CHAPTER ONE

INTRODUCTION

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). In Malaysia alone, an estimated RM 0.5 billion worth of flood induced damages and carnage are recorded (Bernama, 2007).

The flood event of December 2007, coming as it did after a relatively dry period, sparked a renewed interest in the management of flood risk, especially in terms of property price preservation (Tan, 2008). The basic cause of flooding in Malaysia is the incidence of heavy monsoon rainfall and the resultant large concentration of runoff, which overwhelms river systems (Ho et al., 2002).With the buzzword of climate change, now more attention is turned towards the preservation and rehabilitation of properties, namely, residential properties so as not to further exacerbate the financial conundrums brought upon the erosion of the homeowners property prices.

The immediate effect of flooding on its victims in terms of loss of property and displacement from their homes is readily apparent. Surveys of US flood victims document the wider impacts (Ketteridge and Fordham, 1998, Samwinga et al., 2004). A key worry expressed by homeowners in UK and USA is that they may experience insurance problems and that enhanced awareness of flood risk due to media coverage, legal disclosure and proposed flood insurance systems may cause depression in the price of flood-prone property (Samwinga et al., 2004).

A sustain preservation of property price 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. 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).

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.

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 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 background

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). The damage to property, infrastructure and business has been studied in some detail by Penning-Rowsell and others (Penning-Rowsell and Wilson, 2006) in order to evaluate the cost benefits of flood management programmes. In Malaysia, the focus is on flood mitigation project and one of it is a Asian Development Bank backed Klang River Basin flood alleviation project (ADB, 2009)

The assumption that flooding will have an impact on property price is commonly held and makes intuitive sense but not yet proven for the UK (Clark et al., 2002) and on the same breath, the same can be said for Malaysia (Department of Irrigation and Drainage, 2002). Conflicting theories suggest that a measurable impact of flooding on property price 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 price 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 price implications of flood risk and reinforces the need to examine the relationship using actual transaction data.

Studies of the effect of flooding on property price 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 price loss (Gaschen et al., 1998). Different flood insurance systems exist across countries mentioned unlike Malaysia which, at this moment, a fully operational federal run flood insurance with national coverage is almost non-existent .Except for ING Home Insurance Houseowner Policy which covers, inter alia, flood, bursting of water pipes/tanks, aircraft damage, storm, earthquake and theft (ING,2008).

Of course this example is non-exhaustive and not representative of other insurance firms' policy cover or posture on flood insurance coverage. But a federally administered flood insurance policy is different from other private run insurance mechanisms and objectives. While the reason for being of commercial entities is of course purely commercial, the sole objective of federal run flood insurance policy is to serve and protect victims, just like any insurance per se but the former serves the shareholders, the latter has the victims' interests at heart.

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 price 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 Malaysia. 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 price of houses.

1.3 Aims and rationale

The main aim of this research is to determine whether flooding has any effect on housing prices in Malaysia, notably in Kota Damansara and Dungun. And to manifest the aim of this research, the objectives will seek to address the identified gaps in the current research in the following ways:

1. To conduct a comprehensive appraisal of relevant literature in order to identify any consensus in the previous analysis of the impact of flooding upon property price. The review will also encompass methodological approaches with the intention of identifying appropriate methodologies for measuring the impact of flooding on property price.

2. To develop a conceptual model in Malaysian context, of the impact of flooding upon property price.

3. To estimate using models the impact of flooding on property price. Data on property–specific variables will be collected and combined into the price models to explore the relationship between flooding, characteristics of a property and property price.

1.4 Research scheme

The summary of research scheme is shown in Table 1-4.

Table 1-4: Research Scheme

Stage	Objective	Method
Theoretical Knowledge	To conduct a comprehensive appraisal of relevant literature in order to identify any consensus in the previous analysis of the impact of flooding upon property price. The review will also encompass methodological approaches with the intention of identifying appropriate methodologies for measuring the impact of flooding on property price.	Literature review
Empirical Investigations	To develop a conceptual model in Malaysian context, of the impact of flooding upon property price.	Descriptive analysis
	3. To estimate using models the impact of flooding on property price. Data on property–specific variables will be collected and combined into the price models to explore the relationship between flooding, characteristics of a property and property price	Hedonic Regression
Findings & Conclusions		Review of Core Findings

Even a cursory glance at the literature reveals that practitioners from diverse fields, such as economics, engineering and finance have studied the impact of flooding on property as per many Anglo-Saxon studies. A spectrum of competing and complementary theories of behaviour have been offered and yet futile to become a beacon to valuation and other real estate practitioners.

The initial research strategy was to investigate the wider context of flooding, house price and insurance literature via a survey of the published research. Hence, a conceptual model of the impact of flooding on the price of property could be developed. The strategy also drew in estimation of the model parameters using Malaysian 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 shunned.

1.5 Parameters 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. Malaysia will form the backdrop for the study during the literature review stage. Although US,UK and Australia have different regulatory mechanisms , property transfer process and have more experience on this current theme, during the empirical model building stage, the study will also focus on these countries though not mutually exclusive.

Domestic residential property only will be considered. For the purposes of the empirical analysis only transacted property will be included.

1.6 Framework and flow

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 are 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 price are detailed. This chapter draws on flood pricing literature on UK, Australia, Malaysia and USA flood insurance-related literature.

In addition to the extensive review chapters, conceptual model development is described in chapter 5. Chapter 6 lays out the practical steps necessary in the empirical analysis phase of the research based on transaction data from the Malaysian property market. In chapter 6 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 7 showcases a collection of textual data about the study sites and the preliminary data analyses to obtain local price indices for each site. Choice of model and model validation is also contained in the same chapter.

Chapter 8 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.

1.7 Summary

It has been shown within this chapter that flooding is an important issue, not just for Malaysia 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 Malaysian homeowner are seen to be under researched.

Better understanding of these long term impacts is proved to be useful for a diverse 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 property price 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 on-going 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 TWO

FLOODING AND 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 Kuala Lumpur 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).

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 price.

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 describes the various types of flooding. Section 3 considers the likely increase in future flood risk. The impact of flooding in the built environment is described in section 4. Sections 5 and 6 consider the prediction of flooding from a scientific and public perception perspective. Section 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.

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 Malaysia, for residential property, all types of flood are not normally covered by domestic house insurance. Therefore, the flood type and the associated damage plus the distinction between types are 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.

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.

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 tide locking 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 river or 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 many 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, UK, in August 2004 (Doe, 2004) and Kuala Lumpur (Hazalizah, 2007) 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.

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.

2.3 Climate change and 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 last century's 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 Malaysia 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 Meteorological Office (Hadley Centre, 2003) estimates suggest that whatever action is taken some warming is inevitable due to current carbon dioxide levels.

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 rose from USRM1 billion to USRM21 billion (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 is 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 Malaysia. While the scale and timing of this increase is unclear, however, the detailed implications of climate changes 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 are 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. It is also desirable to locate new development close to existing ones in order to increase housing density.

The price of land on the floodplain may also be a factor in favour of floodplain development. In UK, 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).

The researcher is sure that despite existing 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).

2.3.3 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 were 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%.

The increased costs of flooding observed in recent flood events in Malaysia and the projections of further cost increases can therefore be seen to be a combination of increased risk, exposure and vulnerability (Ibid, 2002). 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 ramifications of flooding on 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 are 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. These cause 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 below:

Table 2-1: Forms of loss

Forms of loss	Tangible	Intangible
Direct	Damage to buildings	Loss of archaeological merit
Indirect	Loss of productivity	Increase in travel expenses; inconvenience, health impacts

Source: adapted from Penning Rowsell et al, 2005

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 Kuala Lumpur during monsoon season in 2007 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 are 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 US, 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 was 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.

2.4.2 Damage repair

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 impacts of aid to the uninsured versus insurance claims are explored by Fordham and Ketteridge (1995).

For the insurance industry Black and Evans (1999a) estimated the average cost of reinstatement to be RM22,000 for buildings and RM13,000 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 on-going in the UK by the H R Wallingford research organisation on behalf of the Building Research Establishment (Tagg, 2006), Sheffield Hallam University (Lambert, 2006) and the National Flood School (Netherton, 2006). Achieving excellence in the sphere of flood repair may contribute to the maintenance of property price 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 (Samwinga et al., 2004).

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 those indirect losses from a flood are 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 losses 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.

Disruption of road transport and essential local services can also be costly involving rerouting 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 (Samwinga et al., 2004).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 price 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 price 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

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 Malaysian flood episodes. 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 price 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 below:

Table 2-2: Homeowners experience after flood damage to their property

Economic effects
Financial – expenses associated with living in temporary accommodation. Property Price – fear of potential reduction in property price 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 effects
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 price and irreplaceable. Fatigue – associated with cleaning up and repair work Reaction to flooding – included Disbelief, Shock, Surprise, Devastating, Stressful, Worried,
Physical aspects
Flood characteristics – e.g. floodwater depth, contamination, amount of floodwaters, and duration of flooding, define the nature of the flood event. Extent of damage – extent of property damage and whether or not it's insured. Flood warning – how much warning homeowners had before the flood. Physical Aspects Flood Timing or Season – holiday time can be particularly distressing.

Source: adopted from Samwinga et al, 2004

2.5 Public perception of risk

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 preconceptions (Slovic, 1987, Barnett and Breakwell, 2001, Brilly and Polic, 2005).

2.5.1 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 reveal 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 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 conveyance 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).

2.5.2 Source of information

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).

2.5.3 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 mismanagement 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.

2.6 Reaction by property owners when faced with flood risk

Given the recent 2007 January flood history in the Malaysia and worldwide with significant media attention one might anticipate a behavioural change in those residents 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 in Malaysia. 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. Affected 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 price (Samwinga et al., 2004).

2.6.1 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 Malaysia, however, flood insurance per se is neither non-existent nor bundled into standard household fiscal policies(property tax or quit rent) implying that people are not insured against flood by default if they are insured at all.

Emergency flood relief in Malaysia are promptly given and not difficult to obtain since the government has an efficient disaster response network. Insurance coverage is low or non-existent in Malaysia however (Joseph

Rowntree Foundation, 1998) postulates that those who are uninsured tend to express a desire to have insurance but are prevented by low incomes. 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.

2.6.2 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 per cent 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 is looked upon to pick up the damage bill. Only those at risk of frequent flooding have the experience and knowledge to own the problem themselves.

2.6.3 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.

2.6.4 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 price 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.

Evidence to back up these theoretical positions is sketchy: A survey of New Orleans 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 per cent reported that they hardly worry about 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 an impact on price 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 was formed (Thrush et al., 2005). In Woking, England, 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 Kota Damansara had some knowledge of flood risk but had not expected to be severely affected.

2.7 Summary

This chapter summarises some of the copious literature on flooding events and flood risk globally and yet scarcely in Malaysia. 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 Malaysia.

It has been shown in this chapter that the risks of flooding within the UK and US have 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. It is perhaps inevitable that Malaysia should adapt NFIA-ala type of flood insurance considering the various merits and demerits of government-run insurance. Considering the similarities of the fate shared by flood victims in Malaysia, UK or US, these victims' needs and welfare can be well taken care of by having a flood insurance mechanism administered by the government instead of private enterprises. There is a danger that private enterprise, in fulfilling their commercial needs, may charge high premiums for flood victims and the coverage extended may be inadequate.

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.

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 THREE

THEORETICAL MODELS OF HOUSE PRICES

3.1 Introduction

Project benefits result from increases in consumer's and producer's surpluses due to the presence of the project. In the case of flood damage reduction projects, project benefits are due to decreases in flood damage to property within the project area. (Clark et al, 2002) use of benefit-cost analysis to evaluate projects, assumes a partial equilibrium market model for expecting a discount in the price of a floodplain property. However, McDonald et al., (1987) explain the model as follows:

"The estimation of willingness to pay for a reduction in flooding hazard is based on the relationship between housing price differentials and rational consumer behaviour. The consumer will make a location choice which maximizes expected utility. The potential loss associated with flooding hazard forces the consumer to incorporate the hazard into this choice. The rational consumer will be willing to pay an amount, dependent on the perceived loss and its probability of occurring, to locate in an area where the hazard does not exist (or exists with a reduced probability of occurrence). Conversely, the rational consumer will locate within the hazard area only if they are compensated for accepting the potential loss. The willingness to pay (or compensation) should be capitalized into the prices of housing with respect to different probabilities of flooding. Further,

if insurance is available, the housing price differentials should reflect the insurance premium differentials which exist for the various probabilities of a flood occurring.”

However, market dynamics are not so simple. Flood damage risk is but one of many factors that determine property price decisions. Attitudes and perceptions of risk, knowledge of flood risk, expectation of government disaster relief, including recovery assistance, and the rules of the National Flood Insurance Program (NFIP) add to the complexity of market dynamics. Prices of floodplain properties are also affected by other attributes unique to the floodplain. The condition of properties may be poor because post-flood repairs fall short of full restoration, especially for properties subject to frequent flooding. The development of the floodplain may be unique from the rest of the community thus making it a different market. Location in the floodplain also offers benefits (such as access to the water and nice views) which are difficult to separate from flood risk disbenefits when assessing property price decisions.

Because of these complicating factors, there is some question as to whether the P&G assumption that properties are discounted for primary flood damages is correct. In fact the existence of a discount for primary flood damages has never been empirically demonstrated. The methods to empirically measure the contribution of an attribute to the price of a property include hedonic price models and contingent valuation techniques.

The study focuses on hedonic price models because they are more effective in separating out non-mutually exclusive factors.

The central aim of this research is ascertain whether flooding has any impact on the price of Malaysian residential property. And the secondary objective of this study is limited to a search for evidence that expected annual flood damages borne by flood plain activities are or are not capitalized into the fair market price of floodplain properties For the purposes of this thesis the primary measurement of property price employed will be the transacted price because in a competitive market economy price is the most common and accessible expression of inherent price.

In 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 price implications of flooding and the practical mechanism by which this price impact could be expressed in the market price. The specific market in this instance is the residential property market for Kota Damansara and Dungun. In tandem with the 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 Malaysian will be covered in section 3.3. The heterogeneous nature of the housing product is then considered in section 3.4 and sections 3.5 to 3.8 describe ways in which the heterogeneous 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 Housing price theory

The theory of house price movements falls into both the fields of macro and micro economics (Bourne, 1981). Macroeconomics 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 price or utility of that goods or services to an individual, organisation or government. The price placed upon a good or service can therefore give information about the price of a good and can induce changes in behaviour when the price 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 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 this 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 price.

In this ideal scenario with willing buyers and sellers, price and price can be regarded as the same but in practice there are no property markets where this is the case. 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 price homeowners place on this 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 Malaysian residents the home is the most significant financial investment they will ever make. Many homeowners

anticipate that their property will appreciate in price 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 price of floodplain homes due to this perceived investment weakness.

In Malaysia, 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 in Malaysia

An understanding of the salient features of the Asian housing markets would provide the contextual underpinnings to the analyses of the estimation results that are obtained from the regressions.

Culturally, there appears to be greater propensity towards home ownership in Asia. The property sector is normally dominated by few major developers. The banking system alongside government housing finance system play important roles in meeting the demand for housing for in most sample economies (Ng, 2006).

In Malaysia, land transactions are based on Torrens system and are governed by the National Land Code, 1965 (“NLC”). However, if the separate title of the real property has not been issued, the transaction will be completed by way of an absolute assignment, where the beneficial ownership of the real property will be passed to the purchaser. Upon issuance of the separate title to the real property thereof, a Memorandum of Transfer (“MOT”) (a form prescribed under the NLC) will be submitted to the relevant land office/registry for registration, wherein the legal ownership of the real property is transferred to the purchaser.

