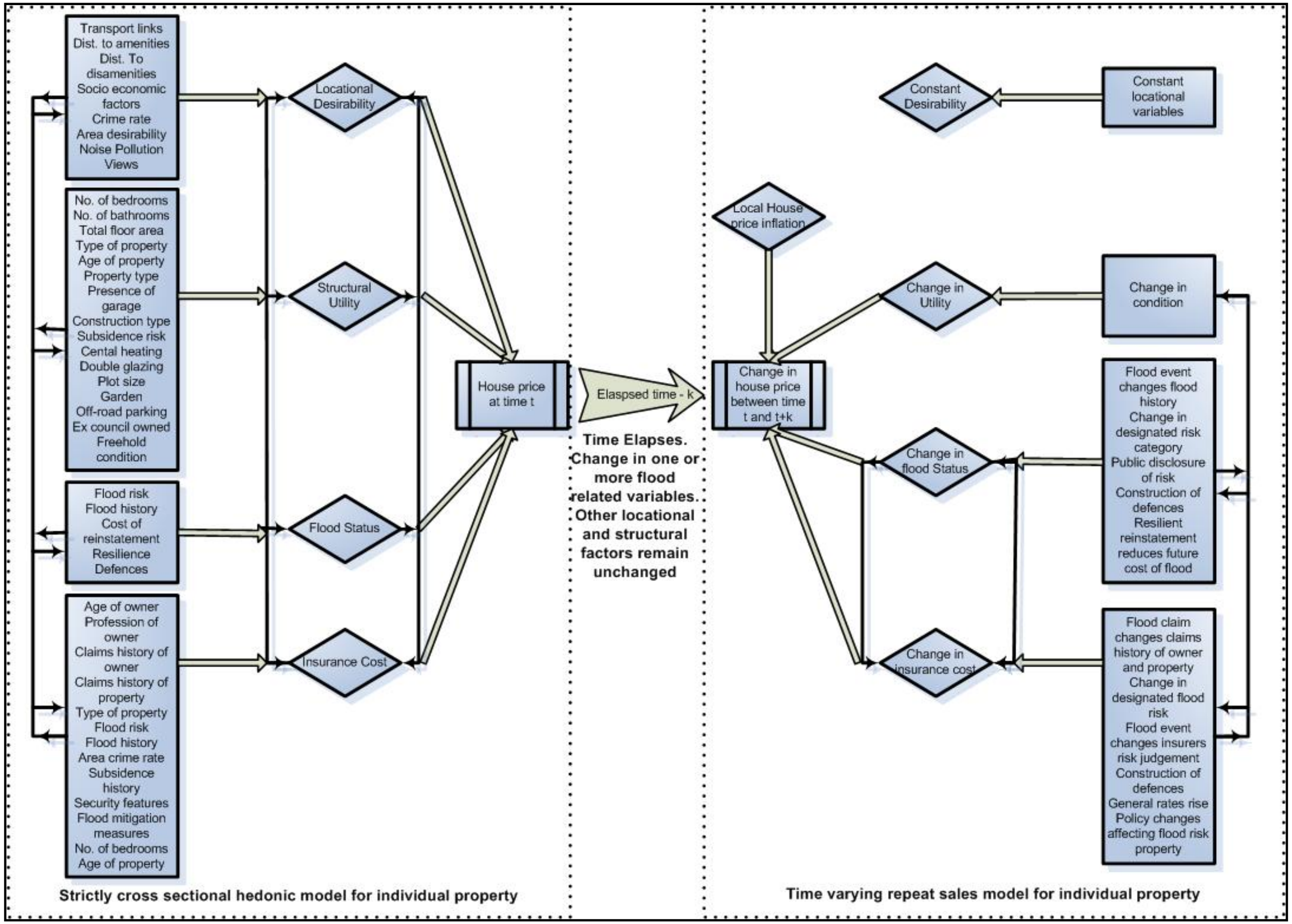


Figure 6-2 : Repeat sales specification for the UK market

6.4 THEORETICAL PROFILES OF FLOOD IMPACT ON PROPERTY VALUE

Tobin and Newton (1986) present a theoretical framework for the impact of flood event on land value. Integrating flood hazard research and urban economics literature they present charts of land value which vary with time and the severity and frequency of flood events. These profiles are examined in the context of actual flood events by Tobin and Montz (1994) who suggest that the speed and scale of the recovery in value is dictated by various socio-economic and environmental characteristics in addition to the flood characteristics. The profiles can be further developed, based on scenarios encountered in the literature into four fundamental profiles as discussed below, for clarity inflation has been ignored. These recovery profiles, if borne out in UK examples, can form the basis of prediction of the impact of future flooding events. Figure 6-3 shows a basic profile where a one-off flood event temporarily depresses prices and then over time the price level recovers.

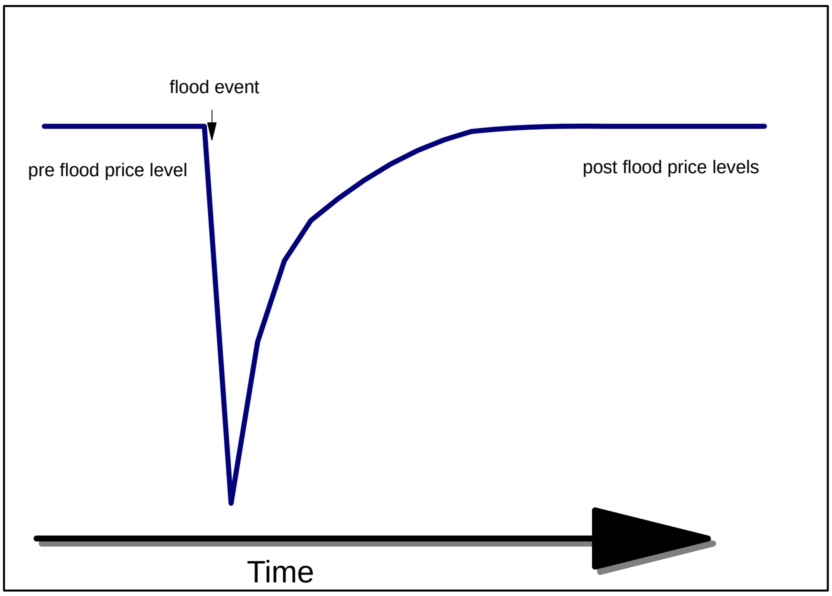


Figure 6-3 : Theoretical impact profile 1 - One off or infrequent flood

This profile might be observed under a number of conditions such as the occurrence of a flash flood in a low flood risk area. Since the risk of return is low there is no rationale for prices to remain low. In this case, the interval before price levels recover would probably be quite short, possibly as short as the time taken to reinstate the property. Price trends following a flood in a moderate risk area could also display this profile, as was seen in Sydney (Eves, 2004). The recovery happens as people collectively forget about flood risk, and so the recovery time might be expected to be longer than for a flash flood.

However, if flooding is regular and already capitalised into house prices then a study of an individual flood event might reveal no effect. Regulated disclosure or mandatory insurance could also cause this zero-impact scenario because a new flood event presents no new information to the property buyer. Figure 6-4 shows this theoretical profile.

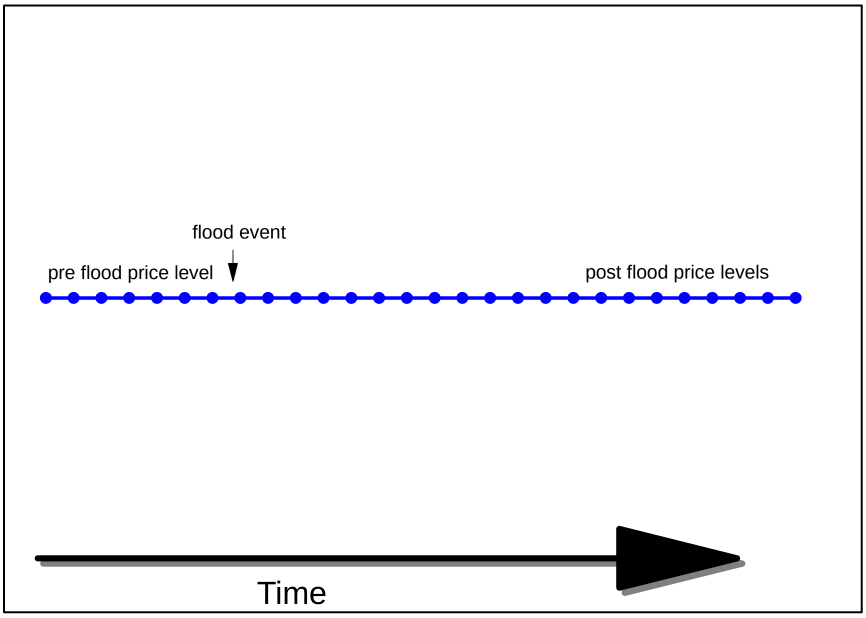


Figure 6-4 : Theoretical impact profile 2 - Flood effect permanently capitalised

The profile could also be observed in fully resilient housing whatever the flood risk category. Fully resilient property will experience inconvenience for the duration of the flood but require minimal clean up and costs should be reasonably low. This type of property might be regarded by a rational consumer as similar to a property with no risk.

Figure 6-5 shows the profile which might occur if new information were imparted by the flood and permanently changed the expectations of the residents. This might happen if a first flood occurred on a new estate where there was no previous expectation of flooding. It may also be observed if a flood signals a risk to the insurance community and brings with it financing issues for potential purchasers.

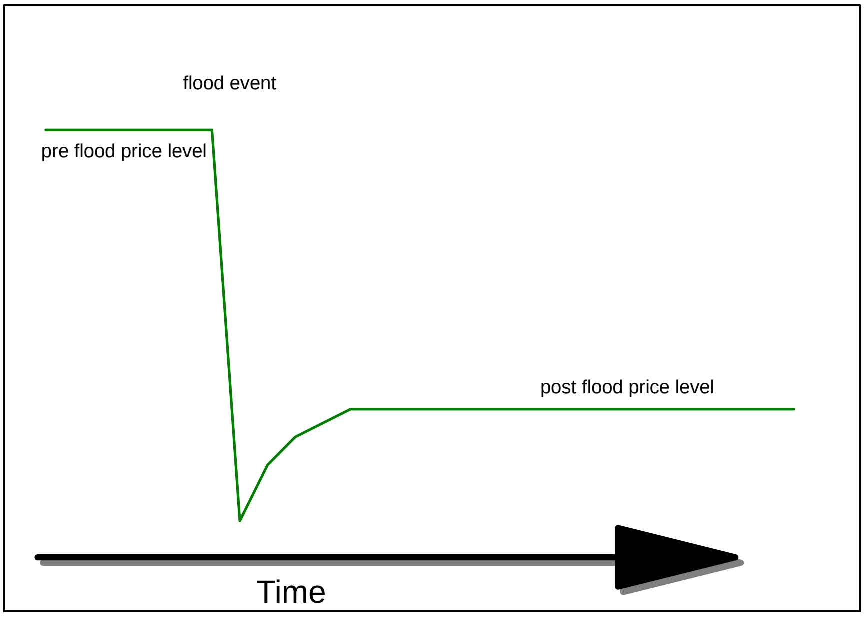


Figure 6-5 : Theoretical impact profile 3 - Flood effect becoming capitalised

This scenario may also be typical in high-flood-risk areas, where long gaps have occurred between events and the population have forgotten about the possibility of flooding. A renewed awareness may be generated by a new flood incident. This has been the case for many locations in the UK inundated in the 1998 and 2000 floods because they occurred after a prolonged dry period of about two decades.

The final profile (Figure 6-6) is included, despite being counter-intuitive because it was observed by Montz (1992) and by Tobin and Montz (1994). Here, post-flood values of flooded homes were seen to improve relative to non-flooded comparatives. This could be due to reinstatement of the property resulting in betterment as might be the case after a flash flood of an old property, particularly if that requires bringing up to building standards exceeding the original specification or involves updating fixtures and decoration. Another instance where it might be observed would be where flood defences are improved immediately following a flood event. This would not be a true flood effect but might be confused with flood impact.

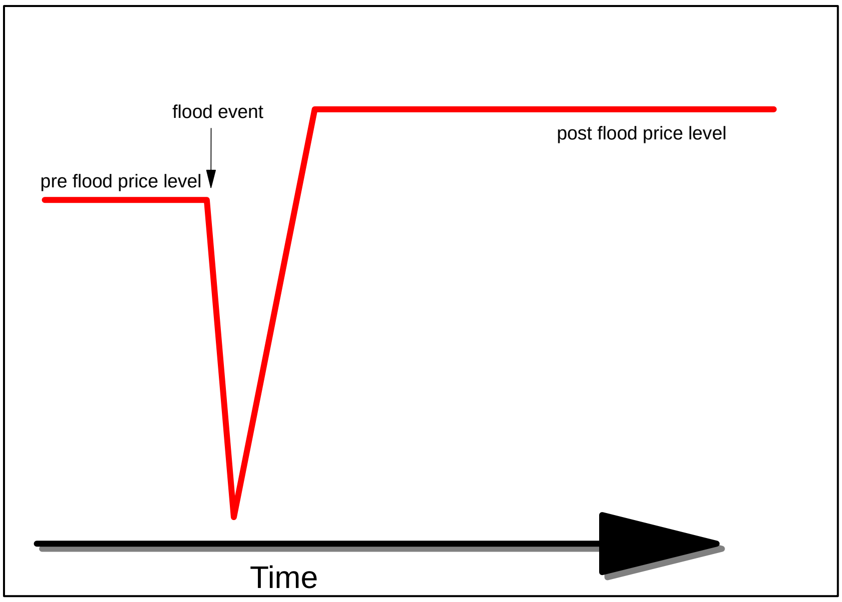


Figure 6-6 : Theoretical impact profile 4 -Betterment

These theoretical profiles, which have been derived from the international literature demonstrate the necessity of considering the temporal dimension in any study of the UK market. They also suggest that the flood impacts on property prices in UK flood sites are likely to vary greatly depending on local circumstances. Observed patterns of flood impact may fall into one of these profile types but may also display a combination of them, for example where improvements in flood defences follow closely but not immediately after a flood or where two floods occur closely together in time.

For the purposes of the empirical analysis the development of these flood impact profiles serves the primary purpose of demonstrating how flood impact can vary over time. The methodology described below is designed to detect this variable impact. The interpretation of findings from the empirical study may also be aided by the above discussion. In future research, if data was more plentiful, it might be possible to test for the specific profiles in an events or interventions analysis. Categorisation of flood location typographies could then aid in prediction of the likely impact for specific flood events in the future.

6.5 HYPOTHETICAL CAUSES OF DISCOUNT DUE TO FLOOD INSURANCE PROBLEMS IN THE UK HOUSING MARKET

As described in chapter 5 the market for flood insurance in the UK has many unique aspects and it is inextricably linked to the property market via financing. Notwithstanding the fact that many authors have discussed the link (Clark et al., 2002, Eves, 2004, Building Flood Research Group (BFRG), 2004) there has been little clarity in describing a mechanism by which insurance cost and availability can impact on property price. In previous studies of flood insurance the concept of discounting the future cost of insurance premiums as an expression of payment to avoid flooding has been used, mainly in the US. However, within the housing transaction the cost and availability of insurance could potentially act as a severe supply side imperfection as surveys of valuers have revealed (Building Flood Research Group (BFRG), 2004, Eves, 2004). This section summarises the way that insurance could have an impact on the property transaction in the form of three hypotheses.

The Cash Buyer Hypothesis: Properties on which their owners cannot get insurance or can only obtain insurance with an excess charge over £2,500 will be regarded as a risk by mortgage lenders. They will therefore be subject to a discount due to the need to attract a cash buyer or a low loan to value ratio buyer. This might result in observed price drops for such properties but the impact on price may be concealed due to non-entry of these properties into the market or withdrawal due to lack of offers. Eves (2004) asked about financing issues in his survey and found that in some areas difficulties in obtaining insurance had led to financing restrictions. Some evidence to support the cash buyer hypothesis was also encountered during the survey of valuers carried out by BFRG (2004). One agent was quoted as saying 'If there is a history most owners and agents have been aware, sales are to cash buyers reflecting problems with insurance cover. They tend to be rented out or owners just stay there unable to take the hit on value.'

The American hypothesis: High flood insurance premiums are a disincentive to purchase and result in a continuous loss of value proportional to the insurance rate.

This is the hypothesis underlying the inclusion of insurance rates into hedonic models and also the discounted premium model prevalent in the US. House buyers act in a rational manner substituting avoidance of risk via insurance for physical avoidance, sellers accepting cash discount as a substitute for physical evacuation. In the presence of insurance, insurance rate rather than direct damage cost is the rational calculation.

The Disclosure Hypothesis: In the UK because disclosure of flood risk is not mandatory during property transactions, a high insurance quote or refusal may be the first signal of flood risk. Awareness of flood risk is generated regardless of whether or not the potential buyer accepts the high quote or can gain finance. This might result in the collapse of a sale or in price renegotiation regardless of eventual insurance rate achieved. This eventuality was mentioned by valuers in the BFRG(2004) survey, which cites 'Two occasions where insurance turned down based on potential risk, clients went elsewhere', these were houses that have never flooded. It must be noted that these quoted examples did not, at the time, represent a large proportion of property transactions and also that the fact that one sale fell through does not necessarily imply that any eventual sale would be at a reduced price.

These hypothetical actions are derived from supposition and examples in the literature but have not been tested using empirical data in the UK. As a first step towards an empirical validation the hypotheses are considered further below.

The most natural way to measure the action of insurance cost as represented by the American hypothesis is to include it in a hedonic model of property price along side the flood risk variable. This approach can be considered despite the reservations expressed about their use in the US because of the supposition that at present insurance cost in the UK is not wholly determined by flood risk. However, the inclusion of the absolute cost of insurance in a standard hedonic model will immediately cause some difficulties. The cost of insurance cannot be simply included in the model as an independent variable because it will be determined to a large extent by property specific variables, locational variables and personal details. Property variables and locational variables will themselves affect house prices independent of their action through insurance, therefore collinearity may be induced in the model. Use of a insurance rate variable as proposed by Speyrer and Ragas (1991) will partially solve this problem by removing correlation with structural variables.

Measurement of the supposed impact of the disclosure hypothesis would be highly labour intensive because it would entail tracking large volumes of purchases, and would use information about reasons for sale collapse which is not collected on a routine basis. However from a survey of floodplain residents some insight may be gained into the prevalence of insurance issues at the time of purchase and any potential correlation with realised price.

The cash buyer hypothesis contains two necessary conditions, first it is assumed that insurance problems result in cash buyer status, then it is assumed that cash buyer status causes a reduction in realised price. As with the disclosure hypothesis testing this fully would involve tracking the purchase process. However if the cash buyer status is true then a necessary but not sufficient correlation would exist between insurance problems at purchase and cash buyers. This correlation can be looked for in a survey of floodplain properties.

6.6 THE THREE DIMENSIONAL NATURE OF FLOOD STATUS

If the buyer is made aware of the risk to property of flooding during a property transaction the range of information available to quantify that risk can be conflicting. In the forgoing chapters the variable quality of flood designation has been noted. The lack of official sources for flood history has been detailed and the fragmented nature of the insurance market described. In considering the purchase of a property in the floodplain the buyer must weigh up all this information and decide whether to avoid the risk by buying elsewhere or to accept the risk due to some compensatory factor, possibly a financial one. There is no clear evidence to determine which aspect of the flood status of a property is most important to purchasers. Figure 6-7 shows the three dimensional space into which flood risk status may fall.

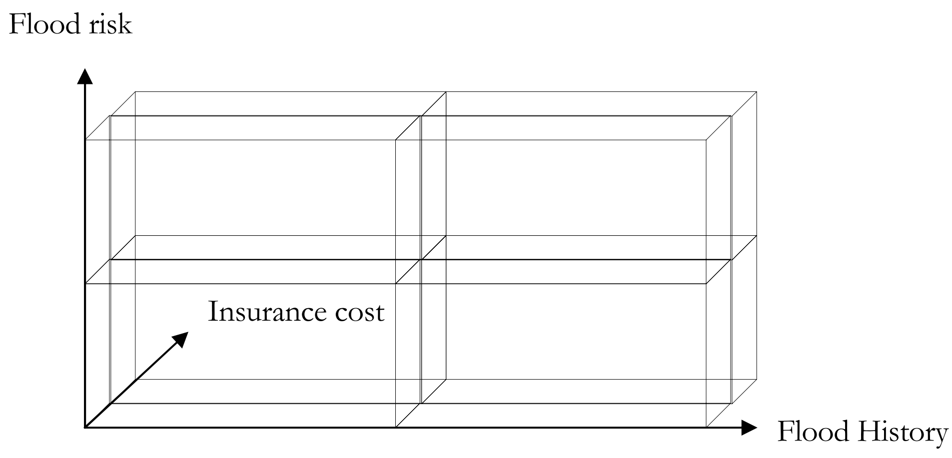


Figure 6-7 : The three dimensional nature of flood status

Under the assumption that a buyer can access information regarding these three factors in advance and that there are only two levels of each factor then there are eight possible variants of flood status. The best case scenario would be low risk, no flood history and no problems with insurance. The worst case scenario would be high risk, frequently flooded and no available insurance. If there are more levels of each factor the possibilities multiply quite quickly. In the UK, because flood history is not wholly reflected in designated flood risk and flood risk is not reflected in insurance premiums it will be feasible to observe houses in all categories. Therefore the effect of each factor on the value of transacted property can, in theory, be tested separately.

6.7 DATA ISSUES FOR THE UK MARKET

In estimating models of house price impacts within a given market the pragmatic researcher must consider access to appropriate data. As discussed in chapter 4 methodology used in housing studies is often determined by the limits of available data. A data review was an essential preliminary step before determining which estimation procedures would succeed in the UK market. Many issues concerning data have been discussed in the preceding chapters, this section summarises the data issues and the sources chosen for the present study. These decisions are linked to the choice and development of the novel methodology described below.

6.7.1 House price data

Data on asking prices of houses is relatively accessible on an ad hoc basis. Often, studies of house prices use asking prices taken from local estate agents or local press (Henneberry, 1998). In the case of a study of flooding, or indeed any newly introduced amenity or disamenity market reaction will take time to filter through to asking prices. As discussed in chapter 3 asking prices are not ideal for studies of the impact of disamenities on house prices.

Data on realised prices are available in Scotland via the Register of Sasines on an ad-hoc basis. However the difficulty in collating these records into an accessible form has made large scale studies problematic. Transaction data has been even more difficult to obtain in England and Wales where, until recently, the central source of such data, the Land Registry, refused to release the information. Since 2005 the Land Registry database has opened up and is now available at an individual property level from April 2000 to date. In summary the data available is the price of property transfers at market rates complete with date of transfer by residential address.

6.7.2 Descriptive housing data

In order to build hedonic models of housing markets it is necessary to obtain structural details of transacted property. The Land Registry only provides information regarding the type of dwelling (Flat, Semi or Detached), whether a property is newly built or not and the nature of land tenure. Details such as the number of bedrooms and other structural characteristics would need to be acquired from another source. Locational variables are similarly difficult to obtain, although they are more accessible since they can be determined from outside the property (Day, 2003). The main body of the study will be based on repeat sales methods in order to avoid the collection of property specific structural data and locational data. However, as discussed below, additional information will be collected for a subset of properties by means of a questionnaire survey. The number of bedrooms, age of property and number of storeys can be included in a truncated hedonic model for those properties.

6.7.3 Insurance premium data

Since insurance is the concern of private companies, commercial interests dictate that very little information is shared. Estimates of changes in average insurance costs are provided by the AA in their premium index, however these are not sufficiently detailed to pinpoint costs for any group of policyholders. A review of sources likely to hold insurance data was carried out in the initial phases of the research but identified no reliable and publicly available source of premium data.

Many of the problems in obtaining insurance data within the UK have been discussed in sections 5.4 and 5.6. In summary, surveys of published insurance rates for the UK are likely to overestimate the population affected by insurance problems because they cannot take account of the joint history of insurer and policyholder. In this instance, surveys of policyholders will give a more accurate picture.

The use of a questionnaire survey was therefore determined upon as the method of collecting insurance premium data for this study. Only a subset of properties could be surveyed due to time and cost considerations. The design and implementation of the questionnaire survey is described in section 7.6.

6.7.4 Flood history information

Studies which focus on a particular flood event necessarily require information about that event. Further information about the past floods will also be useful in assessing the significance of the studied event in the context of local flood experience. Flood history information is not routinely collected at the detailed level necessary for housing studies. Many previous analyses have encountered this difficulty (Skantz and

Strickland, 1987, EA/DEFRA, 2005) with the inability to definitively identify flooded properties.

It is often necessary to collate multiple sources of information in order to build up the best possible picture of flood history for an area. Institute of Hydrology (1999) suggests the use of rainfall records, local records, river authorities, parish registers, newspaper reports, the Dundee database and previous studies compiled for different purposes. Within this thesis many of these sources will be examined and referenced. However, it is beyond the scope of this research to provide forensic evidence of past flooding, in part because it is the intention of the research to address multiple flood sites. In order to remain consistent across sites a simplifying definition of flood history is necessary, despite the fact that this will be inaccurate in some cases. Categorisation of flood sites will be achieved via reference to textual information about flood history and defence improvements. For the main body of the research a property will be assumed to have a flood history if it is designated at risk and is within a location which has suffered flooding. This simplified flood history definition may also reflect the reality for a property buyer as they would also lack access to accurate flood history information. For a subset of individual properties, flood history information will be collected via the insurance questionnaire.

6.7.5 Flood designation

Flood designation can be determined from the Environment Agency profile maps. These maps change as new models are developed and new defences are installed The designation category of the properties used in this analysis is a snapshot, taken during 2007 and as such may be unrepresentative of the designation at the time of purchase.

This is an unfortunate limitation of the study which could not be rectified due to the reluctance of the Environment Agency to provide any better estimates. Interpretation via textual sources is possible in judging whether the designation will have changed significantly since the 2000 event.

6.8 METHODOLOGICAL DEVELOPMENT

To overcome the difficulties expressed above several novel model developments are presented here. These represent an original contribution to methodology of this research programme. The methodology is based upon a repeat sales specification of the general hedonic model adapted for the UK market as described above. The modifications described below are designed to combat the problems represented by small sample sizes, the time varying nature of flood effect and the three dimensional nature of flood status.

6.8.1 A time varying specification

Revisiting Equation 2 with the addition of a simple flooding term the growth in price of property i between time t and t+k is given by Equation 3:

Equation 3

$$\ln P_{i,t+k} - \ln P_{i,t} = \sum_{j-1}^{J} \beta_j \ln X_{j,i,t+k} - \sum_{j=1}^{J} \beta_j \ln X_{j,i,t} - \gamma Z_{i,t+k} + \gamma Z_{i,t} + c_{t+k} - c_t + \varepsilon_{i,\tau}$$

β_j = a vector of coefficients representing the elasticity of price with respect to the matrix of locational and property specific explanatory variables, $X_{jit.}$

Z_{it} is the flood status variable at time t with coefficient $-\gamma$ (0 if not previously flooded 1 if previously flooded)

$\varepsilon_{it,}$ the error term is distributed mean 0 and variance σ_e^2

c_t a generalised logarithmic market growth term.

Property factors such as size and age of house are assumed not to change significantly in the small time between t and t+k. Thus Equation 3 reduces to:

$$\text{Ln } P_{it+k} - \text{Ln } P_{it} = -\gamma(Z_{it+k} - Z_{it}) + c_{t+k} - c_t + \varepsilon_{i\tau}$$

In a flood free property the flood status component cancels out leaving the average growth in a flood free property determined by the market growth rate plus a random error. This is the basis of the repeat sales index as shown in section 3.6. For a flooded property the term will persist when t is a time before the flood and t+k is after the event. The growth effect of the change in flood status is estimated by Equation 4:

Equation 4

$$\gamma = -(1/n)\sum_{i=1}^{n}((c_{t+k} - c_t) - \ln(p_{i,t+k} / p_{i,t}))$$

where t is some time period before the event and t+k is after the flood, n is the number of properties which have a sale before and after the flood event and are in the flooded cohort. The percentage change in price due to flood becomes $(e^{\gamma}-1)*100$.

If the time periods are restricted to two: one before and one after the flood then the result is a model very similar to the "difference-in-difference" model of Gibbons and Machin (2005). Where, using the non-flooded property as a control to estimate c gives

$$(\ln P_{i2} - \ln P_{i1})^{f} = -\gamma(Z_{i2} - Z_{i1}) + (\ln P_{i2} - \ln P_{i1})^{nf} + \varepsilon_{i\tau}$$

and therefore

$$(\ln P_{i2} - \ln P_{i1})^{nf} - (\ln P_{i2} - \ln P_{i1})^{f} = \gamma + \varepsilon_{i\tau}$$

However in this analysis, if the 2000 flood event is to be measured, Land Registry data (which is available at a property level from April 2000 to date) covers a period of only seven months prior to the flood and six years after the flood. The observations are also likely to be sparsely spread through the time horizon. Thus it makes sense to introduce a more flexible time adjustment.

There are a number of ways to do this. Pairing sales to ensure that the average time between sales is the same for the non-flood and flooded cohorts is a simple option but involves reducing the number of observations still further. Gibbons and Machin (2005) estimate a time trend from their full sample although adjustments are made to allow for time trends which differ between locations and this is seen to affect the estimates of transport impact substantially. Rather than using the whole sample, the control population could be used. Growth rate can then be estimated using Equation 4.

These methods result in an estimate of event impact that is constant whatever the time elapsed since the flood event. Tobin and Montz (1994) and others have argued that flood effect declines with distance from the flood event. If the control population is used to estimate underlying market growth, c, then the difference in growth at each point in the post event history will give additional information. Essentially Equation 4 is estimated separately for each time period (d) post flood

$$\gamma_d = -1/n_2 \sum_{i=1}^{n2} ((c_d - c_{d-k}) - \ln(p_{i,d} / p_{i,d-k}))$$

where d is a post-flood time period and d-k is pre-flood, n2 is the number of properties which sold pre-flood and again in time period d. For a single location, this sort of model can be estimated using a regression formulation for the entire population, positing Ln (P_{id} /P_{id-k}) as the dependant variable and using time dummies and flood status time dummy interactions as the independent variables. The significance of the flood effect is tested within the regression context.

An alternative to the full regression model is to estimate the price index on the control population in the first instance and then for a sample of flooded and flood-free properties, calculate the error in prediction of the growth rate. A similar idea was used by Shabman and Damianos (1976) who built a hedonic model of a flood free sector to predict the prices of floodplain property. The null hypothesis is that the mean does not differ significantly from zero. The control and flooded properties should be chosen to be as geographically close together as possible. This enables the extension across locations proposed below.

6.8.2 Novel framework for small sample size

Most of the sites affected during the 2000 event saw only tens of properties flooded which makes it difficult to construct robust statistical models of the impact of flooding for an individual site. By using repeat sales analysis, thereby removing the need to collect large amounts of property data, it becomes possible to extend the analysis across multiple flood locations in a straightforward manner. An approach based on experimental block design can be used. Block design has been used by Black (1999) and Leech and Campos (2003) to measure the effect of school catchment areas. The problem of measuring school performance is similar to measuring flooding effects because the boundaries of school catchment and of flooding can subdivide residential areas. Sometimes streets can be divided in two so that the only difference between one side of the street and the other is the variable of interest; for example school catchment or flood status. In essence Black (1999) and Leech and Campos (2003) have used the block design to offset the effect of locational variables in their studies. They argue that it is impossible to measure adequately all locational variables and that by focussing on discrete, small districts, the differences in those locational variables can be minimised. The same can be true of flooding studies; one of the few benefits of the small numbers of properties involved in flooding incidents in analysis terms is that there should be a surrounding area which can be taken as a control and which is not too different in characteristics from the flood zone. It is common practice in flooding studies to make this assumption (see for example Skantz and Strickland, 1987 and Shilling et al, 1989). Where Gibbons and Machin (2005) use a large number of control properties, much larger than the treatment population, traditional block design would dictate that a similar number of treatment and control properties would be used in each block or town.

Cheshire and Sheppard (2004), also modelling the impact of school catchment areas, maintain that the theory of homogenous housing areas cannot be tested and so favour the hedonic method. While testing is never going to be possible without collecting all the variables, this is also true of omitted variables in so called full hedonic studies. Gibbons and Machin (2005) compare their repeat sales results to a full cross-sectional model and conclude that full cross-sectional models overstate the effect of transport innovations on house price due to unobserved area-specific effects which are correlated to station proximity.

The use of a block design involves the sweeping assumption of consistency of flood effect across locations. If the assumption is true then it means that the impacts can be measured with greater accuracy by aggregating observations across towns. If during anlaysis it becomes apparent that the assumption does not hold then some information may still be gleaned from the differences between locations. It is difficult to say in advance whether this will be the case; floods are certainly a very local phenomenon but the reaction of a population to a perceived flood risk may be consistent between locations. One major factor that is likely to change that perception is the frequency of flooding: a first inundation may have a different impact to subsequent floods. The locations will grouped by flooding history to test this hypothesis.

6.8.3 Methods for dealing with three dimensional nature of flood status

In the discussion above regarding time varying specification and block design a simple flood status variable has been assumed. However flood status has been shown to be three dimensional for the purposes of this study. It is not possible to judge a priori which definition of flood status is most discriminatory in predicting the value of property. Initially an analysis will attempt to determine this by modelling each vector separately. However to fully understand the picture it becomes necessary to extend the block design to incorporate the complexity of the three dimensions.

In the extended block design, the risk profile of a particular property can be thought of as falling into one of various classes. Figure 6-7 shows the three dimensional nature of the risk profile of a property: flood history, insurance cost and designated risk category. High values of any one of these could negatively affect the value of a property. Properties are likely to be concentrated in the equality diagonal that is having either high risk accompanying frequent flood history and high insurance costs or low insurance cost as a result of low risk and no history of flooding. However, as discussed above, not all properties will follow this pattern and those properties in the other blocks can be used to test the impact of the three dimensions of flood status independently.

For this stage of the analysis a cross sectional hedonic specification will be used. The impact of flood history, insurance problems, and flood designation will be assumed to be static over time. Although ideally the time varying specification and the insurance model should be combined, this was not practical within the limitations of the current study.

6.9 SUMMARY

This chapter has presented the methodological development necessary for the measurement of flood impact on house prices within the UK market. Three developments, a time-varying formulation, hypotheses regarding the action of insurance in the UK and a framework to measure the three dimensions of flood status have been described. This methodological development is necessary because the UK differs from other markets where such studies have been carried out.

Novel methodology is also necessary because there has been no adequate strategy for dealing with the time varying nature of flood impact encountered in the literature. This methodology will be applicable to any flood impact study which examines a dynamic flood situation, either changes in actual flood history or in flood risk perception can be measured.

The available data, the considered choice of data source and the limitations associated with that data are also described within this chapter. It is not always possible to obtain an ideal set of data for a particular study and this research is no exception. Block design is used to counter the problem of collinearity and small sample size. Until the data is collected the full design cannot be specified since the sample size will be unknown.

This chapter marks the end of the theoretical development of the framework to be used for the empirical research. Chapters 2 to 5 presented the extensive literature review and contained metholodogical and contextual analysis. Chapter 6 has distilled this analysis into a novel framework for empirical analysis within the UK market. The way in which this new framework has been implemented is now the subject of Chapter 7 which will include the mechanics of data capture and the choice of locations for study.

Chapter 7 : EMPIRICAL RESEARCH DESIGN AND METHODS

7.1 INTRODUCTION

The output from the literature reviews in chapters 2 to 5 led to the development of conceptual models, described in Chapter 6, for the measurement of the impacts of flooding on house prices and insurance. Chapter 6 also described the way in which data limitations do not allow for easy estimation of these conceptual models and that it is not possible to combine all concepts simultaneously. In the pragmatic spirit of this research, rather than selecting a single model, thus neglecting aspects which have been considered important, multiple models will be estimated and then a selection between models based on their outcomes can be made.

In this chapter detail of the practical processes and data capture are reported. Section 7.2 outlines the research strategy which is based on analysis of sites flooded in the autumn 200 flood event. Section 7.3 describes the 2000 flood event and section 7.4 details the selection of case study locations. The following two sections describe the data capture for the empirical study: secondary data in section 7.5; and primary survey data in section 7.6. The data analysis and model building phase is outlined in section 7.7 and the basis for model comparison is set out in section 7.8.

7.2 RESEARCH STRATEGY

The research strategy employed in the empirical phase of the thesis combined a quantitative analysis based on transaction data, a bottom up approach and triangulation of novel approaches with more traditional techniques. Primary and secondary data were fused through the inclusion of questionnaire survey data generated within this research programme with secondary data sources for property transaction and flood designation categories.

7.2.1 Quantitative transaction based analysis

The underlying strategy for the empirical stage of the research programme is to build quantitative models of the impact of flooding based on actual transaction data. Chapter 3 examined the broader house price theory and concluded that theory does not predict adequately the behaviour of property stakeholders in the presence of flood risk and that empirical analysis is appropriate. Chapters 3 and 4 concluded that contingent valuation methods cannot be relied upon to predict the value of property at risk of flood because of the relative inexperience of practitioners in this area and their widely differing views. A transaction based method was therefore proposed to address the third research objective. However, Chapters 4 and 5 also concluded that the optimum methodology for performing these analyses was not established within the literature and, in addition, there were particular problems inherent in the UK housing and insurance market which required novel approaches to be employed. Chapter 6 described the development of those approaches and they will be adopted below.

7.2.2 Inclusion of questionnaire survey

In dealing with the issue of insurance, as described in Chapter 5, the most appropriate source of data for the analysis was the collection of primary data from floodplain residents. Study of the policies of insurers and their pricing of new business could not yield sound insight because of the competitive nature of the insurance market and because the individual negotiations between insurer and insured based on shared history result in policy prices differing from published rates. The data collection was effected in the form of a questionnaire survey. The output from this survey was analysed in isolation from the transaction based data in order to determine the prevalence of difficulties in obtaining insurance. However the data was combined with the secondary data on flood risk and transaction prices to form the most complete picture possible of the flood status of properties in order to estimate all three vectors of flood impact on property price.

7.2.3 Bottom-up approach

A prominent conclusion from the literature review was that the impact of flooding on property value differs widely dependent upon local circumstances, for example flood history and insurance regime. Therefore a bottom-up approach was adopted building multiple local models rather than attempting to build a top level national model. This approach allowed for different local circumstances to be observed and for measured impacts to vary by location. Subsequent combining of data could then be based on an assessment of whether or not a national model is appropriate.

7.2.4 Triangulation

Triangulation of the results of these novel approaches was also necessary in the discussion of the model outputs. A comparison of more traditional approaches with the novel methods employed enabled judgements about the value of these novel approaches in measuring the impacts of flooding in the UK. It also shed light on whether these methods could be employed elsewhere and in other circumstances.

7.3 THE 2000 FLOOD EVENT

The flood sites included in the empirical stage of the research were selected from locations which were flooded or narrowly avoided flooding during the 2000 flood event. This section briefly describes this event and its national impact.

Autumn 2000 was the wettest autumn for 270 years (EA, 2001) and it followed on from a wet spring and early summer. Heavy and prolonged rainfall during October and November resulted in serious floods over all parts of England and Wales as illustrated in Figure 7-1 causing severe disruption to transport and business and requiring 11,000 people to be evacuated from their homes.

Estimates of numbers of properties affected vary but the Environment Agency estimated that 10,000 homes and businesses were flooded while a further 280,000 were protected from flooding by flood defences (EA, 2001). Insurance industry estimates of damage costs for the 2000 floods run to £1bn (ABI, 2005b), economic losses have been estimated at £0.8bn (Penning-Rowsell and Wilson, 2006). During the 2000 event locations with long and frequent flooding history were inundated but there were also floods in areas which had not flooded in a generation. Description of the 2000 flooding as one event masks the fact that the flooding took place over the space of more than a month, commencing in October and going into November with many locations being inundated more than once and for prolonged periods (EA, 2001).

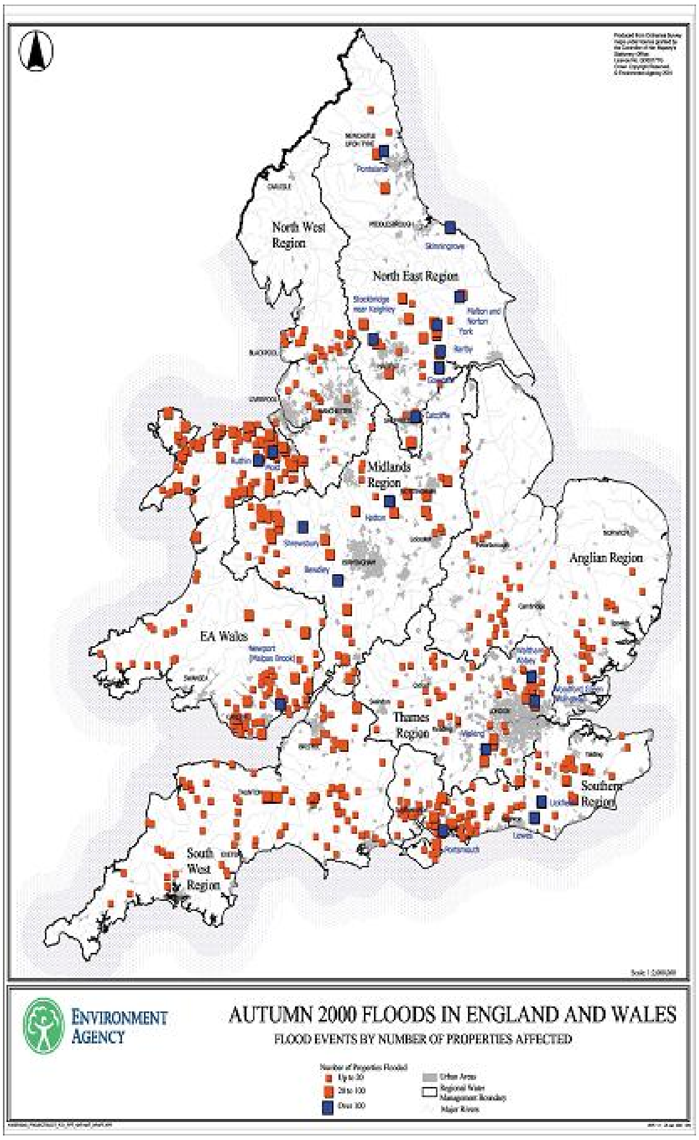


Figure 7-1 : Map of sites affected during the 2000 flood event (copyright Environment Agency)

The choice of this large scale national event as the basis for the empirical study had two major advantages: Firstly the number of properties affected was large in UK terms, if dispersed, providing maximum data; Secondly sufficient time had elapsed since the event for recovery to take place and for the medium term impact of flooding on insurance and house prices to be assessed.

7.4 CASE STUDY SITE SELECTION

Selection of the analysis sites from the 700 locations flooded during the 2000 event was based on the need to represent the widest possible variation both geographical and flood typology while retaining minimum numbers of properties within each selected site. To that end only sites with greater than 100 affected properties were considered. The selected sites and their main features are summarised in Table 7-1.

Table 7-1 : Selected locations for empirical analysis

LOCATION	DEFENCES	SOURCE	FLOOD STATUS	No. FLOODED/ PROTECTED	REGION
Malton/ Norton	No protection	main river	Flooded	169	North East
Woking	No protection	main river	Flooded	100	Thames
Shewsbury	No protection	main river	Flooded	230	Midlands
Bewdley	No protection	main river	Flooded	140	Midlands
Barlby	overtopped defences	main river	Flooded	152	North East
Lewes	overtopped defences	main river	Flooded	800	Southern
Hatton	overtopped defences	main river	Flooded	142	Midlands
Ruthin	Ordinary watercourse	non main river	Flooded	250	Wales
Mold	Ordinary watercourse	non main river	Flooded	181	Wales
Newport	Ordinary watercourse	non main river	Flooded	130	Wales
Southsea	surface water	non main river	Flooded	200	Southern
West Bridgford			Not flooded	9700	North East
Wakefield			Not flooded	1150	North East

Locations highlighted in BOLD are to be included in the insurance survey

The geographical spread of the selected sites ranged from Northern England to the South coast, from the East to the West of England and North and South Wales. They are illustrated in the map depicted in Figure 7-2. Consideration was also given to the type of reported flooding, the selected sites cover main river flooding, non-main river flooding, defences overtopped and overland flow. Past flood history of locations was also varied across the locations from the frequently flooded Shrewsbury and Bewdley through Ruthin with little or no flood history to sites which due to defences had not flooded in the 2000 event such as West Bridgford.

7.5 SECONDARY DATA CAPTURE

The questionnaire survey collected insurance and flood history information for a subset of properties but the major data sources for the empirical investigation were designed to be existing secondary sources. In this way a much larger sample of properties could be used. For the pricing analysis actual transaction price was obtained from the Land Registry. Designated flood risk which was obtained from the Environment Agency Website. Flood history information was gained from a multitude of sources.

7.5.1 Land Registry data

Data on all property transactions requiring registration are collected by the Land Registry on behalf of Government. The registry holds details of title, covenants, plot details for residential and commercial property in England and Wales. During 2005 a subset of this data became publicly available at an individual property level, it can be purchased directly from the Land Registry.

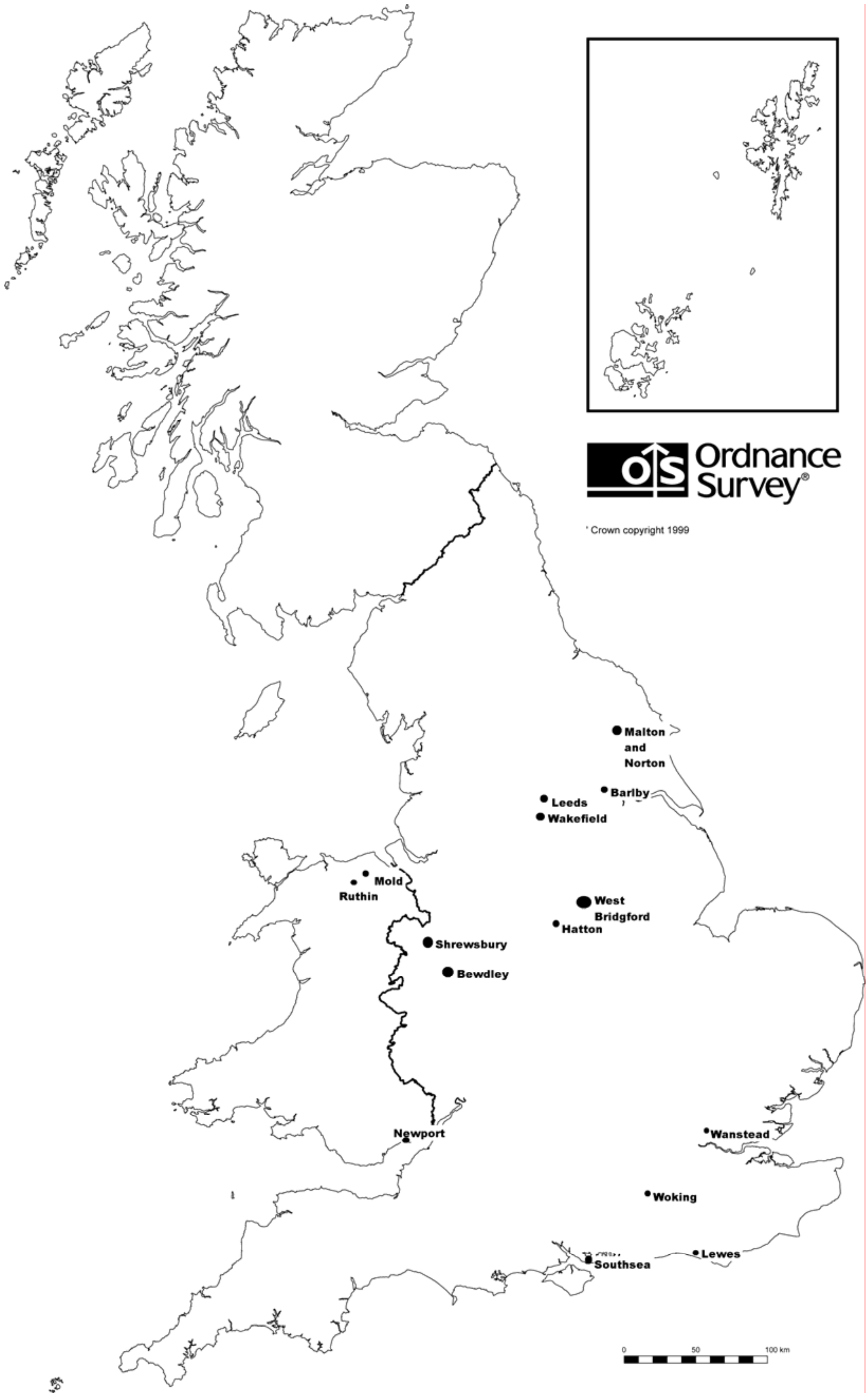


Figure 7-2 : Map of study sites

Detailes of the dataset is tabulated in Table 7-2. It specifically excludes all commercial transactions, transactions before April 2000, and transactions likely to be completed below market value for example 'right to buy', short leasehold, gifts and compulsory purchase orders. These data are the most complete record of housing transactions in the UK but do not include property details such as size of accommodation or condition information.

Table 7-2 : Land Registry price paid dataset

Data Record	Details
Full Address	PAON, SAON, Street Postcode Locality(if available) Town, county
Price Paid	£ Unadjusted for inflation
Date	Date of property transfer
Property Type	Detached Semi-detached Terraced Flat/Maisonnette
Tenure	Freehold Leasehold
Newbuild	Yes No

Data were purchased from the land registry for the flood locations identified in section 7.4, postcode sectors were identified which contained the postcodes at risk of flooding by reference to Environment Agency floodplain maps. All property transactions within these postcodes were purchased forming a large database of property transactions numbering tens of thousands. The numbers of repeat transactions by location are tabulated in Table 7-3.

Table 7-3 : Number of property transactions at each study location

LOCATION	No. OF REPEATS	1st in 2000	SIG	MOD	LOW	OUTSIDE
Malton/ Norton	316	84	8	14	12	282
Woking	508	174	33	8	11	456
Shrewsbury	2354	680	86	11	492	1765
Bewdley	222	44	13	0	26	183
Barlby	270	73	0	102	1	168
Lewes	452	116	54	26	41	331
Hatton	457	91	1	107	101	248
Ruthin	126	25	3	6	10	107
Mold	157	44	16	11	4	126
Newport	275	58	53	15	6	201
Southsea	709	222	0	0	281	428
Wakefield	338	73	41	8	1	288
West Bridgford	446	117	109	92	0	245
Total	6314	1717	409	386	974	4546

7.5.2 Environment Agency data

As described in section 2.6 indicative floodplain maps are available in England and Wales via the Environment Agency website. These maps were used initially to identify postal codes within the flood risk areas in combination with online mapping sources. However the maps depict the outline of the 1 in 100 year flood event the four probability classes significant (S), moderate (M), low (L) and outside the floodplain (O) are accessible via a 'learn more' facility. Once transaction data had been collected the individual properties were allocated to one of these classes using the 'learn more' facility.

7.5.3 Flood history information

The variety of sources used for flood history information was large. Newspaper reports, flood defence scoping reports, crisis management reports, maps supplied by local EA offices, previous surveys of floodplain populations and the insurance survey were all employed in building up a picture of the flood history of the selected sites and the individual properties within them. A summary of the information collected is contained in chapter 8. Whereas the quality of the information on price and designated flood risk was the same across flood study sites the flood history information used was the best available for that location and varied between sites.

Flood history information was collected for three main purposes: First to identify flood locations suitable for analysis and to narrow down the collection of transaction data to areas close to the floodplain; second to categorise flood history for the selected sites, past frequency of flooding and the presence of flood defences were key variables in this regard; third for the insurance modelling phase to attribute a flood history category to an individual property. There is no database available which records whether or not a given property has been subject to flooding in the past. A best assumption has therefore to be made from questioning the residents and the other sources mentioned here.

7.6 SURVEY DESIGN

The motivation for undertaking the questionnaire survey was the inadequacy of available secondary sources as discussed in section 5.6.2. This inadequacy not only made it impossible to access detailed data for the modelling phase but also left open to debate the scale of the insurance problem for flooded and flood-prone housing. Therefore the survey instrument had a dual purpose, firstly to establish the distribution of insurance costs within the floodplain population and secondly to provide detailed data for the price model.

As detailed at some length above, in the UK there is no published formula from which one could calculate insurance cost. Property details will be used by a specific insurer to quote for buildings and contents insurance in a structured way, however not all insurers will use the same formula. An approximation to the relationship for structural variables can be made however using the BCIS building cost formula (ABI/BCIS, 2005). An insurance rate can then be calculated for each property, this is the cost of insurance per sum insured.

In order to fulfil the double needs of data collection and exploratory survey a mixture of factual, numeric and open questions was used. A large sample was targeted from within and without the floodplain. The number of questions was kept reasonably low to make the questionnaire respondent friendly. This had the added benefit of reducing the burden of data entry and coding. The questionnaire was revised in the light of comments from a flood victim, an insurance industry representative and a member of a local flood action group.

Following a pilot study of 350 households in one location, the questionnaire was revised once more before mailing to 2,130 households spread across four different locations during the last week in September and first week in October 2006.

7.6.1 Initial design

In planning the questionnaire layout and the implementation of the survey, elements of the Dillman tailored design method (Dillman, 2000) were employed. Due to cost considerations the entire methodology could not be observed but those recommendations which were applied appeared to boost the response rate.

The survey instrument employed in the study was a self administered postal questionnaire. This delivery method was selected in order to minimise cost since the costs of a postal questionnaire are generally lower than face to face or telephone interviews (Dillman, 2000). The low response rate of postal questionnaires has been well explored: Bourque and Fielder (1995) states an expected return rate of 20%. However in this instance it was also felt that a postal method would increase compliance in those questionnaires returned because the information requested from the respondents was largely of a factual nature and may require the homeowner to refer to insurance documentation. This is more likely to be achieved if the respondent answers in their own home and can find the information at their leisure rather than make guesses under time pressure with a face to face or telephone interview.

Self selection of respondents is also an issue for self-administered questionnaires. The danger that those who reply to a survey are those with a special interest in the survey topic or are different from the normal population in some other way. There is no way to avoid the bias introduced by self selection and this must be borne in mind when interpreting the results.

In the proposed price model there are three vectors of flood status, flood history, flood insurance category and flood risk designation. Designation is available from the Environment Agency Indicative Floodplain Map. Accurate information on properties actually flooded and insurance cost however is very difficult to obtain from secondary sources. The survey was designed to provide the insurance and flood history data on a subset of properties. Flood history information and insurance cost were therefore the most important sections of the questionnaire. Questions about the frequency and severity of flooding and about the cost of insurance and claims history were included.

It was also necessary to collect details of the property and householders because they can affect the insurance premium charged. Other questions were included to identify policyholders who have inflated insurance premiums due to some cause unrelated to flooding. Although it was not deemed possible to completely discount for all factors affecting insurance premiums, the sample could be checked for bias. The property details could also be utilised in a truncated hedonic model of floodplain properties for comparison with the repeat sales model as described below.

Questions about the search strategies involved in choosing an insurance policy were included to ascertain how far increased costs can be avoided by shopping around. These sections were also important in determining whether lack of insurance was due to choice, cost or lack of availability. The identity of the insurance company was requested to study the difference between the insurance market for flood-risk and flood-free households.

In order to generate realistic ranges for the numerical questions research was undertaken into expected values for these data. A combination of the building cost estimator, former surveys and expert opinion were used as described in Table 7-4.

Table 7-4 : Information sources

Annual premium buildings	AA (2005) index sample from £57(shoparound) to £633 (average). Defaqto (2003) average £312 on home insurance Sample quotes from £57 to £350. combined quotes from £160 to £691 Datamonitor (from Crichton 2005) 2002 average £300, flood areas £600 will rise by at least £180 in 2003. Which? (2005) report quotes from Sainsbury of £819 for flood risk house or of £400 with £250 excess
Annual premium contents	AA (2005) index goes from £39 (shoparound) to £423 (average) Defaqto (2003) sample quotes £110 to £600
Excess	Crichton 2005 up to £5000 but £1,000-2,500 more common Datamonitor (from Crichton 2005) up to £25,000
Age of resident bands	Use categories from the DEFRA/EA (2004) 18-39,40-64,65-74,75+. Can also compare under 65 and over 65 with census.
Age of property bands	From BCIS rebuilding cost table (ABI, 2006)
Number of bedrooms bands	Use to categorise size of house for BCIS rebuilding costs. Common bands from hedonic studies.
Type of property	From BCIS rebuilding cost table (ABI, 2006)
Tenure	From Census
Length of residence	Split at 6 years to reflect resident during 2000 event. Residents with a long history, greater than 10 years may have better relationships with insurers than short term ones.
Length of insurance	Longer than 6 years would mean insured during 2000 event and any claims would be with existing insurer. Lower values can be used to compare at-risk residents loyalty patterns with those not at risk.

The survey instrument was intended to be fairly short and simple to complete requiring less than 15 minutes effort. To that end most of the questions were closed options requiring ticks in the relevant box. An open comment box was placed at the end to allow respondents to express any views or add extra information. A booklet format was chosen as recommended by Dillman (2000) and an accompanying letter to explain the purpose of the questionnaire was also designed.

Return postage was prepaid and the return envelope was pre-addressed to the same individual who signed the covering letter. Such personal touches are seen to be important in raising response rates (Dillman, 2000). The most sensitive questions, about cost of insurance and insurance claims were situated on the inside pages and so were not likely to put respondents off at an early stage (Dillman, 2000). A copy of the pilot questionnaire is included in appendix A together with the accompanying covering letter.

7.6.2 Pilot study

The pilot study was carried out in Bewdley, a town in the West Midlands. Details of Bewdley flooding history are discussed in section 8.2. Questionnaires were issued to 350 addresses and a follow up postcard was sent out a fortnight later to residents who had not responded. Dillman (2000) states that multiple contacts is the most effective method for generating higher response rates.

Addresses were selected from the council tax register, a list of properties collated for local taxation charging. This register is available on the internet and contains address but not name details. It was suitable for the purposes of the survey because it was not necessary to survey individuals therefore name details were not required. A census sample of these addresses was drawn from the streets of interest. All streets wholly within the flood outline were selected. Streets adjacent to the flood outline were selected. There were several long streets which crossed the flood outline and property numbers within the outline and those outside but close to it were chosen for these streets. A small area removed from the floodplain entirely was also selected.

For the pilot phase, apart from the form of the questionnaire two further aspects were directly tested. Class of postage was varied randomly across the mailing to assess whether there was any difference in response rate due to postage class. Alternative versions of the questionnaire were presented randomly to the recipients, one version contained tick boxes containing ranges for the questions regarding insurance cost. The second version had an open space for the insertion of insurance costs. For such a sensitive piece of information the danger of leaving an open space for respondents was that it would reduce compliance. The range box example was seen as more likely to boost response rates but would have an associated lack of precision. In particular, because sums of the insurance cost ranges would be taken, a marked improvement in response rates would be needed to offset the lack of precision.

During the pilot exercise, analysis of the responses was carried out primarily to learn any lessons and modify the instrument for the full stage of the survey. Total response rate was 23.7%, i.e. 83 questionnaires. Type 1(with tick boxes for premium costs) had slightly better return rate at 25.7% rather than 21.1%. Answers to questions about cost showed a slightly larger gap, 21.1% versus 15.4%. Postage class made no difference. Those in the floodplain were slightly more likely to respond, 26.1% rather than 17.6%. The returns following the first mailing numbered 65 (18.5%) and after the reminder postcard 18 further questionnaires were received ie an extra 5%.

A wave analysis was performed to assess the potential for non-response bias. Those who responded only after a reminder postcard can be regarded as closer to the non-respondent population than those who responded earlier (Cresswell, 2003). The results were reassuring as in key variables the differences were negligible as shown in Table 7-5.

Table 7-5 : Wave analysis of pilot responses

	Wave 1	Wave 2	Total
Percent of respondents in flood risk area	74	67	72
Percent of respondents assumed flooded	54	50	52
Percent of respondents with no insurance	5	5	5
Respondents median insurance cost category	2	2	2
Respondents modal insurance cost category	2	2	2
Number of respondents in category	65	18	83

If there are any differences in the two populations this table suggests that those least at risk are least likely to respond but the differences are no larger than rounding errors.

Thirty of the properties had changed hands since the 2000 flood event. Fifty two respondents were therefore resident during this severe flood. Of those 52, 41 live in the designated 100 year flood zone and 26 reported having flooded i.e 63%. Many reasons were advanced for being resident in the floodplain and not flooding including large sloping gardens, lack of a ground floor, the ground floor consisting of a garage or having been built on raised ground due to planning guidelines.

Twenty six properties reported a flood history, including those reported as having flooded prior to respondents residence, twelve had flooded only once, five had flooded twice, seven had flooded up to fiive times and two had flooded more than five times. The average depth of flooding was less than 1m. Only one property experienced flooding above 2m and this was a frequently flooded property. The duration for most was over 24 hours. The typical flooding experience was therefore a prolonged shallow flooding event.

Only one resident reported a failure to obtain insurance due to flood risk. This respondent was told that they could gain insurance but would require a letter from the Environment Agency (EA). The cost of this letter had deterred the tenant from pursuing the matter. One further respondent reported having been refused insurance by many companies but had eventually managed to find cover at a high price. Only four respondents had no insurance, five had buildings only and five had contents only. 83% of residents had both types of insurance.

Only one respondent had premium and excesses in the highest bracket that is premium cost of over £800 and excess of over £2,500. Excess of over £2,500 may be regarded as a serious disadvantage when an occupier comes to sell because it will be regarded by mortgage lenders as capital at risk. In the event of a flood £2,500 is a sizeable sum for a property owner to pay.

7.6.3 Revised design

In the light of the pilot study, several decisions could be made about the full survey with increased confidence. Second class postage could be used without impact on the response rate. The questionnaire was in general clear enough for people to fill in. No adverse comments were received about the format or the motivation behind the study.

Response rate of 24% is good for an unsolicited self administered questionnaire. Therefore a major redesign of the instrument was not required. The decision was also taken to use the free entry version of the premium cost question. Although the response rate would be anticipated to be slightly smaller the increased precision was seen to outweigh this disadvantage.

There were a few questions on the survey which were poorly complied with. Gender was left blank by 25 respondents. Perhaps they felt it was irrelevant. In fact unless they were the named insured their gender was of little relevance. The question was removed.

Insured contents value was left blank in 59 out of 83 examples. An alternative strategy was therefore needed to deal with contents value in calculating insurance rate. The question was removed.

"Reasons for changing insurer" question was only completed by 20 respondents. In the light of the small numbers being refused insurance it was deemed worthwhile to explore further the added effort in obtaining insurance for flooded versus non-flooded residents. The question was replaced with a tick box list of difficulties experiencesd while seeking insurance garnered from comments on the pilot study and expert opinion.

Tick all that apply strategy questions were changed to tick the one that most applies because of the tendency for all respondents to tick "I chose a company I trust".

The questions were rearranged slightly to flow more logically and so that the most contentious questions were even further down the line.

7.6.4 Implementation of full study

Addresses lists for the full study sites which had suffered flooding were selected in a similar way to the pilot study. Flood outlines were obtained for Shrewsbury and Malton and Norton. For Southsea a map showing reported flood incidents was available, streets which had at least one reported incident were included in the sample, adjacent streets with no reported flooding were included and a small area just outside the designated floodplain was also included. In the light of the difficulties in assessing buildings and contents values for flats and from observation that many flat were insured via leaseholders, addresses identifiable as flats from the address details were excluded from the mailing list. For West Bridgford, which had not flooded and had a very large number of properties at risk of flood a small selection of streets from one section of West Bridgford which crossed the designated risk bands was selected. A small area jut outside the designated floodplain was also selected. Questionnaires were posted to all addresses in each selected street (or street section if street is very long).

The modified questionnaire was issued to the four full study sites within two weeks at the end of September 2006. Three weeks later a reminder questionnaire was sent to those who had not responded.

7.7 DATA ANALYSIS AND MODEL BUILDING

The strategy employed during the data analysis and model building stage was a sequential one with each analysis building on previous ones and dependent on the outcomes. Figure 7-3 shows the stages of data capture, data analysis and model building and indicates where the analysis outputs can be found in the remaining chapters. It clearly shows the way in which the initial data analysis stages provide building blocks in the form of insurance categorisation and repeat sales indices which are necessary for the model building stage. The results from the analysis and models can then be compared to determine the strengths and weaknesses of the approaches.

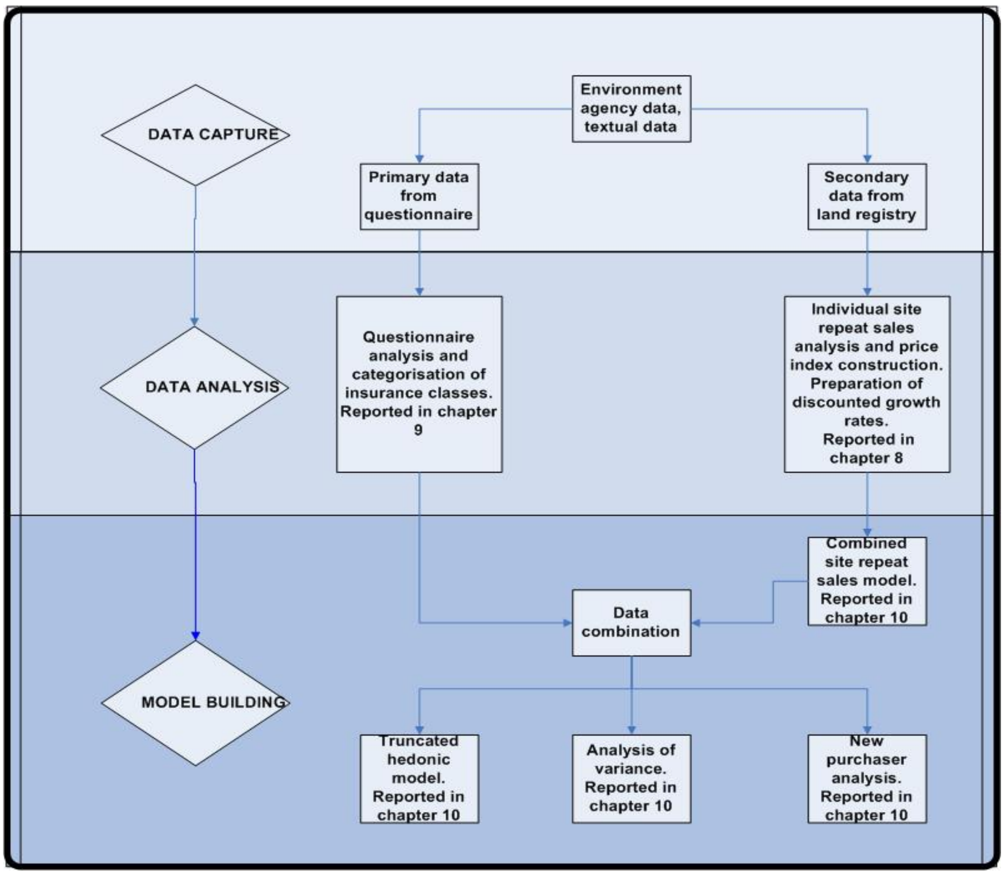


Figure 7-3 : Summary of data analysis and modelling phases

7.7.1 Individual site repeat sales analysis

Chapter 8 considers each case study site in turn, summarising the textual and individual repeat sales analysis. In order to combine growth rates across sites it is necessary to discount the growth by the average local growth as discussed in chapter 4. This yields an opportunity to consider each site in isolation in accordance with the bottom up approach. Three indices are constructed for each site: within the floodplain; outside the floodplain; and total. The models are compared using a chow test to determine whether the indices are significantly different over the whole time horizon. Finally a temporal evaluation is carried out using floodplain/year combination variables to determine whether there are temporary effects which are significant.

7.7.2 Insurance questionnaire analysis

The main purpose of the insurance analysis is to determine the strength of the relationship between the flood status variables and the cost and availability of insurance. This relationship has been claimed but not proven on UK data as described in chapter 5. The assertion that for the UK the evaluation of insurance cost as a driver in discounting the value of floodplain property can be undertaken because of the weak relationship between insurance cost and other status variables rests on this analysis.

As the insurance data is categorical in nature appropriate robust statistics such as the Kruskal-Wallis analysis of variance and Kendall's Tau correlation analysis will be used. This analysis is detailed in chapter 9. Categorisation of the insured into classes for the combined model will be an essential outcome of the insurance analysis.

7.7.3 Combined site repeat sales model

Discounted growth rates were calculated using the individual site analyses and these were combined into a model of the form described in section 6.5. First a global model was considered and then the data was divided into three groups of locations with broadly similar flood histories. In this way flood designation alone could be tested followed by flood designation in combination with flood history. Finally the change in flood designation due to the much publicised relaunch of the Environment Agency indicative floodplain maps was tested by examining the growth rates before and after the relaunch.

7.7.4 Truncated hedonic model

For a subset of locations a truncated hedonic model was constructed. Property details were taken from the responses to the questionnaire survey and locational detail was limited to the survey site. Due to the reduction in sample involved in using the questionnaire data log of actual price rather than growth was used for this and the following analysis. Four models were estimated namely: flooded respondents; non-flooded respondents; all respondents; and all respondents with flood status variables. The first three models were compared using a Chow test to establish whether the markets for floodplain and non-floodplain property are different.

7.7.5 Analysis of variance

A robust analysis of variance was carried out on the combined data including flood status categories as an alternative to the hedonic regression. As discussed in chapter 6 an analysis of variance approach can more clearly demonstrate strengths and weaknesses in the data. In using a robust method, invalid data assumptions are avoided. The use of two estimation methods provides a useful validation tool.

7.7.6 Analysis of insurance problems at purchase

In a further reduction of sample size there were some respondents to the insurance questionnaire who had purchased their property since the 2000 event. Analysis of the difficulties encountered by these residents and the prices subsequently paid by them was undertaken in order to address the disclosure hypothesis and cash buyer hypothesis formulated in chapter 6.

7.8 MODEL COMPARISON

In the previous section many analyses and models were described which could potentially produce conflicting results and which have contrasting strengths and weaknesses. It is part of the planned internal validation of the analysis to compare the model outputs and determine whether they are consistent or inconsistent. Findings which are consistent across models will naturally carry more credence than those which do not. Anomalies will be highlighted and may indicate areas for future research. Ultimately the output from one model will be selected to form a predictive framework for the discount due to flooding. This section describes the method by which judgement regarding the most appropriate model will be effected

Comparison of the fit of the model to the data is the most fundamental test of model performance. However, the variety of models and analyses used cannot be compared on that basis because they use different subsets of a large database. The model fit statistics will be used only where like can be compared with like.

Models based on the widest representation of data will be preferred, in other words unless inclusion of primary data adds significantly to the explanatory power of the model then the larger sample of secondary data will be preferred.

Ease of application, is another aspect to be considered. In a market environment it is unlikely that conclusions reached by this study about the expected levels of discount due to flooding will remain valid in the long term. In the light of expected changes in the housing market and in the anticipation of climate change it is important to revisit the analysis periodically. A methodology which will allow this revisiting with minimum effort is therefore relatively more attractive than one which requires intensive data collection.

7.9 SUMMARY

This chapter has described the research strategy for the empirical stage of the current study. Central themes of the empirical study such as the bottom up approach and the comparison of methodology have been explained and justified. The process of primary data collection has been reported in some detail including the design of the questionnaire survey and brief results of the pilot study. The rationale behind the selection of study sites has been explored and the secondary data sources clarified.

The following chapter summarises the large volume of data from textual and map sources which was gathered to determine the flood histories of the selected sites, the repeat sales indices are also presented. This will be used as contextualising information for the chapters 9 and 10 which present the results of the quantitative analyses.

Chapter 8 : FLOOD HISTORY AND PRICE INDEX ANALYSIS OF THE CASE STUDY SITES

8.1 INTRODUCTION

This chapter summarises the textual sources utilised to determine flood history for the case study sites. Newspapers, websites, Environment Agency reports and flood risk assessment reports are the major sources for information on the 2000 event, other historic flood events and subsequent defence improvements. Also depicted in this chapter are the indicative floodplain maps for the sites under analysis. These data demonstrate the great variation in flood history and risk profile for the selected sites.

Price index analysis is also presented in this chapter. The primary aim of the price index analysis is to establish local price indices for all sites with which to discount the sales of floodplain and flooded property. Property price inflation is a very important aspect of the UK housing market during the period under analysis. Many of the local indices show prices doubling over six years and clearly to deal inadequately with inflation could mask any flood impacts unless they were of the same order. Local indices were deemed necessary because housing markets move differently across the country (Alexander and Barrow, 1994, Cook, 2003). Two sales indices were constructed for each site one outside and one within the floodplain. These indices are compared although with the paucity of data these are unlikely to provide robust estimates of floodplain impact excepting those sites with large datasets.

A Chow test is performed to determine whether the floodplain subset is significantly different from the rest of the market. This test, as used by Day (2003) states that when combining two regression models

$$\frac{(RSSR - SSR_1 - SSR_2)/k}{(SSR_1 + SSR_2)/(n-2k)} \sim F_{k,\, n-2k}$$

RSSR The sum of squared residuals for the combined model

SSR1 AND SSR2 the sum of squared residuals for the individual models

n = number of observations, k parameters common to both models.

Finally in this section a combined regression model tests the significance of the difference between floodplain and non-floodplain property annually by estimating a flood index parameter for each year. The chapter is divided into 13 sections one for each case study site, section 8.15 summarises the analysis.

8.2 MALTON AND NORTON

Malton and Norton are situated on opposite sides of the river Derwent in North Yorkshire and effectively form one conurbation. Major flood events occurred in Malton and Norton in 1947, in March 1999 during a period of prolonged rainfall, and in 2000 during the 2000 event (ARUP, 2006). Other flood events were recorded in 1892, 1931, 1960, 1963, 1982 and 2004. Flooding can be caused by overflowing of the river Derwent but Mill and Priorpot beck are also involved. During 2000 flooding occurred in Old Malton, particularly Town Street, up to 3 ft (EA/DEFRA, 2005) in an area of mixed housing. Springfield Garth and Riverside view in Norton were flooded, a mix of housing and flats (EA/DEFRA, 2005). Flooding in the 1999 and 2000 events from Priorpot beck were described as 1 in 5 year events. Groundwater flooding was also reported during the 1999, 2000 and 2004 events (ARUP, 2006). The flooding was prolonged estimated at 7 days (EA/DEFRA, 2005).

Since 2000 a new flood alleviation scheme has been constructed, completed in 2003, which protects Malton and Norton to a level of a 1 in 50 year flood (ARUP, 2006), there are no plans to raise these defences further. The Mill and Priorpot beck problems have been alleviated by pumping water from these becks into the Derwent upstream. In 2004 a flood event occurred on the Derwent after the defences had been installed. Figure 8-1 shows the indicative floodplain map for Malton and Norton.

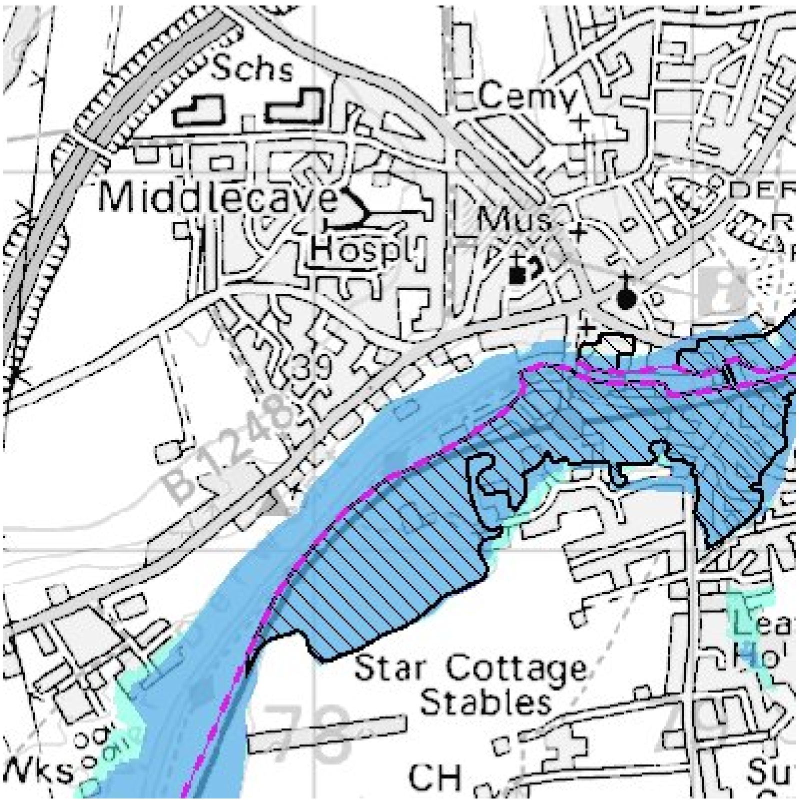
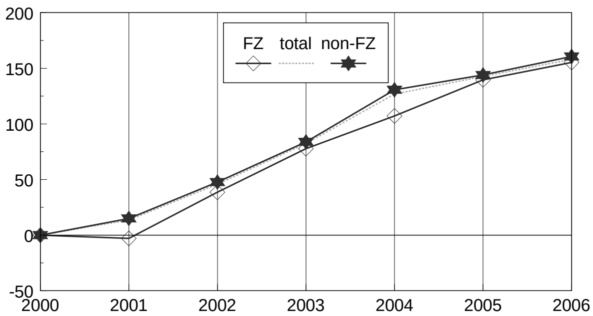


Figure 8-1 : Indicative floodplain map for Malton and Norton

For Malton and Norton there were only 316 valid repeat sales, 34 of which were in the floodplain. The difference between property inside and outside the floodplain is negligible. Figure 8-2 shows that the floodplain properties appear to lag behind the market for two years at most. Both the Chow test and the index regression model indicate that these differences are not significant.