In Malaysia, it is common for the vendor to appoint a real estate agent to negotiate initial salient terms (such as the purchase price, completion period) with potential purchasers. Once the parties reached an agreement on the salient terms, an offer to purchase will be prepared by the real estate agent to be signed by both parties. Thereafter, a lawyer will be appointed by the purchaser to draft and finalise a sale and purchase agreement within 14 days. It is up to the Vendor whether he/she elects to appoint his/her own lawyer to review the sale and purchase agreement.

The parties will sign the sale and purchase agreement after they have mutually agreed on the terms and conditions contained therein the sale and purchase agreement. The purchaser is normally given 3 months with an extension of 1 month (subject to payment of interest) to complete the sale and purchase transaction. Upon payment of full purchase price, legal/beneficial ownership will be passed from vendor to purchaser once the MOT is registered in favour of the purchaser/ Deed of Assignment duly signed by both parties and stamped.

3.3.1 Tenure system

In terms of tenure, freehold and leasehold systems are the most prevalent in Malaysia .In both economies, the government is effectively the sole owner of the land and the land market is essentially a market of land leases. They have in place the land rights use system, whereby, the process of land allocation is governed by the auction system.

Freehold and leasehold (30, 60 and 99 years) are the two types of tenure. Since the 1990s, residential property transactions have accounted for a sizeable portion of total real estate transactions, both in volume and price (Ng, 2006). This trend has been aided by the Malaysia Government’s thrust towards promoting access to comfortable living and affordable housing especially for the lower-income group. Significant portion of development spending was allocated to housing development in successive five-year Malaysia Plans since 1971. Financial supports as well as incentives have been provided under various programs. Malaysia has the lowest house-price-to-income ratio in Asia (Ibid, 2006).

While the recent run-up in housing prices is driven by strong demand for luxury properties, more subdued price increases in the mass market have been attributed to oversupply and the government’s attempt to make housing more affordable. By end-2006, property-overhang in the residential market increased by about 68 per cent. It was observed that the average sales performance of new launches of residential property had been on a downward trend since 2002 and only started to pick up in the third quarter of 2006 (Ng,2006).

In terms of housing finance, banking institutions (commercial banks, finance companies, Islamic banks and merchant banks) are by far the biggest primary market lenders in providing financing for the purchase of residential properties. Apart from banking institutions, development finance institutions such as the National Savings Bank, Cooperative Bank, Malaysian Building Society Berhad and Borneo Housing Finance Berhad; and a number of insurance companies also provide financing for the purchase of residential properties. The Treasury Housing Loan Division (THLD) of the Ministry of Finance is also involved in the housing loan market by providing end-financing to public-sector employees.

3.3.2 Mortgage credit conditions

There are two types of property financing genre available in Malaysia: Islamic or Sharia-compliant and conventional.

Islamic house financing is a distinctive feature of the Malaysian banking system. Islamic house financing products generally share the same characteristics as normal housing loan products but are based on the concept of Bai Bithaman Ajil (BBA). BBA or Deferred Payment Sale refers to the sale of goods on a deferred payment basis at a price that includes a profit margin agreed upon by both the buyer and the seller. Islamic house financing is mostly fixed rate financing, but as of 2003, banks have begun to offer variable-rate Islamic house financing products (Bank Negara Malaysia, 2000).

In Malaysia, there are two primary mortgage mechanisms: mortgage-backed security (run by Cagamas) and conventional retail banking system.

Cagamas was created in 1986 and commenced business in 1987. The corporation was set up to alleviate the liquidity problems of primary market lenders by allowing them to use their mortgage loan portfolios as collateral to obtain additional funds. In addition, it allows them to reduce interest rate risk by making available longer term fixed rate funds, narrowing the difference between the maturities of their assets and liabilities. An additional objective of the company was to deepen of the financial sector by creating a new source of fixed-income securities and to widen the range of low-risk placement alternatives for banks' liquidity reserves.

Incorporated in 2007, Cagamas Holdings Berhad is the holding company of Cagamas Berhad, Cagamas MBS Berhad, Cagamas SME Berhad and BNM Sukuk Berhad. Cagamas Berhad, the National Mortgage Corporation of Malaysia, is perhaps the most successful example of a secondary mortgage facility in a developing country (Cheng, 1997 and 1998). It functions as a liquidity facility providing short and medium term finance and capital market access to mortgage lenders. Cagamas purchases mortgage loans from mortgage originators, with full recourse, at a fixed or floating rate for three to seven years. This is in effect a secured financing with Cagamas looking first to the credit of the financial institutions when mortgage loans default. Cagamas issues unsecured debt securities to investors, in the form of fixed or floating rate bonds, short-term notes, or Cagamas Mudharabah (Islamic) Bonds.

Although Cagamas is the beneficial owner of purchased mortgage loans, it is best characterized as a liquidity facility. This is because it takes very little credit risk (all loans are purchased on recourse so the main credit risk is bank failure) and primarily serves as a centralized funding source for mortgage lenders.

A mortgage seller is assigned a maximum purchase ceiling by Cagamas reflecting its recourse exposure. Mortgage loans are subject to eligibility rules, including a first-ranked mortgage on the residential property title, in an amount less than or equal to Ringgit (RM) 150,000 (US$ 40,000 as of late 1998) which excludes high-cost units, and no arrears of more than three months. There is no over-collateralization requirement. All mortgage payments including scheduled principal and prepayments are passed through to Cagamas.

The seller remains the custodian, trustee of the loans and services the loans on behalf of Cagamas. The seller passes through principal and interest to Cagamas at pre-determined rates, retaining the difference between the loan coupon rate and Cagamas' required yield as its servicing and recourse fee.

Loans that become fully amortized or that are ineligible are replaced by the seller, which must report the performance of the pool to Cagamas quarterly. Controls are limited to the seller's auditor's yearly review, as Cagamas does not conduct on-site inspections.

Cagamas obtains funds by issuing bonds. The bonds are not backed by specific mortgage loan pools but are guaranteed by the company. Cagamas refers to its bonds as mortgage-backed securities but the refinancing function is independent from the mortgage pool. To date all of its bonds have been single-bullet structures, which expose Cagamas to cash flow risk arising from the different payment characteristics of its assets and liabilities.

Its wholly-owned subsidiary, Cagamas Berhad, the National Mortgage Corporation and leading securitisation house, was established in 1986 to promote the secondary mortgage market in Malaysia. It issues debt securities to finance the purchase of housing loans and other consumer receivables from financial institutions and non-financial institutions.

The provision of liquidity at a reasonable cost to the primary lenders of housing loans encourages further financing of houses at an affordable cost. In addition, Cagamas Berhad also securitizes mortgage loans / receivables and SME loans / receivables through its sister company, Cagamas MBS Berhad and Cagamas SME Berhad respectively.

The Cagamas Berhad model is well regarded by the World Bank as the most successful secondary mortgage liquidity facility (Bank Negara Malaysia, 2000). Cagamas Berhad is the leading issuer of debt instruments, second only to the Government of Malaysia, the largest issuer of AAA debt securities as well as one of the top Sukuk issuers in the world. Since incorporation in 1986, Cagamas Berhad has cumulatively issued RM242.76 billion of conventional and Islamic debt securities.

Cagamas was created in response to a financial crisis. A collapse in commodity prices and a sharp rise in interest rates caused liquidity problems for banks, building societies and finance companies which were forced to make a large volume of loans to priority sectors including housing. Selling their loans to an intermediate institution that could raise funds from the capital markets allowed these lenders to obtain additional funds to meet their mandates. Also, through refinancing with Cagamas an originating bank could significantly reduce the maturity mismatch of funding 15 year housing loans with deposits having maturities of one year or less.

In several respects, Malaysia was a good candidate for creating a secondary market institution. It has a well-developed legal and regulatory system based on the British model which underlies the successful mortgage markets in Australia, Canada, the UK and US. In particular, the Torrens system of land registration was put in place in 1966 and security of tenure has been a major emphasis of post war governments (Cagamas, 1997). A substantial body of case law has established the right of property owners to mortgage their holdings and the right of lenders to foreclose and repossess in the event of default. The banking system was relatively well developed and through past government mandates was already significantly involved in housing finance. A relatively well developed government bond market also existed at the time of Cagamas' creation.

3.3.3 Government housing finance system in Malaysia vis-à-vis Asia

Government-housing finance institutions play an equally important role in housing finance system in Asia. These institutions engage either in direct lending, mortgage securitization or both, with most of them carrying explicit or implicit government guarantees, except for Cagamas in Malaysia which is a purely private-sector institution. While the Hong Kong Mortgage Corporation (HKMC) does not have explicit government guarantee, it is largely perceived to carry implicit government guarantee (Chan et al, 2006).

A conventional role of government housing finance institutions is to cater to mortgage financing needs of households, particularly to low income households, and to promote home ownership. Malaysia, the Philippines and Thailand have a number of institutions that provide concessional residential loans. In Malaysia, there are a number of development finance institutions that provide financing for the purchase of residential properties.

Another major function of government housing finance institutions is to facilitate securitization. For instance, the Cagamas (Malaysia) and the HKMC undertake the function of securitization and do not engage in direct lending to households. In Korea, the Korean Housing Finance Corporation (KHFC) was established in 2004 to perform dual functions of lending to households and MBS issuance.

The involvement of government housing finance institutions in securitization was noted to have played a pivotal role in fostering the expansion of mortgage markets and encouraging greater participation of commercial banks in mortgage financing. In Malaysia, banks were less than eager to extend housing loans prior to the advent of securitization. Securitization allowed them to obtain competitively-priced funds, gain profits and diversify their housing loan products (Ng, 2006). The liquidity provided by securitization facilities has made it possible for financial institutions to overcome the liquidity mismatch problem and extend the term of housing loans. Higher liquidity also enhanced the capacity of households to take on greater debt and, thereby, increased demand for houses.

Malaysian 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 depreciated 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 is rather homogenous throughout Malaysia. As usual 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 conveyance 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 may raise awareness before offers are made.

The process of price negotiation in the majority of residential property transfers in Malaysia 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 a typical Malaysian 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 valuers in valuing similar properties will have a great bearing on the accuracy of their assessment of price. However, the valuers 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 Malaysia 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 Malaysia 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 Housing Attributes

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 one's own property provides financial stability, collateral, a long term financial investment and loan security. Perhaps even more importantly the location or neighbourhood in which the dwelling place is located provides a social milieu and defines an individual as belonging to an income bracket, race or religion, "kampong" or "orang bandar", "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 price 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 price of a residential property with vacant possessions 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 usually advertised. 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 be 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

Attributes	Description
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 Fitted kitchen Spacious/ample/large Improved/extended Well maintained/immaculate/ Modern/recently built/character/mature/period features
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

Source: adapted from 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 price in Malaysia 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 price 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 Regression models

The term hedonic was used to describe “the weighting of the relative importance of various components among others in constructing an index of usefulness and desirability” (Goodman, 1998: 292). Rosen (1974: 34) defines hedonic prices as “the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them” (Ustaoğlu, 2003).

Rosen (1974) comprehensively laid down a theoretical foundation for determining the bid price, or implicit price of the attributes of a commodity for different consumers.

As stated above, the theory of hedonic price functions provides a framework for the analysis of differentiated goods like housing units, whose individual features do not have observable market prices. The traditional use of hedonic estimation in housing studies has been for the purpose of making inferences about non-observable prices subway or highway) and neighbourhood amenities (Janssen et al. 2001).

The hedonic-based regression approach has been utilized extensively in the housing market literature to investigate the relationship between house prices and housing characteristics. The primary reasons for such extensive application are analysing household demand for these characteristics as well as constructing housing price indices (see, for example, Can, 1992; Sheppard, 1999).

However, this approach is subject to criticisms arising from potential problems relating to fundamental model assumptions and estimation such as the identification of supply and demand, market disequilibrium, the selection of independent variables, the choice of functional form of hedonic equation and market segmentation. These problems have been of great concern in the literature (see Sheppard, 1999; Malpezzi, 2003, Fan et al., 2006).

Most of the price studies are conducted with hedonic modelling and other methods based on multiple regression analysis. Basically, these methods are appropriate to a straightforward estimation of the relationship between price and the various characteristics. However, these techniques might become problematic if the agenda of the appraisal is widened to include aspects such as outliers, nonlinearity, spatial and other kind of dependence between observations, discontinuity, and fuzziness.

There are, however, some plausible alternatives, one being the use of neural networks, which are better suited to deal with these aspects. The neural network is, in fact, an example of a flexible regression approach. These types of methods are basically different from the standard methods. Specifically, they allow for a broader range of variation in the output than the hedonic regression model, with its spatial extensions. However, it is not clear how the coefficients in the model vary in space, and there is no straightforward functional relationship between the input and output prices (Kauko, 2003).

Hedonic price model is based on Lancaster (1966)'s consumer theory. Since this theory has been extended to the residential market by Rosen (1974), residential hedonic analysis has become widely used as an assessment tool and for property market and urban analysis. The regression of house prices on a variety of property specific and neighbourhood descriptors evaluates their marginal contribution, also called implicit or hedonic prices. A comprehensive treatment of hedonic price theory is provided by Rosen (1974). A theory of hedonic prices is formulated as a problem in the economics of spatial equilibrium in which the entire set of implicit prices guides both consumer and producer locational decisions in characteristics space.

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.

An extension of demand theory due to Lancaster (Lancaster, 1996) 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 (Ibid, 1996). 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 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 priced 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 price 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.

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

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.

In forming hedonic price models to assess a discount for primary flood damages, an obvious, simple variable to choose is a dummy variable α_1 ($\alpha_1 = 1$ for a property in the floodplain and $\alpha_1 = 0$ for one outside of the floodplain) to represent location in the floodplain. Let the price differential between otherwise identical properties be defined as:

$$\Delta P_L = P_{out} - P_{in}, f(\alpha_1 = 0, \alpha_2, \ldots, \alpha_n) - f(\alpha_1 = 0, \alpha_2, \ldots, \alpha_n) \quad (Equation\ 3.4)$$

where P_{out} is the price of a property not subject to flood risk and P_{in} is the price of an otherwise identical property subject to flood risk. Being in or out of the floodplain is equivalent to being exposed or not exposed to flood risk. It does not reflect degree of risk. An alternative to a dummy variable, which better captures the degree of risk, is to use flood frequency to the first floor elevation as the variable.[1]

In either case, ΔP_L is the hedonic price (discount) for floodplain *location*. ΔP_L is not, however, the same as the discount for the capitalized price of primary flood damages, defined as ΔP_D . A change in property *D* price according to floodplain location is due to primary flood damages as well as other negative and positive floodplain attributes. The negative attributes include monetary (e.g., anticipated loss of income, temporary evacuation

[1] A note on function form. Although the functional form of a hedonic price model cannot be identified a priori,the coefficients from a log-linear form are easier to interpret than those from a linear model. A log-linear model withdummy variables for location in the floodplain yields the percentage change in price due to floodplain location, rather than the absolute change given by a linear model. If the range of prices in the data set is large, then a non-sensical result can result if the floodplain location discount calculated from a linear model is greater than the absolute value of the property.

costs, and condition of houses) and non-monetary damages (e.g., emotional and nuisance factors, knowledge of or experience with flooding, potential for government flood assistance, effectiveness of floodplain regulations and risk attitudes). Positive attributes include recreational and aesthetic prices. $\Delta \mathbf{P}_L$ as well as some of the other negative and positive attributes varies, in price across the floodplain. For example, access to waterborne recreation is much greater if a property abuts the river.

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). 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 price 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 Valuation Models

Just like the issue of flood insurance, it is inevitable that the issue of different choices of valuation model, must be discussed when the subject matter of the effects of flooding on house prices (Yeo, 2006). After all, the aforementioned components are intertwined and their constituents' effects have clout on the other. Bear in mind that this research seeks to satisfy the aforementioned aims and crystallise the objectives; it does not however, through the following paragraphs, seek to offer new valuation approaches or suggest appropriate valuation methods to appraise flood- affected properties.

The valuation of real estate is central tenet for all businesses. Land and property are factors of production and, as with any other asset, the price of the land flows from the use to which it is put, and that in turn, is dependent upon the demand (and supply) for the product that is produced. Valuation, in its simplest form is the determination of amount for which the property will transact on a particular date (Pagourtzi et al, 2003)..

However, there is a wide range purposes for which valuations are required. These range from valuations for purchase and sale, transfer, tax assessment, expropriation, inheritance or estate settlement, investment and financing.

Specialised Properties are properties that are more heterogeneous than homogenous (Ibid, 2006). That is, the nature of the property is such that the type of property concerned doesn't transact sufficiently to be able to determine price by comparison of previous sales. In such circumstances the valuer needs to resort to a valuation model that addresses the underlying fundamentals of that property so that its price can be determined by reference to the wealth producing qualities of the asset.

For most non-specialised property, the price of the property is based upon its income producing potential as an investment. For most specialised property, the price is based on the owner-occupier's views of the worth of the property, i.e. the contribution it will make to business profit, as well as subjective issues such as status and feelings of security. Valuers, with hardly any transaction evidence, can only attempt to replicate these calculations of worth in arriving at an estimate of exchange price by reliance upon an accepted valuation model (Hendriks, 2005)

For any valuation model to have validity it must produce an accurate estimate of the market price. The model should therefore reflect the market culture and conditions at the time of the valuation. It should be remembered that the model should be a representation of the underlying fundamentals of the market and that the resulting figure of the valuation is "price."

Value is an estimation of the price that would be achieved if were the property to be sold in the market, and Worth is a specific individual's perception of the capital sum that she/he would be prepared to pay (or accept) for the stream of benefits that she/he expects to be produced by the property (Hendriks, 2005)

Market Price is the estimated amount for which an asset should exchange on the date of appraisal between a willing buyer and a willing seller in an arm's length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently and without compulsion (Ibid, 2005).

This is the definition of the International Valuation Standards Committee (IVSC) and has been fully adopted by most national property organisations. The most common methodologies of estimating Market Price are direct capital comparison, the investment method, the contractor's method, the residual method and the profits method (see on).

Valuation is simply a model to try to determine price. Price is the end result. It is the quantification of an understanding of the market; the legal impact; the physical constraints; the planning regime; the availability of finance; the demand for product and the general economy all influence the price of property. Valuation is the process of determining market price; an estimation of the price of exchange in the market place (Ibid, 2005).

Valuations are required for many different purposes ranging from open market transaction to compulsory purchase. Although the underlying preferred method of valuation should not be dependent upon the purpose of the valuation, it is important that the purpose is determined before undertaking any calculation.

Each country will have a different culture and experience, which will determine the methods adopted for any particular valuation. Valuation Methods can be grouped as follow (Pagourtzi et al (2003) :

- **Comparable method**

Used for: most types of property where there is good evidence of previous sales.

- **Investment/Income method**

Used for: most commercial (and residential) property that is producing, or has the potential to produce, future cash flows through the letting of the property.

- **Accounts/Profits method**

Used for: trading properties (other than normal shops) where evidence of rents is slight as they tend not to be held as investments. The accounts method determines an appropriate rent, which is then used in the investment method.

- **Development/Residual method**

Used for: properties ripe for development or redevelopment or for bare land only. It is used to determine the price of the asset undeveloped relative to the potential sale price of the completed development.

- **Contractor's/Cost method**

Used for: only those properties not bought and sold on the market and for technical (accounts and statutory) purposes only.

Globally there are a number of different models used. In the UK, there are five recognised methods (above) whereas in the United States and in Germany, they divide this down into only three methods. The principal three methods are Capital Comparison, Investment Method and Depreciated Replacement Cost Methods (Pagourtzi et al ,2003). The addition two UK methods, the Residual Method and the Profits Method, are actually sued in the other markets but are considered to be sub-sets of the Investment Method. Given that the latter two are often used to price specialised property, this paper will use the UK convention of splitting them into five approaches (Hendriks, 2005)

We have already determined that a fundamental valuation model should therefore reflect this thought process of determining the worth of the asset to the potential owner. However, in a market where there are frequent transactions it is possible to observe the level of prices without the need to interpret the underlying fundamentals. Price is determined by comparison. This is the principal "unit of currency" for the Capital Comparison and the Investment Methods both of which are used for the valuation of non- specialised property.

However, the investment method has moved away from modelling the thought processes of the players in the market, and instead assesses the market price of a subject property by reference to observed recent transactions of similar properties in the same area (Pagourtzi et al ,2003). If there are insufficient sales to determine a comparable price and if there is no rent produced because the property is in owner-occupation, then the valuer must determine the price by returning to a detailed market analysis and it is the valuer's role to assess the economic rent for the property from first principles. This is calculated by assessing the potential revenue to be expected each year from the asset, and deducting all other costs of a prudent entrepreneur in realising that cash flow. The residue will be an estimation of the economic rent for the property. The capital price can then be derived by multiplying the annual rent by an appropriate multiplier (Yeo, 2006).

This process reverts to a fundamental analysis of the worth of the property to the business. The economic rent is a derivative of the supply and demand for the final product. The same principle will apply to any type of property where the market price of the property is intrinsically linked to the business carried out within that property. This is the basis of the profits method (Hendrik, 2005).

A further way in which it is possible to estimate the market price of land and property is the contractor's method or the replacement cost method. If the property being priced is so specialised that properties of that nature are rarely sold on the open market, it will be effectively impossible to assess its price by reference to comparable sales of similar properties. Similarly, if there is no rental produced, the investment method will also be inappropriate. The profits method could be applied if the property is intrinsically linked to the business carried out in the property, however, where that business is one of production (rather than service) it is difficult to determine the contribution of the property to the overall usage (Pagourtzi et al ,2003).

Thus, once again, the valuer must revert to understand the thought process of the user of the building. Here the nature of the business is so specialised that there are no comparisons, thus, the owner of the building will simply assess the market price of the building by reference to its replacement cost.

How much would it cost to replace the property, if the business were deprived of its use? In simple terms, market price will equate to reconstruction costs (Yeo,2006). The valuer will assess the market price of the raw land (by reference to comparable land prices in an appropriate alternative use), add to this price the cost of rebuilding a new building which could perform the function of the existing structure and from this then make subjective adjustments to allow for the obsolescence and depreciation of the existing building relative to the new hypothetical unit. It is reasonable to assume that this mirrors the thought process of the owner-occupier and thus should be viewed as a valid and rational method of valuation. This is the Contractor's or Cost method (Pagourtzi et al ,2003).

Thus the valuer has the choice of a number of methods and the method used will be a reflection of the available information in the market place. Generally the less information, in the form of comparable sales, the more the valuer will incline to use a model that reflects the role of property as the asset to the business. These types of property tend to be referred to as Specialised Property. Conversely, where there is a lot of comparable transaction data (either in the form of capital price and/or rents/yields) then the valuer will price without reference to the original thought process of the occupier. They take "second-hand" information from comparable and interpret this information within the context of the current market to estimate the price of the subject property. This is used for non-specialised properties (Pagourtzi et al ,2003).

The type of property that would be referred to as specialised are those properties where there is insufficient market data to price them by some form of comparison. The assumption with all valuations of specialised buildings is that they are to be priced on the assumption that the existing use of the building will continue. On this basis, there are a number of assets that could be described as specialised. These may be (Pagourtzi et al ,2003):

- **Agricultural Land**

Although, in its purest form, agricultural land can be priced by comparison often the market is distorted by governmental policy and the price of the land may relate to the payments that are made in the form of grants and set-asides or quota allocations. As such, the price is determined on an Accounts or Profits method.

- **Telecommunications**

This may incorporate a whole host of facilities. Aerial masts are now so common that comparative valuations are now the norm. Whist, cabling, overhead wiring and relay or booster sites may, in the absence of comparison, is priced by reference to their contribution to the business. As such, their price is determined on an Accounts or Profits method.

- **Mineral Extraction**

This is a classic case of land as a factor of production. The land is the core element of the business and as such the price of the land is based on the likely profits arising from the extraction of the mineral(s) in the ground relative to the costs of extraction. As such, the land price is determined on an Accounts or Profits method. Alternatively, it is possible that a Residual approach could be adopted, which is a simple variation on the Accounts basis.

- **Land Fill**

As this is the reverse of the above, Mineral Extraction, then it follows that the same thought process will apply. Except in this case, profits are generated by what you can put into the ground not take out. Once again, the land is core to the business and the appropriate method will be the Accounts or Profits method.

- **Bars and Restaurants**

In many countries, the sale of bars and restaurants has become commonplace and as such there can be sufficient comparable information available for it to be priced by either the Comparable or Investment methods. However, in areas where there is a paucity of comparables, then the valuer needs to resort to an analysis the likely profits arising from the use of the building as a leisure business from the sale of food and drink. As such, the property price is determined on an Accounts or Profits method.

- **Hotels**

Another leisure-type property where the building is integral to the business. The room charge is only one component to the revenue producing potential of a hotel. Generally, the larger the hotel, the more variation in the ways in which they generate income. They can offer food, drink and entertainment. But many of them also offer conference facilities, health clubs and swimming pools. All of which generate additional, and often substantial, income. Once again the appropriate valuation method will be the Accounts or Profits method.

- **Leisure Properties**

An all-encompassing heading to cover health clubs, Tennis(Private) courts, swimming pools, football pitches, golf clubs, athletic clubs and the like. Some of these are now sold sufficiently often to generate comparable allowing them to be priced by either the Comparable or Investment methods. But, as with hotels, it is more normal to view the property associated with the business as an asset to generate income by changing a market price (which may be high to reflect exclusivity) for its use and as such the most common valuation method will be the Accounts or Profits method

Most local or municipal authorities have a brief to provide (Public) leisure facilities to the general public and generally at a subsidised price. As such, they are non-profit making organisations and thus the use of an Accounts or Profits method would be inappropriate. In these cases, the only way in which price can be assessed is by reference to the replacement cost of the building. And thus the Contractor's or Cost method should be used.

- **Care/Nursing Homes**

As with leisure properties there is a distinct split in the market between private and public nursing homes. The former are priced as income -generating properties by the Accounts or Profits method. The latter, the public nursing/care homes, are non-profit organisations and will be priced by the Contractor's or Cost method.

- **Development Property**

Development property is on the cusp between specialised and non-specialised property. Obviously, the end use of the completed development may be either a specialised or non- specialised use and as such the calculation of the completed development price might, in the case of specialised property, rely upon a Profits or Contractor's method. However, the overall method adopted to determine the land/property price in its existing state will be the Residual method.

- **Petrol Stations**

Petrol stations are income-generating business and as such they are priced by the Accounts or Profits method. In this section, we have reviewed the methods that have been used for estimating real estate property's price for specialised property. The underlying requirement is to estimate market price. The role of the valuer is to choose the method that is the best model to achieve this objective. A valuer must work with the recognised techniques. In the case of specialised property, these are methods that go back to analysing price from first principles by identifying the price of the property to the business or potential development of a land. With a plethora of approaches and (Yeo, 2006) considered flood- affected properties, innovative valuation approaches or tweaking of current methods are needed to appraise flood-affected properties, fairly.

3.7 Experimental 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 Valuers, direct market comparison backed up by gut feel (Clark et al., 1994).

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 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.

3.8 Repeat Sales Method

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 location *l* at time period *t* is

$$\boldsymbol{ln\, P_{i,l,t} = \sum_{j=1}^{J} \beta_j \, lnX_{j,l,i,t} + \sum_{k=1}^{K} \gamma_k C_{k,l,t} + e_{i,l,t}} \quad (\boldsymbol{Equation\ 3.5})$$

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}.
γ_k= vector of coefficients representing the elasticity of price with respect to the matrix of the number of houses located in different flood category k where k= f(floodB,floodC,floodD, floodE), location and time
ε_{ilt}, the error term is distributed mean 0 and variance σ^2

This adaptation of the standard cross-sectional hedonic model combines the data for the number of houses located in different flood categories, within the same location at a particular time.

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 consumers' 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.

3.9 Contingent Valuation method

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 price 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.

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 price 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-à-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 price 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 Malaysia 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 price 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). Hence, with these viewpoints in mind, no survey work was done for this current research exercise but will be implemented in future research journal.

4.0 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 price 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 price 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.

This chapter has also outlined some relevant aspects of buying and selling residential property in Malaysia. 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 price 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 methodological 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 price 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 Malaysian property scene. 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 mean 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 price. 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 this allows for generalisation of findings.

Hedonic model examines the effect of characteristics of goods on their prices. This research analyses the effect of flooding on house prices in Malaysia. Hedonic regression model is employed in the analysis. Log linear form is used in this study. Ordinary least square method is employed in estimating the hedonic model. Montz (1993) and Bin and Kruse (2006), inter alia, in analysing the environmental impacts on house prices use hedonic price model.

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 FOUR

ANALYSIS OF COEVAL 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 coeval 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 gravity of evidence argument proposed by Freeman (1979) suggests that some indication of the impact of flooding on residential house prices might reasonably be garnered 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 price.

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

4.2 International studies on flooding: analyses

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 South-east Asia were sought but proved elusive. When interpreting the results from the research to date, and particularly its relevance to the Malaysian residential property market, 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 Malaysia where there will be ad hoc discovery of flood risk.

4.2.1 UK studies

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 price, 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 price 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 price of between 5-15% if insurance were available but stressed the lack of knowledge among the respondents. There was consensus that property prices 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 price 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 price 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 its 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.

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 depression in house prices.

The long-dominant neoclassical paradigm in housing economics for conceptualising the relationship between house prices and environmental disamenities has been hedonic theory (Harrison et al., 2001; Rosen, 1974). Hedonic theory implicitly assumes that the household will choose a dwelling that maximises expected utility, wherein the various attributes of the dwelling and environs are assessed in evaluating utility. The rational decision maker should be willing to pay a premium to avoid flood hazards, the amount depending on the perceived expected value of utility lost from floods. This differential premium across properties varying in their flood hazards should be fully capitalised into house prices insofar as information about the frequency and severity of flooding associated with each location is accurate and widely known (MacDonald et al., 1987). Thus, with the exception of transitory post-flooding price reductions while homes are being repaired, the hedonic approach would predict no temporal variation in home prices as a result of flood occurrences in an efficient market.

Tobin and colleagues (Tobin & Newton, 1986; Tobin & Montz, 1994) contributed an important advance by arguing that utility reduction from flooding (and thus home price) depends on the spatial, temporal and hydrological aspects of the flood. They suggested that there are different temporal profiles depicting flood impacts on home prices, depending on how often floods occur compared to the time required to restore the property to pre-flood utility. At one extreme with rare flooding, house prices fall immediately after a flood event and then recover fully after repairs and remain at this higher level until the next rare flood. In this case, over the long-term, neither past nor prospective flood damages are capitalised. At the other extreme with flooding occurring so frequently that housing utility has insufficient time to recover much if at all, house prices remain low.

In this case, flood damages have been almost completely capitalised into house prices ex post facto. Cases of intermediate flood frequencies yield in their formulation an inter-temporal housing price pattern with incomplete and imperfect capitalisation of flood damages.

Although the Tobin et al. approach offers a useful perspective, it is under-developed. First, their model appears to assume no market foresight regarding floods, hence prices capture only actual losses of utility, not future risks. Second, their model does not distinguish between risk-adjusted house prices and observed (actual) house prices or their interrelationship, yielding two additional ambiguities. First, it is unclear whether the price fall following a flood described in their model is due entirely to the physical damage to the property or because of inadequate capitalisation.

The former allows one to retain the neoclassical assumption that risk-adjusted prices do not diverge from observed prices, while the latter assumes that observed prices drifted away from their risk-adjusted levels prior to the flood.