Chow test statistic 1.15 not significant at 10%

	Coefficient	Sig
I2001	0.142	0.000**
I2002	0.392	0.000**
I2003	0.596	0.000**
I2004	0.844	0.000**
I2005	0.897	0.000**
I2006	1.007	0.000**
F2001	0.017	0.918
F2002	0.071	0.655
F2003	0.110	0.183
F2004	0.032	0.716
F2005	0.033	0.671
F2006	-0.175	0.350
Adj R-square 0.851	f-test 0.000**	

Figure 8-2 : Repeat sales indices for Malton and Norton

8.3 WOKING

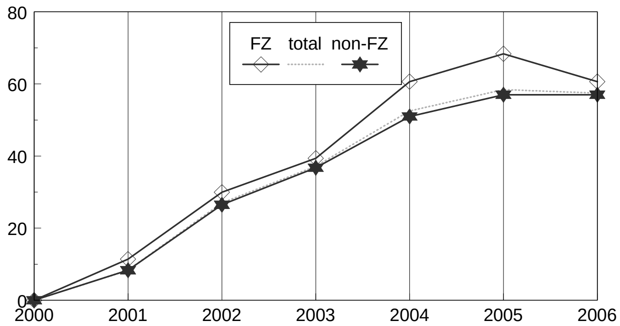
Woking is a large heavily developed town in Surrey in the London commuter belt. It is situated on the river Wey, a tributary of the Thames. At Woking the Wey forks forming the Hoe stream which flows through the Hoe Valley area of the town.

In 2000 Woking flooded from the Hoe stream around the area of Bonsey Lane, 142 properties were affected (Thrush et al., 2005) in a flood estimated as 1 in 15 year return period. Many properties on Bonsey lane affected were maisonettes, implying that upstairs maisonettes would not be flooded. On the high street flood water was a few inches and did not enter many properties with raised entries (EA/DEFRA, 2005). Though a flood watch was in place for the River Wey catchment (including the Hoe Stream), no direct warning system existed at the time of the Autumn 2000 flood events. Warning of flooding in the Woking area reportedly came late; information in the form of leaflets to at-risk households was disseminated by the Borough Council prior to the flood but some residential roads were mistakenly omitted (Thrush et al., 2005). The 2000 flood was described as the worst since 1968. In a 1 in 100 year flood an estimated 300 would be inundated (Woking Borough Council, 2006). Figure 8-3 shows the indicative floodplain map for Woking.

Figure 8-3 : Indicative floodplain map for Woking

Flood defences for Woking were proposed in 2003 to protect 300 homes to a 1 in 100 year standard. To fund the flood defences the scheme also planned to clear up contamination on a nearby former tip situated partly on the floodplain allowing further development involving houses and flats. Detailed proposals have now been drawn up but funding is still an issue (Woking Borough Council, 2006).

In Woking there were 508 valid repeat sales in the area studied of which only 53 were in the flood zone. There were few differences between the two index curves, if anything floodzone property grew faster than its equivalent flood free neighbours. Figure 8-4 shows the price indices for Woking within the floodplain, outside the floodplain and total, the largest differences are in 2004 and 2005 when the flood risk property grew slightly faster than the rest. The Chow test suggests that the two subsectors are different at the 5% level. However the individual index figures are not significant.



Source: Land Registry/Environment Agency

	Coefficient	Sig
I2001	0.080	0.000**
I2002	0.235	0.000**
I2003	0.313	0.000**
I2004	0.412	0.000**
I2005	0.451	0.000**
I2006	0.451	0.000**
F2001	0.030	0.505
F2002	0.027	0.754
F2003	0.020	0.680
F2004	0.062	0.167
F2005	0.069	0.349
F2006	0.023	0.860
Adj R-square 0.677	f-test 0.000**	

Chow test statistic 2.08 significant at 5%

Figure 8-4 : Repeat sales indices for Woking

It is also interesting to note that property prices grew less steeply in Woking than in many of the other areas studied. After 2004 very little growth is seen. It is reassuring then that flood risk property is still holding its own in a less buoyant market.

8.4 SHREWSBURY

The Shropshire county town, Shrewsbury, in the West Midlands has a medieval history with many historic buildings situated in the floodplain. Shrewsbury town centre is nearly surrounded by the river Severn and during floods can be almost entirely cut off. The flood history of Shrewsbury is long and frequent, one of the most frequently flooded of the case study sites. Evidence of the long flood history can be seen in the elevation of some properties in order to escape the flood levels. These modern properties coexist alongside older terraced property, historic buildings and a large number of flats. The most recent event prior to 2000 that flooded domestic property was in autumn 1998 at 4.87m. In the 2000 event Shrewsbury was flooded extensively three times in quick succession, the peak was 5.25m. The flooding in Shrewsbury is quite dispersed geographically, many affected buildings are business premises but it is estimated that 230 domestic properties were flooded (NAO, 2001).

Many flood alleviation schemes have been discussed for Shrewsbury over the decades but because of the geographical dispersal few have economic viability. In 2003 a section of the river in the Frankwell area was defended to the level above the highest ever recorded peak (5.7 m in 1795) with a combination of permanent and demountable defences. Other areas of the town have temporary defences and a permanent scheme is currently being constructed in the English Bridge area. However there are no plans to defend other properties at risk. In 2004 during a flood equivalent to the 1998 event the Frankwell defences proved adequate in defending against flooding, temporary defences succeeded in defending properties in Coleham but other areas complained of greater flood depths as a result. A large area of Shrewsbury is designated as within the 1000 year floodplain but outside the 100 year floodplain as shown by the light blue areas in Figure 8-5, much greater extent than any other of the analysed locations.

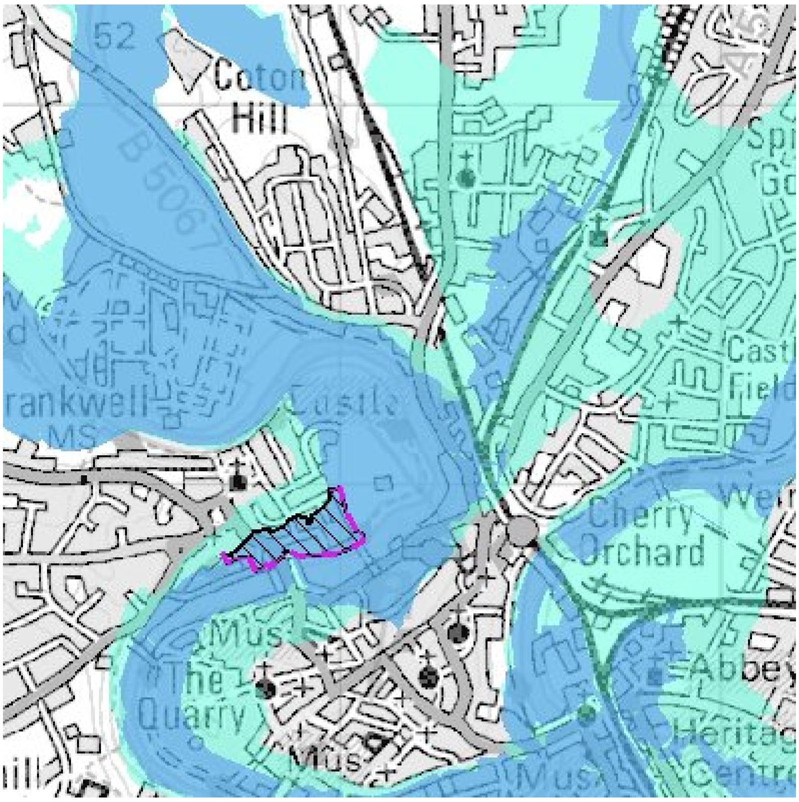
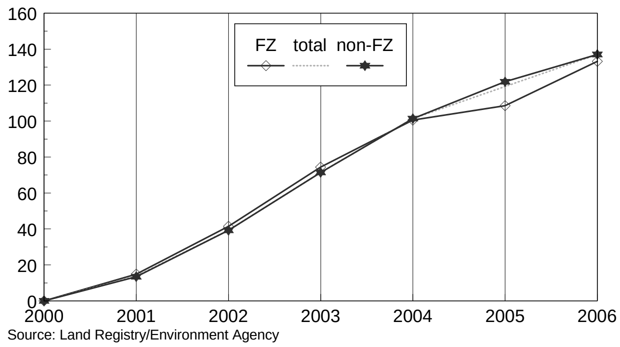


Figure 8-5 : Indicative floodplain map for Shrewsbury

The large extent of the extreme flood outline may in part explain the lack of price impact when the 1000 year outline is used to distinguish the flood designation as any impact would be diluted among properties unlikely to flood. Figure 8-6 shows that over most of the time period growth in and out of the floodplain are practically indistinguishable. However in 2005 there is a marginally significant difference of -5% for the floodplain property. The chow test confirms that there is a marginal difference between the two subsectors. However the effect is temporary, disappearing in the following year.

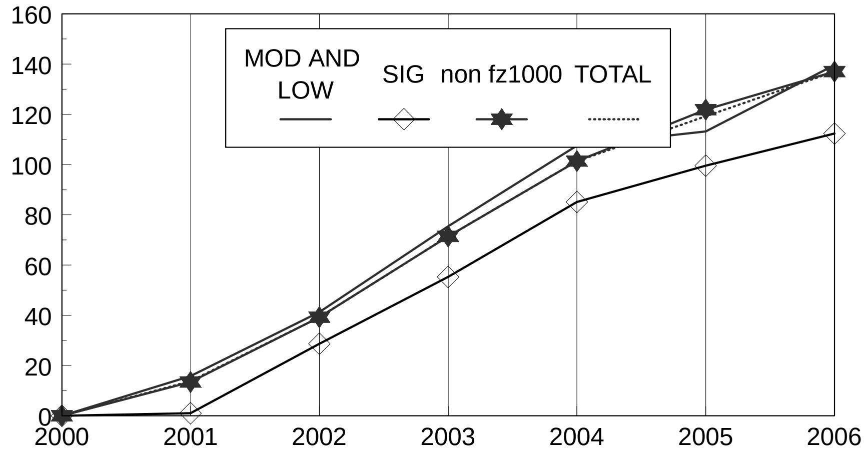


	Coefficient	Sig
I2001	0.126	0.000**
I2002	0.330	0.000**
I2003	0.536	0.000**
I2004	0.695	0.000**
I2005	0.797	0.000**
I2006	0.863	0.000**
F2001	0.014	0.533
F2002	0.004	0.839
F2003	0.010	0.647
F2004	0.021	0.357
F2005	-0.046	0.051
F2006	-0.004	0.874
Adj R-square 0.87	f-test 0.000**	

Chow test 1.54 significant at 10%

Figure 8-6 : Repeat sales indices for Shrewsbury

For Shrewsbury it is possible to disaggregate a little further with 86 significantly at risk properties. Figure 8-7 reveals that the growth in price of significantly at risk property in Shrewsbury may have been affected by the 2000 event. Whilst moderately at risk and low risk property shows no impact. This analysis demonstrates the importance of sufficient disaggregation of data. However for most locations this is impractical as there are not sufficient properties selling within each risk category. The combination of locations into a global model in chapter 10 is designed to overcome this issue by increasing the sample size in each category.



Source: Land Registry/Environment Agency

Figure 8-7 : Disaggregated price indices for Shrewsbury

Chow test of the model significant properties versus the rest is not significant

8.5 BEWDLEY

Bewdley is an attractive town built on the banks of the river Severn in Worcestershire. The town is extremely susceptible to flooding; the highest recorded event was in 1947 at 5.8 metres above average summer levels. According to the Environment Agency (EA, 2003a) there are properties in Bewdley that are likely to have been flooded more than 50 times in the last 100 years. In the 1980s and 1990s a relatively dry period in Bewdley's history meant that when properties changed hands the new residents were unaware of the risk of flooding. Properties were upgraded without consideration of flood resilience. Although the Environment Agency had been considering flood alleviation schemes for Bewdley since 1995, in autumn 1998 the worst major flood for decades came as a shock to residents (BBC, 1998). Two years later in November 2000 the worst flooding for 50 years occurred and 140 properties were inundated. At the time, one hundred and seventy five properties fell into the 1 in 100 year floodplain (EA, 2003a) about 4% of Bewdley, Arley and Wribbenhall households (based on census estimates of 4,600 households). In October 2002 the Severnside North flood alleviation scheme was completed with the aim of protecting 40 properties in the Severnside North area of Bewdley. The defences proved successful in defending these homes in January 2004.

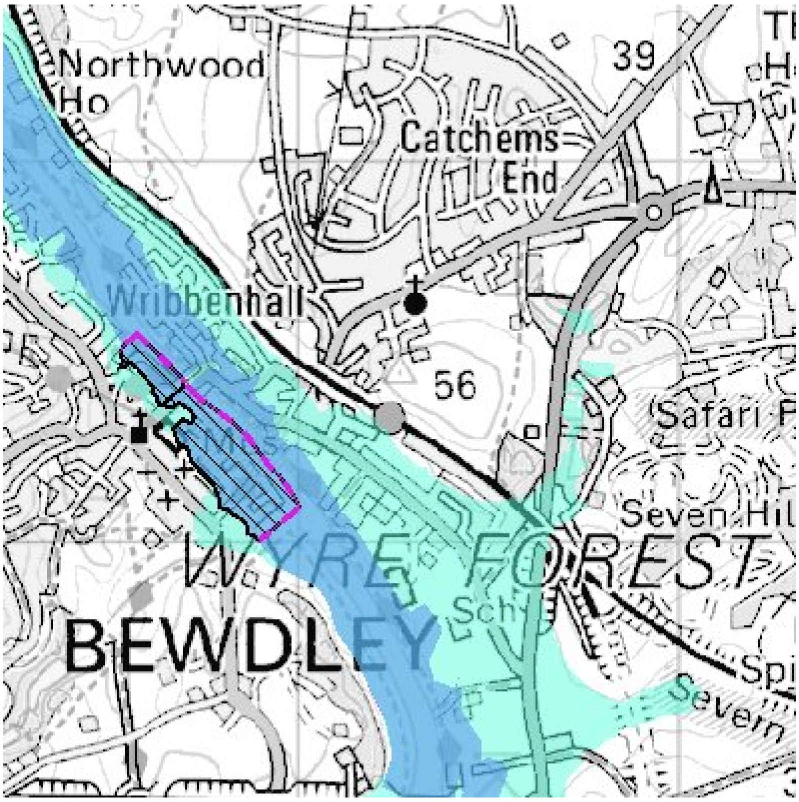
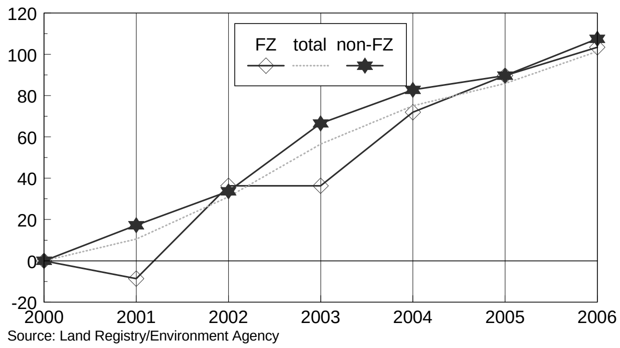


Figure 8-8 : Indicative floodplain map for Bewdley

Figure 8-9 shows that the growth in house price in the flooded cohort fell behind the not at risk property in 2001 and 2003. Flooding occurred in 2000 and 2002 whereas flood defences were improved for some areas in 2002 and for others in 2005. The

Chow test demonstrates that the differences in flooded and flood free indices are significant at the 1% level.



	Coefficient	Sig
I2001	0.154	0.000**
I2002	0.293	0.000**
I2003	0.508	0.000**
I2004	0.595	0.000**
I2005	0.640	0.000**
I2006	0.734	0.000**
F2001	-0.245	0.001**
F2002	0.02	0.820
F2003	-0.201	0.008**
F2004	-0.052	0.503
F2005	0.000	0.993
F2006	-0.024	0.815
Adj R-square 0.826	f-test 0.000**	

Chow test 3.3 significant at 1%.

Figure 8-9 : Repeat sales indices for Bewdley

Figure 8-9 shows that the flood status for 2001 makes a significant difference to the price realised for property sold during that year. On average they are selling at a discount to the property outside the floodplain. This discount amounts to a decline of seventeen percent of value whereas the rest of the market grew by 10% over the same period. However the flood risk properties caught up with the flood free ones in the following year. A similar pattern is seen in 2003 recovery following in 2004.

8.6 SELBY AND BARLBY

Selby and Barlby are situated in North Yorkshire, Barlby is a village to the North East of the small town of Selby. Selby and Barlby are susceptible to flooding from the river

Ouse, the last serious flooding occurred during 1947. In Barlby, which is bordered to the West by the river Ouse and to the East by the A19, in the past there have been two distinct areas within the village, Barlby Hilltop and Barlby Bridge. New development is now in-filling the gap between these areas. Barlby is partially protected from flooding by a flood defence bank. The presence of defences, as is often the case, had reduced the expectation of flood to the extent that much new development had been or was planned to be built in the low lying areas of the village. The areas in Selby liable to flood consist of older properties.

During the autumn 2000 floods the local defences were overtopped inundating 150 properties (NAO, 2001), many of them of recent construction (EA/DEFRA, 2005) to up to 2 feet. It was a dramatic local event, the planned level of defence was seriously exceeded by the flood water and it was only thanks to prompt defensive action by the emergency services that the flooding was prevented from encompassing more property. From a Manchester University report on the emergency action (Wearne, 2002) there was 'A massive deployment of sandbags (some via chinook helicopter) on the left bank of the river from above Barlby and down to Selby'. This partially succeeded but while overtopping was prevented, scour and piping through resulted in flooding. Two thousand people were evacuated from their homes and local hospitals were emptied (Pook, 2000).

After the flood in 2001, emergency strengthening activities were carried out costing about £1m (Wearne, 2002). Following this shoring up of defences, permanent improvement of the defences for Barlby were planned. A scheme costing over £10m to cover Selby and Barlby was started in 2004. In April 2007 the main phase protecting

1,000 properties in Barlby was opened (Glyn-Jones, 2007) although there is still a further phase to be completed. Figure 8-10 show the floodplain map for Selby and Barlby and it can be seen that large areas remain at risk of moderate flooding despite the recent defence improvements.

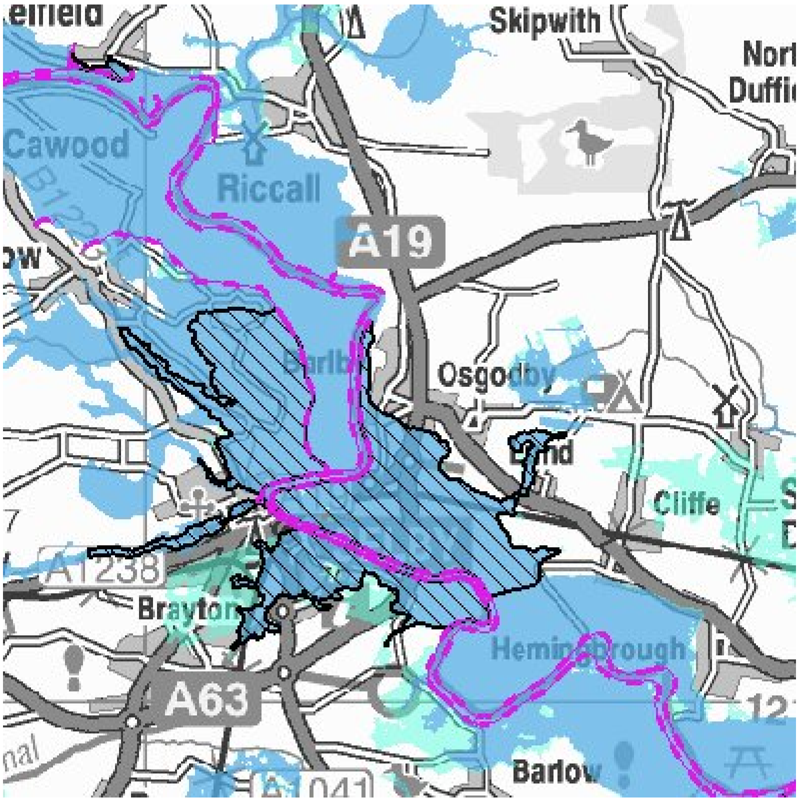
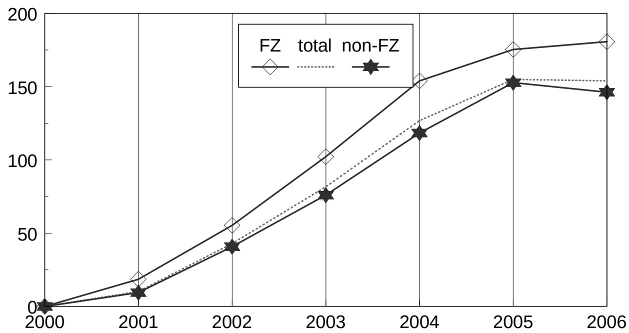


Figure 8-10 : Indicative floodplain map for Selby and Barlby

The repeat sales indices for Selby and Barlby are shown in Figure 8-11 and it can be seen that the floodplain property outperformed the market. The chow statistic reveals that the differences are significant at the 5% level. When Barlby is analysed separately as in Lamond and Proverbs (2006) there appears to be a much closer correlation between floodplain and non floodplain property with an apparent short term negative impact of flooding. Finally the index regression model in Figure 8-11 shows that, on an annual basis there are no significant differences between floodplain and non floodplain property price growth.



Source: Land Registry/Environment Agency

	Coefficient	Sig
I2001	0.09	0.046**
I2002	0.342	0.000**
I2003	0.565	0.000**
I2004	0.781	0.000**
I2005	0.927	0.000**
I2006	0.901	0.000**
F2001	0.075	0.403
F2002	0.097	0.264
F2003	0.139	0.125
F2004	0.151	0.088
F2005	0.085	0.359
F2006	0.131	0.133
Adj R-square 0.86	f-stat 0.000**	

Chow test statistic 2.08 significant at 5%

Figure 8-11 : Repeat sales indices for Selby and Barlby

8.7 LEWES

Lewes is the county town of the historic county of East Sussex in the South of England containing many historic buildings including a castle. It is situated in the lower Ouse sub-catchment about ten miles from the city of Brighton. Lewes is largely built on a hill but there are some low lying areas adjacent to the river. Lewes had a long flood history and before the 2000 event had flooded in 1960 and subsequently a flood defence scheme was designed to protect to a 1 in 100 year flood (Puvacharoen, 2003). Flooding also occurred in 1979 (EA, 2006b).

In 2000, widespread flooding in Lewes started at about 1.00pm on 12th October. Flood defences were overtopped at a number of locations and the town centre was inundated. Hundreds of people were stranded and had to be rescued by the Emergency Services in boats. By the time the floodwaters peaked at about 9.30pm, parts of Lewes were under 3.6m of water. Since the flood defences were breached in so many places the whole of the floodplain was affected and the waters could not flow freely away, the flooding lasted for three days. The flood outline as illustrated below in Figure 8-12 matched almost precisely to the EA extreme flood outline shown in Figure 8-13.

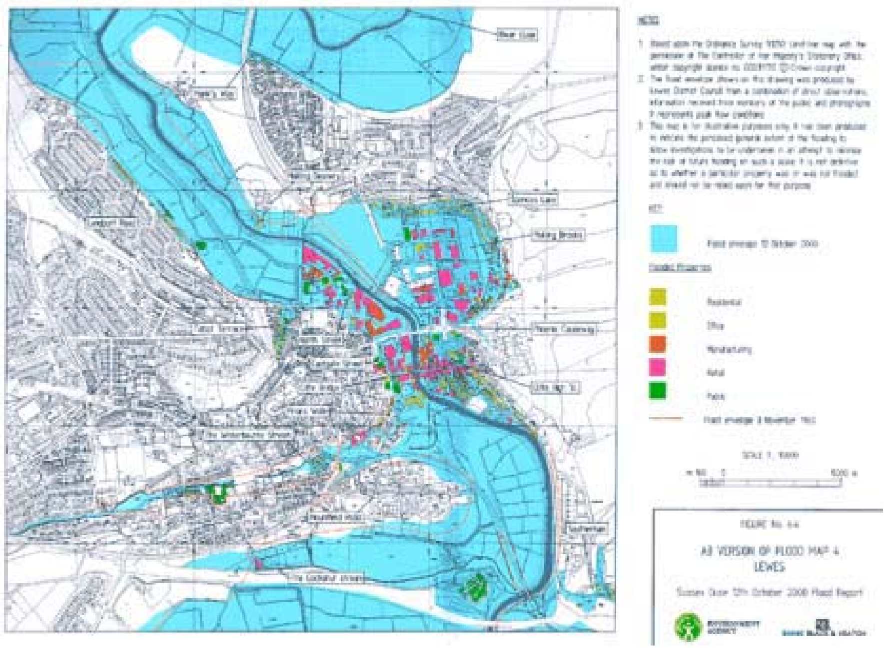


Figure 8-12 : Flood outline for the 2000 event (after Black and Veatch, 2001)

In total 613 residential properties are believed to have flooded in Lewes, principally in the Malling and Cliffe areas some of which are not included in designated high flood risk areas. Flood protection schemes are proposed for some of the properties but as yet only one has been installed. The Malling Brooks catchment is now protected with defences costing £1.8m completed in 2004. The breakdown for each area is as shown in Table 8-1 (adapted from Black and Veatch (2001)).

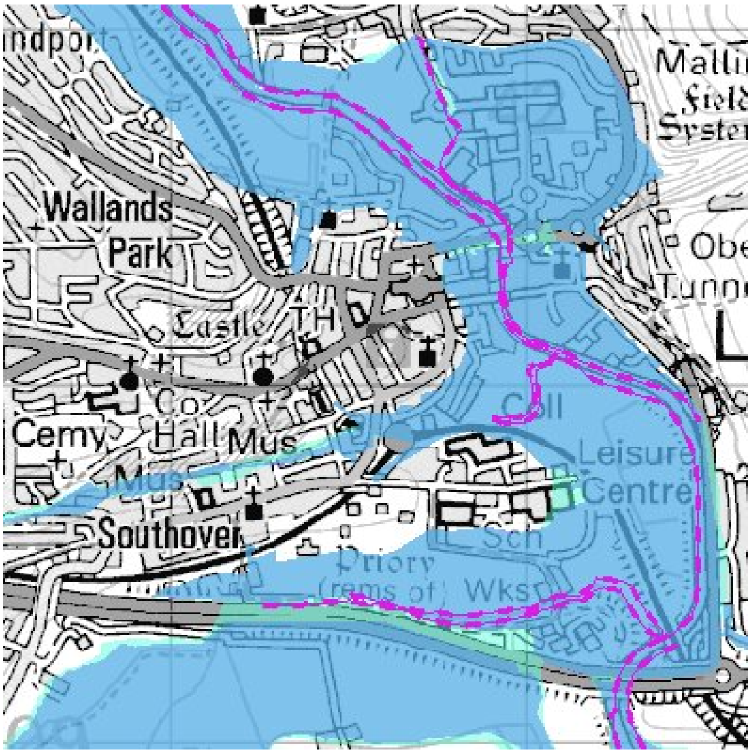


Figure 8-13 : Indicative floodplain map for Lewes

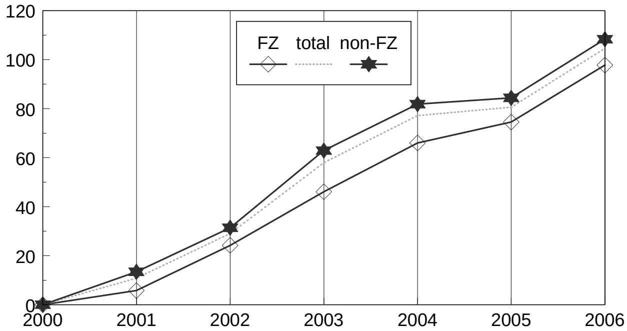
Many development proposals have been put forward in Lewes since the 2000 event. One particular area, know as the "Phoenix Area" has been subject to several bids for improvement often incorporating flood defence schemes. The latest version in early 2007 (Lewes Matters, 2007). Some of this area was flooded in 2000. Another area, partly at risk of flood and partially flooded in 2000 is Landport road. This area is predominantly council owned although parts of this estate have been sold off under the right to buy.

Lewes was officially denoted as the location with the largest number of affected properties in the 2000 event, it also has one of the most active flood action groups. In Lewes the floodplain property has fallen behind the market growth consistently as shown in Figure 8-14, however the chow test suggests that this difference is not significant.

Table 8-1 : Flood risk and flooded properties in Lewes

Cell No.	Cell Name	Flood Risk	No of residential properties flooded	Standard of Protection proposed
1	Malling Brooks	1 in 125	227	1 in 200
2	Cliffe	1 in 50	212	1 in 100
3	Town Centre West	1 in 50	32	1 in 100
4	North Street	1 in 50	1	1 in 200
5	Talbot Terrace	1 in 75	46	1 in 200
6	Landport	1 in 25	40	1 in 25
7	Malling Deanery	1 in 25	4	1 in 25
8	North Malling	1 in 25	13	1 in 25

The index regression model confirms this conclusion and shows that the largest potential impact is a slowing of growth by 11% in 2003. Flooding issues have been held front of mind by the continual debate around the regeneration and accompanying flood defences. A more detailed analysis of the Lewes market might yield further insight into whether the differences are concentrated in the putative regeneration area and further monitoring of this area should be carried forward to assess the impact of future developments.



Source: Land Registry/Environment Agency

	Coefficient	Sig
I2001	0.126	0.000**
I2002	0.273	0.000**
I2003	0.488	0.000**
I2004	0.598	0.000**
I2005	0.612	0.000**
I2006	0.734	0.000**
F2001	-0.070	0.221
F2002	-0.056	0.289
F2003	-0.109	0.066
F2004	-0.091	0.113
F2005	-0.056	0.350
F2006	-0.051	0.356
Adj R-square 0.773	f-test 0.000**	

Chow test statistic 0.72 not significant at 10%

Figure 8-14 : Repeat sales indices for Lewes

8.8 HATTON

Hatton is a village situated in the Trent Valley. Hatton and the surrounding area last flooded in autumn 2000 from the river Dove. An estimated 142 properties in Hatton and nearby Hilton and Scropton were flooded (EA/DEFRA, 2005). The problem is not a new one, previous flooding occurred in 1957 (South Derbyshire District Council, 2005). These are old villages which have seen large expansion in the 20th century and are now surrounded by modern housing estates. Traditionally there had been small amount of building which had been on raised banks. Opposite Hatton on the other bank of the river is the ancient settlement of Tutbury. As shown in Figure 8-15, Hatton lies wholly within the 100 year floodplain, Tutbury has a small area within the floodplain but is largely outside the floodplain. Tutbury is a village with more historic attractions and a larger proportion of older buildings.

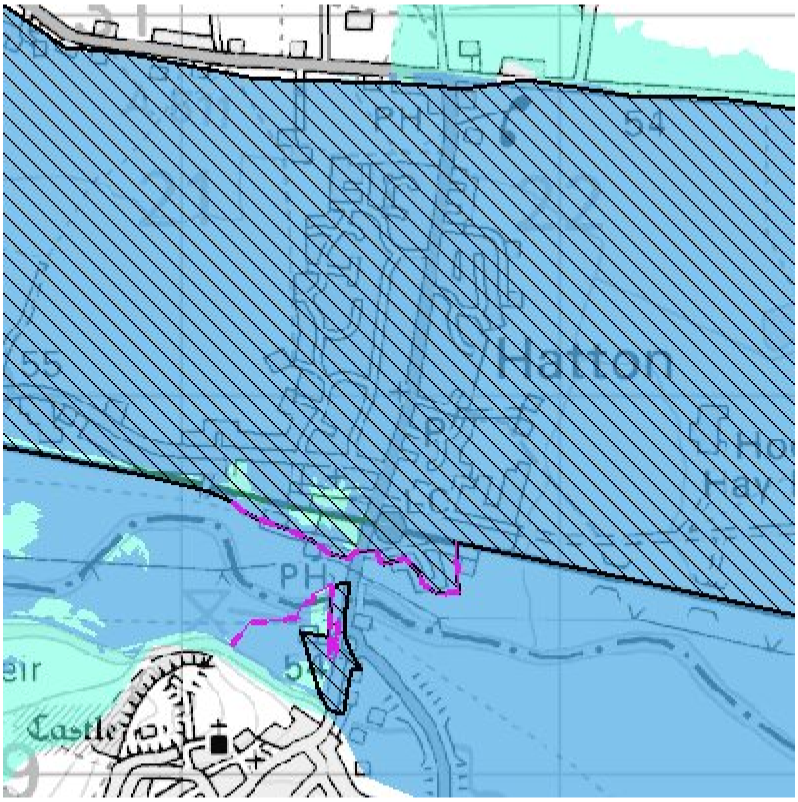
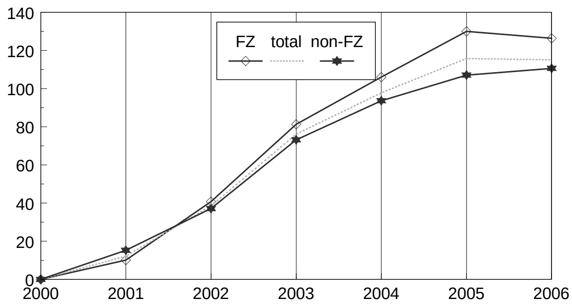


Figure 8-15 : Indicative floodplain map for Hatton

Hatton was not defended prior to 2000 and initially was judged uneconomic to defend. However, grants of £550,000 for a flood defence scheme were awarded in January 2004. In early 2005 work started on improving the flood defences for Hatton (South Derbyshire District Council, 2005) and these were completed in April 2006. However the flood risk for the majority of the properties in Hatton remains moderate, with a few at significant risk.

The average house price for Hatton is lower than for Tutbury. In fact the average house price for Hatton is the lowest of all surrounding areas at a mean of £90k over the period 2000-2006. Tutbury over the same period averaged £121k, Rolleston £157k and Hilton £151k. The majority of sales in all villages were detached, freehold properties with very few flats. The concentration of detached dwellings was most marked in Hilton.

There were 457 repeat sale pairs in the data, about half in Hilton, the rest spread between the remaining three villages. About one third contained a new build sale. About half were in the floodplain. Two repeat sales indices were calculated from the property inside and outside the floodplain as shown in Figure 8-16. The chow test shows that the two submarkets are significantly different at the 1% level. The flood zone property matched the non-floodplain property for growth in the first two years following the 2000 flood but after 2003 their value began to outstrip the rest. The index coefficient analysis shows that only the 2003 difference is marginally significant at greater than the 10% level.



Source: Land Registry/Environment Agency

	Coefficient	Sig
I2001	0.126	0.000**
I2002	0.273	0.000**
I2003	0.488	0.000**
I2004	0.598	0.000**
I2005	0.612	0.000**
I2006	0.734	0.000**
F2001	-0.070	0.221
F2002	-0.056	0.289
F2003	-0.109	0.066
F2004	-0.091	0.113
F2005	-0.056	0.350
F2006	-0.051	0.356
Newbuild	-0.007	0.000**
Tutbury	0.120	0.000**
Adj R-square 0.89	f-test 0.000**	

Chow test Statistic 2.7 significant at 1%.

Figure 8-16 : Repeat sales indices for Hatton.

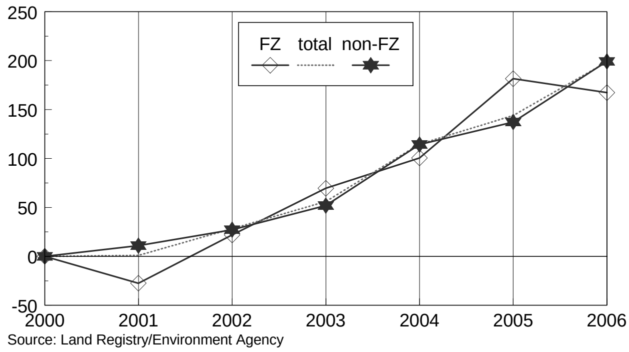
A combination of factors might be at work here. If there was a long term capitalisation of floodplain location prior to the 2000 flood it is possible that the completion of flood defences in 2005 may have boosted the price of Hatton property, removing the long term capitalisation. Tracking of the price of Hatton houses in the longer term might reinforce this slim evidence. There are two additional terms in this model, newbuild and a Tutbury term included because of the concentration of newbuilds in the dataset and the high correlation between Tutbury houses and non floodplain location. Removing these terms does not impact significantly on the fit of the model but it changes the significance of the floodplain dummies, shifting the emphasis from growth within the floodplain to growth within non-floodplain. The Tutbury term is maintained because it is significant and because it is consistent over time.

8.9 RUTHIN

Ruthin is the county town of Denbighshire in North Wales located around a hill in the southern part of the vale of Clwyd. The older part of the town, the Castle and Saint Peter's Square are located on top of the hill, while many newer parts of the town are on the floodplain of the river Clwyd. However, Ruthin had no great history of flooding, the worst recorded incident impacted upon only 3 or 4 properties in the 1960s (EA, 2005). Figure 8-17 shows the Environment Agency floodplain map for Ruthin.

Ruthin was affected by flooding three times within six days from the 6th November 2000 onwards. An estimated 250 properties were affected in Park Road, Mwrog Street and Parc-y-Dre/Denbigh Road. Main flooding was from the river Clwyd. The flood model for Ruthin did not predict the flooding of properties in the Parc y dre estate (EA, 2005) which was suspected to derive from the Mwrog street culvert. In Mwrog street the water was only inches high and many properties may have escaped damage (EA/DEFRA, 2005). There are mainly terraced houses in this area. In the Borthyn area the depth was greater. In 2001 flooding occurred again in Ruthin before the flood defences had been improved. In October 2003 new flood defences came into force for Ruthin they were tested in February 2004 and successfully protected Ruthin against flooding (BBC News, 2004). The price indices for Ruthin are shown in Figure 8-18. There appears to be a small temporary impact of the 2000 flood event. In 2005 a small boost is observed correlating with the year following the implementation of new flood defences. While the chow test indicates a marginal difference between the two subsets, the index model statistics show no significant flood index coefficients.

Figure 8-17 : Indicative floodplain map for Ruthin



	Coefficient	Sig
I2001	0.010	0.220
I2002	0.240	0.002**
I2003	0.417	0.000**
I2004	0.760	0.000**
I2005	0.861	0.000**
I2006	1.107	0.000**
F2001	-0.319	0.175
F2002	-0.027	0.925
F2003	0.087	0.671
F2004	-0.058	0.763
F2005	0.186	0.401
F2006	-0.189	0.402
Adj R-square 0.81	f-test 0.000**	

Chow Test 1.79 significant at 10%

Figure 8-18 : Repeat sales indices for Ruthin

8.10 MOLD

Mold is a town in Flintshire, North Wales sited on the river Alyn which grew up around a castle (now ruined) in the twelfth century. Mold was flooded on the 6th November 2000, 206 domestic properties were affected (EA, 2005). Twenty six properties were affected due to defence overtopping during excessive rainfall. Overland flow was responsible for the remaining 179 properties. As a 1 in 100 year flood event the 2000 flooding was similar in extent to a flood in 1976. However, more damage ensued in the 2000 flood due to recent construction in the floodplain. Since the 2000 flood two phases of defence improvements have been implemented. In April 2006 the new defences were opened with a designed protection level of 200 years for 24 of the properties. The indicative floodplain for Mold is shown in Figure 8-19.

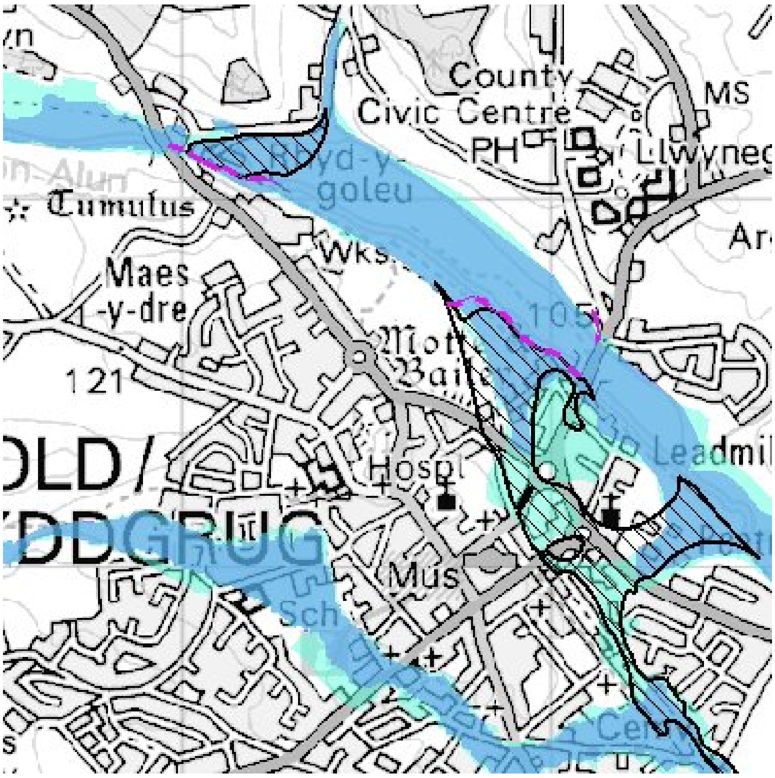
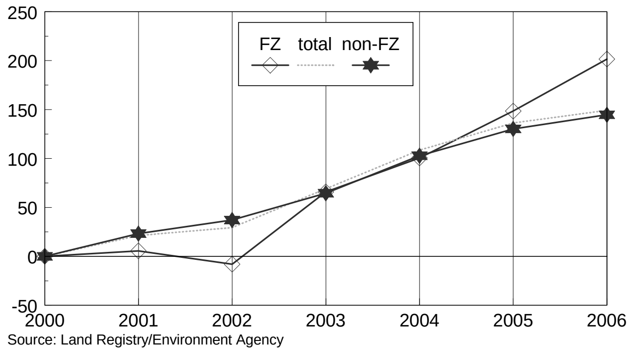


Figure 8-19 : Indicative floodplain map for Mold

Floodplain property in Mold fell behind the market for two years as shown in Figure 8-20 but then recovered. In 2006 floodplain property appears to have overtaken the non-floodplain cohort. The Chow statistic shows that the apparent differences are not significant over the whole time period. However there are significant annual effects as demonstrated by the index regression model in Figure 8-20. In particular there is an unexpectedly large and significant negative impact of flooding in 2002. This coefficient is based on 5 properties. Removing one of these properties halves the estimate of flood impact and renders it insignificant.



	Coefficient	Sig
I2001	0.209	0.000**
I2002	0.316	0.000**
I2003	0.498	0.000**
I2004	0.707	0.000**
I2005	0.834	0.000**
I2006	0.895	0.000**
F2001	-0.154	0.284
F2002	-0.399	0.004**
F2003	0.008	0.945
F2004	-0.011	0.923
F2005	0.075	0.582
F2006	0.209	0.122
Adj R-square 0.849	f-test 0.000**	

Chow test statistic 0.23 not significant at 10%

Figure 8-20 : Repeat sales indices for Mold

8.11 NEWPORT

Newport is the third largest city in Wales standing on the banks of the river Usk. It was a major trading port from the middle ages onwards. Newport has a history of flooding from the river Usk and the sea in 1930, 1936 and 1957. In 2002 flood risk was reported as being a major obstacle to the redevelopment of many brownfield or urban redevelopment sites in and around Newport (Shared Intelligence, 2002).

However, in the 2000 event flooding in Newport was attributed to smaller watercourses and surface runoff. The combination of high tide and heavy rainfall had resulted in a state of tidelock on the Malpas Brook (EA, 2005). Sluice gates were opened by the county council allowing water in a storage lagoon to be released. The main flooding was up to 2 feet inside 130 terraced properties in Malpas Road, Walford Road and Goodrich Crescent (EA/DEFRA, 2005). Flood duration was relatively short at about nine hours but local residents blamed the council for poor management. The area is not covered by Environment Agency warning schemes. In June 2005 £1.9 m flood defences were officially completed protecting 45 properties in Isca and Lulworth road. Figure 8-21 shows the huge extent of flood risk in Newport from the sea and river. The area around Malpas brook is shown in Figure 8-22.

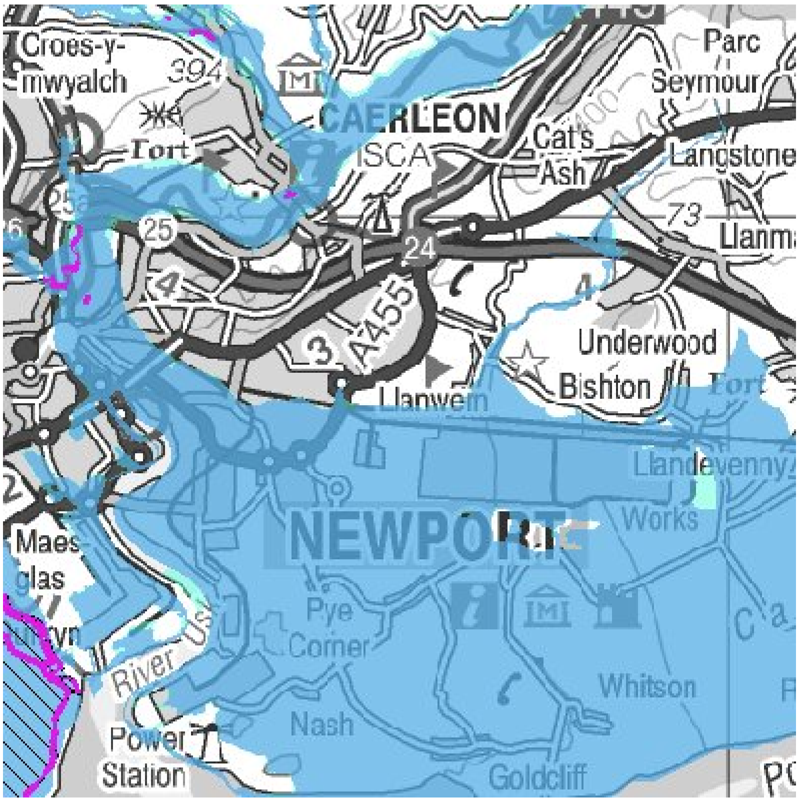


Figure 8-21 : Indicative floodplain map for Newport

The repeat sales analysis shown in Figure 8-23 is for the areas which flooded in 2000: Malpas Brook and surrounding areas. Floodplain property grew broadly in line with the rest of the market with perhaps a small temporary impact. Both the Chow test and the index regression model indicate that there are no significant differences.

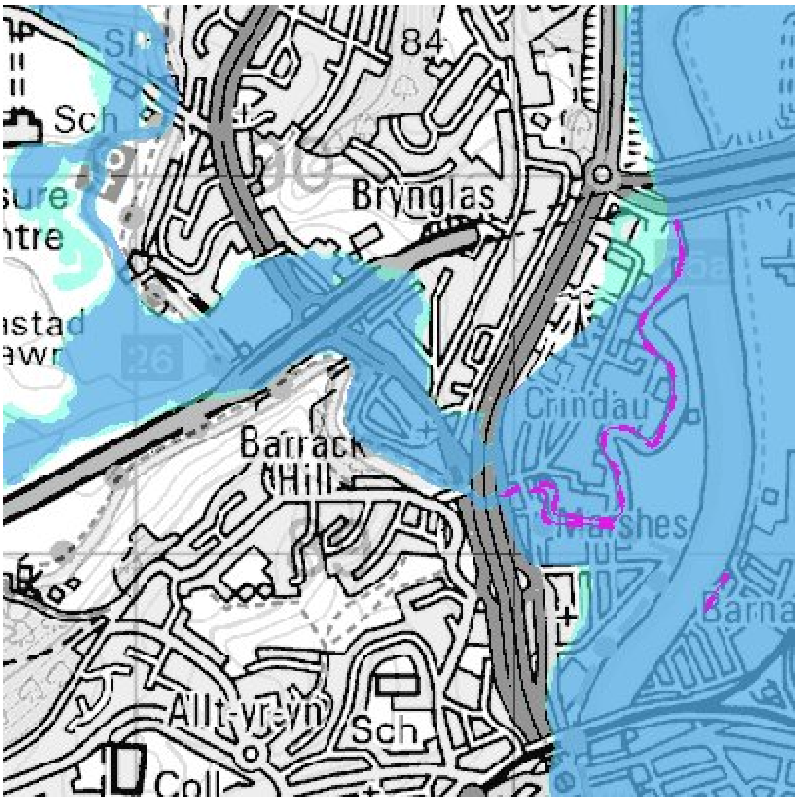
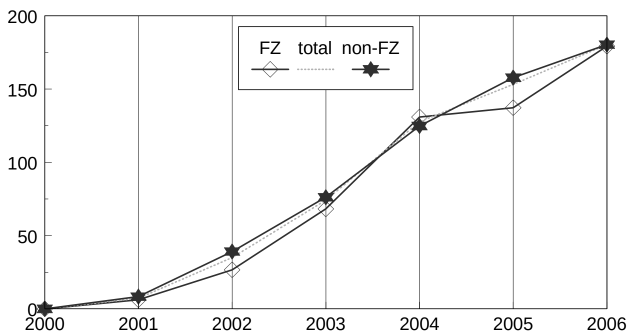


Figure 8-22 : Malpas Brook area flood map



Source: Land Registry/Environment Agency

	Coefficient	Sig
I2001	0.080	0.120
I2002	0.333	0.000**
I2003	0.568	0.000**
I2004	0.814	0.000**
I2005	0.954	0.000**
I2006	1.033	0.000**
F2001	-0.008	0.934
F2002	-0.097	0.246
F2003	-0.047	0.624
F2004	0.016	0.857
F2005	-0.081	0.397
F2006	-0.028	0.973
Adj R-square 0.853	f-test 0.000**	

Chow test statistic 0.6 not significant at 10%.

Figure 8-23 : Repeat sales indices for Newport

8.12 SOUTHSEA

Southsea is an area of Portsmouth, a major port on the south coast of England which is at risk of coastal flooding. Large areas lie below sea level and are protected by barriers from permanent flooding. Indeed much land reclamation has occurred in the past (Clark, 2000). Other flooding can occur due to flash flooding during heavy rainfall and drainage pumps are a necessary part of Southsea flood defence. In 1953 seawater flooded the rock gardens (Clark, 2000). The 2000 floods were the worst since records began but were termed a one in 50 year event. During a period of heavy rain the main sewage pumping station at Eastney failed. (Clark, 2000). Rivers of floodwater mixed with sewage poured through peoples' homes until the emergency services managed to pump the water away about three hours later. Temporary pumping measures remained in force for more than a month whilst new pumps were installed. The emergency services recorded attending 260 flooding incidents.

The risk of flooding for the properties in the Southsea floodplain is described as low, about 1 in 200. The risk from coastal flooding is mitigated by existing defences and the water company, having repaired the pumps, does not expect failure to occur again. Figure 8-24 shows the Environment Agency floodplain map for Southsea. Flooding in 2000 was contained within but did not encompass the entirety of the designated flood zone. One might immediately expect therefore that any impact of the flood on property values within the floodzone would be diluted. An added complication is that more than half the properties are flats vertically removing them from the flood zone.

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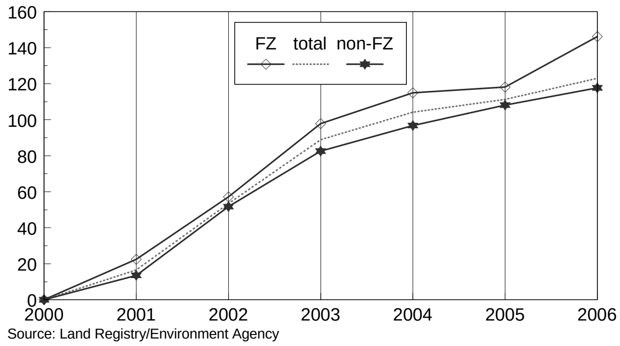
Figure 8-24 : Indicative floodplain map for Southsea

It is apparent from the price indices in Figure 8-25 that flood zone properties suffered no discount at the time of the event, instead they appear to have marginally outperformed the market. The index regression model indicates that the differences are significant in 2003 and 2004. However the chow test shows no significant difference between the two submarkets. Excluding flats lowers the price indices very slightly but does not change the conclusions regarding the impact of floodplain designation. The chow test statistic for separating flats and the rest (1.15) is not significant at 10%.



	Coefficient	**Sig**
I2001	0.127	0.000**
I2002	0.417	0.000**
I2003	0.602	0.000**
I2004	0.677	0.000**
I2005	0.733	0.000**
I2006	0.778	0.000**
F2001	0.072	0.057
F2002	0.034	0.250
F2003	0.084	0.034*
F2004	0.093	0.018*
F2005	0.048	0.237
F2006	0.123	0.086
Adj R-square 0.827	f-stat 0.000**	

Chow test statistic 1.48 not significant at 10%

Figure 8-25 : Repeat sales indices for Southsea

It would appear that the flooding of Southsea has not alerted the residents to their risk of flooding, albeit that risk is designated as low. In the questionnaire responses it seems that residents place the blame for the 2000 event squarely on the pumping station failure and regard this as a one off ignoring the ever present coastal risk. If only the properties in streets with flooding reported are considered, only 29 repeat sales fall into this category and their average growth rate does not differ from the mean.

8.13 WEST BRIDGFORD

West Bridgford is an area of Nottingham situated within the flood plain of the river Trent. It is a leafy suburb of mainly residential housing with many large properties. West Bridgford experienced floods in 1901, 1910 and 1932, with the last serious flooding in 1947. Subsequently flood defences were constructed throughout Nottingham. Improvements to these defences planned for completion after 2008 should raise them to the 1 in 100 year flood level and will allow for more housing development (Warren, 2005). Figure 8-26 shows the extent of the floodplain.

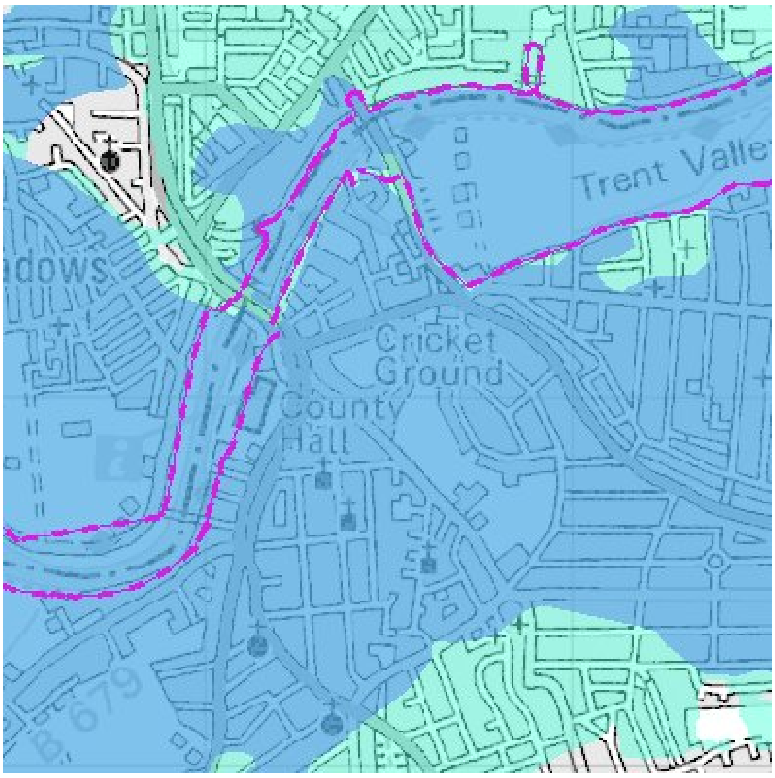
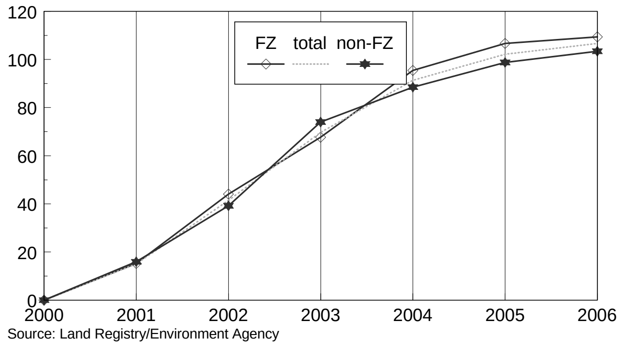


Figure 8-26 : Indicative floodplain map for West Bridgford

The occurrence of a 1 in 100 year event could devastate this area putting thousands of homes under water. Although there was no flooding of West Bridgford in 2000 adjacent areas did suffer inundation and therefore awareness of flood risk may be high in this area. However, the repeat sales price indices depicted in Figure 8-27 show that the floodplain and non floodplain properties grew at very similar rates over the period. The Chow test statistic shows that there are no significant differences. This conclusion is confirmed by the price index regression model.



	Coefficient	Sig
I2001	0.148	0.000**
I2002	0.331	0.000**
I2003	0.554	0.000**
I2004	0.634	0.000**
I2005	0.687	0.000**
I2006	0.710	0.000**
F2001	-0.052	0.928
F2002	0.034	0.537
F2003	-0.047	0.420
F2004	0.036	0.500
F2005	0.039	0.496
F2006	0.029	0.598
Adj R-square 0.782	f-test 0.000**	

Chow test statistic 0.65 not significant at 10%

Figure 8-27 : Repeat sales indices for West Bridgford

8.14 WAKEFIELD

The city of Wakefield is situated on the river Calder in West Yorkshire. The city has medieval roots and then grew due to a variety of industries in the 18th and 19th centuries. Wakefield expanded to incorporate surrounding villages in the early 20th century with infilling of council property. Other rivers meet the Calder within the city of Wakefield notably Ings Beck which has a large catchment prone to flooding. Flooding has occurred in some parts of Wakefield in 1968, 1976, 1977, 1978, 1983, 1998, 2000 and 2001. The worst recent incident was in 1983 when 450 properties were affected. Improvements to the defences, started in 1988, were never fully completed. In 2000 flooding was not widespread, the centre of Wakefield was flooded by the river Aire (NAO, 2001) but actions of emergency services in sandbagging prevented worse inundation. An estimated 12,000 properties could be affected by a 1 in 100 year flood. The postcode sectors considered in this analysis escaped the flooding in 1998, 2000 and 2001 and so for the purposes of this analysis Wakefield is described as a non flooded location but one in which flooding was narrowly avoided. Figure 8-28 shows this area of the city and the Environment Agency flood outline.

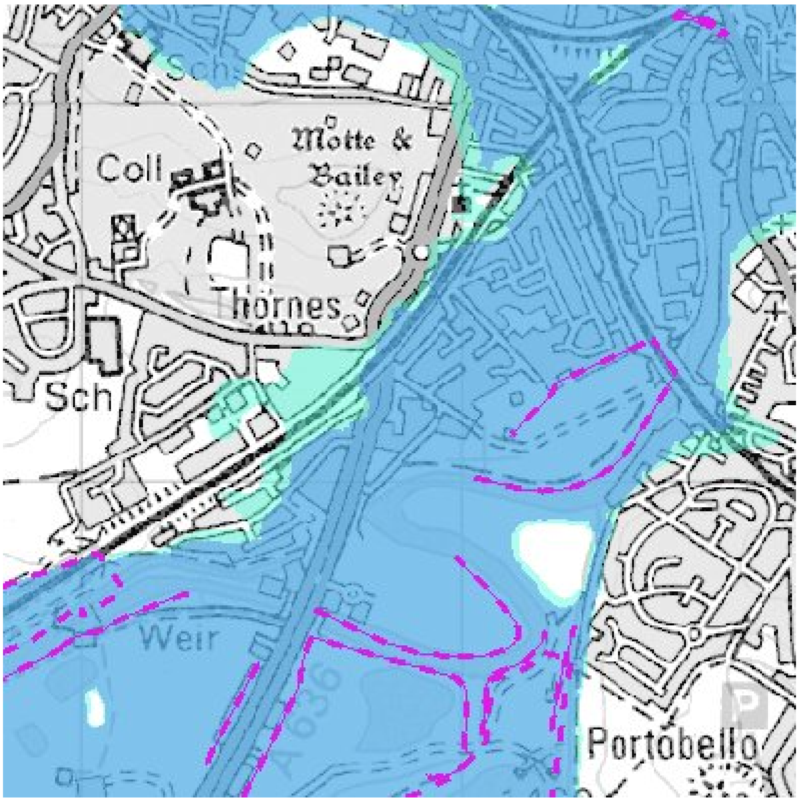
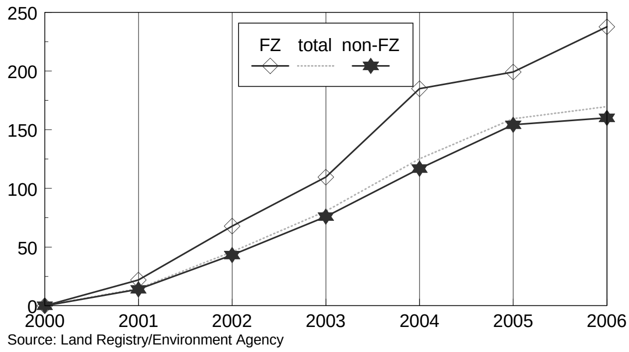


Figure 8-28 : Indicative floodplain map for Wakefield

A £7m flood prevention scheme for Wakefield was implemented by 2003 involving 10km of flood defences and upstream flood storage. More than 1,000 properties are protected by this new work.

The flooded cohort in Wakefield appears to have outperformed the market as shown in Figure 8-29 but this is seen as not significant by the chow test statistic. Individual flood index coefficients are significant in 2004 and 2006. It is possible that this may have been due to flood defences boosting the desirability of this property. However it is also possible that regeneration of some ex council areas may explain the differences. Further study would be necessary to confirm either of these hypotheses. No impact of the 2000 event is discernible.



	Coefficient	Sig
I2001	0.131	0.002**
I2002	0.359	0.000**
I2003	0.565	0.000**
I2004	0.774	0.000**
I2005	0.933	0.000**
I2006	0.955	0.000**
F2001	0.066	0.559
F2002	0.160	0.149
F2003	0.175	0.109
F2004	0.272	0.008**
F2005	0.164	0.178
F2006	0.262	0.025*
Adj R-square 0.827	f-test 0.000**	

Chow test statistic 0.78 not significant at 10%.

Figure 8-29 : Repeat sales indices for Wakefield

8.15 SUMMARY

This chapter has summarised the analyses of the individual flood locations. The analysis encompassed a search for textual information about the flood history, defence improvements and current and past flood risk for the selected sites. An indication of the extent of the 2000 flood has been sought and described. The Environment Agency floodplain map for each of the areas under consideration shows the geographical extent of the current flood risk in these locations and demonstrates the proportion and concentration of the area at risk of flood. The price index analysis is also summarised in this chapter for each location. As discussed in chapter 7 the research followed a bottom up approach where individual models would be combined if appropriate. The building blocks of the global model are the price indices generated at the local level by which means the repeat sales of the flooded property can be discounted for the local expected growth rate in the absence of flood risk.

What emerges clearly from the textual analysis is that the event labelled "the 2000 flood event" cannot really be regarded as a single event in the aspect of generating awareness of flood risk. For example the estimated return period of the 2000 event varies widely across locations so that a resident of Barlby for example would be unlikely to anticipate a repeat flood of that magnitude during their lifetime whereas one in Malton and Norton would expect to see several.

Table 8-2 shows a summary of the information obtained from the textual sources combining the main factors which might be anticipated to have a bearing on the perception of risk borne by local residents. Risk categories, flood history and defence improvements are shown. This summary will assist in categorisation of locations for the combined model.

The results vary a great deal between the flood locations not only in terms of the flood histories and risk categories of the sites but also in the measured impacts on property values. This finding was anticipated, indeed partly planned, because locations were selected to include a variety of flood types and histories including some sites which did not flood in 2000. The different impacts observed between these locations can be used to infer which aspect of flood risk is the most important in property devaluation.

The summary table also shows the results of the statistical testing and it can be seen there are very few differences which are significant at the 5% level. In fact there are more flood index coefficients which are significantly positive than there are significantly negative ones. The hypothesis that flood designation will have an impact on property price is far from proved by this analysis. The designation hypothesis will be further tested below by combining all flood locations.

For the two locations at risk of flooding but not flooded in 2000 no price discount was observable. It is possible that some long term discount applies to floodplain property which existed before 2000, this has not been tested by the foregoing analysis, but the events of the last six years have not served to increase any difference.

Two of the previously flooded locations, Bewdley and Mold, showed significant flood index variables. For Mold the evidence was based on very few flooded properties. All the impacts had disappeared within three years of flooding. This strengthens the belief that it is necessary to examine the impact across time. For Shrewsbury weaker evidence of flood impact was observed which was partly attributed to the dilution of flooded property within the designated floodplain. One location shows a significant positive floodplain index which follows a flood defence scheme implementation. Further investigation of this location is recommended.

Table 8-2 : Summary of flood status for selected locations

LOCATION	Last flood affecting property before 2000	Highest Risk Properties	Flooded in 2000	Number flooded	Defences improved since 2000	Number of floods 1998 to date	Chow significance level at 10% or better	flood index coefficients significant at 5% or better	Positive or negative impact
Malton/Norton	1999	Significant	Yes	169	2003	2	Not sig	None	
Shrewsbury	1998	Significant	Yes	230	2003	4	**10%**	None	
Bewdley	1998	Significant	Yes	140	2002 and 2005	4	**1%**	**2001** **2003**	negative negative
Ruthin	1960	Significant	Yes	250	2003	2	**10%**	None	
Barlby	1947	Moderate	Yes	152	2007	1	**5%**	None	
Lewes	1979	Significant	Yes	800	2004	1	Not Sig	None	
Hatton	1957	significant	Yes	142	2006	1	**1%**	None	
Woking	1968	Significant	Yes	100	No	1	**5%**	None	
Mold	1976	Significant	Yes	181	2006	1	Not sig	**2002**	negative
Newport	1957	Significant	Yes	130	No	1	Not Sig	None	
Southsea	1953	Low	Yes	200	No but pump repaired	1	Not sig	**2003** **2004**	positive positive
West Bridgford	1947	Significant	No		No	0	Not sig	None	
Wakefield	1983	Significant	No		2003	0	Not sig	**2004** **2006**	positive positive

Any impact of floodplain measured was temporary in the majority of instances. At the end of the six years only one location, Lewes, demonstrated any impact of floodplain location. In Lewes a discount of 5% was maintained but it was not significant. As discussed above, special circumstances may make Lewes a unique location and further tracking of this location is recommended.

The significant temporary price impacts immediately following the 2000 event varied from no impact to a maximum of 30%. Some locations saw floodplain property outperform the rest. The choice of the FZ1000 outline as the definition of floodplain property may explain some of this variation as in some locations the outline is a good predictor of flood history for example Lewes whereas in others notably Shrewsbury it is woefully inadequate. However in order to maintain consistency during the combined analysis the FZ1000 outline will be used to define the flood free price index.

These findings will form the basis of the grouping of flood locations pursued in chapter 10. As it appears that flood history is likely to affect the measurable price impact it is proposed to group the locations by flood frequency into three groups namely not flooded, flooded once and flooded more than once. However within those groups there is variety in the other aspects of flood status. The not flooded group is fairly homogenous, as is the frequently flooded group but the third group, flooded once contains much more variety. In the following section the group of frequently flooded locations will be combined to form a global model which will consider detailed flood designation and likely flood history. All of these locations were included in the questionnaire survey and so a likely flood history can be constructed for each based on questionnaire responses.

Chapter 9 : QUESTIONNAIRE ANALYSIS

9.1 INTRODUCTION

In this chapter the data from the questionnaire survey is analysed independently of the property sales information. The main purpose of this analysis is twofold: to assess the distribution of insurance availability and cost; and to categorise the insured into groups for the combined model of price effect with insurance.

The evaluation of the hypothesis discussed in section 5.5 and 6.5 that premium loading due to flood risk or difficulty in obtaining insurance due to flood risk leads to depressed house value is critically dependent upon the assumption that property owners in flood risk areas find it difficult to obtain insurance or have to pay more for it. As noted in section 5.6 increases in premium and difficulties in obtaining insurance due to flood risk have been predicted in the light of recent developments in the insurance market and ABI guidelines. In addition, anecdotal evidence and media speculation have increased the perception that difficulties with insurance availability are widespread but this has yet to be demonstrated by systematic research. The results of this survey will determine the cost and availability of insurance for five of the areas under study. If insurance problems are detected then categorisation of the insured will then be possible which will allow for testing of the link between insurance and property value.

As outlined in chapter 7, this dual purpose survey was carried out using a self administered postal questionnaire, which was piloted in one location before full delivery in four selected sites. A brief summary of findings from the pilot were included in section 7.6 and the results presented below are for the four full survey locations, excluding the pilot unless otherwise indicated. The main findings are consistent across pilot and full survey where comparisons are possible but since the questionnaire changed after the pilot the two sets of results have not been combined.

Some descriptive and exploratory findings are also included in this chapter which do not directly address the specific objectives outlined above. These exploratory findings are valuable and interesting in their own right and may suggest avenues for future research in the area of flood management and insurance.

Section 9.2 deals with the distribution of the response data, comparing it to national statistics where possible in order to make an assessment of how representative it may be of the wider floodplain population. There follows a description of the search for insurance including the search mechanisms and difficulties encountered in section 9.3. Section 9.4 summarises the eventual outcome of that search detailing the proportion who failed to obtain insurance. The average cost of insurance and its distribution across flood designation and flood history is the focus of section 9.5. Section 9.6 deals with the perception of risk and mitigation activities pursued by floodplain residents. Categorisation of the insured necessary for the ongoing analysis is achieved in section 9.7.

9.2 RESPONSE RATE AND DATA DISTRIBUTION

This section addresses the two issues of generalisation of responses to the study sites and to the wider floodplain population. The response rate and distribution by categories are considered and then comparisons are made with national statistics where possible. Finally the typical flood experience is summarised.

9.2.1 Distribution within sample locations

The questionnaire was issued to a pilot location during April 2006 and then to the four study locations during September 2006. Three study locations flooded in the year 2000 and one narrowly avoided flooding, the pilot location flooded in 2000. The response rates are shown in Table 9-1. While these response rates are lower than the ideal for survey analysis they are not unusual rates for an unsolicited postal questionnaire given that no incentive apart from altruism was offered to the participants. One in five households responded and a sizeable sample of over 400 responses was collected.

Table 9-1 : Questionnaire response rates

	Issued	Returned	Percent return
Shrewsbury	657	144	22
Southsea	575	90	16
West Bridgford	277	60	22
Malton and Norton	585	107	18
Total	**2094**	**401**	**19**
Pilot Bewdley	350	83	24
Total with Bewdley	**2444**	**484**	**20**

More important than the actual return rate is the potential for non-response bias, a small response rate does not necessarily imply a large response bias and a large response rate will not guarantee a representative sample (Foster Wheeler

Environmental Corporation and Harris, 2001). In the pilot survey the tendency of those in the floodplain to respond was slightly higher than those outside the floodplain. This might imply a slight bias due to salience in the responses but comparisons within risk groups would not be subject to this bias. While it is never realistic to completely rule out non-response bias the wave analysis of the pilot survey in section 7.4 allayed concerns that the respondents would be unrepresentative in respect of key variables like flood history.

For the full survey, the questionnaire was sent to residents in all EA risk categories and to areas which had different recent flood histories. The response distribution across those categories is detailed in Table 9-2. Responses were obtained in all categories and were relatively evenly distributed across the Environment Agency risk categories also implying that the bias due to non-response will be minimised.

Table 9-2 : Distribution of responses across flood status categories including Bewdley

EA risk	Outside		Low		Moderate		Significant		Total	
Claim?	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Flooded?										
never	0	105	0	98	0	98	0	61	0	362
Once	0	2	15	5	14	7	10	4	39	18
twice	1	1	2	0	16	3	3	2	22	6
3-5	0	0	0	1	5	0	0	0	5	1
6+	0	0	3	0	4	0	0	3	7	3
Total	1	108	20	104	39	108	13	70	73	390

Those at significant or moderate risk of flood number 230, that is approximately half the properties. It is clear from this table that many of the properties at risk of flooding had not flooded in the six years prior to the study. Seventy-five percent of those properties at significant risk of flood had not flooded. Sixty-six percent of those moderately at risk and 80 percent of those at low risk reported no flooding. One quarter of all those which reported flooding had not claimed: the total number of flood claims reported was 73 whereas the total number reporting flooding was 101.

This distribution of actual flooding is lower than might be anticipated if it is considered that, during an exceptional event, properties at or above moderate risk are likely to have flooded. Partly this discrepancy can be explained by the fact that one site was selected where no recent flooding had occurred despite some property within high risk categories. There were also properties which reported no flooding because the current residents were not present during the flood. There still remain 60 properties representing 26% of those moderately and significantly at risk which did not flood although the area experienced flooding. This demonstrates that the cautionary statement from the Environment Agency in stating that their outlines are not designed to assign risk to individual properties is justified. The EA map simply does not account adequately for localised ground height or building adaptation. In their comments many residents stated that their property was built on raised land or was of raised construction. Some were quite infuriated by the inability of insurers to understand their special circumstances and had suffered premium increases while others had successfully explained their flood risk situation and received low premiums.

This finding is significant for the modelling phase of the project because in any hedonic price model perfect information for all parties is assumed, clearly this condition would be violated as the best available information, the EA categories, gives inaccurate information whereas the vendor has better information about flood history which he or she is not obliged to disclose.

The analysis above gives no indications that any specific section of the sample population refrained from responding to the survey or responded in greater than expected numbers. Wave analysis of the pilot showed no differences between early and late respondents. Generalising from the respondents to the locations under study was therefore seen to be reasonable from the above analysis.

9.2.2 Comparison with national statistics

Comparisons of the distribution of questionnaire responses with national statistics are presented here to assess whether the respondents are typical of the wider population. Respondents' tenure, age, type of property and age of property are considered. Figure 9-1 shows a histogram of the distribution of ownership of the property. It can be seen that the respondents are predominantly owner occupiers. In comparison with census estimates this represents a higher concentration of owner occupation than might be expected.

This might reflect the interest with which owner occupiers regard the issue of property insurance relative to tenants but may also be a true reflection of floodplain tenure. Owner occupiers represented 83% of the respondents as opposed to 69% nationally (based on 2001 census estimates). Owning outright saw the biggest discrepancy with survey proportion of 43% as opposed to 29% nationally. Owned with a mortgage were roughly comparable at 40% against 39% nationally.

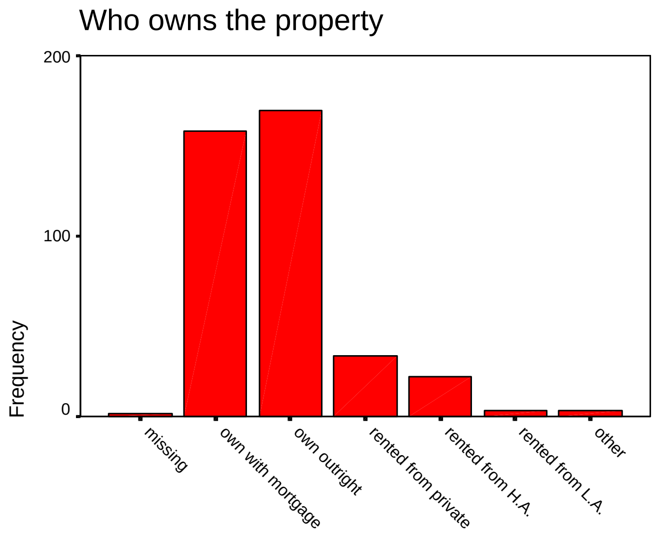


Figure 9-1 : Distribution of ownership of property

Figure 9-2 shows the age distribution of respondents. The respondents were heavily weighted towards older people as compared to national populations. For example the census that estimates 9% of the adult population are 75 or over as opposed to 21% of this sample. If chief income earner is considered the census estimates that 13% of households are supported by an individual 75 or older. Concentration of respondents in the older age categories is a fairly common experience for questionnaire surveys (Foster Wheeler Environmental Corporation and Harris, 2001).