Second, their model suggests that capitalisation occurs if frequency of flooding is sufficiently high, yet it is not clear whether this means that the housing market is perfectly informed (expected costs of rare floods are so infinitesimally small that the house price effect is indistinguishable from zero) or imperfectly informed (frequent floods are necessary to remind residents of the future risks).

Neither the hedonic nor the Tobin et al. approaches offer convincing explanations for the findings of the statistical and survey literature. Some statistical studies have found that home prices are discounted for substantial periods in locations with high flood risks (Barnard, 1978; Bartosova et al., 1999; Bin et al., 2008; Donnelly, 1989; Harrison et al., 2001; Speyrer & Ragas, 1991). Other studies have observed negligible price effects (Bialaszewski & Newsome, 1990; Zimmerman, 1979). Nevertheless, a consensus has been reached that a price discount due to flood risks, if any, is greater after a flood than before (Bartosova et al., 1999; Bin & Polasky, 2004; Eves, 2002).

Proponents of the efficient market models may suggest that this finding only reflects transitory adjustments while repairs are underway on damaged properties. Indeed, several studies have suggested relatively rapid rebounds of housing prices in the wake of floods (Babcock & Mitchell, 1980; Lamond & Proverbs, 2006; Montz, 1992). It is more plausible to posit that these findings indicate imperfect capitalisation due to imperfect risk assessment, as a flood informs people about true flood risks.

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

Year	Authors	Place	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
1989	Shilling et al	Baton Rouge, Louisiana	-8%
1989	Donnelly La Crosse	Wisconsin	-12%

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 Local and international studies on amenities and disamenities

In Malaysia 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 effects of overhead power lines have on nearby houses (Anuar, 2005). Azhari (1991) argued that the variety of floor finishes in Malaysian houses suggest that floor finishes has an influence on prices as this has been practiced by many Valuers when undertaking property valuation exercises. 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.

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.

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.

4.4 Methodological review of 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 misspecification 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 author 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. 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 i.e. 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	Appearences	No. of times positive	No. of times negative	No of time not significant
Lot size	42	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	5
No of storeys	13	4	7	2
No. of bathrooms	40	34	1	5
No of bedrooms	40	21	9	10
Air-conditioning	37	34	1	2
Distance	15	5	5	5
Time of market exposure	18	1	8	9
Time trend	13	2	3	8

A similar analysis of the sixteen (16) Malaysian 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 Malaysian housing studies analysed and it can be seen that the majority are structural.

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 Malaysia hedonic studies

Variables	Number of occurences	In Sirman's top twenty
House type	14	No
Number of bedrooms	10	Yes
Floor area of property	10	Yes
Age	8	Yes
Number of bathrooms	8	No
Central business district distance	6	No
Neighborhood dummy	8	No

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 flood zone 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. of times positive	No. of times negative	No of 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 Malaysia 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.

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 learnt

The above examples of research examining the influence of flooding on property price illustrate some of the issues that will face the proposed research in Malaysia. 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 price impact of flood as examples in the literatures 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 RM50 million (AUS) and subsequently the flood defences were raised to increase future protection. Lambley and Cordery (1997) compared the average house price 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 price.

Two years after the flood, property prices 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 prices which are discussed and developed further in a later chapter.

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 Malaysian market, 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.

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 Malaysia, 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 .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.

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 prices 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 than 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 floods 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 per cent 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 Flood insurance's influence upon ΔP_D

Few researchers have included flood insurance premium as an independent variable in hedonic price models, let alone specify the hedonic model to account for the complexity of NFIP. Shilling, Simans and Benjamin [1989] created a log-linear hedonic price model with insurance premium as an independent variable.

The coefficient for this variable was significant and negative as hypothesized. Since they did not report descriptive statistics, it is not possible to determine how much of the insurance was subsidized. Thunberg and Shabman (1991) formed a log-linear model with a dummy variable representing whether a property owner had or did not have flood insurance, and a dependent variable of willingness-to-pay for flood control (rather than property price). Their data were based on contingent valuation. They found the coefficient for the flood insurance dummy variable to be significant and of the right sign. Based on this result, they suggest that people are willing to purchase flood insurance over flood control. Griffith (1994) found that property prices dropped when the requirement to purchase insurance was enforced by the lending institution of the mortgage.

Skantz and Strickland (1987) found with a log-linear model that "when insurance rates increased markedly (400%) approximately one year later [after a flood], the higher rates are capitalized into home prices and prices fall." Prior to the flood, insurance rates were so highly subsidized that the average annual premium was only RM14 for properties in the flooded neighbourhood in question.

Speyrer and Ragas (1991) created a spline regression model that included an insurance cost index (ratio of unit premium/unit price divided by ratio of average premium/average price). A spline regression model addresses the spatial distribution of property prices.[2] Through a two-dimensional Cartesian plot of the spline model, they identified neighbourhoods where house prices were lower due to flood risk. They suggest that the discount was due primarily to capitalization of insurance premiums, but also due to the inconvenience of flooding (intangible risk-averse costs).

In summary, these studies generally show insurance premiums are capitalized into property prices. However, these studies cannot be used as evidence to support the assumption that there is a discount for primary flood damages. The first reason is only one of them distinguishes between subsidized and actuarial rates. The second reason, and the more important reason, is NFIP participation rates are low nationally, about 25% in 1990 (Holway and Burby 1990). Further evidence would need to be gathered to demonstrate whether the remaining uninsured floodplain properties discount for flood risk.

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[2] A spline regression uses “Bezier Spline” curves to capture locational variation. The regression equation takes the form of a third-order polynomial which is how a spline curve can be defined. The location of each property is denoted by Cartesian coordinates. The purpose of spline regression is to generate a surface which shows where property values are depressed due to some locational factor such as flood risk.

4.7 The effect of risk attitudes upon ΔP_L

A risk adverse person would discount more than ΔP_D because of the anxiety and/or inconvenience caused by flood hazard. Although information on flood risk may be available to consumers, Thunberg and Shabman [1991], and Griffith [1994] have hypothesized that consumers may have a difficult time assimilating the effect of rare events into their willingness-to-pay. As a result ΔP_L may be significant for frequently flooded areas, on the order of 10 to 25 year flood frequencies, while ΔP_L may be small for rarer flood events.

MacDonald *et al.* (1987) found evidence that consumers are risk averse toward flood risk. They carried out a contingent valuation study and found that ΔP_L was greater than the present worth of actuarial insurance L premiums, which generally is equivalent to ΔP_D . In other words, they concluded that consumers place a cost D for flood risk aside from actual expected damages. Their study was based on contingent valuation rather than actual house sales. They also found risk adverse attitudes were more pronounced among average to above average priced properties. They hypothesized those owners of above average priced homes price security from floods. Meanwhile, some owners of below average priced homes may be less risk averse, because they may perceive that repairs they can make after a flood event will enhance the price of their homes beyond what it was before the flood. In addition, Thunberg and Shabman [1991] found with hedonic price model evidence that individuals are willing to pay for flood protection to reduce expected flood damages and to reduce anxiety and community disruption.

4.8 Summary

The important question of whether a discount due to primary flood damage exists could not be answered from the literature review. Most of the existing studies do not attempt to separate the discount due to primary flood damage from the more general discount due to floodplain location. Even then, the studies on a discount for floodplain location, ΔP_L, are inconclusive. Nevertheless the literature review revealed the complexity of $_L$ hedonic prices for floodplain properties.

More than eight of the studies used a model that employed the dummy variable of location in or out of the 100- year floodplain. Half of the studies show a discount for location (in the floodplain) exists, and half do not. These studies are inconclusive and expected to be so because this model implies that the flood risk is constant across the 100-year[3] floodplain. Flood risk, and therefore any corresponding discount, will vary among properties deep in the floodplain, say within the 25-year floodplain, and those just within the 100-year floodplain.

[3] A 10 year flood has a 10 percent probability of occurring in any given year, a 50 year event a 2% probabaility, a 100 year event a 1% probability, and a 500 year event a 0.2% probability. While unlikely, it is possible to have two 100 or even 500 year floods within years or months of each other.

Four studies examined the effect of flood insurance premiums. All four found property prices discounted by the capitalized price of flood insurance premiums (only where premiums actually are paid). However, none of these studies accounted for the complexity of the NFIP, in particular the relative effects of subsidized versus actuarial rates. Only about a fourth of property owners purchase flood insurance, so it cannot be assumed that all property owners discount for primary flood damages.

It is not clear whether consumers are risk averse or risk seeking. Two studies hypothesized that consumers may have a difficult time assimilating the effect of rare events into their willingness-to-pay. A contingent valuation study suggests that higher-income consumers may be more risk averse than lower-income consumers.

Three sets of researchers studied property prices in the period following a flood. None found a discount in price over the long-term. One study observed a drop in prices followed by a recovery, with the recovery being slower for houses with more frequent flooding. None of these studies included data on the physical condition of houses, all of which were damaged and then repaired.

The results presented showed no existing study comes close to the complex modelling needed to measure a discount for primary flood damages let alone one for floodplain location. The results, however, suggest ways to improve hedonic price models and understanding of the price of floodplain properties. In particular, such studies should address floodplain location at finer increments than the 100-year flood zone, such as the 10, 25, and 50-year flood zones. History of flooding or personal experience with flooding would also be required. Last, because utility functions may vary among income groups, models should be formed from relatively homogeneous markets.

Nevertheless improving hedonic price models to detect ΔP_D would be a considerable task. Data on floodplain attributes is limited. Multiple Listing Service databases do not generally include floodplain attributes, such as access to water and flood proofing. Much of the data is subjective or immeasurable. For example, in measuring nice views of the river, survey takers would have to develop some type of cardinal scale of what are bad, average and good views of the river. It is unlikely that such a subjective scale would be applied consistently across studies let alone within a single study. All the floodplain attributes must be included in the hedonic model. If variables are missing, the magnitude of ΔP_D will be uncertain. Furthermore, if the missing variables are correlated with floodplain location (i.e., vary across the floodplain), then ΔP_D cannot be attributed solely to primary flood damages. It seems unlikely that survey takers and study managers would be able to identify all the floodplain attributes that property owners considered in their purchasing decisions.

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 price relative to non-flooded.

This could be explained by the impact of reinstatement resulting in betterment. The impact of flooding on property prices in Malaysia 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 Malaysia easily accessible detailed data on property transactions are not as readily available as in other markets. This has led to the situation where all previous 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 Malaysian 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.

Availability and cost of insurance were repeatedly highlighted in many international studies when conducting research into flood impacts on property price. Most of these studies mentioned insurance as a key issue. However the inclusion of insurance into either theoretical or empirical models is not a straightforward matter exacerbated by almost non-existence of data and studies on flood insurance in Malaysia. As such, the mechanism by which insurance could potentially influence property price is not clear.

CHAPTER FIVE

CONCEPTUAL MODEL DEVELOPMENT

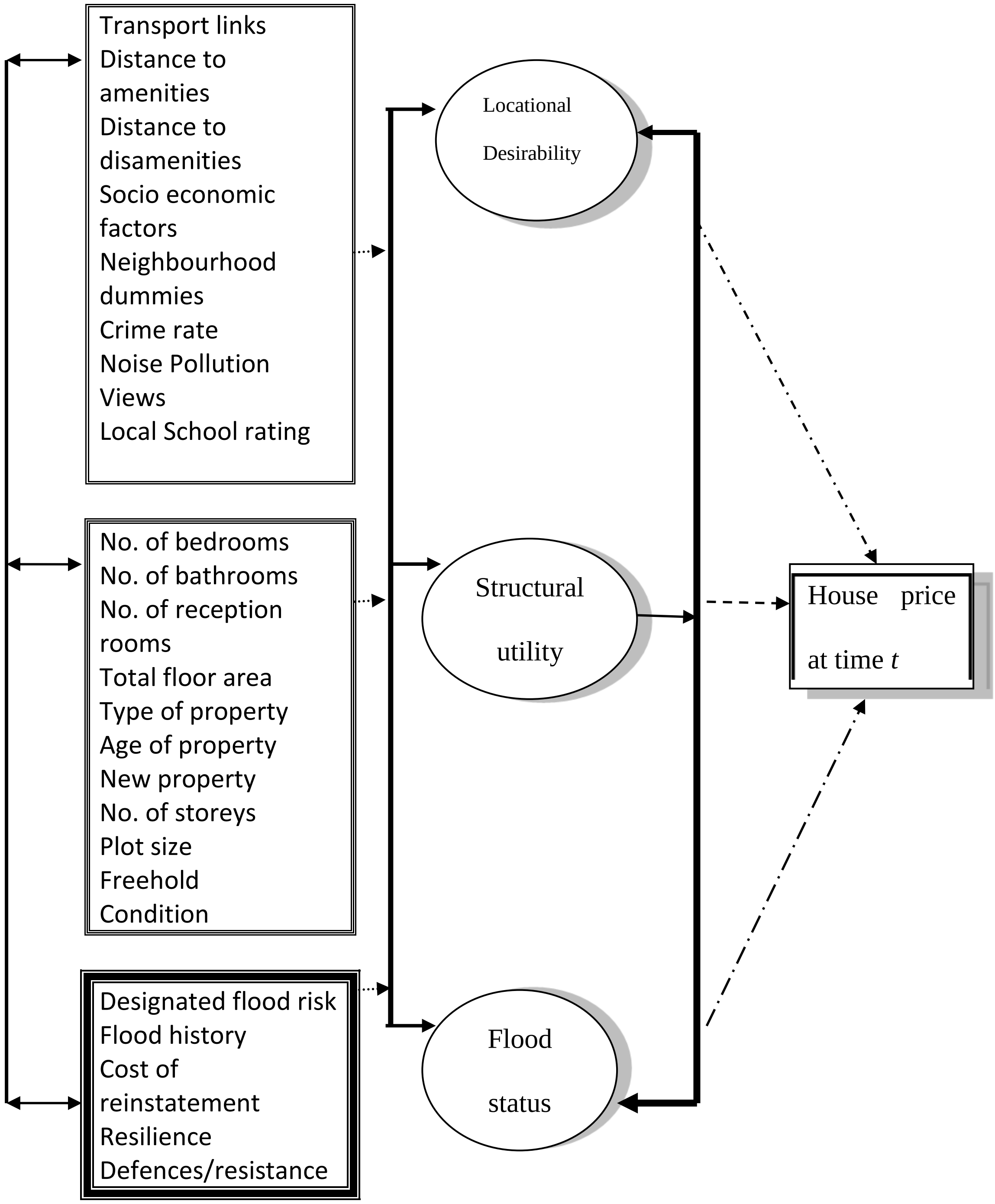
5.1 Introduction

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 Malaysian market. The conceptual model includes a natural log price model, the concept of the two dimensional nature of the flood status of a property. The hedonic specification adapted for flood impact measurement and for the Malaysian market is presented in 5.2. Contemporary theories of flood impact on property prices in 5.3 and the various hypotheses on causes of discount due to flood insurance in 5.4. Section 5.5 describes the two dimensional nature of flood risk.

5.2 Hedonic model: Malaysian market

Using the theoretical hedonic framework for house prices as presented in Rosen (1974) and others a new adaptation for the local market can be presented. Figure 5-1 shows a representation of a generic hedonic cross-sectional model adapted with the addition of flood status variables. Locational and environmental variables have been combined into “locational desirability” and the flood status is separated. The selection of variables to be examined hinges upon the aims and objectives to be met; it is unnecessary to select the gamut of variables presented.

Figure 5-1: A generic hedonic specification for the Malaysian market including flood variables



5.3 Contemporary theories of flood impact on property prices

Tobin and Newton (1986) present a theoretical framework for the impact of flood event on land price. Integrating flood hazard research and urban economics literature they present charts of land price 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 price 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 Malaysian examples, can form the basis of prediction of the impact of future flooding events. Figure 5-2 shows a basic profile where a one-off flood event temporarily depresses prices and then over time the price level recovers.

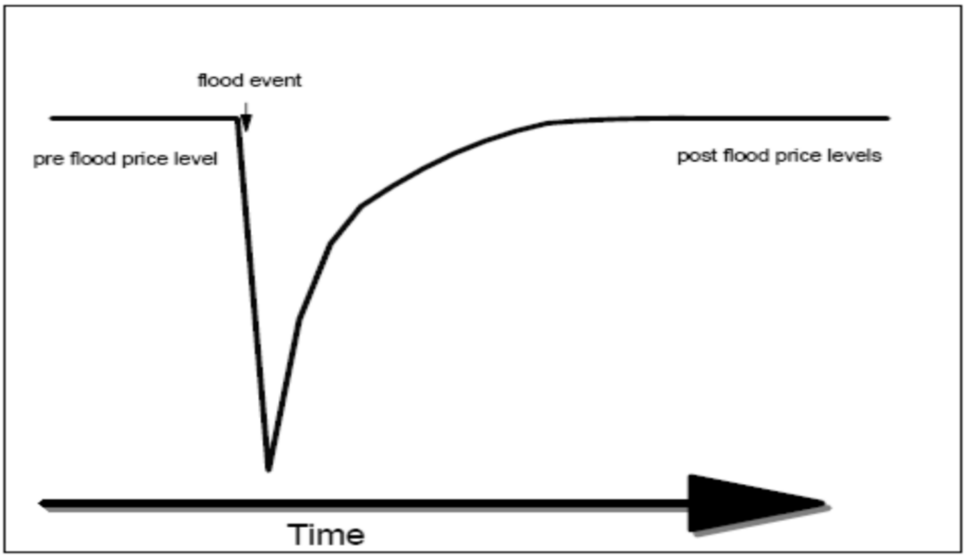


Figure 5-2: Theoretical impact profile 1 - One off or infrequent flood

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 intervals 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 5-3 shows this theoretical profile.

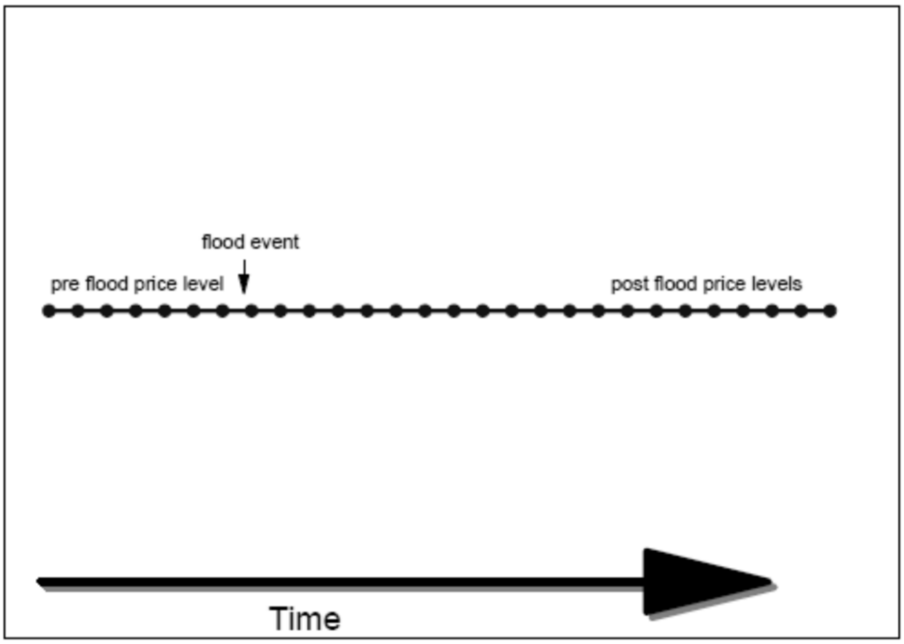


Figure 5-3: Theoretical impact profile 2 - Flood effect permanently capitalized

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 floods 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 5-4 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.

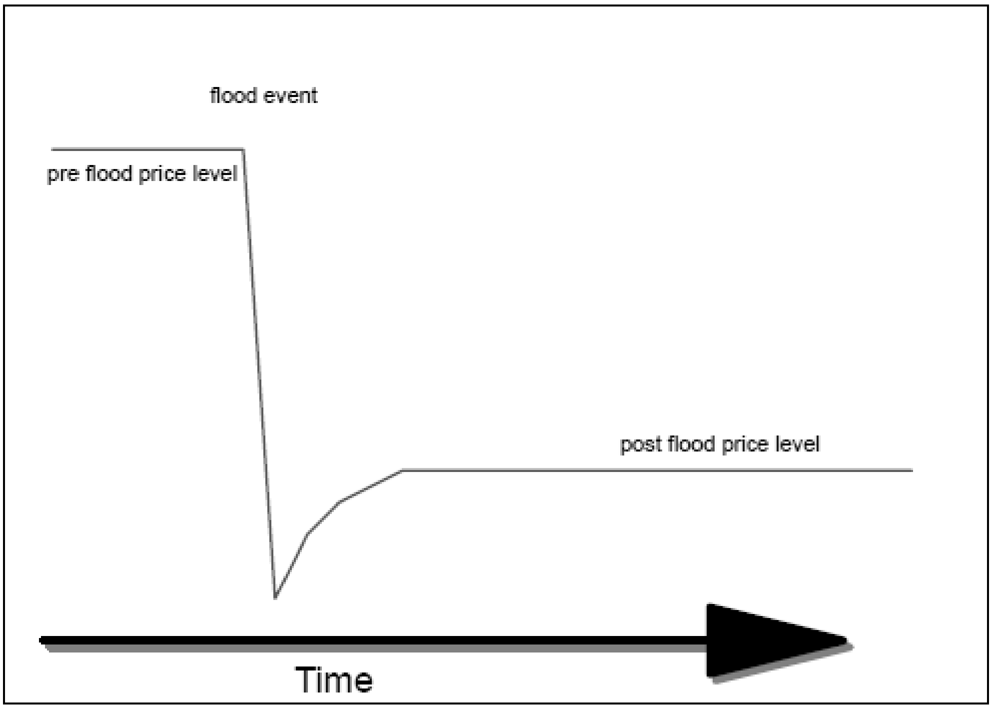


Figure 5-4: Theoretical impact profile 3 - Flood effect becoming capitalized

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 Malaysia inundated in the 2006 and 2007 floods because they occurred after a prolonged dry period of about two decades.

The final profile (Figure 5-5) is included, despite being counter-intuitive because it was observed by Montz (1992) and by Tobin and Montz (1994). Here, post-flood prices 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.

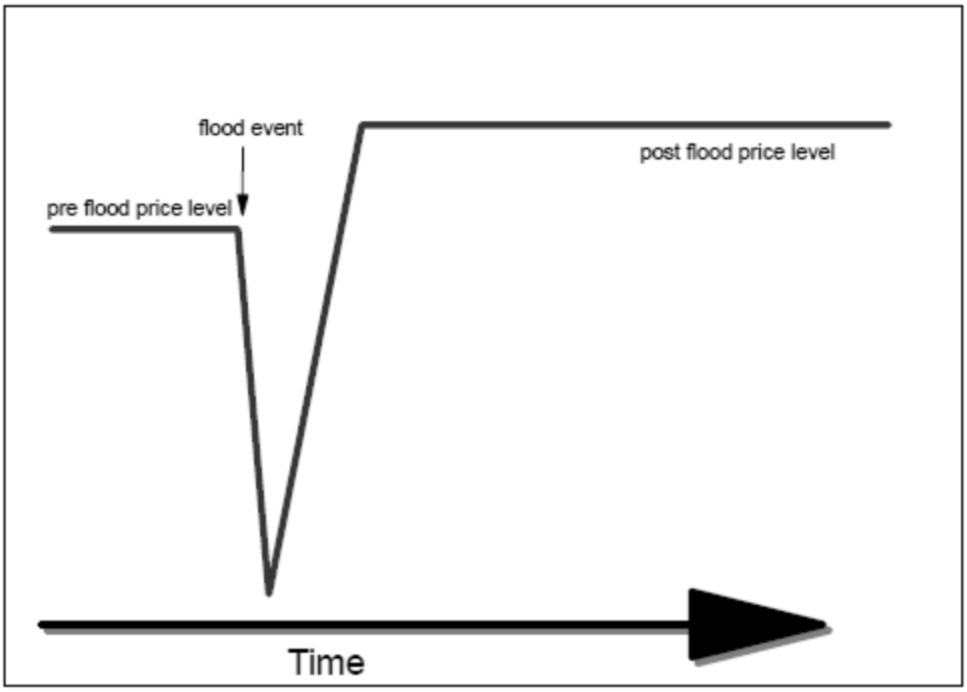


Figure 5-5: Theoretical impact profile 4-Post-flood prices of flooded homes were seen to improve relative to non-flooded comparatives

These theoretical profiles, which have been derived from the international literature, demonstrate the necessity of considering the temporal dimension in any study of the Malaysian market. They also suggest that the flood impacts on property prices in Malaysian 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 serve 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.

5.4 Various hypotheses on causes of discount due to flood insurance

The subject matter on flood insurance is inextricably linked to the whole fabric of research on this theme. As mentioned, currently Malaysia has no government- run flood insurance system akin to UK, US or Australia. But it is deemed worthwhile to explore further on this subject matter. As it is hoped, should such insurance system be established in Malaysia, the merits, demerits and mechanics pertaining to the current flood insurance system, this expansive literature review can serve as a beacon and reference point. Further, with knowledge glean, the future flood insurance regime in Malaysia can not only avoid any detected pitfalls but establish a more polish and people centric policies.

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 price 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 price.’

The American hypothesis: High flood insurance premiums are a disincentive to purchase and result in a continuous loss of price 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 Malaysia. 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 alongside 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, for example, 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 an 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, and 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.

5.5 The two dimensional nature of flood risk

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 5-6 shows the two dimensional space into which flood risk status may fall.

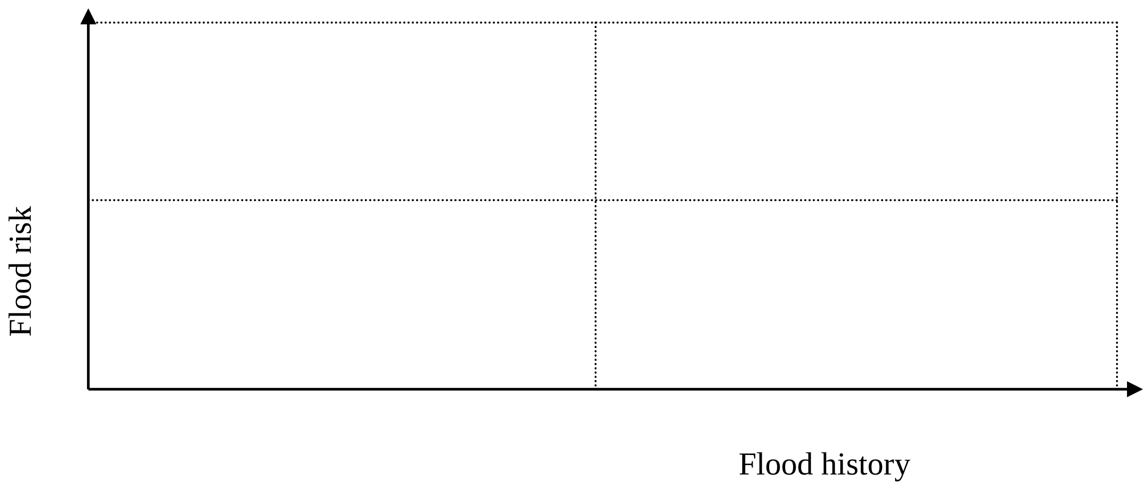


Figure 5-6: The two dimensional nature of flood status

Under the assumption that a buyer can access information regarding these two factors in advance and that there are only two levels of each factor then there are four possible variants of flood status. The best case scenario would be low risk and no flood. The worst case scenario would be high risk, and frequently flooded. If there are more levels of each factor the possibilities multiply quite quickly.

5.6 Summary

This chapter has presented the methodological development necessary for the measurement of flood impact on house prices in the Malaysian market. Two developments, a time-varying nature and an outline to measure the two dimensions of flood status have been described.

Different 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 research which examines the uncertain nature of any flood situation.

This chapter marks the end of the theoretical development of the outline to be employed for the empirical research. The previous chapters have presented the extensive literature review and contained methodological and contextual analysis. The way in which this new framework has been implemented is now the subject of Chapter 6 which will include the mechanics of data capture and the choice of locations for study.

CHAPTER SIX

EMPIRICAL RESEARCH DESIGN AND METHODS

6.1 Introduction

The output from the literature reviews in chapters 2 to 5 led to the development of conceptual models, described in Chapter 5, for the measurement of the impacts of flooding on house prices. Chapter 5 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 6.2 outlines the research strategy which is based on analysis of sites flooded during the monsoon induced December 2006 flooding. Section 6.3 describes the 2006 flood event and section 6.4 details the selection of case study locations. The following two sections describe the data capture for the empirical study: secondary data in section 6.5. The data analysis and model building phase is outlined in section 6.6 and the basis for model comparison is set out in section 6.7.

6.2 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 program with secondary data sources for property transaction and flood designation categories.

6.2.1 Quantitative transaction based analysis

The underlying strategy for the empirical stage of the research program 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 price 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 and hedonic regression method were 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 Malaysia 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.

6.2.2 Bottom-up approach

A prominent conclusion from the literature review was that the impact of flooding on property price differs widely dependent upon local circumstances, for example flood history. 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.

6.2.3 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 judgments about the price of these novel approaches in measuring the impacts of flooding in Malaysia. It also shed light on whether these methods could be employed elsewhere and in other circumstances.

6.3 The December 2006 flood event

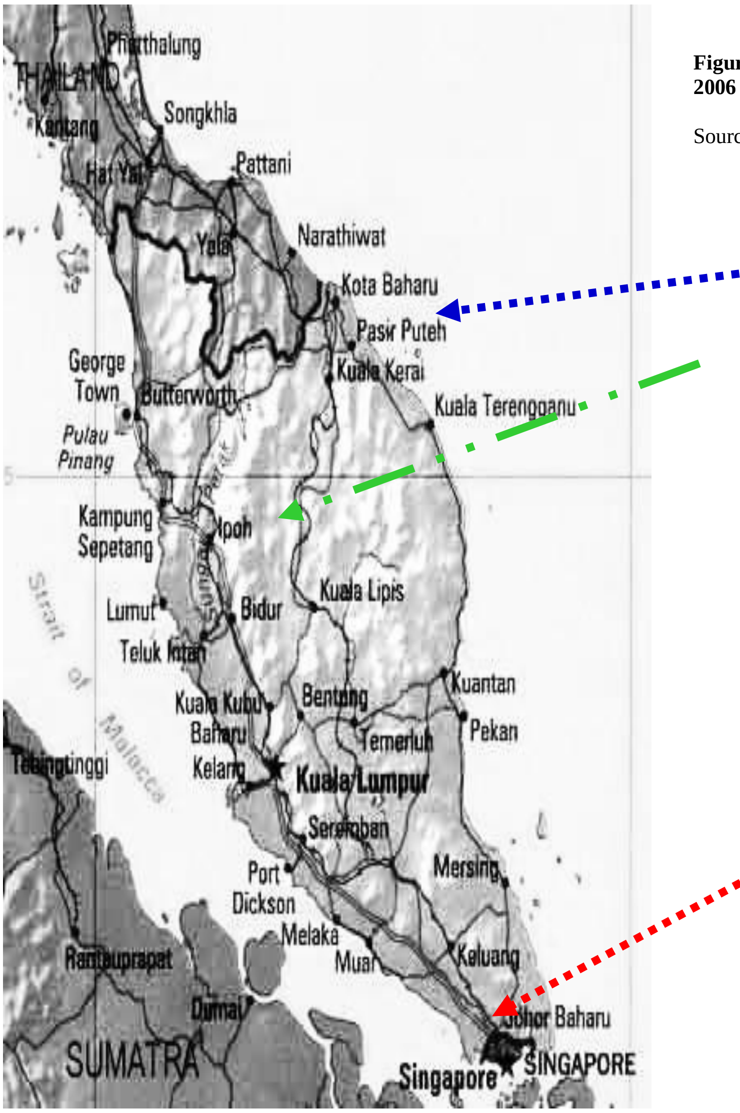
The flood sites included in the empirical stage of the research were selected from locations which were flooded or narrowly avoided flooding during the December 2006 flood event. This section briefly describes this event and its national impact.