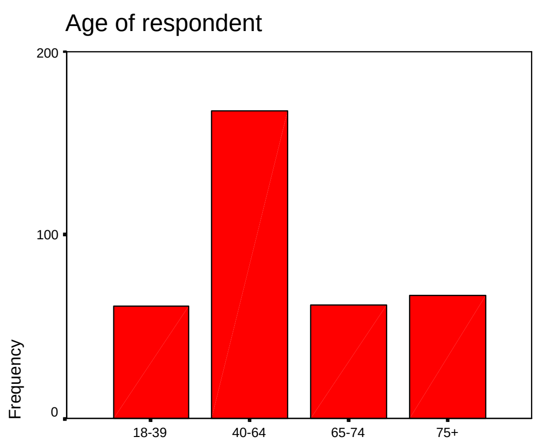


Figure 9-2 : Distribution of age of respondents

The survey design excluded flats, as discussed in chapter 7, where it was possible to identify them as such from the address details. This would naturally lead to a lower proportion of flats compared to the national average in the sample. Figure 9-3 shows the distribution of respondents by property type. Terraces were the most common property types represented in the survey responses at just over 40% of the sample.

Table 9-3 shows the comparison of survey respondents with national figures taken from the English house condition survey 2004. The sample contained a higher percentage of terraced housing than the national picture. This could reflect the town centre location of the majority of the sample where higher density housing is more common. The town centre location could also explain the lack of bungalows, since bungalows are often very low density housing.

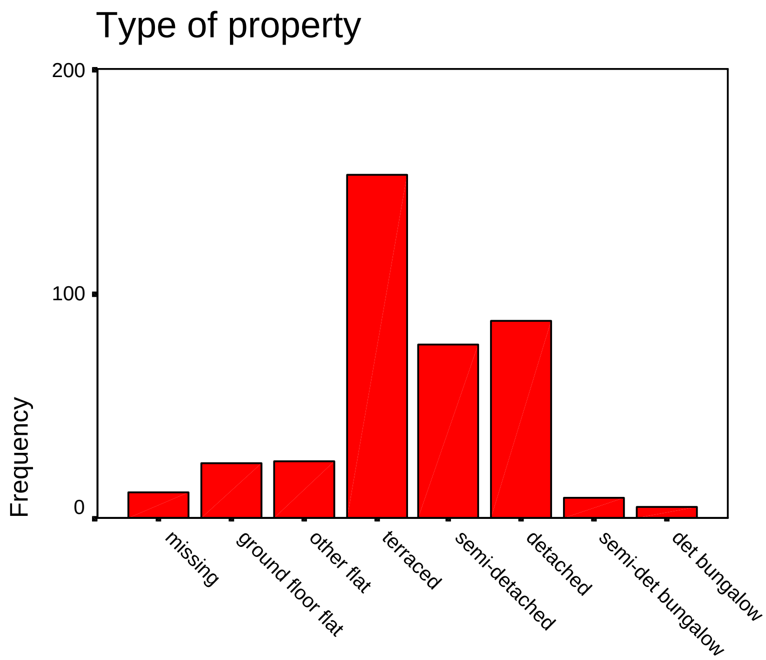


Figure 9-3 : Distribution of property type of survey.

Table 9-3 : Comparison of survey property type with English house condition survey

	National	Survey
Flat	16.9	12.9
Terrace	28.3	40.2
Semi- detached house	16.8	20.2
Detached house	9.6	23.1
Bungalow	16.9	3.7

Figure 9-4 shows the distribution of age of property within the survey sample. Pre 1920 housing dominates the sample, representing almost half the properties. This may again be a reflection of town centre location of most of the floodplain properties,; housing tends to be older in the town centre and get younger as distance to the town centre increases (Bourne, 1981). When compared to the national picture in Table 9-4 it appears that property built between 1945 and 1980 is under represented in this sample compared to national averages. It is not possible to say whether this is a true representation of the floodplain population.

Figure 9-4 : Distribution of age of property

Table 9-4 : Age of housing stock comparison

Percent	England	Respondents
Pre 1919	21.2	48.9
1919-1944	17.8	13.0
1945-1980	42.7	19.8
1980+	18.2	18.7
Total	100	100

It can be seen from the above comparisons that the sample of respondents and properties in this survey does not correspond with national averages in many aspects. It would be difficult therefore to draw conclusions from them about the population as a whole. The findings would be very useful however as a basis of comparison for any future investigations of flood insurance.

The distribution of the population at risk of flood is an unknown quantity and it is not possible to say whether this sample is typical of them or not. It would not be sensible to attempt to weight this sample to reflect national averages and not possible to weight it to reflect the averages within the population of interest. The results will be analysed without weightings. The primary function of this survey was to produce data for the modelling phase of the research and this function is not compromised by the differences between national and sample averages.

9.2.3 Flood experience

Among those residents with experience of flooding a further set of questions explored the frequency and severity of their flooding experience. It can be seen from Figure 9-5 that about half of flooded residents experiencing flooding only once. The frequent flooders who had flooded more than 5 times represented 11% of the total flooded residents.

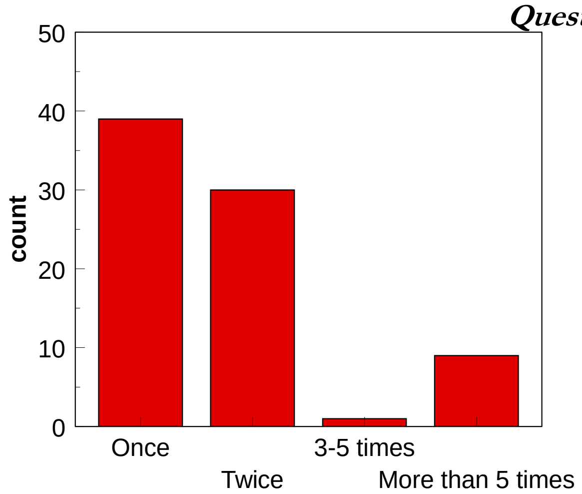


Figure 9-5 : Frequency of flooding amongst flooded residents

Figure 9-6 shows the distribution of flood depth amongst flooded residents. The majority of flooded residents experienced floods of up to one metre above ground level. The number of residents experiencing very deep flooding was small, fewer than 10 residents.

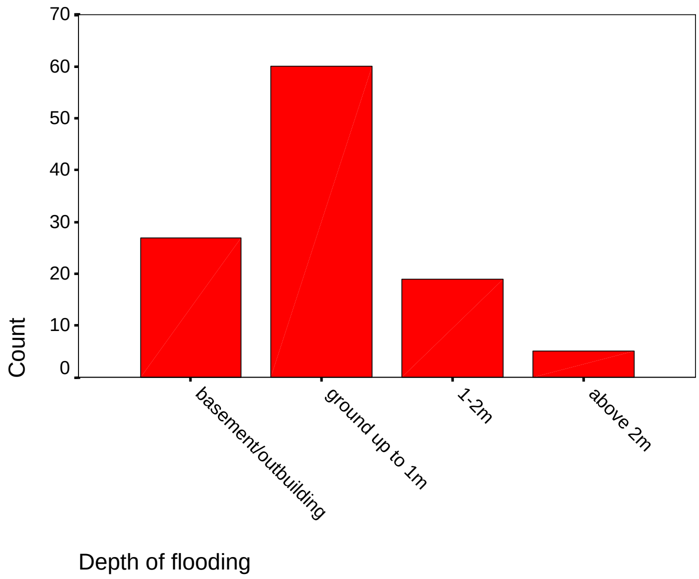


Figure 9-6 : Depth of flooding among flooded residents

Figure 9-7 shows the duration of flooding experienced by respondents. The majority reported floods which lasted over 24 hours.

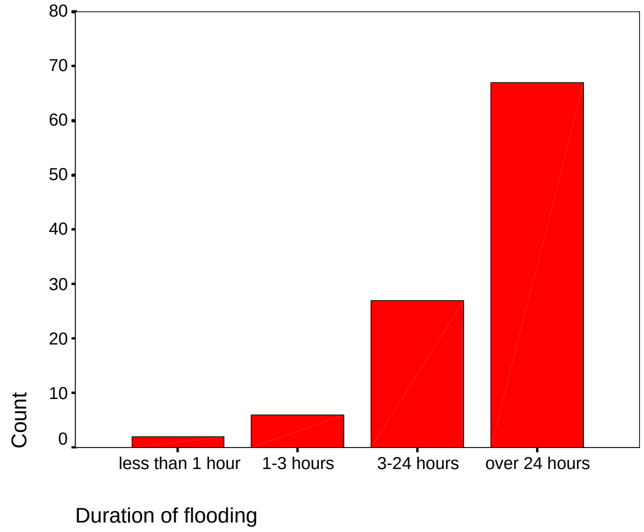


Figure 9-7 : Duration of flooding among flooded residents

Figure 9-8 shows the actions taken by residents in advance of flooding. About 3/4 (72 out of 101) flooded residents reported that they had removed belongings to safety. Less than half of flooded respondents had taken any other actions to prevent damage.

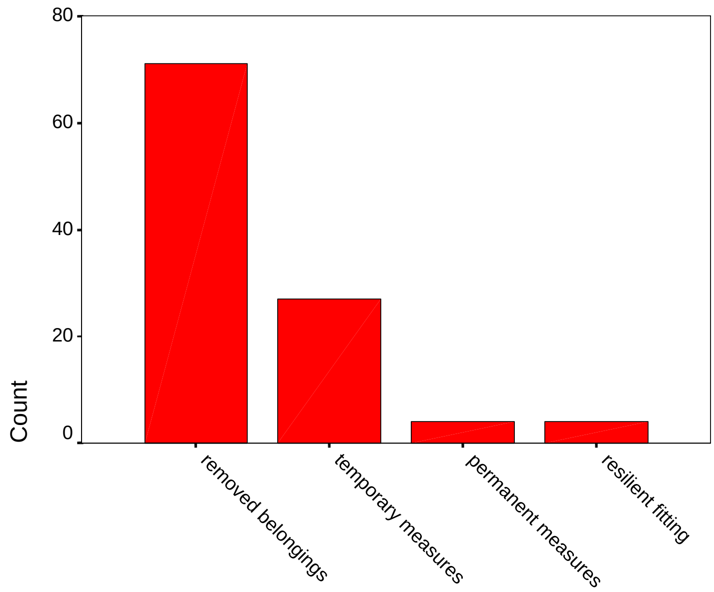


Figure 9-8 : Actions taken in advance of flooding

Respondents were asked to comment on how the condition of their property had changed as a result of flooding and reinstatement. A reassuring picture emerges as 93% stated that their property was the same or better than before the flood. Figure 9-9 shows the distribution of responses regarding the condition after reinstatement only a handful of residents reported being worse off.

In summary the experience of most flooded residents was one or two shallow prolonged floods from which they were able to remove many belongings. After flooding they felt their property was the same or better than before the flood.

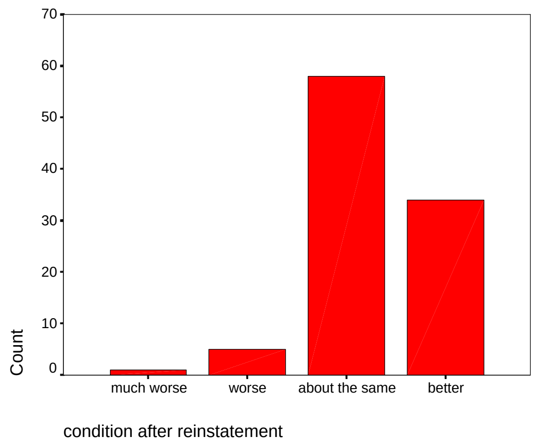


Figure 9-9 : Condition after reinstatement

9.3 DIFFICULTY IN OBTAINING INSURANCE AND CHOICE MECHANISMS

It was suggested in chapter 5 that floodplain residents may experience difficulty in obtaining insurance due to the policies of individual insurers in attempting to avoid flood risk policyholders. In the UK the search for insurance by floodplain residents can encompass a large number of private companies as discussed in section 5.3 and a first refusal does not mean exclusion from insurance elsewhere. Whether or not difficulties are encountered for prospective property owners will determine whether evidence for the disclosure hypothesis can be examined.

9.3.1 Difficulties reported on renewal or shopping around

Table 9-5 shows the responses to the question regarding difficulties encountered when renewing insurance or requesting quotes during the last six years. The most common reported experience was a significant increase in premiums. Second in frequency was refusal of a quote due to flood risk. This aspect of flood insurance is one which the official ABI estimates would not reveal because there is no mechanism to record the number of refusals of new business. More worryingly 12 respondents reported being refused renewal due to flood risk, an unexpectedly high number.

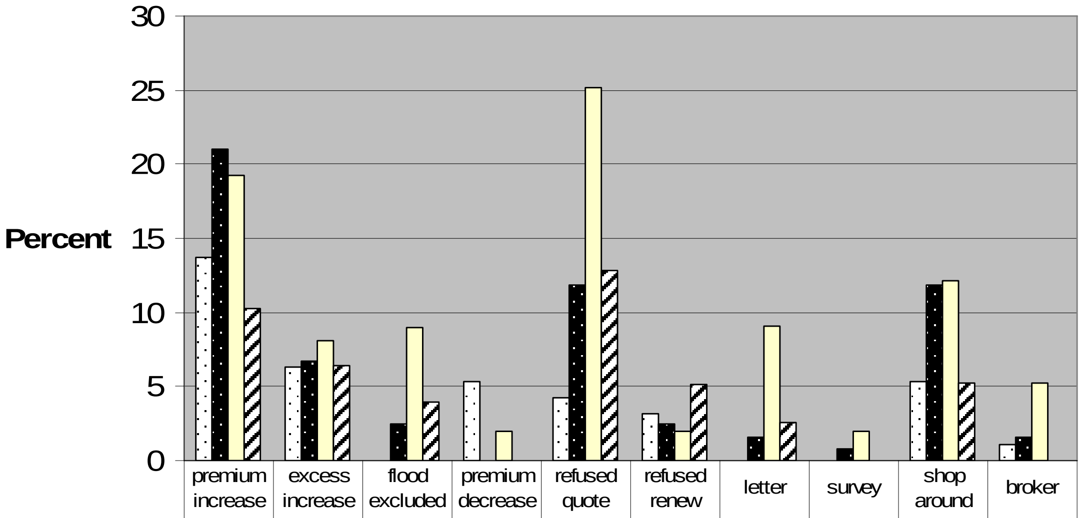
The least common experience was to be asked to install flood protection measures in order to get cover; no respondents reported this. There was only one respondent who reported being required to install resilient features. This was a property owner whose residence had flooded more than once and who had also accepted a high premium and excess on their policy despite their precautions. The evidence from this survey suggests that insurers are not in general encouraging or compelling their customers to take mitigating actions. The questions regarding protection and resilience will be excluded from further breakdowns.

Table 9-5 : Difficulties experienced by respondents on requesting quotes for insurance

Number of respondents experiencing difficulty (Total number of respondents = 401)	For buildings only	For contents Only	For both buildings and contents	Total experiencing difficulty on one or both policies
A significant increase in premium	9	12	44	65
A significant increase in excess	4	6	16	26
Floods excluded from the policy	2	5	8	15
A significant decrease in premium	1	1	5	7
Refused a quote due to flood risk	7	10	36	53
Refused a renewal due to flood risk	4	1	7	12
Required to provide a letter from the environment agency	4	2	7	13
Required to get a survey of flood risk	1	0	2	3
Had to shop around a lot to get an affordable quote	7	6	22	35
Had to use a broker to get an affordable quote	1	0	5	6
Had to install/buy flood protection measures to get cover	0	0	0	0
Had to install resilient fixtures to get cover	1	0	0	1

Figure 9-10 breaks down the responses by flood designation categories and shows the percent of each category experiencing the particular problem. Increases in premiums and excess charges were reported across the board equally irrespective of flood risk. This suggests that the increases were unrelated to flood risk. The most striking feature of the data is that one quarter of those residents who lived in property located in an area at moderate risk of flood reported being refused a quote for insurance due to flood risk. This was twice as high as the reported refusals from residents located in the significantly at risk area.

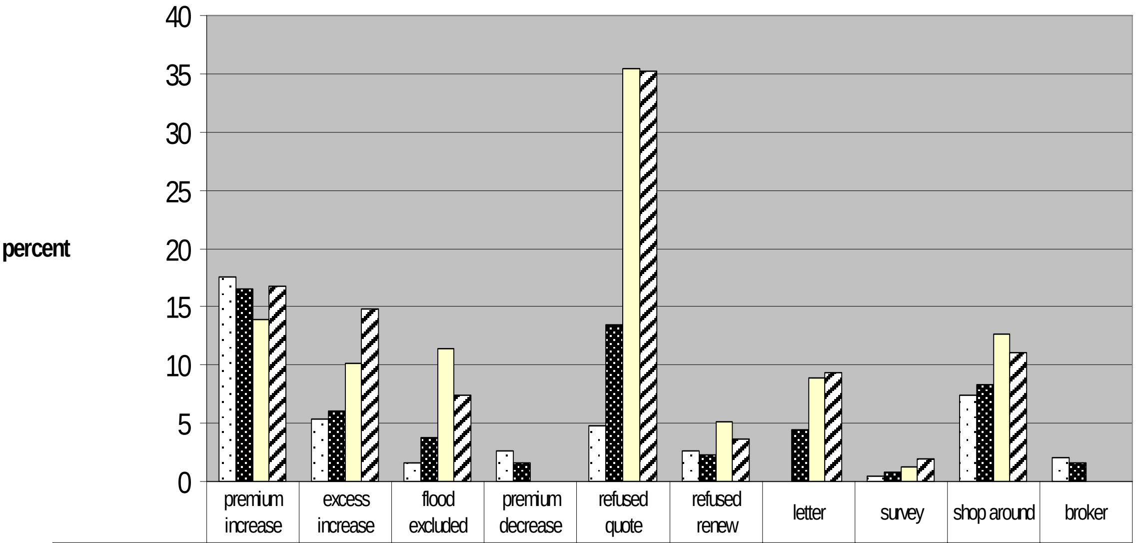
One possible explanation for this unexpected result could be that the residents at significant risk have requested fewer quotes. However, refusal of renewal reflects the expected distribution, being more heavily concentrated in those significantly at risk. Five percent of significantly at risk residents had been refused renewal.



	premium increase	excess increase	flood excluded	premium decrease	refused quote	refused renew	letter	survey	shop around	broker
outside	13.7	6.3	0	5.3	4.2	3.2	0	0	5.3	1.1
low	21	6.7	2.5	0	11.8	2.5	1.6	0.8	11.8	1.6
moderate	19.2	8.1	9	2	25.2	2	9.1	2	12.1	5.2
significant	10.3	6.4	3.9	0	12.8	5.1	2.6	0	5.2	0

Figure 9-10 : Difficulties experienced when requesting quotes for insurance by flood designation

When the data is partitioned by flood history as shown in Figure 9-11 larger differences in responses are observed. Having a history of flooding or flood claim was productive of the most difficulties for residents. Excess increases, exclusion of flood, quote refusal and refusal of renewal were all more prevalent in previously flooded homes. Over one third of flooded residents had been refused a quote for insurance. Five percent were refused renewal. These responses indicate that some insurers are refusing quotations for flood risk and previously flooded property and some are refusing to renew the most at risk. However a majority of residents in the floodplain had experienced no difficulties even with a history of flooding.



	premium increase	excess increase	flood excluded	premium decrease	refused quote	refused renew	letter	survey	shop around	broker
resident not flooded	17.5	5.3	1.6	2.6	4.8	2.6	0	0.5	7.4	2.1
not resident	16.5	6	3.8	1.6	13.5	2.3	4.5	0.8	8.3	1.6
flooded	13.9	10.1	11.4	0	35.4	5.1	8.9	1.3	12.7	0
claimed	16.7	14.8	7.4	0	35.2	3.7	9.3	1.9	11.1	0

Figure 9-11 : Difficulties experienced when requesting quotes for insurance by flood history categories

9.3.2 Difficulties for new residents

A particularly interesting category of respondents for the current research programme is those residents who were not resident during the 2000 flood event but have moved into floodplain property during the study period. There were 133 of these respondents, about one third of the sample. In general the sort of difficulties experienced by those not resident is similar to that of those residents who were resident but did not experience flooding. The main difference is in refusal of a quote due to flood risk which is trebled in those who were not resident over those who were resident but not flooded.

An open question in the flooding literature for the UK is the extent to which new purchasers of flood risk properties are aware of the flood status before purchase. This is because flood risk assessments are not a necessary part of the purchase searches in the UK. Choosing to pay less for a flood risk property is contingent upon flood awareness at purchase. Those who now perceived that they lived in a flood risk area were asked whether they were aware of the risk of flood at property purchase. Figure 9-12 shows that about half of the residents who reported living in a flood risk area were not fully aware of the flood risk status of their property at purchase.

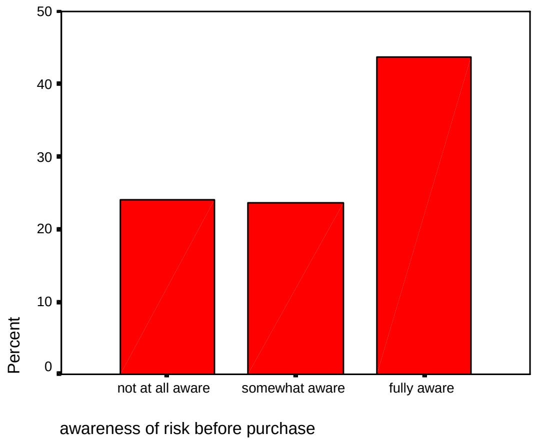


Figure 9-12 : Awareness of flood risk at property purchase

Due to the increase in flooding incidents in recent years it seems likely that people who purchased recently would have a better knowledge of flood risk than longer term residents. In fact this is borne out by the Kendal's Tau correlation (see appendix C) between awareness of risk at purchase and length of residence which was significant at 1% and of the expected sign.

A further question addressed the issue of insuring new purchases of property in the floodplain. Those who had recently (in the last six years) purchased their property were asked whether they had experienced difficulty in obtaining insurance, 84 of the 133 recent occupants replied to this question. One quarter experienced some difficulty in obtaining insurance. Table 9-6 displays the responses split by risk category. Over half of moderately at risk respondents reported some difficulty with obtaining insurance. Significantly at risk residents reported less difficulty.

Table 9-6 : Difficulty in obtaining insurance for a new residence

Percent of category experiencing -	Outside floodplain	Low risk	Moderate risk	Significant risk	All respondents
No difficulty	75.0	76.9	45.0	84.2	74.0
A little difficulty	21.7	7.7	25.0	10.5	12.0
Quite a lot of difficulty	4.3	15.4	30.0	5.3	14.0

It is clear from this table, however that insurance difficulties will not alert all prospective floodplain purchasers to flood risk. Just under half of moderately and significantly at risk residents experienced no difficulty at all. Approximately one in five respondents had to pay more for their insurance or accept exclusions as summarised in Table 9-7.

Table 9-7 : Increases in premiums and exclusions accepted by new residents

	outside	Low	Moderate	Significant	%
Don't know	17.6	20.8	31.6	15.8	20
No	76.5	66.7	47.4	70.6	60
Yes	5.9	12.5	21.1	21.1	20

Whilst this is not a negligible proportion of new residents it does not represent the scale of problem expected from media reports. If alerted to flood risk by the insurance process there is little further disincentive to buy in about four out of five cases. In the majority of cases we would expect no effect from insurance premium increases or exclusions because the purchaser is not experiencing increased premiums or exclusions or does not perceive that they are. Finally when asked when they discovered about insurance problems only 15 responded. The majority had discovered the insurance problems during the purchase process. Six had discovered before the offer stage, seven after offer but before completion and two after completion.

9.3.3 Choice of company

Figure 9-13 shows the distribution of policyholders by company. The larger insurers (for example Norwich Union, Prudential and Direct Line) are under-represented in the flood risk cohort relative to the not at risk cohort.

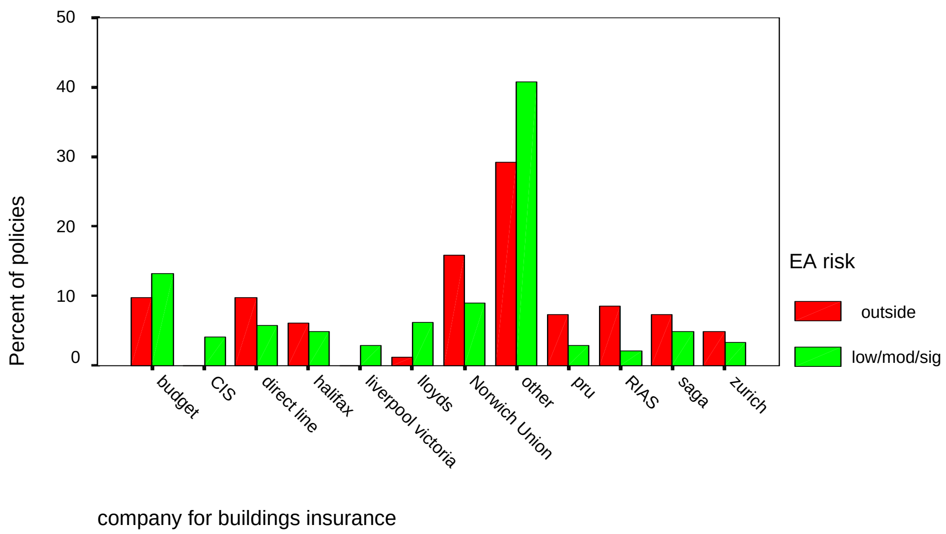


Figure 9-13 : Spread of policyholders by company

There are some companies which are only insuring flood risk residents (CIS and Liverpool Victoria) in this sample or who have higher representation than in non-flood risk (Lloyds TSB). This reflects the wider search strategy needed by flood risk policyholders.

9.3.4 Selection mechanism

Examination of way in which policyholders selected their insurance reveals differences between flood risk and non flood risk residents. The choice mechanisms are summarised in Figure 9-14. The most popular choice mechanism amongst flood risk residents was to stay with their mortgage lender (22% as opposed to 11% for those not at risk).

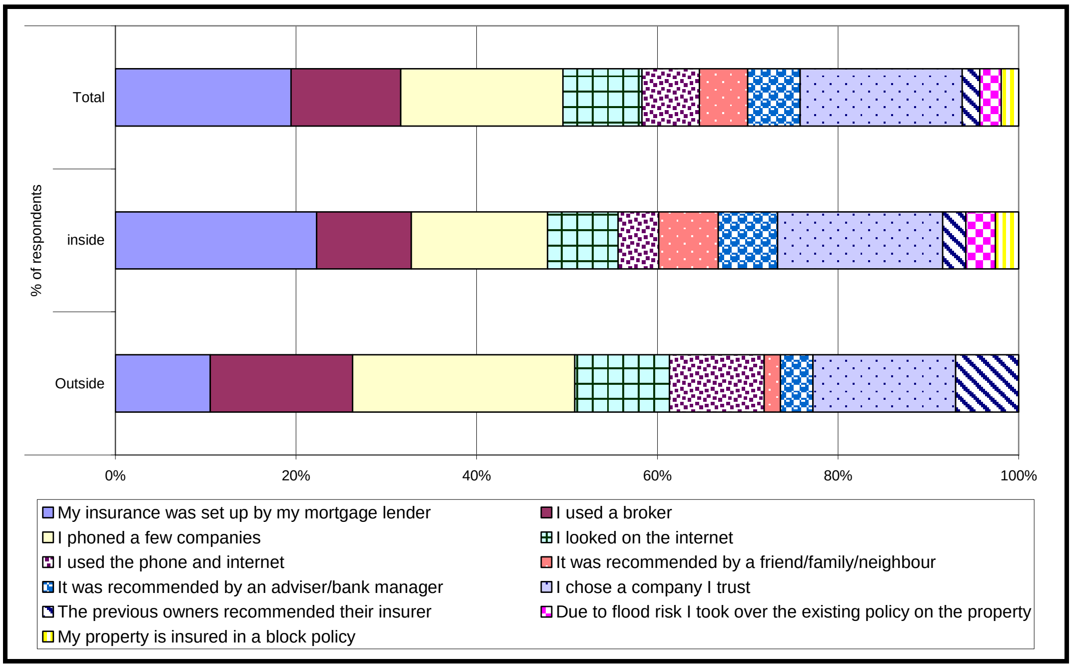


Figure 9-14 : Comparison of primary choice mechanism floodplain and non floodplain residents

For those outside the floodplain the most popular option was to phone around (25% compared to 15% of at risk residents). Perhaps there are 10% of would be switchers who are stuck with their insurer due to flood risk. Phone and internet searching was the primary choice mechanism for 45% of residents outside the floodplain but only 30% of floodplain residents. There were some categories of choice mechanism only used by those at risk of flood including "recommendation from the previous resident" and "only this company would insure my property".

The number of policyholders, resident during the flood who had switched insurers during the past 6 years is shown in Table 9-8. This shows that flooded residents had switched less than the non-flooded but that it is possible to switch insurer with a history of flooding.

Table 9-8 : Tendency to switch insurance based on flood history

	Flooded	Not flooded
Switched	17 (28%)	76 (53%)
Not switched	43 (72%)	68 (47%)
Total	60 (100%)	144 (100%)

In summary floodplain residents and flooded residents are both more likely to experience difficulties in obtaining quotes for insurance than those outside the floodplain but the majority will not experience any difficulty. For new residents about half of those moderately and significantly at risk had some difficulty in insuring their home but only one in five perceived that they had accepted high insurance cost or exclusion as a result. Floodplain residents tend to switch insurers less frequently than those not at risk but when they do switch they may pursue a wider search strategy and employ different choice criteria.

9.4 ANALYSIS OF INABILITY TO GAIN INSURANCE.

Despite the difficulties experienced by floodplain and previously flooded residents described above in section 9.3 the competitive and fragmented nature of the insurance market in the UK allowed most to overcome the difficulties. The eventual outcome of the search for insurance is covered in this and the following section in terms of availability and then cost.

9.4.1 Respondents without insurance

Only seven percent of the survey respondents reported having no property insurance, 93% had either buildings insurance, contents insurance or both. This compares favourably with Gaschen et al (1998) estimates for the Swiss Reinsurance company that 95% of households have buildings insurance. Only one respondent reported being unable to obtain buildings insurance due to flood risk. Three respondents reported being unable to obtain contents insurance due to flood risk. This is a reassuring picture and reflects the perception of the ABI (2005c) that their members are not refusing to insure flood risk residents in large numbers.

9.4.2 Exclusion of flood risk

Although very few residents had failed to obtain property insurance, for some flood risk residents their cover may be compromised by the exclusion of flood risk or by the imposition of high excess charges. Inclusion of flood risk in the standard domestic policy is the default position for the UK as described above in chapter 5. However anecdotal evidence had suggested that some flooded or flood risk property owners had accepted flood exclusion or high flood excess in order to gain cover for other risks such as fire and theft. Clearly for a flood risk respondent exclusions and excess charges may severely compromise their ability to reinstate a flooded property. In addition and most relevant for the current investigation, for the purposes of property purchase this exclusion or excess may be regarded by lenders as capital at risk.

Surprisingly 80 respondents (20%) did not know whether their insurance covered flood risk, 26 of these were at moderate or above risk of flooding. This is worrying in that these residents do not seem to be concerned about flooding risk, but it is fair to assume that if they have not been told that flooding is excluded from the policy then it will almost certainly be included since inclusion is the default position in the UK.

Exclusion of flooding from their policy was suffered by 24 respondents (6%). Of these respondents, six had previously flooded and a further nine were at moderate or above risk of flooding. It is not possible to determine from the survey whether these respondents had any choice in accepting the exclusion which may have been an option taken to reduce insurance cost.

Excess charges are another way in which cover can be compromised. Excess over £2,500 may be regarded as capital at risk by mortgage lenders (Clark et al., 2002). In this survey four policyholders (1%) had to accept excess of £2,500 or above. As with flood exclusion this may have been an option.

In summary, 18 respondents were at moderate or above risk of flooding and had no cover for flood risk. This is 5% of the total sample and 10% of those at moderate or above risk of flooding. The majority of these were covered for other risks. This is a cause for concern for those property owners but reassuring that the proportion of at-risk residents who can get insured for flood risk is so high.

9.5 COST OF INSURANCE WITHIN THE FLOODPLAIN

For the analysis of insurance costs a subset of respondents was selected. Respondents who held both buildings and contents insurance, for whom flooding was included in the policy and who had provided their insurance cost details were included. This provided a sample of 198 questionnaires. Insurance rate was calculated for each property as described in section 7.6. The median rate of insurance by category is presented in Table 9-9. The differences between categories are very small, in general statistically insignificant, and do not reflect the doubling suggested by other sources (Crichton, 2005).

Table 9-9 : Median insurance rate by EA risk category (£per £000 insured)

Median	Total	Resident	Not resident	Flooded	Resident not flooded
Outside	2.2	2.5	1.9	Na	2.5
Low	2.6	2.5	2.6	3.2	2.4
Moderate	2.5	2.4	3.7	2.5	2.3
Significant	2.5	2.3	2.3	2.4	2.3
Total	2.5	2.5	2.5	2.5	2.4
Kruskal Wallis	0.101	0.451	0.006**	0.557	0.353

It appears that the variability of premium paid increases with flood risk reflecting the fact that some residents are experiencing difficulty in obtaining insurance and some are not. However for those not resident during the 2000 flood event there appears to be an effect of risk category on premiums paid. Further investigation reveals that the difference is greatest between outside and inside the flood risk map. The distinction between low, moderate and significant risk is not significant. The median difference between outside the floodplain and inside for respondents not resident during the flood is 0.8, an extra 40% on top of average premium of 1.9 but the variation between policyholders is wide. Remember also that this group did not perceive that they were paying more on the whole as demonstrated in Table 9-7.

When flood history is examined no significant differences are observed between the rates paid by the previously flooded and flood free.

In summary then the average premium paid by those who are able to obtain insurance is not determined by the risk of flood or the flood history. For new residents there is an effect of EA risk category but, on average, it is less than double the premium paid by those outside the floodplain.

9.6 PERCEPTION OF RISK AND MITIGATION UNDERTAKEN BY HOMEOWNERS

One further aspect of flood risk is the perception of the homeowners themselves. In sites where flooding occurred during 2000 the residents may have a better idea about the likelihood of flooding in a similar event than the Environment Agency. A comparison of stated flood risk versus EA category shows that about a quarter of respondents outside the floodplain considered themselves to be living in a flood risk area while a third of those living in the significant category did not consider themselves at risk of flood.

Table 9-10 shows the Kendalls tau_b correlations between flood risk categories for all repondents. The variables are significantly correlated but the level of correlation is not uniformly high. In particular the correlation between EA risk category and perceived flood risk is only 0.3 suggesting that there is a large element of disagreement between the residents' perceived risk and the EA estimated risk. This is pertinent to the current thesis because as discussed in section 5.5.1 the gulf in risk perception between official estimates and residents will result in lower willingness to pay to evacuate the floodplain.

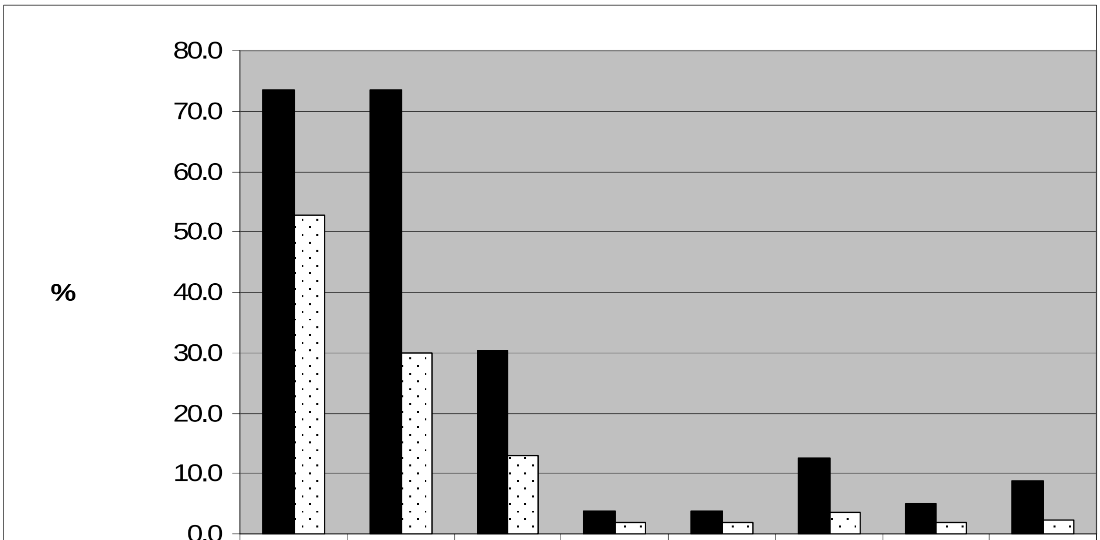
Table 9-10 : Correlation between flood risk status variables

	Resident During flood	Flooded	Claimed	Perceived in flood area	EA risk category
Resflood	1	0.239**	0.239**	0.003	-0.030
Flooded		1	0.734**	0.335**	0.207**
Claimed			1	0.239**	0.138**
Perceived				1	0.301**
EA risk					1

This may have serious implications for the modelling work which will use EA estimates of risk to categorise properties. However, as discussed in chapter 6, prospective purchasers will not always have access to the vendor's assessment of flood risk and may in any case lend far more weight to official estimates.

Respondents were asked what measures they had taken to mitigate against flood damage. The responses for those who perceived a risk are summarised in Figure 9-15. Just over half had registered for flood warnings and less than 10% had taken any of the other measures namely purchasing temporary barriers, installing permanent barriers or installing resilient fixtures and fittings.