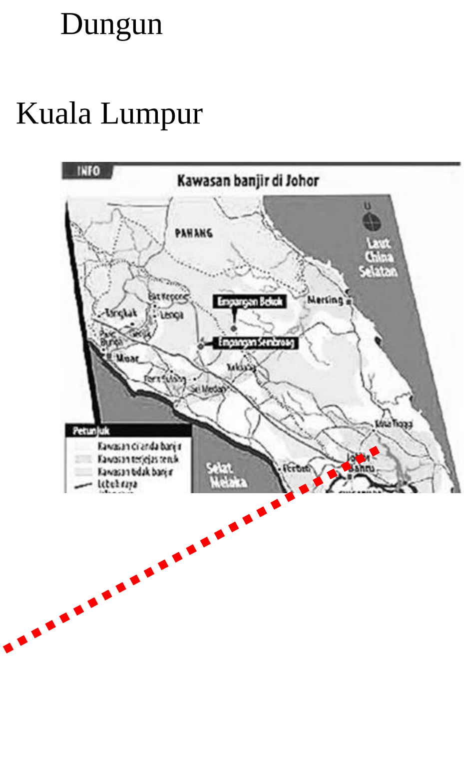
The floods were caused by above average rainfall, which was attributed to Typhoon Utor which had hit the Philippines and Vietnam a few days earlier (Tangang et al., 2008). By the third week of January 2007, Johor was hit by a larger flood. Singapore and certain parts of Indonesia were flooded due to the same typhoon.

Throughout the week of December 18 in 2006, a series of floods hit Johor, Malacca, Dungun and Kuala Lumpur (see Figure 6.1). During this period, these eastern, southern and central Malaysian states, along with Singapore, experienced abnormal rainfall which resulted in massive floods. The rainfall recorded in the city of Johor Bahru on December 19 amounts to 289mm when the annual rainfall of the city alone is 2400mm (Ibid, 2008). The flooding began when torrential downpours since Sunday caused rivers and dams to overflow.

Figure 6-1 : Map of sites affected during the December 2006 flood event.

Sources: JPSM, The Star,





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 Malaysian 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 house prices to be assessed.

6.4 Case study site selection

Selection of the analysis sites from the 200 data sets during the 2006 event was based on the need to represent the widest possible variation both geographical and flood topology 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 summarized in Table 6-1.

Table 6-1: Selected locations for empirical analysis

LOCATION	DEFENCES	SOURCE	FLOOD STATUS	REGION	ELEVATION
Dungun	No protection	Main river	Flooded	East Coast	Coastal
Kuala Lumpur	Labyrinth of storm drains, reservoir	Tributary rivers	Slightly inundated	Central	Approx. 40 m above sea level; valley

The geographical spread of the selected sites ranged from east coast to the capital of Malaysia, Kuala Lumpur. 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 Kuala Terengganu and Kuala Lumpur with little or no flood history till the December 2006 event such as Kota Tinggi, Johor.

In a nutshell, these two cities sit in the two extreme ends of the flood-prone cities spectrum. Dungun, being a coastal city, is no stranger to annual inundation while Kota Damansara in Kuala Lumpur, is only affected when storm drains belch out rain onto the streets during sudden and heavy downpour. Both of these cities are disadvantaged due to their location, Dungun sits near the coast and Kuala Lumpur is located in Klang Valley, Hence it would be interesting to observe how these two cities' real estate market react once inundation sets in.

6.5 Secondary data

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 JPPH. Flood history information was gained from a multitude of sources.

6.5.1 JPPH data

Data on all property transactions requiring registration are collected by the JPPH on behalf of Government of Malaysia. The registry holds details of title, covenants, and plot details for residential and commercial property in Malaysia.

Details of the dataset are tabulated in Table 6-2. It specifically excludes all commercial transactions, transactions before April 2000, and transactions likely to be completed below market price for example ‘right to buy’, short leasehold, gifts and compulsory purchase orders. These data are the most complete record of housing transactions in Malaysia but do not include property details such as size of accommodation or condition information.

Table 6-2: JPPH dataset

Data Record	Details
Address	Street, town ,country
Valuation price	RM unadjusted for inflation
Date	Date of valuation
Property type	Landed
Tenure	Freehold , Leasehold
Newbuild	Yes, No

Data were kindly donated by JPPH for the flood locations identified in section 6.4,

6.5.2 Flood history information

The variety of sources used for flood history information was large. Newspaper reports, flood defence scoping reports, crisis management reports, maps, 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.

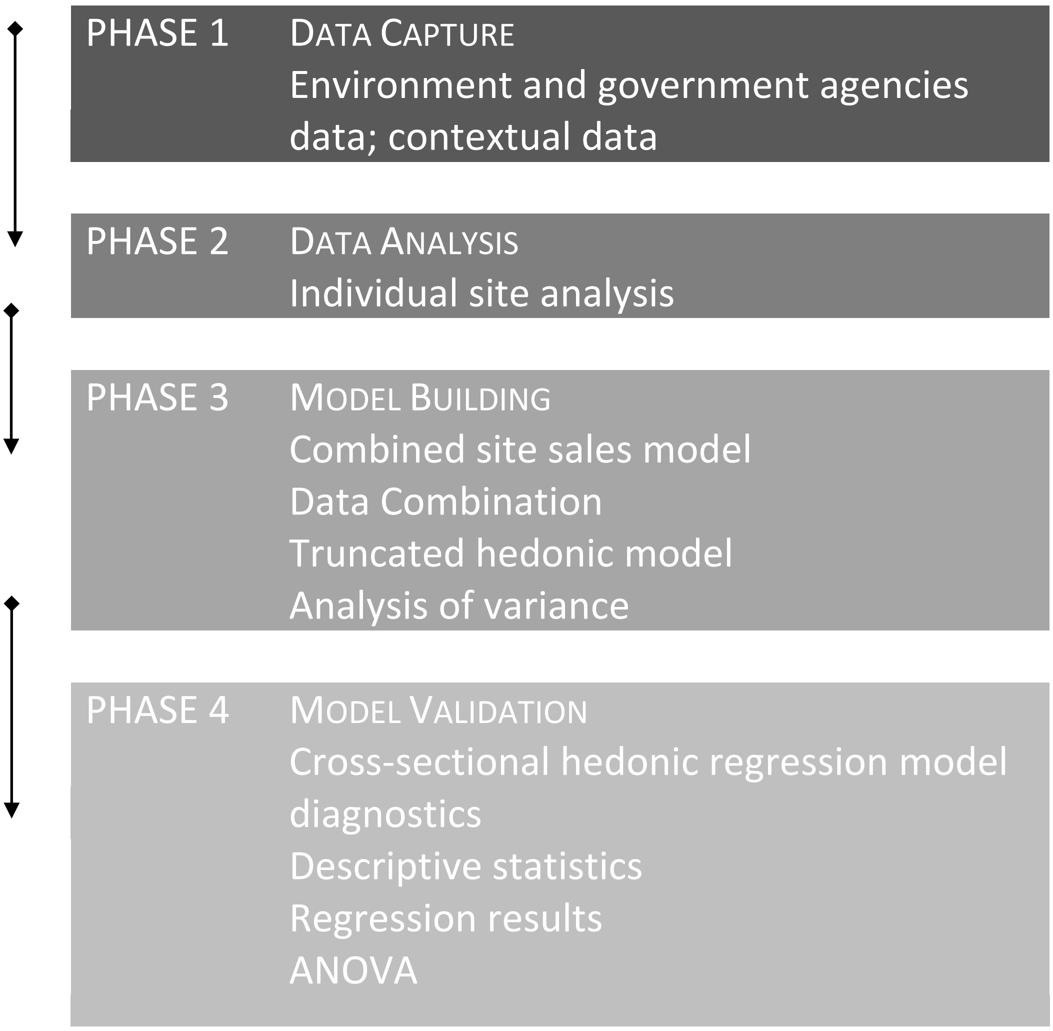
Whereas the quality of the information on price and designated flood risk was the same across flood study sites the flood history information used was the best available for that location and varied between sites.

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 categorize flood history for the selected sites, past frequency of flooding and the presence of flood defences were key variables in this regard. There is no database available which records whether or not a given property has been subject to flooding in the past.

6.6 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 6-2 shows the stages of data capture, data analysis and model building and indicates where the analysis outputs can be found in the remaining chapters. The results from the analysis and models can then be compared to determine the strengths and weaknesses of the approaches.

Figure 6-2 Summary of data analysis and modelling phases



6.6.1 Individual site repeat sales analysis

Chapter 7 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 yield an opportunity to consider each site in isolation which in accordance with the bottom up approach. Finally a temporal evaluation is carried out using floodplain/year combination variables to determine whether there are temporary effects which are significant.

6.6.2 Combined site repeat sales model

Discounted growth rates were calculated using the individual site analyses and these were combined into a model. 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.

6.6.3 Truncated hedonic model

For a subset of locations a truncated hedonic model was constructed. Property details were taken from National Property Information Centre (NAPIC) and locational detail was limited to the survey site. Four models were estimated namely: flooded respondents; non-flooded respondents; all respondents; and all respondents with flood status variables.

6.6.4 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 7 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.

6.7 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 judgment regarding the most appropriate model will be affected.

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.

6.8 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 rationale behind the selection of study sites has been explored and the secondary data sources clarified.

CHAPTER SEVEN

MODEL ESTIMATION

7.1 Introduction

The literature review failed to disclose whether a discount for primary flood damages either exists or does not exist. However, the understanding gained from analysing the literature provided a framework to specifically evaluate primary flood damages. Two case studies were analysed for evidence of discounting for primary flood damages: i) Dungun, Terengganu and ii) Kota Damansara, Kuala Lumpur.

As noted in the earlier chapter, data indicating simply whether a house is in or out of the 100-year flood frequency zone are insufficient to measure the $\Delta \boldsymbol{P_L}$, let alone $\Delta \boldsymbol{P_D}$. The case studies include data on finer increments of flood frequency zones. The Kota Damansara, Kuala Lumpur case study examines the effect of income upon $\Delta \boldsymbol{P_L}$ and the Dungun case study includes data on not only flood frequency but more importantly expected annual flood damages. With the damage dataΔP_L could be compared to the present worth of expected annual flood damage, ***PW (E [FD])***.

As will be discussed, even with these case studies, it is not possible to make broad generalizations. These case studies offer a better understanding of hedonic price modelling for flood risk. Nevertheless, it is extremely difficult to gather sufficient and comprehensive sets of data and to form effective hedonic price models to detect $\Delta \boldsymbol{P_D}$.Because the data were not gathered specifically for this study, they omit important $_D$ information that prevent effective modelling of all the relevant property attributes. In particular, the separation of positive floodplain attributes from negative floodplain attributes, and the effect of subsidized insurance could not be addressed in these case studies.

The integrity of the multiple regression analysis models (MRA) presented here will be established based on the following parameters: the standard error of the residuals, the coefficient of determination and finally the F-test of the analysis of variance (Mun, 2010).

7.2 Case studies

7.2.1 Kota Damansara.

Much of this research was guided by Griffith's 1994 study entitled "The Impact of Mandatory Purchase Requirements for Flood Insurance on Real Estate Markets," which compiled data on residential sales prices, house characteristics including floodplain location by frequency zone, flood insurance, and other traits significant to the real estate market.

The upmarket township of Kota Damansara, a suburb of Kuala Lumpur, is one of most vibrant commercial city of Malaysia. The undergoing development of the area, reclaiming17.66 acres of the total 45.89 acres water retention lake to build 6 blocks of apartment and commercial units will create adverse impacts to the area downstream (Maisarah, Noor Shakilah and Kamaruzzaman, 2007).

Moreover, it is believed that the collapse of a bund in the wetland in 2006 had compounded towards the massive flood situation in other cities located downstream (Ibid, 2007). Flash flood is not new or foreign to the people living in Kuala Lumpur or on the outskirt. They usually experience a few flash floods within a year. Table 7-1 shows flash flood frequency for some selected localities within the study area between 1979 and 2005 based on the Drainage and Irrigation Department's records at Sungai Tua, Sungai Gombak at 16th kilometre, and Genting Kelang stations.

Since flash floods are most frequently associated with violent, convectional storms which tend to be of short duration and are also normally of small areal extent (IASH, 2004), the Drainage and Irrigation Department's recording stations, which are located upstream of the study area, do not actually show the true picture of the frequency of flash flood in Kuala Lumpur area (Mohd Barzani Jumaat ,Mohd Ekhwan , Sahiban and Hafizan (2007) .On the average these areas experience from 3 to 5 flash floods within a year, although the frequency has slightly declined in 2002 (Ibid, 2004)

Table 7-1: Flash flood frequency at selected localities from 1979-2005

Locality	Frequency							
	1979	1981	1984	1989	1995	1998	2002	2005
Kampung Kasipillay and surrounding areas	3	2	5	3	4	3	2	2
Segambut Luar and surroundings	4	2	2	4	5	3	2	2
Damansara, Taman Tun and surroundings	4	3	2	5	4	3	3	1

Source: Drainage and Irrigation Department, Federal Territory 2006

Much of the real estate data for Dungun and Kuala Lumpur were obtained from the Valuation Services Department. For sales made between January 2005 and December 2007, the sales price and house characteristics such as date of closing, square footage, were collected. Data obtained from the Department of Irrigation and Drainage hazard map included flood frequencies, specifically location within zones of probabilities of flooding.