If previously flooded residents are considered the percentage registering for warnings increases to 73% and 20% have taken other measures. Experience of flooding appears to have given some residents the motivation to take action but these actions are largely those which are cost neutral or can be deployed once a flood is imminent.



	registered for flood warnings	removed belongings	deployed sandbags/ doorboards	purchased temporary measures	resilient fixtures and fittings pre flood	resilient fixtures and fittings post flood	installed permanent measures pre flood	installed permanent measures post flood
■ flooded	73.4	73.4	30.4	3.8	3.8	12.7	5.1	8.9
□ perceived at risk	52.7	29.9	12.9	1.8	1.8	3.6	1.8	2.2

Figure 9-15 : Mitigation measures taken by residents perceiving a flood risk

These findings suggest that the complacency reported in previous studies of at risk populations (Clark et al., 2002, Grothmann and Reusswig, 2006) is repeated in this sample of respondents. Experience of a flood in their area improves awareness of risk but only among those whose property actually flooded. The implication of this complacency in terms of anticipating low potential property value impacts has been well rehearsed above.

9.7 CATEGORISATION OF INSURED

The results of the Kruskal Wallis tests show that insurance premium paid is not in general correlated to EA flood risk status. For the crucial group of new residents there is a relationship between insurance premium and EA risk category. However the correlation is reasonably low at 0.3 and therefore as outlined in section 6.8, it may be possible to test the two factors separately.

The aim of categorising the insured into premium bands based on their insurance rate is to form a factor in the block design phase of the price modelling described in section 10.4. In the conceptual description in section 6.8 two levels of insurance cost were envisaged. However, in the light of the analysis of perceived problems above it would appear that a categorisation of insurance problems can be constructed which incorporates more of the difficulties experienced by floodplain purchasers than simply increased insurance cost.

Three categories can be used – normal insurance, high premium and compromised insurance. Insurance is said to be compromised if a resident is uninsured for flood or has accepted an excess charge of above £2,500. The choice of cut off point for the category of high premium will be based on the upper limit of the inter-quartile ranges for the respondents outside the floodplain. This leads to a definition of high premium rate of 3.05 or above. Sixty nine respondents (30%) fall into this category. All other insured will be placed in the normal category.

9.8 SUMMARY

Analysis of the questionnaire survey data was necessary in this research because the availability and cost of insurance for floodplain residents has not been studied previously in the UK. Studies of the impact of flooding on house prices have identified insurance cost and availability as an important issue in determining the size of discount. Understanding the difficulties encountered by floodplain residents is important in determining the way in which insurance can be incorporated into the price model.

Chapter 5 discussed the available evidence about the cost of insurance to homeowners in detail. The main conclusion was that the competitive nature of the UK home insurance market (into which flood insurance is subsumed) made it impossible to predict with any precision a priori the insurance rate paid by individuals from their property details. The output from the questionnaire survey largely backs up this conclusion especially with regard to flood risk, neighbouring properties of similar type can experience very different treatment by their insurers and will also take different steps in their search for affordable cover.

For the studied flood risk locations it appears that for most residents full insurance is available. For a minority of residents the problems in obtaining insurance have proved insurmountable. It is not possible to say whether or not these respondents could gain insurance but near neighbours have done so.

On average the floodplain resident faces more difficulties in obtaining insurance. They are more likely to experience a range of problems when looking for a policy, and perhaps in consequence they are more likely to remain with their mortgage lender. However the majority of floodplain residents reported no difficulties at all.

The premium paid by residents who obtained full insurance showed no relationship with EA flood risk category except for new residents. Some new residents of property at risk, a minority, perceived they were paying more for cover and this was confirmed by examining their average insurance rate. However the increase in rate was only 40% on average. Extreme excess charges were experienced by very few respondents but these were exclusively in flood risk areas.

Recently flooded residents faced more difficulties in obtaining insurance than those who had not flooded and also more than those who were at risk but not flooded. It is still the case however that more than half reported no difficulties with gaining cover. There was no relationship between flood history and average premium paid.

The analysis resulted in a three stage definition of insurance categories for the price model: Compromised insurance; high premium insurance; and normal insurance. These categorisations will be used in the construction of the insurance model, which is the third combined model described in the following chapter.

Chapter 10 : MODEL ESTIMATION

10.1 INTRODUCTION

Chapters 8 and 9 above have provided detailed analyses of the data collected in order to build a combined model of the price impact of flooding across multiple flood sites in the UK. These analyses have provided some insight into the state of the flood insurance market in the UK and the variation in property price impacts. The primary purpose of these analyses however was to generate local price indices for discounting the repeat sales of floodplain property and to derive a categorisation of insurance costs appropriate to include in the insurance model.

For the individual locations very few significant value impacts could be measured. Partly this was due to small sample sizes but the dilution of flood risk categories were also shown to have a bearing in some cases. The research design described in chapter 7 had anticipated this issue and the combined model described in this chapter is the proposed solution in that it combines the data, in the expectation that this will allow for increased statistical power.

10.2 COMBINED SITE REPEAT SALES MODEL

Data were generated from the individual repeat sales analyses by discounting the growth figures by the local price index calculated from the property outside the floodplain as described in section 6.5. The data from the 13 sites were combined into a global database and the annual discounted growth rates calculated. Repeat sales pairs were limited to those which had a first sale before the flood and the average discounted rates were calculated. The date of the second sale being used as the summary year as described in section 6.5.

10.2.1 Impacts in all flood locations

When all categories of flood site were combined and flood designation is considered to be whether inside or outside the 1000 year floodplain there was no discernable impact of flood designation on the discounted growth in price. This is an important finding because it suggests that designation alone had no impact on the growth in price of floodplain property. When it is considered that several factors may have increased the importance of flood designation in the mind of the floodplain population over the analysis period this finding is suggestive of the conclusion that flood designation alone has no impact on property value growth.

10.2.2 Impacts in flooded locations

Control sites, those which had not flooded in the year 2000, were then removed and the analysis repeated for those sites which had flooded in 2000. The results are shown in Table 10-1. It is clear that the averages are close to and not significantly different from zero. There is no negative effect of flood designation on growth in property price even in those areas which suffered a flood event. A Kruskal-Wallis rank test (see appendix G) confirms this assessment.

Table 10-1 : Mean discounted growth rate for properties inside and outside the extreme flood outline

	Fz1000	Non fz1000
2001	0.10	0.07
(n)	(47)	(120)
2002	-0.01	0.04
(n)	(70)	(197)
2003	-0.01	-0.01
(n)	(62)	(187)
2004	0.04	0.00
(n)	(68)	(167)
2005	-0.04	-0.04
(n)	(52)	(158)
2006	0.00	-0.01
(n)	(40)	(135)

However if instead of the fz1000 outline, the Environment Agency risk categories are used then those significantly at risk of flood emerge as of lower rank as shown in Table 10-2. This weak result, which is significant at the 10% level, shows that there is a tendency for the price of properties within the significantly at risk category and in locations which flooded in the year 2000 to grow at less than the average rate. Those moderately at risk, at low risk and outside the floodplain appear to grow at comparable rates.

Table 10-2 : Mean rank of growth rates by flood designation category

EA Category	Number of Sales Pairs	Mean Rank
Outside Floodplain	963	656
Low Risk	239	670
Moderate Risk	41	632
Significant Risk	60	535
Kruskal-Wallis Test	0.087	

10.2.3 Effect of flood frequency

The sites were further subdivided into those which had flooded once and those flooded 'frequently' defined as subject to more than one flood in the period 1998-2006.

The category of flood risk was subdivided into low moderate and significant. This disaggregation further confirmed the tendency within significantly at risk properties in areas which were subject to flooding in 2000 to grow more slowly.

For those which were flooded once only the tendency to slow growth was very limited as shown in Figure 10-1 peaking in 2003 for significantly at risk properties. This is not perhaps surprising given the analysis of individual sites where some displayed no impact at all. An interesting anomaly in the averages is the tendency for 2001 sales to have a positive discounted growth. This could be due to the impact of short holds – properties must have been bought in 2000 and resold in 2001 to feature in this average. A positive tendency might reflect the impact of entrepreneurs improving property for profit.

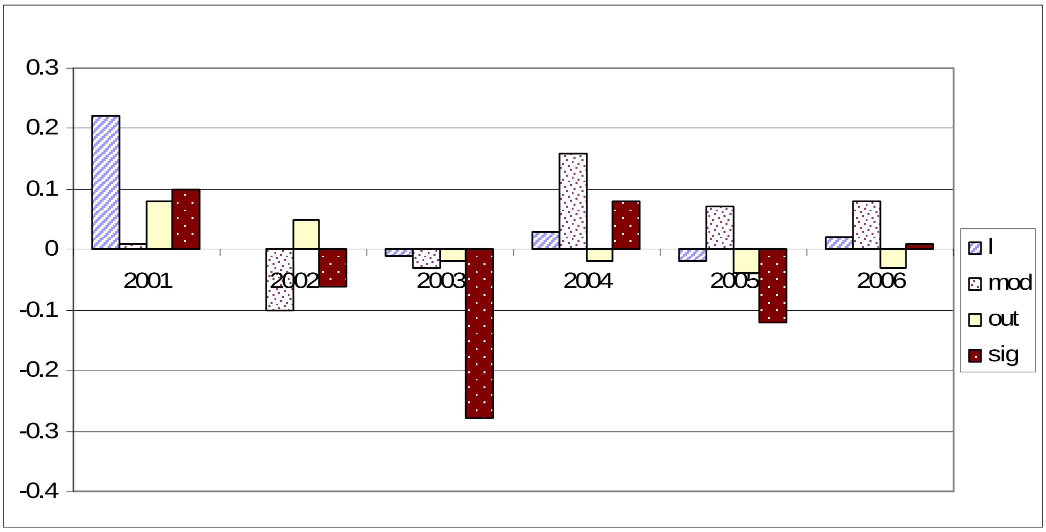


Figure 10-1 : Discounted growth rate, flooded locations, by designated risk category

Within locations which flooded more than once stronger trends were observed. The average discounted growth is shown in Figure 10-2. For significantly at risk properties the average discounted growth is consistently negative. This implies that significantly at risk properties in flood locations which flooded frequently grew at less than the average rate after suffering flooding in 2000. For those moderately at risk the effects are smaller and in 2006 a positive impact is seen.

Whilst these averages are not significantly different from zero, they are consistently negative and of greater magnitude than the property outside the floodplain. Having noted the effects it has to be reiterated that even for the most at risk properties in the areas with the most frequent flood history these are small scale impacts averaging only 9%. It is also worth noting that these are changes in growth rate. In fact, on average, property within the floodplain continues to grow in price throughout the period but grew at a slightly reduced rate. Also of note is the fact that the largest impact was observed in the year 2005. This date corresponds with the year following a minor flood in 2004, the re-launch of the Environment Agency maps and coincided with the year of the massive flooding in Carlisle. However care should be exercised when interpreting the results based on only 20 examples.

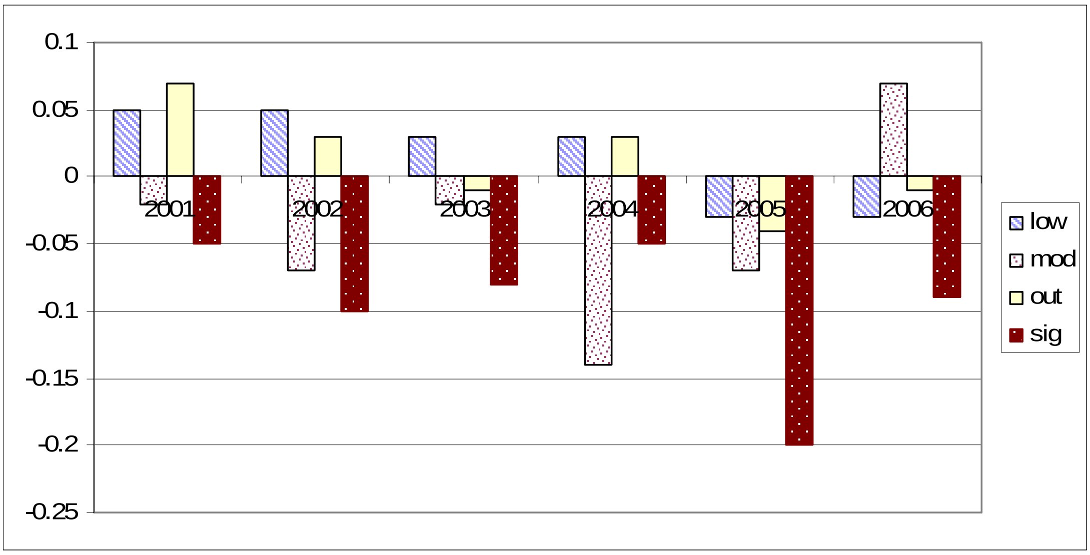


Figure 10-2 : Discounted growth rate, frequently flooded locations, by designated risk category

The conclusion suggested by this analysis is that the impact of flood risk designation on the growth in residential property price is small even in the aftermath of actual flood events and non-existent in the absence of flood events. The greater the number of recent events and the more significant the designated risk the higher the effect.

10.2.4 Impact of flood history

Further analysis of the most frequently flooded locations, Shrewsbury, Malton and Norton and Bewdley, was made possible by use of extra information about flood history. In the foregoing analysis frequency of flood was taken for the floodplain as a whole and, as discussed in chapter 6, property by property flood history was not available. More detailed flood history information was available for the three frequently flooded via the questionnaire survey but also via extra information provided by the Environment Agency for these three locations. A flood history variable was therefore constructed for individual properties based on a judgement, nearest neighbour approach. A property was defined as flooding never, once twice or more than twice.

The results of the resulting analysis are in line with expected patterns as shown in Figure 10-3. The properties flooded most frequently display lower discounted growth rates in the immediate aftermath of the 2000 event. The impacts are seen to decline with time.

The maximum average impact is for those properties flooded more than three times, a discount of 30% in the year following the 2000 event. For some properties this represented a reduction in absolute price mainly for properties in Severnside South in

Bewdley which sold in 2000 and again in 2001. It is possible that these properties were sold in a compromised condition.

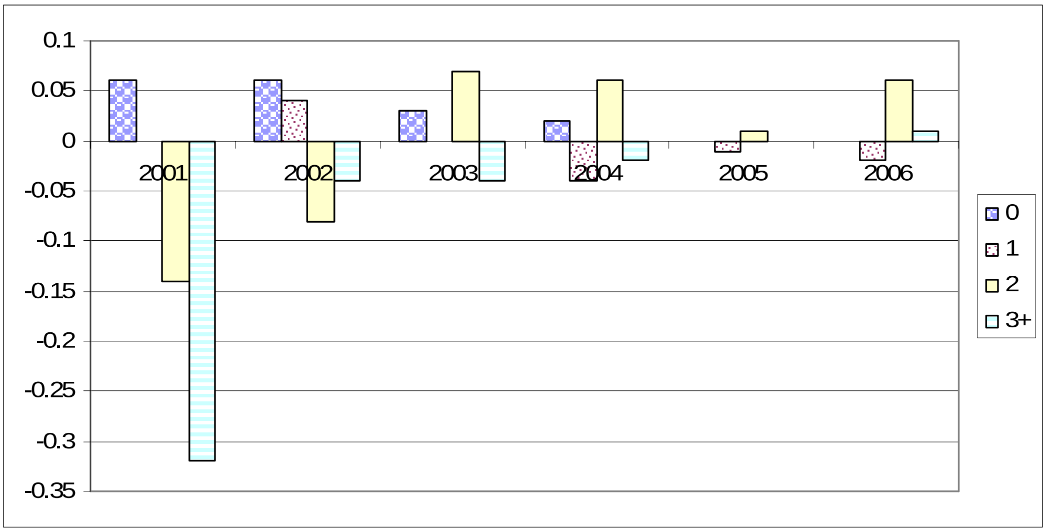


Figure 10-3 : Discounted growth rate, frequently flooded locations, by flood history

The maximum average impact is for those properties flooded more than three times, a discount of 35% in the year following the 2000 event. For some properties this represented a reduction in absolute price mainly for properties in Severnside South in Bewdley which sold in 2000 and again in 2001. It is possible that these properties were sold in a compromised condition.

All the repeat sales models point to the same conclusion. There is a small effect of flood for the most significantly at risk properties in areas which have suffered a recent inundation and it is worst for those frequently inundated. This suggests that house purchasers are behaving in an entirely reactive manner and evaluating risks based on recent experience rather than scientifically calculated probabilities. The absence of any measured impact in towns which have not suffered recent flooding reinforces this view.

10.2.5 Impact of change in designation maps

A final comparison was made between flood designation categories. This analysis was carried out for properties which sold before and after the 2004 relaunch of the flood maps. Using the same technique of temporal analysis as for the 2000 event no impact was measurable.

A further conclusion from this modelling work is that the accuracy of the identification of the flood history of properties could make a large difference to the model estimates. If purchasers are more concerned with history than with designation (as the questionnaire survey output also suggests) then use of risk category information will not yield results appropriate for those properties which have been flooded. A detailed analysis of significantly at risk properties in flooded areas is more appropriate. Obtaining detailed flood history information would be a necessary condition of such an analysis.

10.3 TRUNCATED HEDONIC MODEL INCLUDING INSURANCE

From the responses to the questionnaires it was possible to determine which properties had changed hands during the previous six years. The price and date at which these properties changed hands could then be extracted from the transaction database. This resulted in 141 data records, some properties having sold more than once. The distribution of these properties across sites is shown in Table 10-3. Property details were taken from the questionnaire including type of property, number of bedrooms and purchase condition. A hedonic model was then constructed for these records.

Table 10-3 : Distribution of property sales across locations

Bewdley	24
Portsmouth	29
West Bridgford	18
Shrewsbury	43
Malton and Norton	27
Total	141

The nomal p-plot of price and natural log of price (lnprice) are shown in appendix E and lnprice is seen to conform more readily to the normality. The descriptives in appendix E show that taking the logarithm reduces the tendency to skewness and is also consistent with the foregoing repeat sales model.

A stepwise regression procedure (executed in SPSS) was employed as an aid in selecting relevant variables, the candidate variables are described in Table 10-4. In the end all year variables were forced into the model for completeness. Correlations between the focus variables are discussed below. Correlations between other included raw variables (shown in appendix E) were negligible apart from a tendency for four bedroom detached houses to be concentrated in West Bridgford. However these correlations were below 0.5 and so were not felt to prevent model construction. Table 10-5 shows the final selected model with an adjusted r-squared of 83%.

Table 10-4 : Candidate variables for the hedonic regression model

	Possible values	Reference value	No of responses
Type of property	Ground floor flat, flat not on ground flood, terrace, semi, detach, semi det bungalow, detached bungalow	terraced	141
Age of property	Pre 1914, 1915-1945, 1945-1980, 1980+	1915-1945	139
Number of bedrooms	1,2,3,4+	2 beds	137
Number of storeys	1,2,3,4+	2 storeys	139
Newbuild	Y/N	N	141
Leasehold	Y/N	N	141
Owner occ	y/n	Y	141
Perceived at risk	Y/N	n	131
EA category	O,L,M,S	O	141
Aware at purchase	Not at all aware, somewhat aware, fully aware	Not at all aware	94
Assumed flooded	0,1,2,3-5, 6+	0	141
Purchase condition	Just flooded, needs modernising, about average, excellent recently renovated	About average	121
Insurance class	1,2,3	1	141
Insurance problems at purchase	None, a little, a lot	None	115
Has to pay more or accept excess	No, yes don't know	No/don't know	106
When discovered	Before offer, after offer before completion, after completion	Before offer and Before completion	24
Year of sale	2000,2001,2002,2003,2004,2005,2006	2000	141
Study site	Southsea, Bewdley, Shrewsbury, Malton and Norton, West Bridgford,	Shrewsbury	141
Owner occupied	Yes, no	Yes	141
constant			

Table 10-5 : Truncated hedonic model

	Flooded respondents	Respondents not flooded	All respondents	All respondents with flood status variables
N	44	97	141	139
Adj r2	0.70	0.86	0.83	0.84
Constant	10.935**	11.083**	11.016**	11.030**
Detached	0.506*	0.504**	0.436**	0.399**
Semi Bungalow	Na	0.282	0.343	0.319
Det Bungalow	-0.06	0.604**	0.515**	0.378*
1 bed	-0.153	-0.382**	-0.287**	-0.330**
3 bed	0.329*	0.05	0.149*	0.172**
4 bed	0.575**	0.590**	0.624**	0.611**
Propage 4	0.244	0.009	0.158*	0.144*
Propage 1	0.175	0.203**	0.163**	0.143*
Cond 4	0.100	0.114	0.118*	0.092
Y2001	-0.322	-0.067	-0.062	-0.001
Y2002	0.193	0.237*	0.271**	0.252**
Y2003	0.600**	0.485**	0.507**	0.508**
Y2004	0.595*	0.593**	0.655**	0.689**
Y2005	0.648**	0.590**	0.651**	0.658**
Y2006	0.735**	0.659**	0.715**	0.720**
Southsea	0.352*	0.141	0.188**	0.178*
Malton	-0.219	-0.200*	-0.272**	-0.210**
West Bridgford	n/a	0.258**	0.315**	0.397**
Insurance class 3				0.167*
Insurance class 2				-0.049
Designated sig				-0.108
Designated mod				-0.078
Assumed flooded				0.089
Assumed flooded and sold in 2001				-0.182
Dependent variable ln price	* sig at 5% ** sig at 1%		Chow test statistic 0.94 not sig at 10%	

All the variables included bear signs that are readily interpretable. The inflation in house value over the study period is very marked as observed in the earlier sections. Number of bedrooms is acting as a proxy for property size. The regional distribution is roughly as expected with Malton and Norton having lower average property prices and Portsmouth having higher ones than the Shrewsbury/Bewdley average. West

Bridgford house prices are the highest of all – this reflects the fact that West Bridgford is a prestige suburb of Nottingham.

In line with findings of the repeat sales analysis that without history of flooding designation is not an important predictor of price the data set was split between previously flooded and not flooded property. Three models were estimated: flooded, not flooded and total these are shown in Table 10-5. There is no significant difference between the models according to the Chow test also shown in the table. The coefficients which display large changes are the 2001 growth, detached bungalows and the condition variables. The 2001 coefficient could be due to the effect of flood impacting in 2001, therefore a flooded and sold in 2001 interaction term was introduced to the flood status model. Bungalows could change due to lack of data in the flooded cohort or to the fact that retirement markets are more sensitive to flooding.

There are relatively few significant variables included in the model and the relative importance of the year and site dummies indicates that small errors in their estimation might have large knock on effects for detecting smaller impacts due to other locational factors. Bearing that caution in mind the next stage was to attempt to incorporate flood status variables into the model.

The final model shown in Table 10-5 included the flood status variables. Flood status variables were constructed as follows: Designated risk category was extracted from the EA website as described in section 7.7.2; flood insurance class was taken from the questionnaire responses as described in section 9.6; flood history took the value 0/1 dependent upon whether the property was judged to have flooded in 2000 as described below.

Judgement about flood history was made based on the response given on the questionnaire where there was knowledge of past history. Where this was not available assumptions had to be employed. First it was assumed that properties outside the floodplain and flats not on the ground floor did not flood. Finally nearest neighbour giving evidence was used. If a property was in the designated flood area and the nearest (postcode and address details were referenced on detailed maps) neighbour reported flooding then a property was assumed to have flooded the same number of times.

The table of correlations shown in Table 10-6 demonstrates the fact that the vectors of flood status are not strongly correlated. It is particularly noteworthy that the correlation between significant designation and other variables is so low.

Table 10-6 : Kendal's Tau Correlations between the vectors of flood status

	Floodass	EA cat mod	EA cat sig	Ins3	Ins2
Floodass	1	0.302**	0.074	0.193*	0.220*
EA cat mod		1	-0.315**	0.195*	0.229**
EA cat sig			1	0.095	-0.108
Ins3				1	-0.194*
Ins2					1

Including any of the vectors of flood risk into this model had a very marginal effect upon the explanatory power of the model. Insurance class is the only one to have significant coefficient but the sign of the impact is counter intuitive as shown in Table

10-5. Designated risk category has the largest absolute value impact but is not significant at the 5% level.

From this truncated hedonic model therefore we can conclude that there is no strong evidence to suggest an impact of flood designation, flood history or insurance class on the value of property in the studied locations.

10.4 ANALYSIS OF VARIANCE INCLUDING INSURANCE

As an alternative to the regression model described above an analysis of variance approach was also taken. Five dimensions were considered: flood designation, flood history, flood insurance class, location and year of sale. In order to adjust for size of property the independent variable chosen was cost per bedroom. Table 10-7 shows the distribution of properties by the three vectors of flood status.

Table 10-7 : Distribution of sold properties across flood status categories

	Significant		**Moderate**		**Low**		**Outside**		**tot**
	Flooded		Flooded		Flooded		Flooded		
	Yes	No	Yes	No	Yes	No	Yes	No	
Ins class 1	6	15	5	11	9	25	0	23	94
Ins class 2	3	1	10	4	3	6	0	5	32
Ins class 3	3	2	6	3	0	2	0	0	16
Tot	12	18	21	18	12	33	0	28	142

This is clearly an incomplete and unbalanced block design and so a robust analysis such as median polish was most appropriate. Information was lacking on the impact of flooding on properties outside the designated floodplain. Compromised insurance was largely limited to those at moderate or significant risk of flooding.

Median polish was carried out by subtracting level medians from the cost per bedroom for each of the five dimensions in turn. The total sum of squares falls quickly but then oscillates, as do the factor effects, indicating some interaction between the factors and reducing the confidence that factor effects are estimated precisely. Three iterations of the five dimensions were sufficient to achieve convergence, which was judged by the reduction in residual sum of squares see appendix H. The resulting model is summarised below in Table 10-8.

Table 10-8 : Factor effects from median polish analysis

Global Median 59768									
Year effect		Site Effect		Designation effect		Flood History		Insurance Class	
Y2000	-21,233	Bewdley	-2,158	Outside	16,070	Not Flooded	-820	Normal	365
Y2001	-18,967	Shrewsbury	-4,671	Low	1,339	Flooded	278	High	-11,069
Y2002	-13,362	Southsea	3,788	Moderate	-3,376			Compromised	7,548
Y2003	1058	West Bridgford	31,605	Significant	-10,242				
Y2004	14,959	Malton and Norton	-20,790						
Y2005	11.180								
Y2006	21,818								

Some similarities to the truncated model can be observed. Insurance class has effects which are counter intuitive, those properties with compromised insurance selling at above average price. Flood history also has the wrong sign with previously flooded property selling at a premium. Designation has broadly expected effect with moderately and significantly at risk properties selling at a discount to the rest. Location factors have a similar pattern, albeit on a larger scale, to the hedonic model and inflation explains most of the variability.

From this median polish we can therefore conclude that there is no strong evidence of impacts due to flood status variables. The general property inflation is the biggest effect observed. Of the three status variables flood designation acts as expected with the other two vectors behaving counter-intuitively. No judgement as to the significance of these effects can be made.

Discounting the price using the truncated hedonic model, all respondents without flood status categories, as shown in Table 10-9, yields a similar picture again. With insurance class 3 having an above average selling price.

Table 10-9 : Median discounted price by flood status categories

	Significant		**Moderate**		**Low**		**Outside**		**tot**
	Flooded		Flooded		Flooded		Flooded		
	Yes	No	Yes	No	Yes	No	Yes	No	
Ins class 1	-0.08 (6)	-0.14 (15)	0.02 (5)	0.06 (11)	0.20 (9)	-0.01 (25)	(0)	-0.08 (23)	-0.02 (94)
Ins class 2	-0.12 (3)	0.16 (1)	0.03 (10)	0.08 (4)	-0.07 (3)	-0.03 (6)	(0)	0.19 (5)	0.02 (32)
Ins class 3	0.16 (3)	-0.11 (2)	0.16 (6)	0.14 (3)	(0)	0.49 (2)	(0)	(0)	0.15 (16)
Total	0.00 (12)	-0.11 (18)	0.07 (21)	0.06 (18)	0.08 (12)	0.0 (33)	(0)	-0.04 (28)	0.0 142

10.5 ANALYSIS OF INSURANCE PROBLEMS AT PURCHASE

Using the output from the questionnaire allows us to explore some further aspects of the insurance regime in detail. For those who responded to the questions about the process of insuring their new home it is possible to investigate the impact of any insurance issues during the purchase process. Referring back to the three hypotheses in chapter 6 about the action of insurance in the presence of flood risk, all three hypotheses rely upon the fact that insurance issues arise at purchase.

The disclosure hypothesis relies only upon insurance difficulties signalling a flood risk. Of the 45 properties which we have assumed to have flooded recently and therefore to be likely to experience problems in fact only 18 did so of which 20% discovered the problems after completion. This implies that only one third of purchasers of property designated at risk and recently flooded would have been alerted to a possible flood risk via insurance problems. Figure 10-4 shows the distribution of errors in estimation for those reporting that they had insurance problems which were discovered before completion. There is no difference in the two distributions (see appendix G).

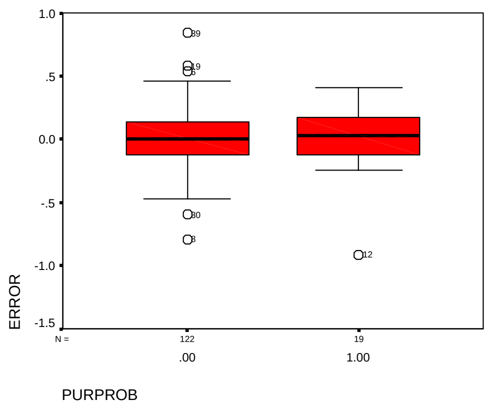


Figure 10-4 : Distribution of prediction errors for those experiencing insurance problems at purchase

The discounted premium hypothesis relies on purchasers being charged more for insurance. This happened to 15 respondents or one third of those assumed to have flooded. Figure 10-5 shows a boxplot of the distribution of the errors in prediction from the truncated hedonic model above. The respondents required to pay more are no different from the rest of the population (see appendix G).

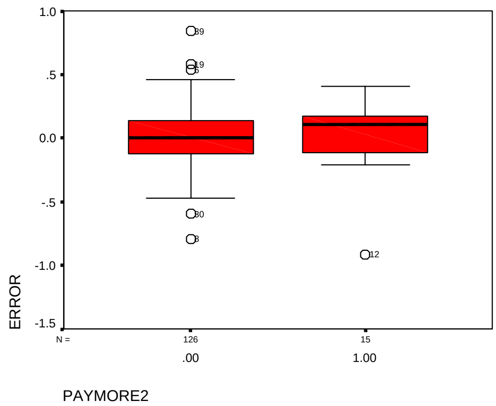


Figure 10-5 : Distribution of prediction errors for those required to pay more

The cash buyer hypothesis assumes that a mortgage was unobtainable because insurance was not obtained. Nineteen respondents reported that they had flood cover excluded from their insurance. Eight of these had achieved a mortgage but two thirds held no mortgage, a slightly higher ratio than would be expected of recently purchased properties. However, there is no way to tell whether this relationship is causal because it is entirely possible that those without the need for a mortgage chose to exclude flood cover to cut costs. There is very little evidence to support the fact that the cash buyer hypothesis would be a factor in the transactions observed in this dataset.

10.6 SELECTION OF MODEL FOR PREDICTION

Since the insurance variable was not found to have a measurable impact upon property value, insurance considerations were excluded from the predictive framework. The supposed three dimensional flood status was reduced to two dimensions. The advantage of excluding insurance is that a larger set of data is available once insurance variables are excluded. The disadvantage of excluding insurance is that nothing can be said about the impact of insurance on the property purchase and if the insurance regime were to change then property prices might change in an unpredictable way.

The evidence above also showed that designation alone had no impact upon the price of property. Home buyers appear to be acting reactively based on recent flooding experience. While it is not clear exactly how a buyer may make a judgement upon flood history, the most consistent factor resulting in a measurable price impact is a sustained history of flooding. A tentative predictive framework for the impact of flooding on house prices is therefore based mainly on the impacts shown in Figure 10-3 and has associated large uncertainty. As discussed above more detailed analysis of significantly at risk property would be necessary to make firm predictions of impact for individual properties. The tentative framework is shown in Table 10-10.

Table 10-10 : Predictive framework for categories of flooded property

	Not flooded	**Flooded once**	**Flooded twice**	**Flooded 3+**
Significant	No Impact	Possible temporary impact.	Temporary impact peaking at 15% in first year.	Short term temporary impact peaking at 35% in first year.
Moderate	No Impact	Possible temporary impact	Temporary impact peaking at 15% in first year.	Short term temporary impact peaking at 35% in first year.
Low	No Impact	No impact	No information	No information
Outside	control	No information	No information	No information

10.7 MODEL VALIDATION

Validation of negative findings, that is those that have failed to measure an impact, is not as straightforward as validating models which find a measurable impact. It is not possible to compare predictions with and without the measured effect. However, there are several factors which will lead to confidence in the conclusions from this analysis.

10.7.1 External Validation

The findings from this analysis do not contradict theory. It has been observed that, although a rational consumer should be willing to pay to avoid flood risk, the assessment of flood risk is a highly individual and subjective matter in the UK. Disclosure is not standard practice and as chapter 9 demonstrates finance problems do not force disclosure for all property transactions.

The findings are within the range of previously published studies of the impact of flooding on property value as discussed in chapter 4. The maximum measured impact is at the limit of previously measured average impacts but this impact is temporary, declines quickly and only observed for those properties which have flooded frequently and which are, by extension, significantly at risk of flood. It is also possible that some of these properties may have been sold in an unrestored condition. The observation that designation produces no impact has also been duplicated in previous studies and may be seen to be reasonable in the absence of enforced disclosure of risk during the property transaction.

The findings from this research agree with practitioner beliefs in many respects. In the survey of valuation professionals carried out by the Building Flood Research Group (BFRG) (2004) the median discount for flooded was estimated at 12-15% which can be regarded as consistent with 15% discount for property flooded more than once, maximum discount was up to 40% which can be regarded as consistent with the average 30% discount for property flooded more than 3 times. Furthermore in the BFRG investigation and also in the study by Eves (2004) large variability was observed in the responses from professionals and this is supported from the transactional analysis. Finally the consensus view from these two surveys of practitioners was that flood impact would decline with time elapsed from the flood a conclusion which the current research supports.

In discussions during workshops of the flood repair forum repair specialists and insurance company representatives agreed that three or more floods were usually needed before homeowners recognised themselves as at serious ongoing risk of flooding. This accords well with the finding that the most significant impacts are seen in properties which have flooded three times or more.

10.7.2 Internal Validation

The most compelling internal validation of this analysis is the fact that where more than one approach tested the same hypotheses the same broad conclusions were reached. This is not a common experience in studying flood impact as demonstrated by Schaeffer (1990) and it adds confidence to the interpretation of the findings. This means that within the foregoing comparison, validation was being carried out and triangulation was achieved for the broad conclusions.

However for the more detailed conclusions, the temporary impacts which were observed were measured with a great deal of surrounding uncertainty and can be described as weak results. There is a tendency towards discount in frequently flooded property but the scale of discount is unpredictable. Attempting to make point estimates on a property by property basis of the impact on price in the year following flood would be doomed to failure. The results can be regarded as general framework of guidance on the impact of flooding rather than a detailed predictive tool.

10.8 SUMMARY

The above analysis reveals that the overriding feature of the property price data used in this study is the strong growth over time. However, if there was devastating property blight due to the risk of flood, a recent flood history or insurance problems for transacted property then these analyses should detect it despite the market growth. We can conclude that among property which is traded any flood status effect is small relative to location, property size and type.

Measured impacts of flooding on property price are temporary in nature, they appear to be a reaction to flood events rather than to risk designation.

The insurance class variable has a correlation with price which is wholly unexpected. On reflection a possible explanation may be that compromised insurance, which comprises mostly those who have flood excluded from their cover may contain an element of choice by the policyholder. The correlation may be due to richer, perhaps better informed, individuals inhabiting higher value property and choosing to self insure the risk of flood from a position of financial strength or better information. Since these data were not collected the supposition cannot be tested.

In reflecting on the messages emerging from the two analyses above it is important to remember that this period of analysis was one of very strong price growth. Authors have speculated (Whittle, 2005) that in a strong market flood risk may be less of an issue than it would be in a weak market. That contention cannot be tested in the current economic conditions.

Chapter 11 : CONCLUSIONS AND RECOMMENDATIONS

11.1 INTRODUCTION

The aim of this research was to explore the relationship between flooding and the value of residential property in the UK. Measurement of the impact of flooding and the role of the cost and availability of insurance in influencing the relationship between flooding and property value were also central to the research aim.

A driving principle behind the research was the desire of property stakeholders to be able to predict the impact of flood on property in the face of future flooding or designation changes. Apart from the obvious concern of the property owner in maintaining the value of their investment, several other property stakeholders were identified as having an interest in the findings of such research. Valuation professionals, house builders, mortgage lenders, insurers and government would be concerned if floodplain property suffered large discount.

A detrimental impact of flooding on property value has often been assumed, for example in cost benefit estimation of flood management schemes (Chao et al., 1998). Press speculation has also often taken this impact as read (Hughes, 2000, Jackson, 2005, Whittle, 2005). This assumption had yet to be fully tested in the UK market and this is a fundamental research gap which the current study has aimed to fill. The three objectives of the study, listed in section 1.6, were formulated in the expectation that the fulfilment of the objectives would make a contribution to, but not completely, close the knowledge gap.

A comprehensive literature review was carried out during this study encompassing flooding literature; economic house price modelling literature; insurance theory; and empirical studies of the impact of amenities and disamenities on property prices, particularly flooding. These reviews are discussed at length in chapters 2 to 5 and fulfil objective 1, covering thematic, theoretical, quantitative and methodological aspects. Some consensus was identified from previous studies and this is summarised below under major research findings in section 11.2. Inadequacies were identified in methodologies previously used in flooding studies and in methods from the wider literature when attempting to measure flood impacts in the UK property market.

Achievement of the second objective followed naturally from the methodological issues identified within the review. Key issues arising from these chapters were: the three dimensional nature of the flood status variable; the time varying nature of the response to a flood event; the lack of a theoretical model appropriate for incorporating insurance into models of house prices in the unique regime prevalent in the UK and the small sample sizes inherent in studying flood events in the UK.

Chapter 6 presented the conceptual developments employed in this research programme to address the key issues within the constraints of available data and resources. These developments included a novel specification of the repeat sales model of house prices; new hypotheses regarding the action of insurance within the UK flood insurance regime; a block design to incorporate the three dimensional nature of the flood status variable and combination of flood sites to increase statistical power.

The third objective was achieved via the collection and analysis of data for the UK market as described in chapters 7 to 10. Chapter 7 described the practical aspects of the empirical research program. The collection of data including the implementation of a large survey of homeowners is explained in detail. The analysis of the collected data and model estimation follow in chapters 8 to 10, findings from this analysis are summarised in sections 11.2.

11.2 RESEARCH FINDINGS

The findings from the study are divided below into findings from the literature, findings about flood insurance in the UK and findings about flood impact.

11.2.1 Findings from the literature review

Discount in the price of property situated in the floodplain can be regarded in economic theory as a reflection of willingness to pay to avoid annual flood damage. Theoretical estimation of the discount amount consistent with this theory is problematic in the UK market because of uncertainties associated with damage estimates and the unique UK insurance regime.

Floodplain property does not necessarily suffer flood discount. Many studies found no impact of floodplain status or of a flood event. Measured flood discount ranges from no impact to an average of 30% with some previously flooded property selling at a premium to the market.

Flood status can be regarded as three dimensional with the impact of flood events, flood designation and insurance regimes all having a bearing on home buyers willingness to pay. There is no strong evidence as to which has most bearing upon a market's willingness to pay and it is partially dependent on insurance and disclosure regimes.

11.2.2 Findings from the insurance questionnaire

The reported flooding patterns within the floodplain revealed that many people designated at risk of flooding, while acknowledging that they lived in a flood risk area, did not consider their property to be actually at risk of flooding. Many had justified that belief by citing evidence of elevation of land or property. This was an unsurprising result and concurs with the Environment Agency view that their maps are not suitable for assessing risk on individual properties.

Many residents experienced difficulties in obtaining and renewing insurance policies but in general insurance was available at a reasonable price for residents at risk of flood. There were only a handful of residents who reported being unable to obtain insurance due to flood risk. A larger minority had accepted the exclusion of flood risk from their policy.

In addition, insurance cost was not determined by flood risk, other factors such as a history with their insurer or the company selected for insurance appeared to make more difference.

11.2.3 Findings from the flood price impact modelling

There was no measurable impact of flood designation as defined by the Environment Agency on the price of property in the absence of a flood event. Both the repeat sales and truncated model failed to find a significant impact.

No significant impact of the cost of insurance was measurable on property prices. An anomalous result regarding the correlation of exclusion of flood from insurance cover with higher property price was found.

A single flood of a property outside the floodplain or in a low flood risk area had no significant measurable impact on the price of property.

Combination of a history of flooding with designated flood risk category moderate or significant can sometimes lead to temporary discount in the price of property. The scale of that impact was highly variable ranging from no impact to a significant measured impact of 35%. Three years after the flood, the effects had disappeared. Repeated flooding could generate a renewed impact.

11.3 CONTRIBUTION

This program of research was designed to make contributions in two areas: in novel methodological approaches which could be utilised in future studies in the UK and elsewhere, and in understanding of the UK market for floodplain property.

11.3.1 Contribution to methodology

The adaptation of repeat sales analysis adopted in this research is a novel approach to measuring the impact of disruptive events. The particular feature which makes it appropriate in studying flooding is the flexibility of observing impacts which change with time elapsed from the disruptive event. The use of repeat sales in itself is not novel, although it has been underemployed relative to the cross sectional hedonic model. The advantage of the repeat sales methodology over the hedonic in reducing the data burden is clear. A method based upon repeat sales can be applied far more easily and economically. In this research the adapted repeat sales was also useful in reducing the data to discounted growth rates which could then be combined across sites without the concern for absolute levels of house prices. In the light of the small impacts detected by the study the question about whether this framework increased statistical power is not definitively answered.

The second contribution to methodology is the treatment of the insurance variable. Within this thesis the flood status of a property with regard to an individual considering investment in the property has been described as three dimensional. Insurance status is one of these vectors of flood status and can be tested independently in the UK because it is not determined wholly by the other two, namely flood risk and flood history. This thesis is unique in considering the mechanics of the action of insurance within the purchase process. Hypotheses stemming from surveys of valuation professionals and from insurance literature have been presented and it is seen that a simple cost of insurance treatment would be inadequate and holds the risk of underestimating the impact of insurance within the property market in the UK. The findings from estimating models based upon these hypotheses are intriguing and warrant further investigation.

11.3.2 Contribution to understanding

The contribution of this analysis to understanding of the market for flood risk property was anticipated to be improved in four ways:

Understanding of the spread of price effect over time was expected. From both the literature review and the empirical study it emerges that the impact of a flood event is temporary. People forget about the flood experience in the absence of other flood risk messages. The empirical study observed significant impacts to be temporary in all studied sites. The maximum length to recovery was three years. In one frequently flooded location a subsequent flood appeared to generate a second impact which again declined quickly.

Designation on the other hand has been seen to have a permanent impact on property value by some authors in the literature review. By contrast this study found no impact due to flood designation temporary or permanent.

The magnitude of the flood effect was seen to be highly variable from the literature. In the empirical phase of this research that finding was reinforced. For some flood locations no impact was measurable whereas significant impacts were measured in others. When flood sites were combined the variability of measured impacts became clear.

The impact of flooding on the cost of insurance has been measured via a questionnaire. A unique insight has been gained and the scale of the insurance cost increases has been seen to be much smaller than anticipated. As may be anticipated from the above insurance finding, no discount was measurable in the price of property which could be attributed to insurance cost. An interesting correlation between property value and self insuring flood has been observed.

11.3.3 Dissemination

Findings from this research have been presented as the research progressed at international conferences, published in peer reviewed journals and discussed at workshops of the flood repair network. A summary of the questionnaire findings has been placed on the website of the flood repair network. A summary of initial findings has formed part of a book chapter. A list of publications is attached at appendix I. Further publications are in preparation and in review. A key aim of the dissemination has been to reflect the multidisciplinary nature of the thesis by publishing in the widest range of sources. Both theoretical and empirical findings have been published.

11.4 LIMITATIONS

This study has been concerned with the impact of flooding on the value of residential property in the UK. Domestic residential property only was considered because business properties are subject to different valuation processes and insurance regimes. While the review of literature has considered a wide range international studies encompassing different flooding types and designation regimes the empirical analysis has been strictly limited.

The empirical research has been based on data from England and Wales, from sites which flooded, or narrowly avoided flooding, in the autumn 2000 event which was limited to inland flooding, mainly river and overland flow. The use of this event was determined by the desire to be able to combine multiple sites. It has not been possible to test whether these results will hold true for another flood event. However the simple methodology developed during the research will allow for such analysis once sufficient time has elapsed from more recent flooding events such as Carlisle 2005 and the Summer 2007 flooding.

Use of the Environment Agency website to obtain flood designation information is a limitation of the study as discussed at length above, this enforced the use of whole postcode designation. Where more detailed lists were available from the Environment Agency it became clear that a more accurate categorisation is possible and this would have lent better precision to the analysis. In addition the categories employed by the Envionment Agency are rather broad, the results of the study suggest that concentrating on frequently flooded and significantly at risk properties would be appropriate in any further study of this issue. The limitations of the Environment Agency categorisation is not detailed enough to allow for this kind of analysis.

For the price impact analysis only transacted property prices have been obtained therefore it is not possible to assess the effect of flooding on the flow of property onto the market. The limitation of using the Land Registry data is that while coverage is the best available it will not be complete.

The data on insurance coverage is limited to five locations in England, while these locations contain some of the most frequently flooded property in the UK it is possible that there are other locations where insurance cover is more problematic. As a self administered postal questionnaire the responses may be subject to self-selection bias. Return rate for the questionnaire was 20% which, whilst good for this kind of study cannot be regarded as complete.

Within the current economic conditions in the UK the housing market has been highly buoyant. Housing markets may react differently to perceived risks in times with lower growth.

Use of the repeat sales model implies the assumption that property details, other than the focus variables remain constant over time. This assumption has not been tested within the research, however the use of multiple sites reduces the chances that a systematic bias will distort the results for the focus variable. A further assumption is that any measured differences in growth rate are due to the impact of flood status, once again the use of multiple sites reduces the chance that an omitted variable is changing at the same time as the focus variable. However, changes in property condition could feasibly be correlated with flood history for all locations and this was not measured during the repeat sales analysis. The absence of condition information is a limitation of the study. Reassuringly the questionnaire responses implied that the majority of flooded properties were restored to about the same condition as pre-flood. The risk remains that short term impacts measured by the study may be due to property sold before restoration.

A further limitation of repeat sales analysis is the fact that only changes can be measured, any long term capitalisation of the impact of flood could not be measured. This limitation was partially addressed by the use of a truncated hedonic model which failed to find any long term capitalisation of designation or flood history.

11.5 IMPLICATIONS AND RECOMMENDATIONS

The findings from the price impact model that, for the vast majority of floodplain properties, flood impacts on property prices are small and temporary imply that the natural concern experienced by property owners about long term equity in their home is largely unfounded. This is a reassuring message which is somewhat unexpected given the amount of media speculation on the issue and the views of some valuation professionals.

A recommendation which stems naturally from the study is that, for the overwhelming majority of flood affected property and where finances allow, property owners can invest with confidence in the restoration of their property to pre-flood condition. If possible, any subsequent sale of the property should be delayed until the market recovers. Where this is not possible, discount should not be anticipated in the asking price because in many instances recently flooded property suffers no discount at all. For professional valuation purposes, in the vast majority of instances, flood risk can be disregarded. If insurance is available in the prevailing market the medium term investment potential of floodplain property appears to be sound.

For those frequently flooded properties where, continuous flooding makes impacts seem longer term, impacts are still small and have been dwarfed by the impact of inflation over the study period. In a more difficult housing market it is possible that the picture would be less advantageous and it is recommended that further study of frequently flooded property and property in static markets should be carried out if data allows.

The implication of the insurance findings are, broadly, that while residents are experiencing difficulties with flood insurance for most residents these are not severe enough to prompt modifications in their behaviour. The current insurance regime is not encouraging mitigating behaviour because switching insurer allows large up-front savings on premium and excess charges whereas improvements in resistance and resilience do not.

The problems with obtaining insurance are also not severe enough to provide a disincentive to purchase in most cases. The consideration of transacted property may have limited this finding, but the current insurance regime does not appear to be unduly obstructing property transactions. Vendors could reduce the chances of insurance problems halting a sale by establishing that their insurer would be willing to continue to provide cover with a future owner subject to that owner's status.

The fact that no measurable impact of designation was detected implies that the official view of flood risk is not capitalised into the price of floodplain property. This raises the further possibility that, if designation regimes changed, for example if the disclosure of flood risk was regulated into the property transaction process, floodplain property might suffer value loss. The literature review suggests that any impact would be relatively small scale in comparison to the possible temporary impacts following a flood event. However policy makers should be aware of this possible additional risk to floodplain occupants.

11.6 SCOPE FOR FUTURE RESEARCH

Opportunities have been created by the validation of a new variant of the repeat sales model within this thesis. Recent and future flood events can be analysed in a relatively quick and inexpensive manner using the methods employed here. Two recent events which would be suitable for this treatment are Carlisle 2005 and the Summer 2007 floods. Other flood related testing could also be carried out with the method for example testing the market impact of new or improved flood defences in areas not recently flooded.

This thesis has identified that the impact of flood on property value is concentrated in significantly at risk and recently flooded property. The work could be extended via a detailed study of high risk and frequently flooded locations. This would require more detailed designation and history information than was available to this research.

The town of Lewes displayed a possible long term impact of flood, not significant but consistent. A further analysis of Lewes taking into account the development and flood defence improvements might yield insights into the role of regeneration schemes in managing the value of property at risk of flood.

This research was limited by the current economic conditions. If these conditions change as experts have suggested they may in the short term the analysis could be extended to the static market.

The second opportunity created by this research is a dataset of responses to the insurance questionnaire. Within the above research much of the data has been utilised but the focus has been upon the relationship with property value. The analysis raised several interesting issues however which could be pursued partly by further interrogation of that dataset but also via alternative research routes. The respondents provided extensive commentary of their experiences which was not formally analysed. The issue of whether self insuring for flood risk is a positive choice or a compulsory imposition from the insurance company is a fascinating area and could demonstrate a gap in risk perception between experts and floodplain populations. The issue of whether insurance deters homeowners from self protection has been discussed for many countries but in the unique UK market as demonstrated by this research, efforts by the insurers to introduce rewards for mitigation may be negated by the ability of homeowners to switch insurers.

11.7 CONCLUDING REMARKS

This study had the stated aim of improving the understanding of the impact of flooding on the value of UK property. In addressing this aim it has been necessary to advance the understanding of the impact of flooding on the cost and availability of insurance and to develop a novel methodology for measuring these impacts. The study has provided a significant step forward in understanding of these issues. The study found that where there is an impact of fluvial flooding on the price of UK property it is local, temporary and triggered by flood events rather than risk designation. The effort expended in generating a novel measurement framework which will be relatively easy to apply to future flood events has created an opportunity to continue to develop understanding in this area.

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APPENDIX A : INSURANCE QUESTIONNAIRE AND COVERING LETTER

FLOOD INSURANCE QUESTIONNAIRE

This questionnaire is divided into six sections. For your convenience most of the questions only require ticks in the relevant boxes. In some cases there are spaces to fill in additional information and exact amounts if known. If you have your insurance policy documents to hand please use them to help you find the answers to section 3 and 4. An event is considered a flood if water enters your property from outside.

Section 1: Questions about you and your household

Age	☐18-39	☐40-64	☐65-74	☐75+		
Type of property	☐ ground floor flat	☐flat not on ground floor.	☐ terraced	☐semi-detached	☐ detached	☐semi-detached bungalow	☐detached bungalow
Who owns the property	☐owned with mortgage	☐owned outright	☐rented from private landlord	☐rented from housing association	☐rented from Local Authority	☐other
Number of storeys	☐1	☐2	☐3	☐4+		
Age of property	☐pre 1920	☐1920-1945	☐1946-1979	☐post 1980		
Number of bedrooms	☐1	☐2	☐3	☐4+		
How long have you lived in your current home?	☐less than 2 years.	☐2-5 years	☐6-10 years,	☐more than 10 years		

Section 2: Questions about your property's flood risk and flooding history

Is your property in a flood risk area?			☐no	☐yes	
If yes, were you aware of the risk before you purchased it?		☐not at all aware	☐somewhat aware	☐fully aware	
Has your property flooded during your residence?	☐ never	☐ once	☐ twice	☐ up to 5 times	☐ more than 5 times
If you purchased your home in the last 6 years, what was the condition in which you bought it?	☐It had just been flooded and needed a lot of work.	☐ It needed modernising or some structural work.	☐ about average, just needing a few changes or redecoration.	☐ very good condition, recently renovated.	
What was the depth of flooding during the most recent incident?	☐ basement/ outbuildings only	☐ between ground level and up to 1m	☐ above 1m and below 2m	☐ above 2m	
How long did the water remain in the property?	☐ less than 1 hour	☐ 1-3 hours	☐ 3-24 hours	☐ over 24 hours	
Did you take avoiding action in advance of first flooding?	☐ removed belongings to safety	☐ installed temporary barriers eg. sandbags or door boards	☐ installed permanent defences to your property eg. skirts or pumps.	☐ installed resilient fittings and furniture	
As a result of flooding and reinstatement. How has the condition of your property changed?	☐much worse than before	☐slightly worse than before	☐about the same as before	☐better than before	

Section 3: Questions about the sort of insurance you have on your property

What sort of insurance do you have?	☐ none	☐buildings insurance only	☐contents insurance only	☐both building and contents
If you have both buildings and contents insurance, are your policies	☐with different insurers	☐with same insurers but separate policies		☐combined policy
Which flood mitigation measures do you have in place? (tick all that apply)	☐ registered for flood warnings	☐ installed resilient fittings and furniture	☐ purchased temporary defences	☐ installed permanent defences to your property eg. Skirts or pumps

What is the name of your present insurer for buildings insurance				
What is the name of your present insurer for contents insurance?				
How long have you been insured with your present insurer?	☐ less than a year	☐ 1-3 years	☐ 4-6 years	☐ longer than 6 years

If you do not have insurance, please tell us why (tick the one that **most** applies)

	buildings	contents
Insurance is a waste of money		
I intend to arrange insurance but have not yet done so		
My landlord arranges the insurance		
I would like insurance but cannot afford it		
I had insurance but my insurer put the price up too high		
Insurance was refused due to flood risk		
Insurance was refused for some other reason		
Other reason please specify		

Section 4: Questions about the cost of your insurance and claims history
(If you have no insurance please go on to section 6).

Amount paid for your **buildings** policy. (If you have a combined policy enter the amounts under buildings and leave the contents question blank.)	Please enter amount (please enter approximate amount if exact amount is not known) £
Amount paid for your **contents** policy	Please enter amount £
Amount of excess on your **buildings** policy. (If you have different excesses for different risks please state the excess relating to flood risk.)	Please enter amount £
Amount of excess on your **contents** policy.	Please enter amount £

Are floods excluded from your policy?	☐ no	☐ yes	☐ don't know
Have you made an insurance claim for flooding on this property in the last 6 years?	☐no	☐once	☐more than once
Have you made any other claim on your property insurance in the last 6 years?	☐no	☐once	☐more than once
Did your premium or excess increase by a large amount as a direct result of making a flood claim?	☐ Yes	☐ No	☐ insurance refused
How much was the cost of your claim for buildings? (Use your largest flood claim if more than one)	please enter amount £		
How much was your claim for contents? (Use your largest flood claim if more than one)	please enter amount £		

Section 5: Questions about the way you chose your insurance

If you purchased your home in the last six years, please answer the next set of questions about the insurance you took out when you bought your home.

Did you experience difficulty in insuring your new home because it was at risk of flood?	☐no	☐yes, a little.	☐yes quite a lot.
Did you have to pay more for your premium, have high excess or accept exclusions due to flood risk?	☐no	☐yes	☐don't Know.
If you had to pay more, have high excess or accepted exclusions, when did you discover this problem?	☐before making an offer	☐ after offer but before completion	☐after completion

How did you choose your current policies? Tick the one that **most** applies

	buildings	contents
My insurance was set up by my mortgage lender		
I used a broker		
I phoned a few companies for quotes		
I looked on the internet for quotes		
I used the phone and the internet to search for quotes		
It was recommended by a friend/family/neighbour		
It was recommended by an adviser/bank manager etc.		
I chose a company I trust.		
The previous owners of the house recommended their insurer.		
Due to flood risk, I took over the existing policy on the property.		
My property is insured in a block policy by the leaseholder.		
Only this company would insure my property.		
A salesman approached me and the quote seemed very good.		
Other please state		

Section 6:

Have you experienced any of the following when renewing insurance or requesting quotes for insurance during the last 6 years. **Tick all that apply**

	buildings	contents
A significant increase in premium		
A significant increase in excess		
Floods excluded from the policy		
A significant decrease in premium		
Refused a quote due to flood risk		
Refused renewal due to flood risk		
Required to provide a letter from the Environment Agency		
Required to get a survey of flood risk		
Had to shop around a lot to get an affordable quote		
Had to use a broker to get an affordable quote		
Had to install/buy flood protection measures to get cover		
Had to install resilient fixtures and fittings to get cover		
Other please specify		

Use this space to write more about your experience. Please include any comments or views you may have about your insurance or flooding history that you could not put elsewhere on the form. Continue on a separate sheet if necessary.

Thank you for completing the questionnaire. Please send it back to us in the prepaid envelope.

Data will be handled in confidence by the University of Wolverhampton and not passed on to any third party

Dear Householder,

You have been sent this questionnaire as part of an investigation into how flooding of people's homes affects their insurance. Please do not be concerned, receiving this questionnaire does not mean that your home is at risk of flooding. The questionnaire is being sent to a number of homes, some of which will have a history of floods and some will not.

This is an independent study into the increased cost of insurance for flooded houses and has not been sponsored by insurers. The information you give will be held completely confidentially by the University of Wolverhampton and will not be passed on to any third parties. The information will not be used to send you any junk mail or to sell you insurance policies. Answering this survey will not directly affect your insurance cover in any way.

If you have been flooded or are at risk, then you probably are aware how important flood insurance can be. You might also be aware of changes in the way insurance companies are dealing with flood-prone properties. This questionnaire survey is designed to collect the real experience of the owners of homes at risk. We hope to be able to discover how much more it costs to insure flood-risk properties and how the cost might be reduced by, for example, registering for floodline warnings direct.

If you have never been flooded and are not likely to be, your information will still be very important to the study. Better understanding of flood insurance will help keep the cost of insurance down for everyone. We need your response to compare to the flooded group.

Please take time to complete the enclosed questionnaire and return it in the prepaid envelope. It should not take more than fifteen minutes of your time. If you have any questions about the study you can call the University of Wolverhampton School of Engineering on (01902) 518530, email jessica.lamond@wlv.ac.uk or write to the above address.

Summary results of the survey will be published on the Government sponsored flood repair network website at www.floodrepair.net in early 2007 but will not contain any individual details. You can access the website now to see a copy of the questionnaire and some useful flooding links.

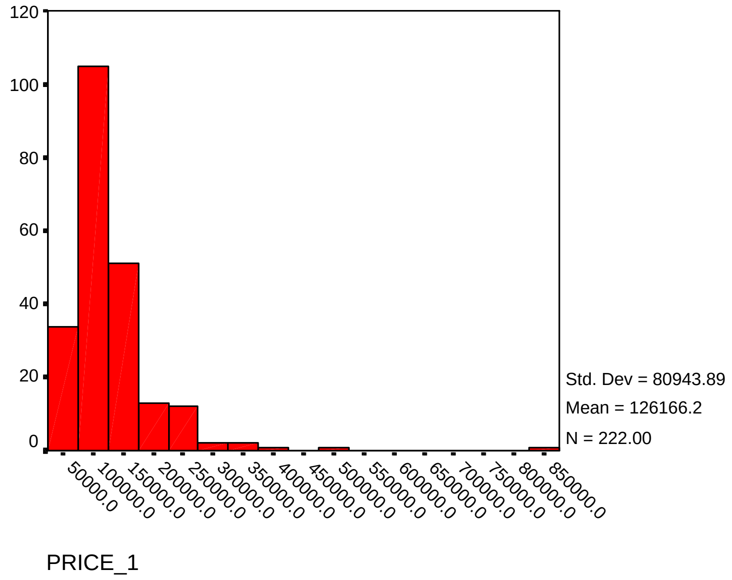
Thank you very much for helping with this important study

Sincerely

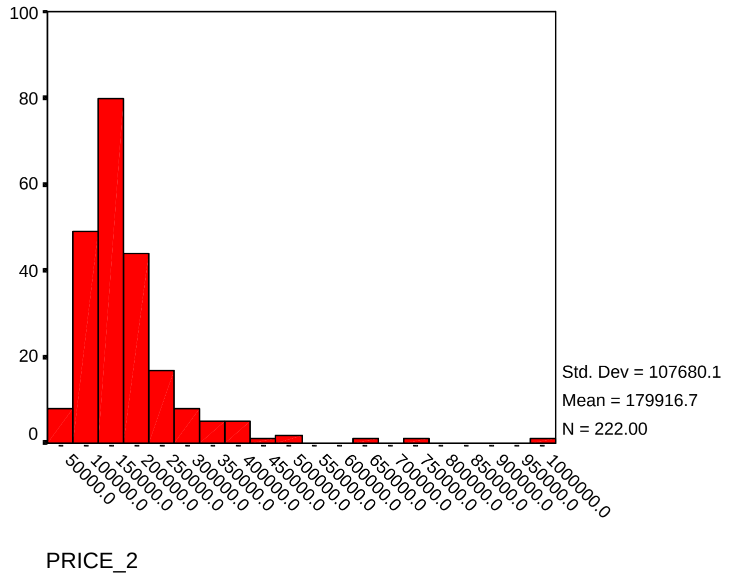
Professor David Proverbs

APPENDIX B: EXAMPLE OF DATA EXPLORATION AND MODEL DIAGNOSTICS FOR INDIVIDUAL SITE INDEX MODELS – BEWDLEY

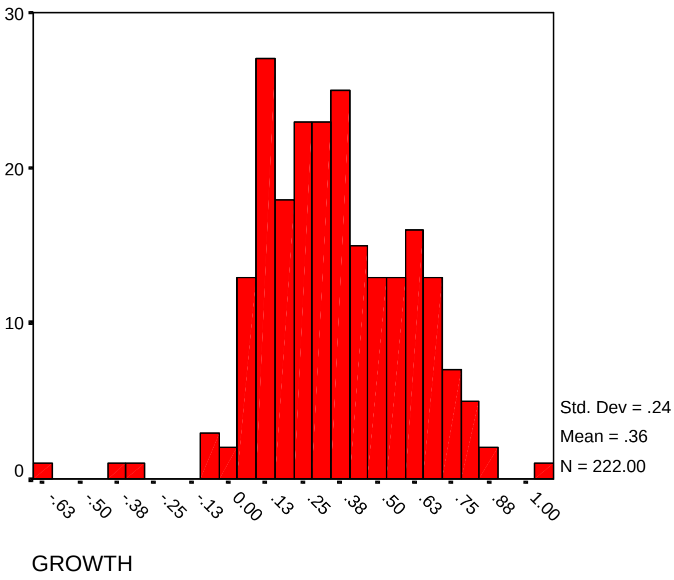
Distribution of price of first sale



Distribution of price of second sale



Distribution of growth in price



Descriptive Statistics

	Mean	Standard deviation	Skewness	Kurtosis
Price of first sale	126,166	80,944	4.5	33.9
Price of second sale	179,916	107,680	3.5	19.2
Growth in price	0.36	0.24	-0.1	0.9

Index regression model non floodplain

	coefficient	Standard error	95%confidence interval		t stat	Sig
			Lower	Upper		
S2001	0.154	0.037	0.082	0.226	4.2	.000
S2002	0.293	0.037	0.220	0.365	8.0	.000
S2003	0.508	0.040	0.430	0.586	12.8	.000
S2004	0.595	0.036	0.524	0.666	16.6	.000
S2005	0.640	0.042	0.558	0.723	15.3	.000
S2006	0.734	0.038	0.659	0.808	19.4	.000

ANOVA

ANOVA[c,d,e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.947	6	4.658	148.363	.000[a]
	Residual	5.557	177	3.139E-02		
	Total	33.503[b]	183			

a. Predictors: S2006, S2005, S2004, S2003, S2002, S2001

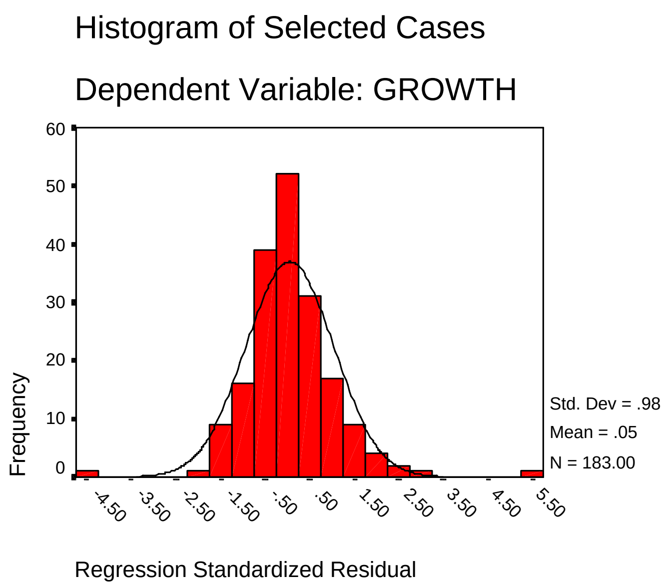
b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

c. Dependent Variable: GROWTH

d. Linear Regression through the Origin

e. Selecting only cases for which FZ1000 = .00

Distribution of model residuals



Index regression model floodplain

	coefficient	Standard error	95%confidence interval		t stat	Sig
			Lower	Upper		
S2001	-0.091	0.066	-0.224	0.043	-1.4	.178
S2002	0.313	0.085	0.140	0.485	3.7	.001
S2003	0.307	0.068	0.168	0.446	4.5	.000
S2004	0.543	0.074	0.393	0.692	7.4	.000
S2005	0.641	0.087	0.464	0.818	7.4	.000
S2006	0.709	0.102	0.503	0.916	7.0	.000

ANOVA

ANOVA[c,d,e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.397	6	1.066	29.162	.000[a]
	Residual	1.206	33	3.656E-02		
	Total	7.603[b]	39			

a. Predictors: S2006, S2004, S2005, S2001, S2002, S2003

b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

c. Dependent Variable: GROWTH

d. Linear Regression through the Origin

e. Selecting only cases for which FZ1000 = 1.00

Index regression model total

	coefficient	Standard error	95%confidence interval		t stat	Sig
			Lower	Upper		
S2001	0.097	0.032	0.033	0.161	3.0	.000
S2002	0.265	0.032	0.199	0.331	8.0	.000
S2003	0.451	0.035	0.382	0.519	13.0	.000
S2004	0.564	0.032	0.501	0.628	17.5	.000
S2005	0.620	0.038	0.545	0.695	16.3	.000
S2006	0.697	0.035	0.628	0.766	19.9	.000

ANOVA

ANOVA[c,d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33.704	6	5.617	163.908	.000[a]
	Residual	7.403	216	3.427E-02		
	Total	41.107[b]	222			

a. Predictors: S2006, S2005, S2004, S2003, S2002, S2001

b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

c. Dependent Variable: GROWTH

d. Linear Regression through the Origin

Chow Test

Model statistic

RSSR = RSS total model = 7.403

RSS1= RSS non floodplain model = 5.557

RSS2 = RSS floodplain model = 1.206

K=6

N=222

(7.403-5.557-1.206)/6)/(5.557+1.206)/(222-12)=3.3

$F_{.01,6,222}$ = 2.05

Models are significantly different at 1% probability level

APPENDIX C : CORRELATION OF QUESTIONNAIRE RESPONSES

Correlations

			AGE	STOREY	PROPAGE	BEDS	RESID	FLOODRIS	AWARE	FLOODED
Kendall's tau_b	AGE	Correlation Coefficient	1.000	-.098*	.060	.027	.408**	-.083	-.198**	.111*
		Sig. (2-tailed)	.	.037	.195	.564	.000	.099	.002	.023
		N	358	351	349	343	355	343	201	337
	STOREY	Correlation Coefficient	-.098*	1.000	-.193**	.277**	-.011	.222**	.080	.107*
		Sig. (2-tailed)	.037	.	.000	.000	.805	.000	.186	.027
		N	351	383	373	367	378	366	217	359
	PROPAGE	Correlation Coefficient	.060	-.193**	1.000	-.065	-.058	-.098*	-.130*	-.019
		Sig. (2-tailed)	.195	.000	.	.156	.198	.044	.033	.699
		N	349	373	378	362	373	362	215	356
	BEDS	Correlation Coefficient	.027	.277**	-.065	1.000	.188**	.079	-.009	.058
		Sig. (2-tailed)	.564	.000	.156	.	.000	.108	.884	.229
		N	343	367	362	373	371	356	215	350
	RESID	Correlation Coefficient	.408**	-.011	-.058	.188**	1.000	-.062	-.427**	.223**
		Sig. (2-tailed)	.000	.805	.198	.000	.	.199	.000	.000
		N	355	378	373	371	385	367	220	362
	FLOODRIS	Correlation Coefficient	-.083	.222**	-.098*	.079	-.062	1.000	.046	.312**
		Sig. (2-tailed)	.099	.000	.044	.108	.199	.	.480	.000
		N	343	366	362	356	367	373	216	351
	AWARE	Correlation Coefficient	-.198**	.080	-.130*	-.009	-.427**	.046	1.000	-.175**
		Sig. (2-tailed)	.002	.186	.033	.884	.000	.480	.	.004
		N	201	217	215	215	220	216	220	217
	FLOODED	Correlation Coefficient	.111*	.107*	-.019	.058	.223**	.312**	-.175**	1.000
		Sig. (2-tailed)	.023	.027	.699	.229	.000	.000	.004	.
		N	337	359	356	350	362	351	217	367

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

Correlations

			FLOODRIS	FLOODED	PURCOND	DEPTH	DURATION	REMOVED	TEMPMEAS	PERMMEAS	RESILFIT	POSTCOND	LENGTH
Kendall's tau_b	FLOODRIS	Correlation Coefficient	1.000	.312**	.182*	.207*	.145	.330**	.237**	.047	.085	-.096	.006
		Sig. (2-tailed)	.	.000	.023	.022	.136	.000	.000	.360	.101	.336	.910
		N	373	351	138	110	101	373	373	373	373	97	321
	FLOODED	Correlation Coefficient	.312**	1.000	.012	.132	.190*	.689**	.414**	.168**	.214**	.103	.187**
		Sig. (2-tailed)	.000	.	.879	.115	.033	.000	.000	.001	.000	.266	.000
		N	351	367	139	109	102	367	367	367	367	96	318
	PURCOND	Correlation Coefficient	.182*	.012	1.000	-.187	-.023	.110	-.022	-.142	.107	-.443**	-.004
		Sig. (2-tailed)	.023	.879	.	.179	.879	.165	.780	.072	.176	.008	.963
		N	138	139	143	42	35	143	143	143	143	32	121
	DEPTH	Correlation Coefficient	.207*	.132	-.187	1.000	.106	-.055	-.096	-.101	-.046	-.017	.177*
		Sig. (2-tailed)	.022	.115	.179	.	.248	.539	.284	.262	.607	.864	.048
		N	110	109	42	111	101	111	111	111	111	92	98
	DURATION	Correlation Coefficient	.145	.190*	-.023	.106	1.000	.028	.237*	-.041	.139	-.040	-.054
		Sig. (2-tailed)	.136	.033	.879	.248	.	.772	.014	.670	.149	.695	.570
		N	101	102	35	101	102	102	102	102	102	89	92
	REMOVED	Correlation Coefficient	.330**	.689**	.110	-.055	.028	1.000	.466**	.121*	.212**	-.020	.180**
		Sig. (2-tailed)	.000	.000	.165	.539	.772	.	.000	.017	.000	.842	.000
		N	373	367	143	111	102	392	392	392	392	98	337
	TEMPMEAS	Correlation Coefficient	.237**	.414**	-.022	-.096	.237*	.466**	1.000	.142**	.262**	-.118	.082
		Sig. (2-tailed)	.000	.000	.780	.284	.014	.000	.	.005	.000	.234	.102
		N	373	367	143	111	102	392	392	392	392	98	337
	PERMMEAS	Correlation Coefficient	.047	.168**	-.142	-.101	-.041	.121*	.142**	1.000	-.012	.074	.092
		Sig. (2-tailed)	.360	.001	.072	.262	.670	.017	.005	.	.819	.456	.068
		N	373	367	143	111	102	392	392	392	392	98	337
	RESILFIT	Correlation Coefficient	.085	.214**	.107	-.046	.139	.212**	.262**	-.012	1.000	-.021	.058
		Sig. (2-tailed)	.101	.000	.176	.607	.149	.000	.000	.819	.	.836	.245
		N	373	367	143	111	102	392	392	392	392	98	337
	POSTCOND	Correlation Coefficient	-.096	.103	-.443**	-.017	-.040	-.020	-.118	.074	-.021	1.000	.119
		Sig. (2-tailed)	.336	.266	.008	.864	.695	.842	.234	.456	.836	.	.231
		N	97	96	32	92	89	98	98	98	98	98	85
	LENGTH	Correlation Coefficient	.006	.187**	-.004	.177*	-.054	.180**	.082	.092	.058	.119	1.000
		Sig. (2-tailed)	.910	.000	.963	.048	.570	.000	.102	.068	.245	.231	.
		N	321	318	121	98	92	337	337	337	337	85	337

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

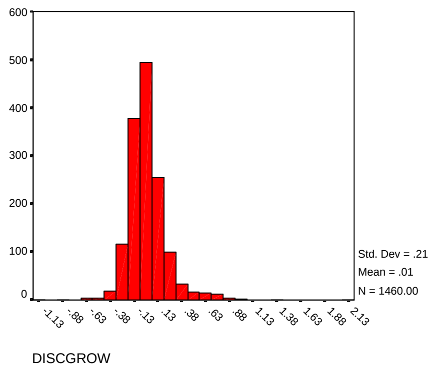
Correlations

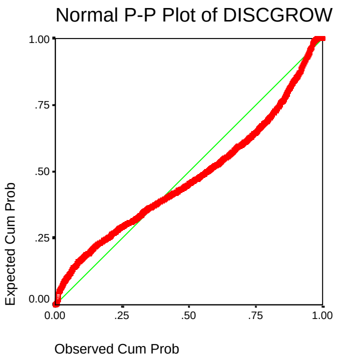
			FLOODRIS	FLOODED	LENGTH	FLOODEX	FLCLAIM	OTHCLAIM	PROBLEMS
Kendall's tau_b	FLOODRIS	Correlation Coefficient	1.000	.312**	.006	-.213**	.244**	-.037	.183**
		Sig. (2-tailed)	.	.000	.910	.000	.000	.515	.000
		N	373	351	321	290	312	305	373
	FLOODED	Correlation Coefficient	.312**	1.000	.187**	-.191**	.704**	-.066	.155**
		Sig. (2-tailed)	.000	.	.000	.001	.000	.231	.001
		N	351	367	318	285	311	303	367
	LENGTH	Correlation Coefficient	.006	.187**	1.000	-.019	.259**	-.050	-.151**
		Sig. (2-tailed)	.910	.000	.	.715	.000	.341	.002
		N	321	318	337	288	307	299	337
	FLOODEX	Correlation Coefficient	-.213**	-.191**	-.019	1.000	-.235**	-.010	-.146**
		Sig. (2-tailed)	.000	.001	.715	.	.000	.858	.006
		N	290	285	288	302	294	282	302
	FLCLAIM	Correlation Coefficient	.244**	.704**	.259**	-.235**	1.000	-.029	.143**
		Sig. (2-tailed)	.000	.000	.000	.000	.	.602	.006
		N	312	311	307	294	327	313	327
	OTHCLAIM	Correlation Coefficient	-.037	-.066	-.050	-.010	-.029	1.000	.154**
		Sig. (2-tailed)	.515	.231	.341	.858	.602	.	.003
		N	305	303	299	282	313	318	318
	PROBLEMS	Correlation Coefficient	.183**	.155**	-.151**	-.146**	.143**	.154**	1.000
		Sig. (2-tailed)	.000	.001	.002	.006	.006	.003	.
		N	373	367	337	302	327	318	392