Table 7-1.1: Reported occurrences of flooding in Kuala Lumpur

Reported Occurences of flooding in Kuala Lumpur

Hazard/Geohazard	Area	Flood Frequency (1995-2005)	frequency per year	Guidelines	
flash flood; flood	Kota Damansara	23	2.30	$1.9<f<2.3$	FLOOD C 50-year flood
flash flood; flood	Bangsar	24	2.40	$2.3<f<2.7$	FLOOD D 25-year flood
flash flood; flood	Jln Glenmarie	22	2.20	$1.9<f<2.3$	FLOOD C 50-year flood
flash flood; flood	Lembah Pantai	25	2.50	$2.3<f<2.7$	FLOOD D 25-year flood
flash flood; flood	Tmn Seri Muda	26	2.60	$2.3<f<2.7$	FLOOD D 25-year flood
flash flood; flood	Brickfields	27	2.70	$2.7<f<3.1$	FLOOD D 25-year flood
flash flood; flood	Jln Tun Razak	19	1.90	$1.5<f<1.9$	FLOOD B 100-year flood

adapted from Institute of Hydrology (1999) and Department of Drainage & Irrigation (2006); source LESTARI-UKM

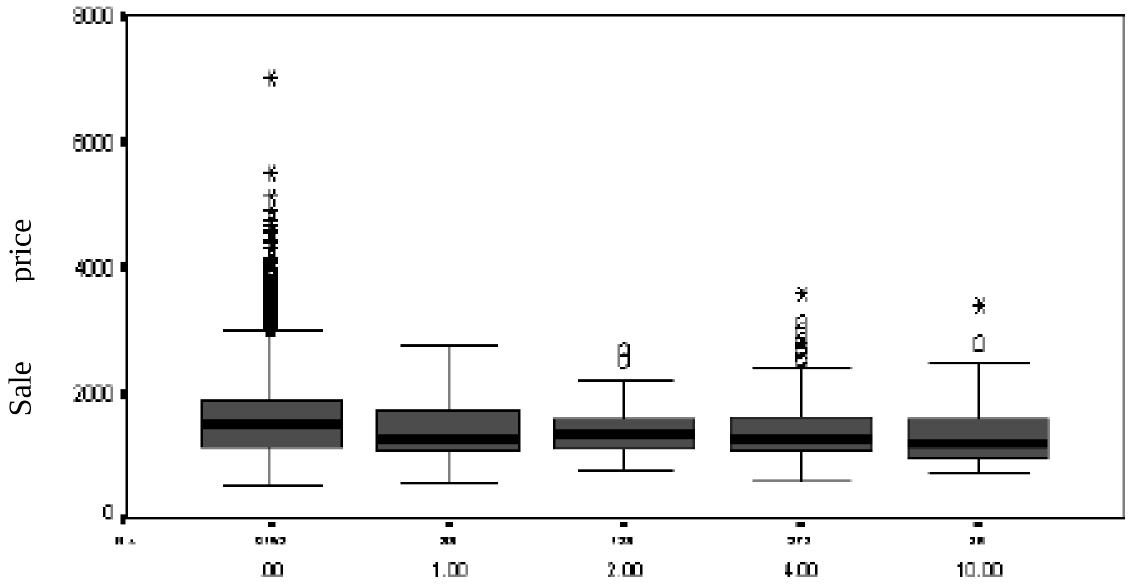
7.2.2 Exploration of the data

Prior to formulation of hedonic regression models, trends in the data which might guide model development were explored. Trends relating the following data fields were examined:

- sale price (ringgit)
- house area (square feet)
- age of house (in 2005) or year of construction (years)
- per cent of graduates in the neighbourhood (per cent)
- flood probability (per cent)

Price by Flood Probability

Damansara data



Flood probability %

Figure 7-1 Sale Price by Floodplain Zones.

Figure 7-1 shows the distribution of observed sales over the flood frequency zones. Probability of zero denotes a relatively flood free location, that is, outside the 100 year floodplain. The percent probabilities of one, two, four, and ten correspond to location within the 100[4], 50, 25, and 10 year floodplain zones, respectively.

Observations by Flood Probability

Damansara Data

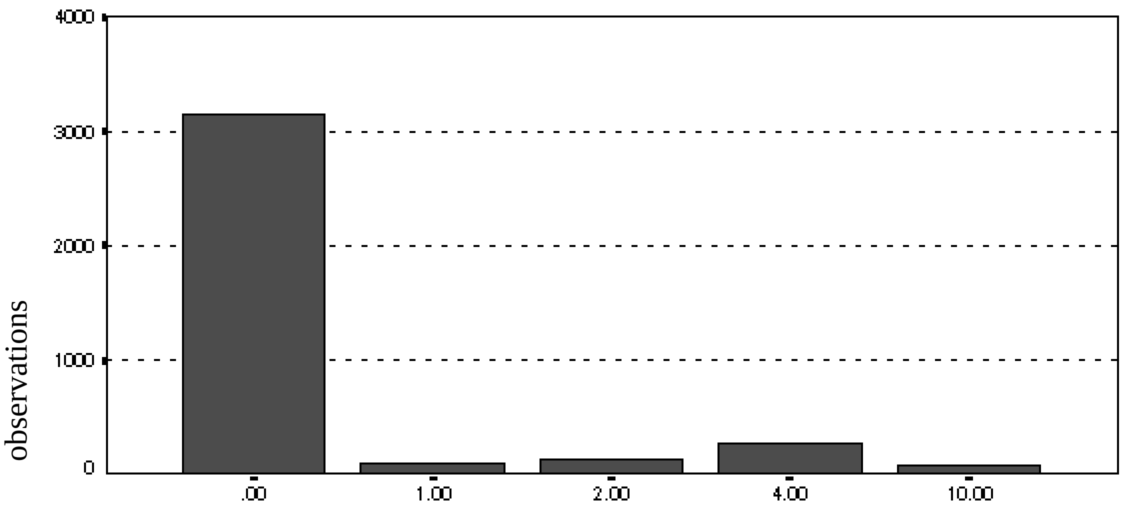


Figure 7-2 Number of Observations by Floodplain Zones.

The next explorations made were box plots of price, area, and construction date by flood probability (Figures 7-2 through 7-4, respectively). It should be noted that the trend of the median does not move monotonically across the floodplain for any of the three variables. This is a reminder that a

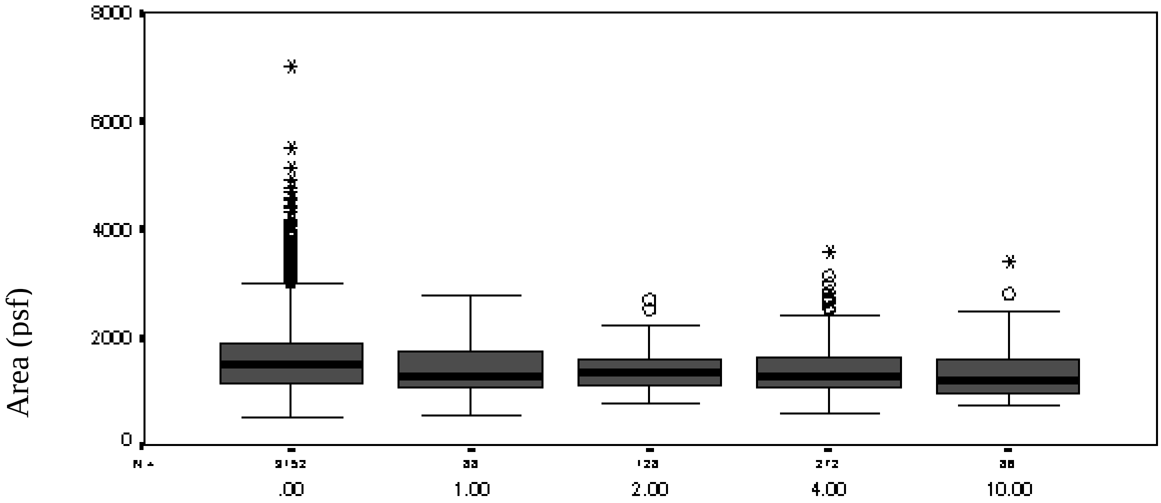
4 Flood Probabilities for any one year: 100-year flood, probability=0.010; 50-year flood; probability=0.020; 25-year flood, probability= 0.040;10-year flood, probability=0.1

decision on a house's sale price is based on complex interactions of many factors, of which flood risk is but one.

Figure 7-2 shows that the median house price is lower in the 100 year floodplain zone than in either the 50 or 25 year floodplain zones. The median house price in the 10 year floodplain is still lower, but the size of the box indicates greater variability in prices in this zone. Figure 7-3 shows little relationship between area and floodplain zone. Figure 7-4 uses age (year built) as the scale variable. It is difficult to discern a trend across the floodplain zones.

However, there are some interesting insights. Figure 7-1,for example, illustrates that older development was more likely to be in the floodplain. The fact that newer houses tend to be outside the floodplain could be attributed to increased recognition of the risks involved. But, it could also be due to historical development patterns in which travel corridors and the development of infrastructure, such as water supply, followed streams and houses were built near roads and services. Finally, while most new development is located outside the floodplain, houses were still being built in the floodplain into the current decade. Houses near the streams, those in the 10 year floodplain zone, were still being built into the late 1980s. This is an indication that floodplain management and regulation have not been completely effective in controlling floodplain development.

Area by Flood Probability (Kota Damansara Data)

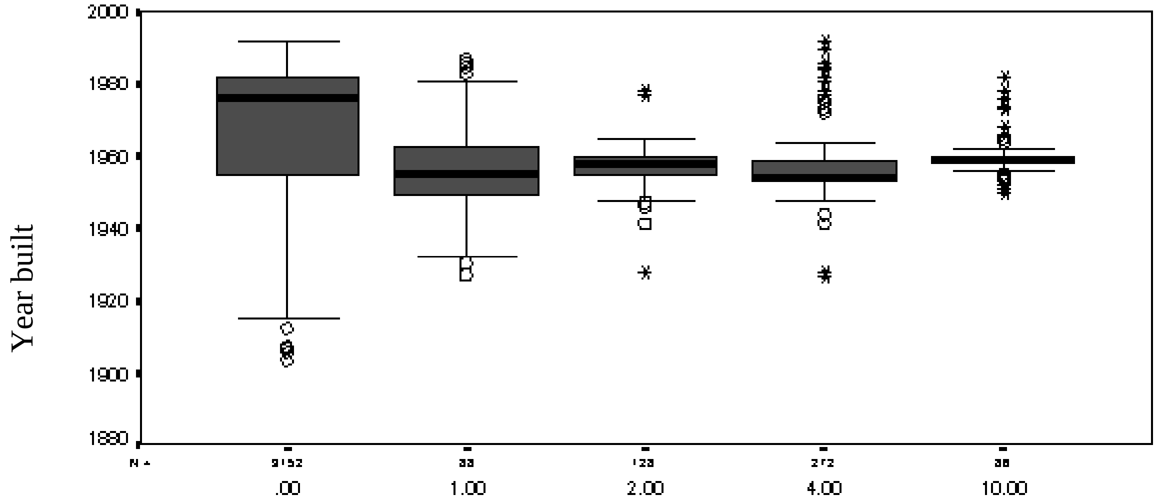


Flood Probability %

Figure 7-3 Area by Floodplain Zones.

Age by Flood Probability

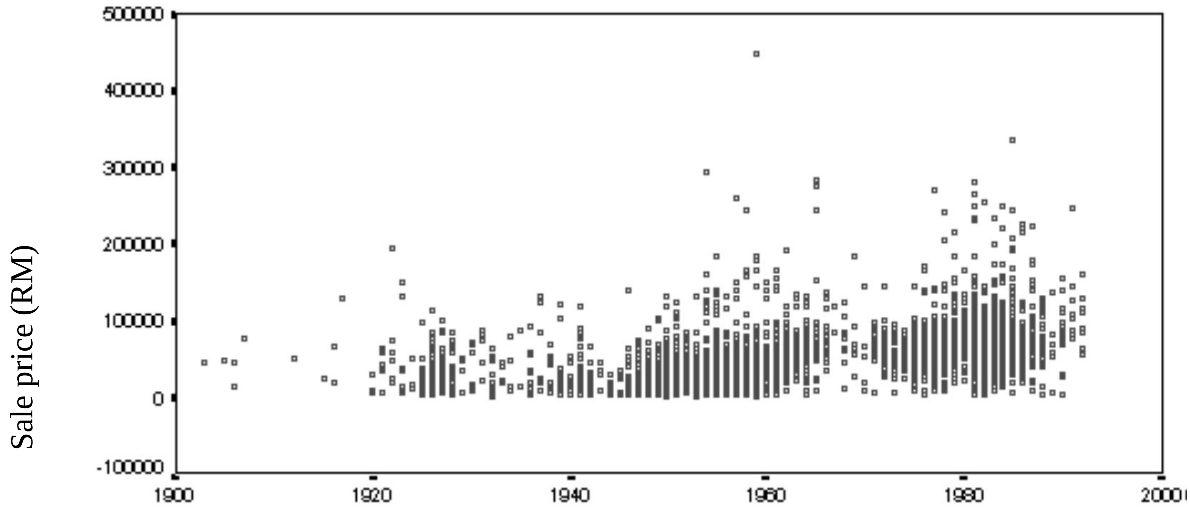
Kota Damansara Data



Flood Probability

Figure 7- 4 House Age by Floodplain Zones

Sale Price by Age (Kota Damansara Data)



Age of house

Figure 7- 5 Sale Price by House Age.

Figure 7-5 shows sale price as a function of construction date. Assuming the age of houses that sold during the study interval were representative of the overall stock of residences, this figure shows the distribution of construction dates in the region. The graph indicates the economic history of the area over the century. The earliest concentration of building occurred in the post-World War 2 era which was sustained further by the discovery oil off the coast of Terengganu.

Figure7- 5 is a reminder that history matters; the long life of houses means their locations are the result of decisions made at different times and under different circumstances

7.2.3 Hedonic Price Models

All models in this case study employed a linear functional form. As noted in Chapter 2, most hedonic studies use either the linear or semi-log functional form. The linear form gave better explanatory power, based on R-squared results, and thus was used for Kota Damansara portion of this study.

The variables used in the hedonic models and their summary statistics are listed in Table 4. Price is the dependent variable in each model. Attributes that reflect the structure of the house are its Area in square feet and it's Age (as of 2005). The per cent of graduates (*Grad*) in the neighbourhood (census tract) is used as a proxy for community education attainment. *Flood1* is a dummy variable with a price of one if the house is in the 100 year floodplain and zero otherwise. *Flood A* is a dummy variable with a price of one for flood free location. *FloodB* through *FloodE* are also dummy variables, taking the price of one, respectively, for location in 100, 50, 25, and 10 year floodplain zones.

Table 7-2: Summary Statistics from Kota Damansara Data

Variables	*μ*	*σ*	Minimum	Maximum	*N*
Price (RM)	518116.00	36699.00	90000.00	450000.00	372
Area(sf)	1578	598	520	7014	372
Age (years)	26.9	16.9	1	30	372
Percent Graduate	81.0	12.9	50	94	372
Flood A (Flood Free)	0.85	-	0	1	372
Flood B (100 year)	0.02	-	0	1	372
Flood C (50 year)	0.03	-	0	1	372
Flood D (25 year)	0.07	-	0	1	372
Flood E (10 year	0.02	-	0	1	372

Five hedonic price models were made with various combinations of the variables. The first model was identical to the initial model of Griffith and was used to provide confidence that data had been transferred and prepared properly.

The results of Griffith's study could not be replicated exactly due to screening of outliers, but adequate agreement between the studies was achieved. However, it soon became apparent that the regression coefficients were not meaningful because the models were derived from the whole data set.

Since the data set includes all sales in Kota Damansara, it includes houses for all income groups. Hufschmidt et al. [1983] note that the "implicit hedonic price for the entire urban area will be wrong if, as some theorists believe, the housing market stratifies into separate segments." Data on incomes of purchasers were not collected, so the data set was divided by sale price to account for differences in behaviour by income groups. Three segments were initially selected, each with the low end of the range at 80 per cent of the high end. The top prices selected for the ranges were RM1,000,000, RM500,000, and RM100,000. The segment of houses in the RM80000 to RM100,000 range was found to be a problem on two counts. First, it appears to be too narrow a range to represent a believable limit to behaviour. Second, the small size of the sample weakens statistical inference. The F-statistic for this segment was not significant at a 95% confidence interval, indicating that the predictive power of the overall model was low. Therefore, this case was replaced by another which used all houses selling for RM100,000 or less. A final case of houses greater than RM1, 000,000 was added to investigate the high end of the market.

The descriptive statistics and hedonic model results for each of the sale price segments are shown in Table 7-3. The descriptive statistics show that the percentage of properties in the 100 year floodplain decreases with increasing house price segment from over 32 % for Run A to less than 2 % for Run D. In other words, the higher income property owners have the wherewithal to choose to live outside of the floodplain.

Table 7-3 shows that the R-squared prices are low for all the segments because much of the variability within the small price ranges is due to attributes (lurking variables) that are not included in the model. Even so, several of the coefficients are significant.