**. Correlation is significant at the .01 level (2-tailed).

APPENDIX D : GLOBAL MODEL STATISTICS ALL LOCATIONS

Distribution of discounted growth rates





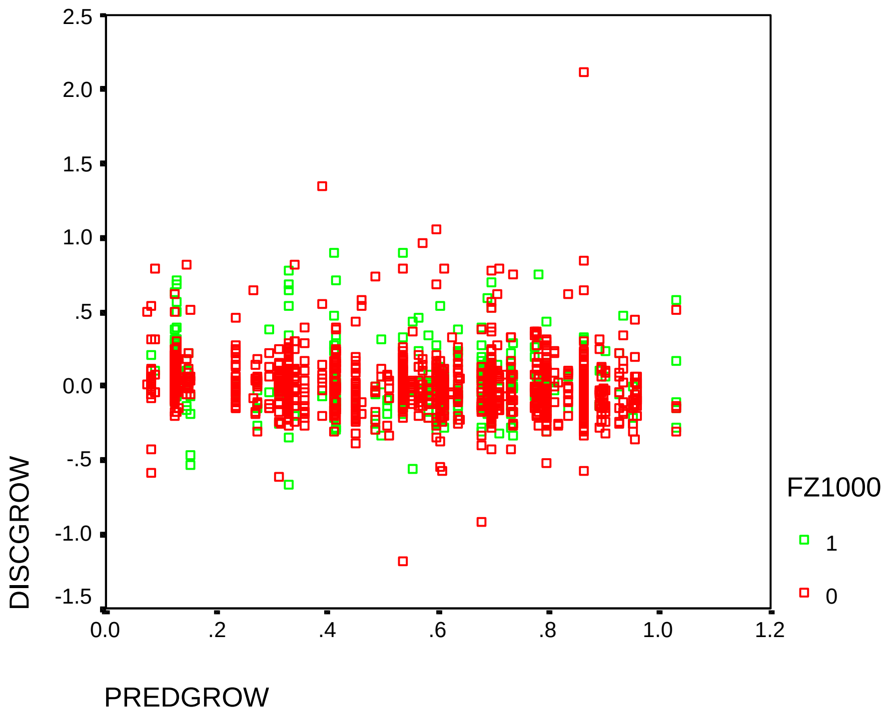
Descriptives

			Statistic	Std. Error
DISCGROW	Mean		9.357E-03	5.471E-03
	95% Confidence Interval for Mean	Lower Bound	-1.38E-03	
		Upper Bound	2.009E-02	
	5% Trimmed Mean		-3.64E-03	
	Median		-1.51E-02	
	Variance		4.370E-02	
	Std. Deviation		.2091	
	Minimum		-1.18	
	Maximum		2.12	
	Range		3.31	
	Interquartile Range		.1931	
	Skewness		1.698	.064
	Kurtosis		11.607	.128

Table of annual mean discounted growth rate by flood designation– all locations

	Fz1000	Non fz1000
2001	0.11	0.07
(n)	(50)	(129)
2002	0.01	0.03
(n)	(708)	(221)
2003	0.00	-0.01
(n)	(71)	(201)
2004	0.04	0.00
(n)	(84)	(194)
2005	-0.02	-0.04
(n)	(59)	(171)
2006	-0.02	-0.01
(n)	(47)	(155)

Scatter plot of discounted growth rate against predicted growth rate



Comparison of mean discounted growth rate by designation

Report

DISCGROW

FZ1000	Mean	N	Std. Deviation	Median
0	6.094E-03	1071	.2050	-1.29E-02
1	1.834E-02	389	.2198	-2.46E-02
Total	9.357E-03	1460	.2091	-1.51E-02

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
DISCGROW * FZ1000	Between Groups	(Combined)	.043	1	.043	.979	.323
	Within Groups		63.720	1458	.044		
	Total		63.763	1459			

Ranks

	FZ1000	N	Mean Rank
DISCGROW	0	1071	731.44
	1	389	727.92
	Total	1460	

Test Statistics[a,b]

	DISCGROW
Chi-Square	.020
df	1
Asymp. Sig.	.888

a. Kruskal Wallis Test

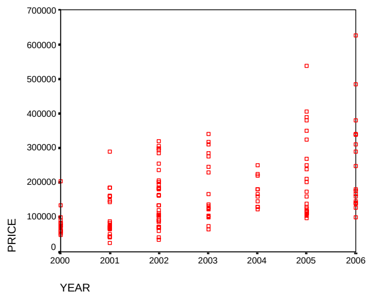
b. Grouping Variable: FZ1000

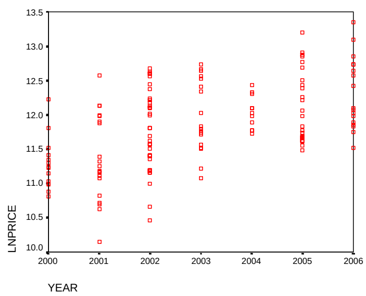
APPENDIX E : ANNUAL AVERAGES FOR TEST OF CHANGE IN FLOODPLAIN DESIGNATION IN 2004

YEAR	**OUTSIDE**	**LOW**	**MOD**	**SIG**
2004	0.05	0.10	0.10	0.09
2005	0.01	-0.01	0.02	0.03
2006	-0.01	-0.01	0.03	0.03
TOTAL	0.00	0.00	0.03	0.04

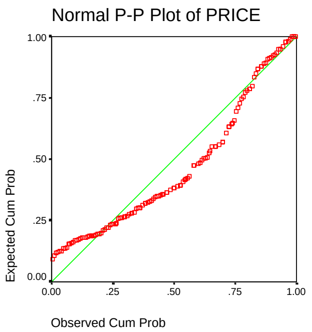
APPENDIX F : EXPLORATORY DATA ANALYSIS AND MODEL DIAGNOSTICS FOR TRUNCATED HEDONIC MODEL

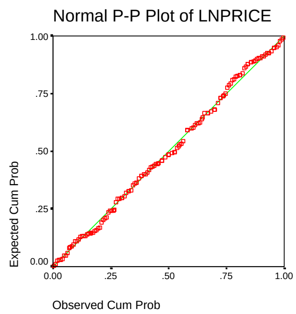
Scatterplots of price and lnprice against year of sale





Normal probability plots of price and lnprice





Descriptives of price and lnprice

Descriptives

			Statistic	Std. Error
PRICE	Mean		166412.5	8896.5755
	95% Confidence Interval for Mean	Lower Bound	148823.5	
		Upper Bound	184001.5	
	5% Trimmed Mean		157279.1	
	Median		135000.0	
	Variance		1.1E+10	
	Std. Deviation		105641.0	
	Minimum		25500.00	
	Maximum		625000.0	
	Range		599500.0	
	Interquartile Range		124977.5	
	Skewness		1.467	.204
	Kurtosis		2.730	.406
LNPRICE	Mean		11.8385	5.176E-02
	95% Confidence Interval for Mean	Lower Bound	11.7362	
		Upper Bound	11.9408	
	5% Trimmed Mean		11.8426	
	Median		11.8130	
	Variance		.378	
	Std. Deviation		.6146	
	Minimum		10.15	
	Maximum		13.35	
	Range		3.20	
	Interquartile Range		.8705	
	Skewness		-.043	.204
	Kurtosis		-.331	.406

Correlation of raw variables

Correlations

			DETACHED	SEMIBUNG	DETBUNG	ONEBED	THREEBED	FOURBED	PROPAGE4	PROPAGE1	COND4	SOUTHSEA	MALTON	WESTBRID	INS3	INS2	EACATS	EACATM	FLOODASS	ASSFL200
Kendall's tau_b	DETACHED	Correlation Coefficient	1.000	-.050	-.071	-.116	.026	.330**	-.102	-.250**	-.120	-.164	-.153	.437**	-.024	-.084	-.164	-.036	-.110	.109
		Sig. (2-tailed)	.	.553	.398	.171	.760	.000	.227	.003	.155	.053	.070	.000	.776	.320	.053	.670	.194	.196
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	SEMIBUNG	Correlation Coefficient	-.050	1.000	-.020	-.033	-.079	-.073	-.069	-.106	-.062	-.061	.094	-.046	-.043	-.065	-.061	.060	-.081	-.025
		Sig. (2-tailed)	.553	.	.808	.695	.347	.389	.415	.209	.461	.470	.266	.587	.612	.442	.470	.478	.339	.765
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	DETBUNG	Correlation Coefficient	-.071	-.020	1.000	-.047	-.020	-.104	.001	-.151	-.089	-.087	.025	.191*	.208*	-.093	-.087	.085	-.023	-.036
		Sig. (2-tailed)	.398	.808	.	.576	.809	.219	.993	.073	.293	.304	.764	.024	.014	.273	.304	.313	.787	.670
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	ONEBED	Correlation Coefficient	-.116	-.033	-.047	1.000	-.183*	-.168*	-.159	-.022	-.076	-.072	-.064	-.106	.075	-.150	-.141	.138	.052	-.058
		Sig. (2-tailed)	.171	.695	.576	.	.030	.047	.060	.794	.368	.393	.447	.211	.372	.077	.096	.103	.535	.491
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	THREEBED	Correlation Coefficient	.026	-.079	-.020	-.183*	1.000	-.402**	-.024	.127	.032	.006	.108	-.207*	-.091	.009	.082	.004	.119	.166
		Sig. (2-tailed)	.760	.347	.809	.030	.	.000	.776	.133	.705	.944	.200	.014	.280	.916	.331	.965	.159	.050
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	FOURBED	Correlation Coefficient	.330**	-.073	-.104	-.168*	-.402**	1.000	-.275**	.138	-.081	.205*	-.214*	.438**	-.066	.014	-.190*	-.090	-.237**	-.128
		Sig. (2-tailed)	.000	.389	.219	.047	.000	.	.001	.102	.335	.015	.011	.000	.434	.865	.024	.288	.005	.130
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	PROPAGE4	Correlation Coefficient	-.102	-.069	.001	-.159	-.024	-.275**	1.000	-.509**	.183*	-.049	.096	-.171*	.105	.002	.154	.085	.038	-.040
		Sig. (2-tailed)	.227	.415	.993	.060	.776	.001	.	.000	.031	.565	.257	.044	.214	.979	.068	.314	.651	.638
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	PROPAGE1	Correlation Coefficient	-.250**	-.106	-.151	-.022	.127	.138	-.509**	1.000	.028	.150	.005	-.039	-.002	.168*	-.027	.027	.205*	.167*
		Sig. (2-tailed)	.003	.209	.073	.794	.133	.102	.000	.	.738	.076	.956	.643	.985	.047	.753	.748	.015	.048
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	COND4	Correlation Coefficient	-.120	-.062	-.089	-.076	.032	-.081	.183*	.028	1.000	.164	.099	-.199*	.087	-.033	-.050	.105	.173*	.062
		Sig. (2-tailed)	.155	.461	.293	.368	.705	.335	.031	.738	.	.052	.240	.019	.302	.692	.553	.215	.040	.462
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	SOUTHSEA	Correlation Coefficient	-.164	-.061	-.087	-.072	.006	.205*	-.049	.150	.164	1.000	-.248**	-.195*	-.182*	-.066	-.259**	-.315**	.036	.067
		Sig. (2-tailed)	.053	.470	.304	.393	.944	.015	.565	.076	.052	.	.003	.021	.031	.433	.002	.000	.670	.431
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	MALTON	Correlation Coefficient	-.153	.094	.025	-.064	.108	-.214*	.096	.005	.099	-.248**	1.000	-.186*	-.117	.339**	-.158	.505**	.100	.165
		Sig. (2-tailed)	.070	.266	.764	.447	.200	.011	.257	.956	.240	.003	.	.028	.165	.000	.061	.000	.236	.050
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	WESTBRID	Correlation Coefficient	.437**	-.046	.191*	-.106	-.207*	.438**	-.171*	-.039	-.199*	-.195*	-.186*	1.000	-.137	-.055	-.089	.049	-.258**	-.081
		Sig. (2-tailed)	.000	.587	.024	.211	.014	.000	.044	.643	.019	.021	.028	.	.105	.515	.290	.566	.002	.340
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	INS3	Correlation Coefficient	-.024	-.043	.208*	.075	-.091	-.066	.105	-.002	.087	-.182*	-.117	-.137	1.000	-.194*	.095	.229**	.193*	-.075
		Sig. (2-tailed)	.776	.612	.014	.372	.280	.434	.214	.985	.302	.031	.165	.105	.	.022	.263	.007	.022	.372
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	INS2	Correlation Coefficient	-.084	-.065	-.093	-.150	.009	.014	.002	.168*	-.033	-.066	.339**	-.055	-.194*	1.000	-.108	.195*	.220**	.137
		Sig. (2-tailed)	.320	.442	.273	.077	.916	.865	.979	.047	.692	.433	.000	.515	.022	.	.201	.021	.009	.104
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	EACATS	Correlation Coefficient	-.164	-.061	-.087	-.141	.082	-.190*	.154	-.027	-.050	-.259**	-.158	-.089	.095	-.108	1.000	-.315**	.074	-.020
		Sig. (2-tailed)	.053	.470	.304	.096	.331	.024	.068	.753	.553	.002	.061	.290	.263	.201	.	.000	.382	.810
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	EACATM	Correlation Coefficient	-.036	.060	.085	.138	.004	-.090	.085	.027	.105	-.315**	.505**	.049	.229**	.195*	-.315**	1.000	.302**	.105
		Sig. (2-tailed)	.670	.478	.313	.103	.965	.288	.314	.748	.215	.000	.000	.566	.007	.021	.000	.	.000	.213
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	FLOODASS	Correlation Coefficient	-.110	-.081	-.023	.052	.119	-.237**	.038	.205*	.173*	.036	.100	-.258**	.193*	.220**	.074	.302**	1.000	.313**
		Sig. (2-tailed)	.194	.339	.787	.535	.159	.005	.651	.015	.040	.670	.236	.002	.022	.009	.382	.000	.	.000
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
	ASSFL200	Correlation Coefficient	.109	-.025	-.036	-.058	.166	-.128	-.040	.167*	.062	.067	.165	-.081	-.075	.137	-.020	.105	.313**	1.000
		Sig. (2-tailed)	.196	.765	.670	.491	.050	.130	.638	.048	.462	.431	.050	.340	.372	.104	.810	.213	.000	.
		N	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

Model output all respondents

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.923[a]	.852	.830	.2531

a. Predictors: (Constant), WESTBRID, Y2001, SEMIBUNG, ONEBED, PROPAGE1, Y2003, COND4, SOUTHSEA, DETBUNG, Y2006, THREEBED, Y2004, MALTON, Y2005, DETACHED, PROPAGE4, FOURBED, Y2002

b. Dependent Variable: LNPRICE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45.065	18	2.504	39.075	.000[a]
	Residual	7.817	122	6.407E-02		
	Total	52.882	140			

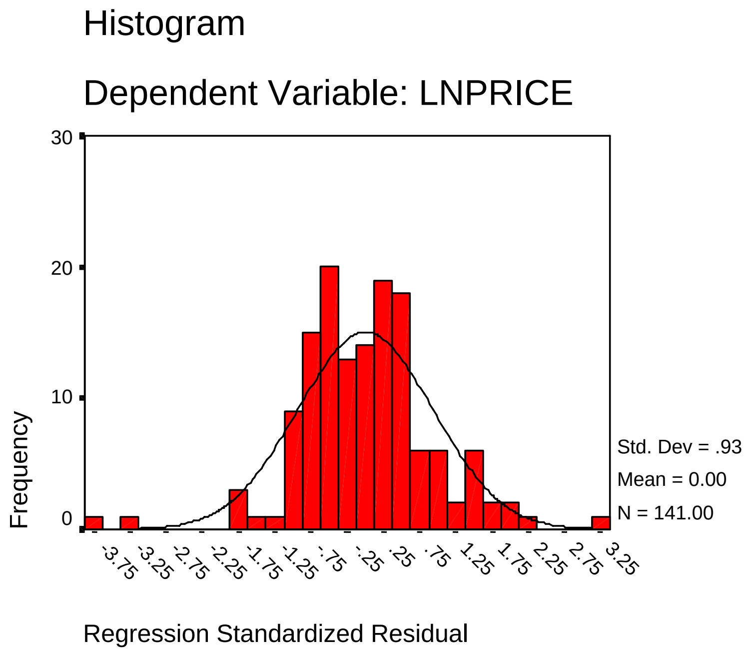
a. Predictors: (Constant), WESTBRID, Y2001, SEMIBUNG, ONEBED, PROPAGE1, Y2003, COND4, SOUTHSEA, DETBUNG, Y2006, THREEBED, Y2004, MALTON, Y2005, DETACHED, PROPAGE4, FOURBED, Y2002

b. Dependent Variable: LNPRICE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.016	.086		127.570	.000
	DETACHED	.436	.079	.253	5.496	.000
	SEMIBUNG	.343	.196	.066	1.750	.083
	DETBUNG	.515	.142	.140	3.616	.000
	ONEBED	-.287	.095	-.120	-3.024	.003
	THREEBED	.149	.058	.112	2.552	.012
	FOURBED	.624	.071	.452	8.843	.000
	PROPAGE4	.158	.067	.112	2.351	.020
	PROPAGE1	.163	.059	.132	2.758	.007
	COND4	.118	.057	.079	2.079	.040
	Y2001	-6.22E-02	.091	-.035	-.686	.494
	Y2002	.271	.083	.189	3.256	.001
	Y2006	.715	.094	.380	7.569	.000
	Y2003	.507	.092	.282	5.500	.000
	Y2004	.655	.107	.287	6.150	.000
	Y2005	.651	.086	.412	7.612	.000
	SOUTHSEA	.188	.062	.124	3.053	.003
	MALTON	-.272	.061	-.175	-4.434	.000
	WESTBRID	.315	.085	.172	3.718	.000

a. Dependent Variable: LNPRICE



Model output flooded respondents

Model Summary[b,c]

Model	R: FLOODASS = 1.00 (Selected)	R: FLOODASS ~= 1.00 (Unselected)	R Square	Adjusted R Square	Std. Error of the Estimate
1	.900[a]	.825	.809	.696	.2946

a. Predictors: (Constant), MALTON, DETACHED, Y2004, COND4, Y2005, DETBUNG, FOURBED, Y2002, ONEBED, PROPAGE1, SOUTHSEA, Y2006, THREEBED, Y2003, Y2001, PROPAGE4

b. Unless noted otherwise, statistics are based only on cases for which FLOODASS = 1.00.

c. Dependent Variable: LNPRICE

ANOVA[b,c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.943	16	.621	7.162	.000[a]
	Residual	2.343	27	8.677E-02		
	Total	12.285	43			

a. Predictors: (Constant), MALTON, DETACHED, Y2004, COND4, Y2005, DETBUNG, FOURBED, Y2002, ONEBED, PROPAGE1, SOUTHSEA, Y2006, THREEBED, Y2003, Y2001, PROPAGE4

b. Dependent Variable: LNPRICE

c. Selecting only cases for which FLOODASS = 1.00

Coefficients[a,b]

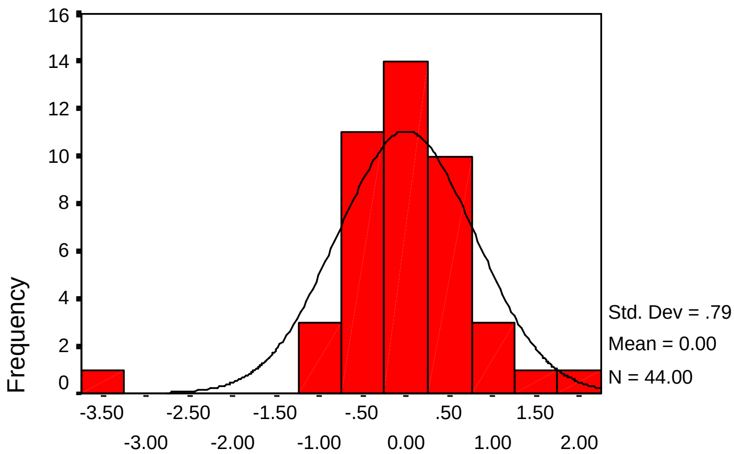
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.935	.230		47.633	.000
	DETACHED	.506	.198	.275	2.557	.017
	DETBUNG	-6.24E-02	.403	-.018	-.155	.878
	ONEBED	-.153	.213	-.083	-.716	.480
	THREEBED	.329	.121	.304	2.730	.011
	FOURBED	.575	.189	.345	3.044	.005
	PROPAGE4	.244	.227	.206	1.075	.292
	PROPAGE1	.175	.173	.162	1.008	.322
	COND4	.100	.109	.088	.917	.367
	Y2001	-.322	.215	-.209	-1.495	.146
	Y2002	.193	.175	.158	1.099	.282
	Y2006	.735	.205	.441	3.582	.001
	Y2003	.600	.180	.416	3.341	.002
	Y2004	.595	.264	.235	2.254	.033
	Y2005	.648	.190	.449	3.407	.002
	SOUTHSEA	.352	.139	.280	2.535	.017
	MALTON	-.219	.144	-.179	-1.513	.142

a. Dependent Variable: LNPRICE

b. Selecting only cases for which FLOODASS = 1.00

Histogram of Selected Cases

Dependent Variable: LNPRICE



Regression Standardized Residual

Model Output not flooded

Model Summary[b,c]

Model	R: FLOODASS = .00 (Selected)	R: FLOODASS ~= .00 (Unselected)	R Square	Adjusted R Square	Std. Error of the Estimate
1	.942[a]	.825	.888	.862	.2381

a. Predictors: (Constant), WESTBRID, PROPAGE1, Y2003, ONEBED, Y2001, SEMIBUNG, COND4, DETBUNG, Y2005, THREEBED, MALTON, Y2006, SOUTHSEA, Y2004, PROPAGE4, DETACHED, FOURBED, Y2002

b. Unless noted otherwise, statistics are based only on cases for which FLOODASS = .00.

c. Dependent Variable: LNPRICE

ANOVA[b,c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34.929	18	1.941	34.242	.000[a]
	Residual	4.420	78	5.667E-02		
	Total	39.349	96			

a. Predictors: (Constant), WESTBRID, PROPAGE1, Y2003, ONEBED, Y2001, SEMIBUNG, COND4, DETBUNG, Y2005, THREEBED, MALTON, Y2006, SOUTHSEA, Y2004, PROPAGE4, DETACHED, FOURBED, Y2002

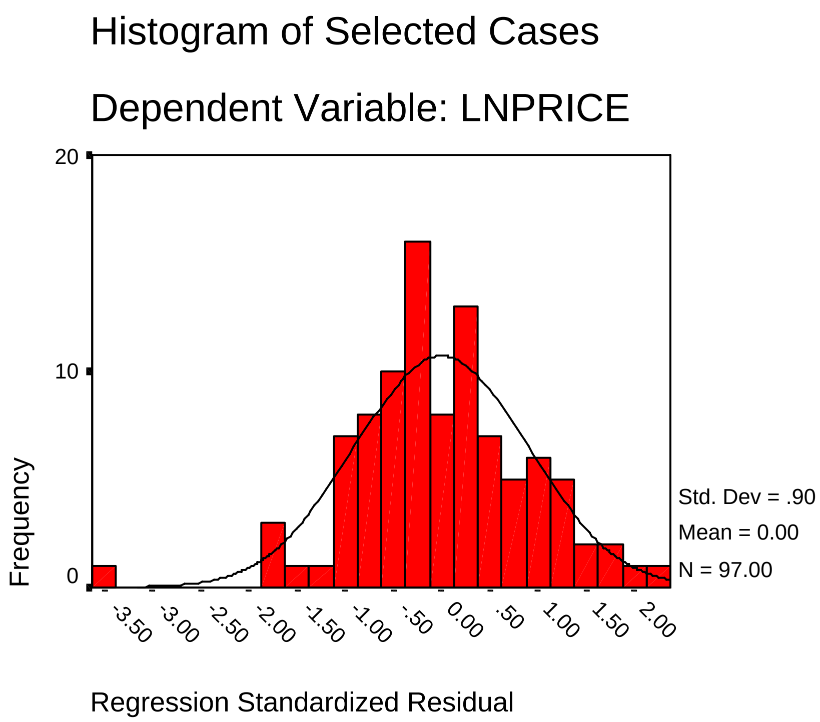
b. Dependent Variable: LNPRICE

Coefficients[a,b]

Model		Unstandardized Coefficients: B	Unstandardized Coefficients: Std. Error	Standardized Coefficients: Beta	t	Sig.
1	(Constant)	11.083	.108		102.498	.000
	DETACHED	.504	.094	.301	5.361	.000
	SEMIBUNG	.282	.191	.063	1.477	.144
	DETBUNG	.604	.164	.164	3.685	.000
	ONEBED	-.382	.117	-.145	-3.258	.002
	THREEBED	4.780E-02	.077	.033	.618	.538
	FOURBED	.590	.087	.439	6.807	.000
	PROPAGE4	8.985E-02	.076	.060	1.185	.240
	PROPAGE1	.203	.070	.154	2.922	.005
	COND4	.114	.077	.066	1.483	.142
	Y2001	-6.67E-02	.110	-.037	-.607	.546
	Y2002	.237	.104	.158	2.280	.025
	Y2006	.659	.116	.341	5.668	.000
	Y2003	.485	.114	.251	4.250	.000
	Y2004	.593	.129	.270	4.596	.000
	Y2005	.590	.103	.367	5.707	.000
	SOUTHSEA	.141	.076	.088	1.860	.067
	MALTON	-.200	.077	-.117	-2.583	.012
	WESTBRID	.258	.088	.158	2.948	.004

a. Dependent Variable: LNPRICE

b. Selecting only cases for which FLOODASS = .00



Model Output including flood status variables

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.929[a]	.864	.836	.2490

a. Predictors: (Constant), ASSFL200, EACATS, SEMIBUNG, DETBUNG, Y2006, COND4, ONEBED, Y2005, PROPAGE1, MALTON, INS3, THREEBED, Y2004, FLOODASS, Y2003, DETACHED, INS2, SOUTHSEA, Y2001, WESTBRID, PROPAGE4,

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45.687	24	1.904	30.693	.000[a]
	Residual	7.195	116	6.202E-02		
	Total	52.882	140			

a. Predictors: (Constant), ASSFL200, EACATS, SEMIBUNG, DETBUNG, Y2006, COND4, ONEBED, Y2005, PROPAGE1, MALTON, INS3, THREEBED, Y2004, FLOODASS, Y2003, DETACHED, INS2, SOUTHSEA, Y2001, WESTBRID, PROPAGE4, FOURBED, EACATM, Y2002

b. Dependent Variable: LNPRICE

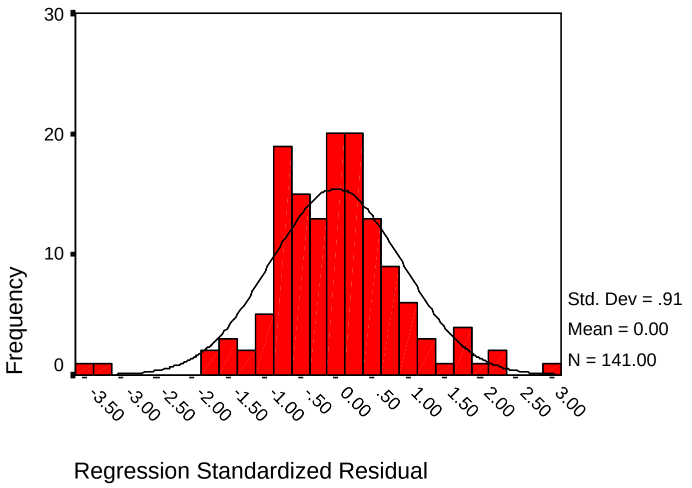
Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	11.030	.098		112.006	.000
	DETACHED	.399	.086	.232	4.647	.000
	SEMIBUNG	.319	.197	.062	1.623	.107
	DETBUNG	.378	.151	.103	2.512	.013
	ONEBED	-.330	.100	-.139	-3.306	.001
	THREEBED	.172	.058	.129	2.950	.004
	FOURBED	.611	.072	.443	8.433	.000
	PROPAGE4	.144	.068	.102	2.123	.036
	PROPAGE1	.143	.062	.116	2.312	.023
	COND4	9.207E-02	.057	.062	1.605	.111
	Y2001	-8.92E-04	.099	-.001	-.009	.993
	Y2002	.252	.085	.176	2.958	.004
	Y2006	.720	.095	.383	7.612	.000
	Y2003	.508	.091	.283	5.573	.000
	Y2004	.689	.106	.302	6.497	.000
	Y2005	.658	.085	.417	7.704	.000
	SOUTHSEA	.178	.075	.118	2.392	.018
	MALTON	-.210	.076	-.135	-2.765	.007
	WESTBRID	.397	.091	.216	4.355	.000
	INS3	.167	.083	.086	2.013	.046
	INS2	-4.89E-02	.060	-.033	-.816	.416
	EACATS	-.108	.074	-.071	-1.454	.149
	EACATM	-7.81E-02	.075	-.057	-1.048	.297
	FLOODASS	8.846E-02	.060	.067	1.484	.140
	ASSFL200	-.182	.141	-.060	-1.295	.198

a. Dependent Variable: LNPRICE

Histogram

Dependent Variable: LNPRICE



APPENDIX G : KRUSKAL-WALLIS RANK TESTS

The Kruskal-Wallis test for equivalence of sample means in the absence of normality and homogeneity of variance is based on the ranks of the observations (Jobson, 1991). All observations are ranked jointly and the sums of the ranks for each subsample computed. The test statistic

$$T = \sum_{j=1}^{g} R_{.j}^{r} - \frac{n(n+1)^2}{4} \Big/ s^2$$

Where $s^2 = \frac{1}{n-1}\left[\sum_{j=1}^{g}\sum_{i=1}^{n_j} R_{ij} - n\frac{(n+1)^2}{4}\right]$

Is distributed $\chi^2(g-1)$.

The facility to perform Kruskal-Wallis tests is a standard feature of SPSS.

Kruskal-Wallis test of distribution for differences in insurance rates

All respondents

Ranks

	EARISK	N	Mean Rank
RATE	.00	57	104.61
	1.00	72	130.98
	2.00	65	120.93
	3.00	40	106.03
	Total	234	

Test Statistics[a,b]

	RATE
Chi-Square	6.236
df	3
Asymp. Sig.	.101

a. Kruskal Wallis Test

b. Grouping Variable: EARISK

Resident in 2000

Ranks

	EARISK	N	Mean Rank
RATE	.00	41	84.51
	1.00	49	90.49
	2.00	49	81.98
	3.00	27	72.04
	Total	166	

Test Statistics[a,b]

	RATE
Chi-Square	2.639
df	3
Asymp. Sig.	.451

a. Kruskal Wallis Test

b. Grouping Variable: EARISK

Not resident in 2000

Ranks

	EARISK	N	Mean Rank
RATE	.00	16	20.06
	1.00	23	40.35
	2.00	16	41.34
	3.00	13	33.50
	Total	68	

Test Statistics[a,b]

	RATE
Chi-Square	12.491
df	3
Asymp. Sig.	.006

a. Kruskal Wallis Test

b. Grouping Variable: EARISK

Resident not flooded

Ranks

	EARISK	N	Mean Rank
RATE	.00	41	63.12
	1.00	36	65.06
	2.00	29	57.86
	3.00	14	46.57
	Total	120	

Test Statistics[a,b]

	RATE
Chi-Square	3.262
df	3
Asymp. Sig.	.353

a. Kruskal Wallis Test

b. Grouping Variable: EARISK

Kruskal-Wallis test of distribution for floodplain designation flooded sites

Ranks

	FZ1000	N	Mean Rank
DISCGROW	0	964	655.75
	1	339	641.34
	Total	1303	

Test Statistics[a,b]

	DISCGROW
Chi-Square	.368
df	1
Asymp. Sig.	.544

a. Kruskal Wallis Test

b. Grouping Variable: FZ1000

Kruskal-Wallis test of distribution for floodplain designation flooded sites

Ranks

	EANUM	N	Mean Rank
DISCGROW	.00	963	655.60
	1.00	239	670.25
	2.00	41	632.32
	3.00	60	534.93
	Total	1303	

Test Statistics[a,b]

	DISCGROW
Chi-Square	6.570
df	3
Asymp. Sig.	.087

a. Kruskal Wallis Test

b. Grouping Variable: EANUM

Kruskal-Wallis test of distribution for insurance problems at purchase

Ranks

	PURPROB	N	Mean Rank
ERROR	.00	122	70.20
	1.00	19	76.11
	Total	141	

Test Statistics[a,b]

	ERROR
Chi-Square	.343
df	1
Asymp. Sig.	.558

a. Kruskal Wallis Test

b. Grouping Variable: PURPROB

Kruskal-Wallis test of distribution for paying more at purchase

Ranks

	PAYMORE2	N	Mean Rank
ERROR	.00	126	69.90
	1.00	15	80.20
	Total	141	

Test Statistics[a,b]

	ERROR
Chi-Square	.852
df	1
Asymp. Sig.	.356

a. Kruskal Wallis Test

b. Grouping Variable: PAYMORE2

APPENDIX H : MEDIAN POLISH ANALYSIS

Summary of Median Polish

Median Polish is a robust analysis of variance technique for examining the significance of various factors in a multifactor model. It can work with unbalanced designs unlike the classical ANOVA and is distribution free. It was first suggested by Tukey (Tukey, 1977). The procedure is iterative, terminating when the improvement in residuals converges to minimal, usually measured via the ratio of the sums of the residuals from two passes. The algorithm involves calculating medians for each level of a factor and subtracting the median levels from the response variable.

Summary of analysis

Since median polish is not available in SPSS the analysis was carried out in Microsoft Excel. Five factors were tested, year, insurance class, flood status, flood history and case study site and the price data was transformed into cost per bedroom as a crude approximation to property size. A summary of the analysis is shown below.

Step one is to subtract the global median 55, 833

Total sum of squares 96,600,000,000

First pass factor medians

Global Median 0.3

Year effect		Site Effect		Designation effect		Flood History		Insurance Class	
Y2000	-24858	Bewdley	4417	Outside	15417	Not Flooded	1125	Normal	1750
Y2001	-20584	Shrewsbury	-3833	Low	125	Flooded	-2583	High	-10,833
Y2002	-10833	Portsmouth	417	Moderate	3542			Compromised	3417
Y2003	7292	West Bridgford	23417	Significant	-10583				
Y2004	9167	Malton and Norton	-19958						
Y2005	7792								
Y2006	24167								

Residual 42,400,000,000 Ratio of RSS = 2.28

Second pass factor medians

Global Median 4165

Year effect		Site Effect		Designation effect		Flood History		Insurance Class	
Y2000	7776	Bewdley	1742	Outside	-11999	Not Flooded	-4395	Normal	-3999
Y2001	3302	Shrewsbury	-3081	Low	-1092	Flooded	10563	High	9167
Y2002	-2521	Portsmouth	1001	Moderate	5271			Compromised	6002
Y2003	-6895	West Bridgford	-10415	Significant	2002				
Y2004	6563	Malton and Norton	5375						
Y2005	2397								
Y2006	-3082								

Residual 46,400,000,000 Residual ratio 0.91

Third pass factor medians

Global Median -280

Year effect		Site Effect		Designation effect		Flood History		Insurance Class	
Y2000	-4151	Bewdley	-8317	Outside	12652	Not Flooded	2450	Normal	2614
Y2001	-1685	Shrewsbury	2243	Low	2306	Flooded	-7702	High	-9403
Y2002	-8	Portsmouth	2370	Moderate	-12189			Compromised	-1871
Y2003	661	West Bridgford	18603	Significant	-1661				
Y2004	-771	Malton and Norton	-6207						
Y2005	991								
Y2006	733								

Residual 41,600,000,000 Residual ratio vs pass 3 1.11 Residual ratio vs pass 2 1.02

Less than 5% performance change convergent

Fourth pass factor medians

Global Median 777

Year effect		Site Effect		Designation effect		Flood History		Insurance Class	
Y2000	1377	Bewdley	5701	Outside	-16313	Not Flooded	-6264	Normal	-6264
Y2001	-2407	Shrewsbury	-3365	Low	-4948	Flooded	9004	High	5626
Y2002	5339	Portsmouth	-5538	Moderate	9306			Compromised	1377
Y2003	-2140	West Bridgford	-16948	Significant	985				
Y2004	1245	Malton and Norton	5860						
Y2005	-4451								
Y2006	-7493								

APPENDIX I : LIST OF PUBLICATIONS

Journal Papers and Book Chapter

1. LAMOND, J. & PROVERBS, D. (2006) Does the price impact of flooding fade away? *Structural Survey,* 24(5)**,** 363-377.
2. LAMOND, J., PROVERBS, D. & ANTWI, A. (2007) Measuring the impact of flooding on UK house prices- a new framework for small sample problems. *Property Management,* 25(4)**,** 344-359.
3. LAMOND, J., PROVERBS, D. & ANTWI, A. (2007) The impact of flood insurance on residential property prices : towards a new theoretical framework for the UK market. *Journal of the Financial Management of Property and Construction,* 12(3)**,** 129-137.
4. SOETANTO, R., PROVERBS, D., LAMOND, J. & SAMWINGA, V. (2008) Residential properties in England and Wales: an evaluation of repair strategies towards attaining flood resilience. IN BOSHER, L. (Ed.) *Hazards and the built environment: attaining built-in resilience. Taylor and Francis ISBN* 9780415427296 *(In press)*

Published, Peer Reviewed Conference Papers

5. LAMOND, J., PROVERBS, D. & ANTWI, A. (2005) The effect of floods and floodplain designation on the value of property: an analysis of past studies. *2nd Probe Conference.* Glasgow.
6. LAMOND, J., PROVERBS, D., ANTWI, A. & GAMESON, R. (2006) Flood insurance in the UK: how does the changing market affect the availability and cost to homeowners. IN BALDWIN, A., HUI, E. & WONG, F. (Eds.) *CIB W89 International Conference on Building Education and Research Conference.* Hong Kong, CIB.
7. LAMOND, J. PROVERBS, D. (2006) Elephants or ostriches, does the collective memory of flood events fade with time? *First World Conference for Accelerating Excellence in the Built Environment.* Birmingham.

Other conference and workshop papers

8. LAMOND, J. (2006) Impact of flooding on residential property values. *Workshop on identification and facilitation of flood damage research.* Sheffield, EPSRC international network of experts in flood damage and repair.
9. LAMOND, J. & PROVERBS, D. (2007) Measuring the long term financial impact of flooding on homeowners, data issues and opportunities. *European Geosciences Union General Assembly.* Vienna.

10. PROVERBS, D. & LAMOND, J. (2007) Putting a value on repair: a modular approach to assessing the cost of flood damage. *European Geosciences Union General Assembly.* Vienna.

Pending publications

11. LAMOND, J., PROVERBS, D. & HAMMOND, F. (2008) Accessibility of flood risk insurance in the UK - confusion competition and complacency. *Journal of Risk and Uncertainty,* in review.
12. PROVERBS, D. & LAMOND, J. (2008) The Barriers to Resilient Reinstatement of Flood Damaged Homes. *4th International i-Rec conference 2008. Building resilience: achieving effective post-disaster reconstruction.* Christchurch, New Zealand. Abstract accepted paper in review