The coefficients for Flood B and Flood C are not significant at the 95 % confidence level for all the market segments. Griffith (1994) hypothesized that consumers may not be able to assimilate rare events into a price of expected annual damage estimates. This result may be explained by that hypothesis.

For properties deeper in the floodplain (10 and 25 year zones), two coefficients are significant at 95 % confidence level, the 10 year floodplain zone for houses priced RM100,000 (Run A) and less, and the 25 year floodplain zone for mid-priced houses (Run B) (demarked with double-lined boxes). The magnitude of the coefficient for Flood E for Run A, RM1735, seems large (although information on expected annual damages was not available) with respect to the average price of the houses for Run A, RM6481. It is possible this discount reflects contents damage and intangible flood damage costs

Table 7-3: Summary of Results by Market Segment (Kota Damansara)

RUN	**A**	**B**	**C**	**D**
SALE PRICE	RM0-RM100000	RM400000-RM500000	RM800000-RM1000000	>RM1000000
Number of cases	297	478	280	294
Price (dollars); mean (standard deviation)	6481 (2244)	45343 (3091)	88438 (5944)	140182 (45573)
Age (years); Mean (standard deviation)	41.5 (14.2)	26.1 (15.9)	18.4 (14)	18 (14.3)
Area (sf): Mean (standard deviation)	1043 (298)	1486 (336)	2183 (371)	2812 (680)
Percent Graduate: Mean (standard deviation)	66.2 (10.9)	82.8 (11.1)	90.7 (5.62)	90.6 (6.58)
Flood A (flood free): mean	0.677	0.828	0.964	0.983
Flood B (100 yr): mean	0.057	0.006	0.029	0.003
Flood C(50 yr):mean	0.054	0.048	0.000	0.000
Flood D (75 yr): mean	0.094	0.105	0.004	0.01
Flood E (10 yr): mean	0.118	0.013	0.004	0.003

Table 7-4: Regression Results

RUN	A	B	C	D
Df	288	469	272	286
Rsq	0.15	0.58	0.14	0.51
Constant	2636 (2.52)*	40199 (27.9)*	66220 (9.6)*	-46848 (-1.49)*
Area	14.3 (3.4)	21.3 (4.41)	63.5 (6.36)	480.1 (17)
Graduate	30.3 (2.46)*	32.1 (2.28)*	101 (1.49)	589 (1.84)
Flood B(100yr)	-254 (-0.46)	-404 (-0.23)	-576 (-0.28)	-14531 (-0.44)
Flood C (50 yr)	155 (0.28)	395 (0.59)	Constant = 0+	Constant = 0+
Flood D (25 yr)	520 (1.17)	-1595 (-3.39)*	-4874 (-0.81)	995 (0.05)
Flood E (10 yr)	-1735 (-4.31)	-1842 (-1.48)	5575 (0.96)	-5439 (-0.16)

*t statistic significant at 95 % confidence interval

+There are no properties for Run C and Run D located in the 50-year flood frequency zone

As for Run B, the model shows that there may be a discount only deep in the floodplain since Flood D and Flood E are on the same order of magnitude, if one accepts that Flood E is only significant to the 80% level. Runs C and D are all statistically insignificant but this may be because there are so few upper income houses in the floodplain and not necessarily because affluent consumers ignore flood risk.

The non-floodplain variables, area, age, and per cent graduates in the neighbourhood, show some interesting trends. The area coefficients, all significant at 95 per cent, rise from RM14.3 per square foot to RM48.01 per square foot. The age coefficients were not significant at that level, but they did decrease monotonically.

The per cent graduates coefficients increased with house prices, although only in the RM100,000 and less and the RM400,000 to RM500,000 ranges were they significant. Having this level of significance only for low and mid-priced houses may be a result of using per cent graduates as the attribute for neighbourhood quality.

By the time house prices top RM800,000, there will probably be few non-graduates who can afford them. It is not that neighbourhood quality is not important, just that per cent of graduates is not a good proxy.

Its import is presumably greater in areas where individuals with lower educational credentials reside.

The regression of choice is Run B (Equation 7.2.1)

$\boldsymbol{ln(P)_{i,damansara,t} = 40199 + (2.13)AREA_t - (18)AGE_t + (32.1)GRAD_t - 404_{floodB} + 395_{floodC} - 1595_{floodD} - 1842_{floodE}}$ **(Equation 7.2.1)**

$\boldsymbol{ln(P)_{i,damansara,t} = \beta_0 + ln\,\beta_{AREA,t} - ln\beta_{AGE,t} + ln\beta_{GRAD,t} - \beta_{floodB} + \beta_{floodC} - \beta_{floodD} - \beta_{floodE}}$ **(Equation 7.2.1 in general form)**

where $P_{i,damansara,t}$ is the price of house *i* in Kota Damansara area at time *t*

Although R-squared price is low for Run B, it has the largest *n* price as compared to the Run A, Run C and Run D and hence, has better representation of all cross-section of properties in that price category(mid-range) and flood frequency classification. The Flood D type for Run B is significant vis-à-vis Flood A, again, maybe because of the largest *n* price, Run B is able to uncover lurking variables that other maybe absent in other Runs.

But a caveat must be issued lest Equation 7.2.1 is treated as a generic model and applied globally across all price ranges. The formulation of Equation 7.2.1 is borne out of a data set which is indigenous in terms of location, the magnitude of flood-frequency and the socio-economic status of the population, to name a few. Hence, in the usage of Equation 7.2.1 or Equation 7.2.2 or hybrid (amalgamation of both), measured choice must be exercised when picking suitable independent variables which are location-centric and price-categorised (Equation 7.2.1) or pure property centric (Equation 7.2.2).

7.2.4 Dungun, Terengganu

Bukit Bauk is located in the Dungun District, Terengganu. The topography of Dungun area is divided into three different morphologies; 40% of the area consists of lowland, swamps and other water bodies covered 20. Environment of Bukit Bauk has been identified as vulnerable to the natural hazards such as flash floods and landslides due to its position of being surrounded by swamps and coastal areas (Gasim, Sahid, Rahim and Toriman, 2010). As such, the geographic isolation of Dungun meant the boundaries of the real estate market could be identified.

Dungun is the site of a study on market price restoration analysis that was conducted as part of the Dungun Evaluation Analysis [1988]. The study was undertaken to assess the magnitude of the difference in market price of residential properties located in the flood plain as compared to comparable non-flood plain properties within the Dungun area. To assess the discounted price of homes located inside the flood plain, the Universiti Teknologi Mara and Majlis Perbandaran Dungun, identified, with the assistance of local real estate agents and community planners, thirteen “comparable” pairs of homes in the area. All of these properties were sold between 1989 and 1991. These properties were paired based on structural similarities, but differed on whether they were flooded in 1978 (a 150-year event).

Average annual flood damages were determined for each of the flood plain homes and this amount was capitalized and added to the sales price of the homes in the flood plain. The remaining difference between the actual selling prices of the comparable pairs was defined as the estimated restoration of market price. The results showed a statistically significant and negative relationship between sales price and the level of flood risk to the property. The weakness of this analysis is that the “comparable” pairs of homes were chosen subjectively by the real estate agents, community planners and Corps personnel. Therefore the measured differences between floodplain and non-floodplain properties reflect their biases and are not statistically reliable.

The data from the Dungun Re-Evaluation Study were used in the present study to obtain a more reliable price of flood risk discount by using a hedonic price model. Although the sample set is small (26 observations), not truly random (drawn from “comparable” residential pairs), this case study was nevertheless pursued because expected annual flood damages, (E [FD]), was part of the set. With E [FD] and data on actual sales price and flood frequency, the flood location discount, $\Delta \boldsymbol{P_L}$ could be compared with the discount due to primary flood damages, $\Delta \boldsymbol{P_D}$.

7.2.4.1 Description of the area and data Sources

Bukit Bauk is located in the Dungun District, Terengganu. The topography of Dungun area is divided into three different morphologies; 40% of the area consists of lowland, swamps and other water bodies covered 20. Environment of Bukit Bauk has been identified as vulnerable to the natural hazards such as flash floods and landslides due to its position of being surrounded by swamps and coastal areas (Gasim, Sahid, Rahim and Toriman, 2010). As such, the geographic isolation of Dungun, meant the boundaries of the real estate market could be identified.

Flooding in the area is frequent and severe. Recent floods include a 150-year flood (2006) and a 40-year flood (2007). Among the 13 flooded properties in the data set, there is significant variation in flood threat. Nine are located outside the 100-year flood zone. Two properties are within the 50- to 100-year flood zone. One is within the 25- to 50-year flood zone.

One property has a very high risk of flood frequency, estimated at 13 years at first floor elevation. The following data were compiled on each of the 26 homes: selling price, total number of rooms, number of bedrooms and baths, house and lot size (Appendix 6). Additional data were available (including age of the house, the number of stories, type of construction, porch, fireplace and air-conditioning), but they could not be incorporated into the model because the data were not available for all 26 homes.

Demographic information on the home buyer and/or general residential area also was not available.

Demographic data, such as age, family-size and type, annual income and/or educational attainment level, is often useful to elicit information about the tastes and preferences of the consumer (i.e., the home buyer). Additional descriptive information is available from the original analysis that suggests that the data were derived from a random sample of all sales during the period. The study sample is relatively homogeneous only in that all the properties are located within a relatively small and contained area, there are common schools and shopping districts, it is racially homogeneous, and almost all the houses were built prior to World War II.

Some aspects that make the sample non-homogeneous are that there is significant variation in flood hazard among homes located in the floodplain, and there are some higher priced homes.

7.2.4.2 Exploration of the data and hedonic model

Scatter chart diagrams were used to assess which of the available attributes were significant determinants of selling price. The scatter charts revealed a few potential outliers with respect to price: there are two relatively higher priced homes as well as one very low priced home, which happened to be the property located deepest in the floodplain . The hedonic price function was estimated with and without these observations. Removal of these observations helped remedy problems associated with heteroscedascity among the explanatory variables.

Five different regression equations were estimated. Runs 1 and 2 exclude the three observations where sales price was less than RM30,000 or more than RM125,000. Runs 3 and 4 exclude only the highest priced home. Runs 1 and 3 include only flood frequency and area, while Runs 2 and 4 include all the independent variables. Run 5 is based only on observations for the flooded properties. This run is included because it was suspected that the non-floodplain properties could possibly have been chosen to exaggerate the price difference between floodplain and non-floodplain properties. A log normal linear model was estimated. Although a complete set of data containing five independent variables was available for each of the 26 observations, only two independent variables were included in the model -- flood probability and square feet.

The other three independent variables (number of rooms, number of bathrooms) were identified as partially correlated with square feet. Exclusion of these three variables also increased the degrees of freedom in the regression model. The preferred regression model was Run 1 because this equation excluded the outliers and Run2 showed that the rooms and bathrooms are not significant independent variables.

$\boldsymbol{ln\ (P)_{i,dungun} = 10.4658}$**+** ***(0.000334)*** $_{\textit{squarefeet}}$ - $\frac{\mathbf{37.2209}}{\boldsymbol{floodfrequency}}$ **(Equation 7.2.2)**

$\boldsymbol{ln\ (P)_{i,dungun} = \ \beta_0 + \ ln\ (\beta)_{squarefeet} - \frac{\beta}{floodfrequency}}$**(Equation 7.2.2 in general form)**

where P_i is the price of house *i* in Dungun area.

Run 1 excludes the property in the 13-year floodplain in order to reduce the possibility that this one observation may dominate the regression model. The likelihood that the property deep in the flood plain is influencing the regression results is evidenced by the instability of the estimated coefficient price for flood frequency with and without this observation (compare Run 1 to Run 3).

The R-squared price obtained for Run 1 is 0.68. The coefficients for each of the variables show the expected sign. Based on this model, both flood probability and total area had a statistically significant effect on the price of the properties sold during the study period, measured at the 1% significance level. Run 5 is comparable to Run 1 except that the non-floodplain properties were not included in the regression. Although the coefficient for flood frequency in Run 5 is not significant due to the lack of points, it is less than that of Run 1. The probable cause for this difference is that the non-floodplain properties may have been chosen to exaggerate the price differential between floodplain and non-floodplain properties. As a result, the price differential between floodplain and non-floodplain properties calculated below from the equation for Run 1 may be exaggerated.

Table 7-5 Summary of results from Dungun model

Variable	Run 1 (n=23) ln linear	Run 2 (n=23) ln linear	Run 3 (n=23) ln linear	Run 4 (n=23) ln linear	Run 5 (n=12) ln linear
Df	20	17	22	19	9
Adjusted R^2	0.6459	0.6339	0.6182	0.5871	0.6369
Constant	10.4658 (81.622)**	10.4685 (43.287)**	10.3450 (67.842)**	10.2104 (36.107)**	10.272 (39.841)**
# Rooms		-0.0189 (-0.348)		0.0298 (0.467)	
#bathrooms		0.1375 (1.086)		0.1090 (0.692)	
Square feet	0.000334 (5.084)**	0.000248 (2.154)**	0.000360 (4.770)**	0.000226 (1.569)	0.000355 (3.780)**
1/flood frequency	-37.2209 (-4.623)**	-38.1404 (-4.619)**	-14.4420 (-4.246)**	-15.0126 (-4.033)**	-23.202 (-1.627)

Runs 1, 2 & 5: eliminated observations where sales price was greater than RM100,000 or less than RM30,000. Run 3 & Run 4: eliminated one observation where sales price exceeded RM200,000. Where left blank, the respective variable was excluded from estimation. Estimated standard errors are shown in parentheses. Significance level: ** statistically significant at the 0.01 level; * significant at the 0.05 level

7.2.4.3 Interpreting the model results.

Run 1 shows that price is related to floodplain location, making it possible to calculate ΔP_L. However, it is not straightforward to calculate aΔP_L from a linear model. To isolate the estimated effect of flood probability on selling price, while holding all other factors constant, it is necessary to express this relationship in terms of the elasticity of price with respect to flood frequency. Elasticities measure the percentage change in a dependent variable (price) associated with a one per cent change in one of the independent variables (flood frequency).

For a linear function, the elasticity is derived from the following equation:

$$\boldsymbol{\varepsilon} = \frac{\partial \mathbf{Y}/\partial \mathbf{X}}{(\frac{\mathbf{Y}}{\mathbf{X}})} = \boldsymbol{\beta}_1 \mathbf{X}$$

This equation is solved using the estimated coefficient price (β_1) in Run 1, multiplied by the average flood frequency price (0.0042) for the 23 observations of Run 1. The resultant price elasticity with respect to flood frequency is estimated at -0.157. This means that, on average, the sales price of the properties examined will decrease 0.157% for each 1% increase in flood probability. Multiplying the elasticity by the average sales price (RM58,430) yields an average floodplain location discount of approximately RM9,200.

Figure 7-6 shows that outside of the 100-year floodplain (1/frequency < 0.01) the ratio varies greatly, while for the three properties within the 100-year floodplain the ratio is constant depending on interest rate.

Although flood insurance information was not available, a possible explanation for this behaviour is that the three property owners within the 100-year floodplain were knowledgeable about the expected cost of flood damage. These property owners may have been made aware of the cost of flood damage through the requirement that flood insurance be purchased for all properties in the 100-year floodplain.

The properties within the 100- to 150-year floodplain zone were discounted significantly more than ***PW (E[FD])*** and over a wide range of prices. These properties were all flooded above the first floor elevation in the 1978 flood. For these properties, the owners may have been aware of the flood threat from having heard news of the 1978 flood or from seeing visible residual damage to the properties, but may have been unsure of how to calculate expected annual damages.

Since they did not have to purchase flood insurance, they probably had little idea of the expected annual damages. The property owners may also have a difficult time assessing the cost of flood hazard because of the low flood frequencies. In addition, since the hedonic model obtained an R-squared of

0.68, the variability in the ratio is also partly due to the uncertainty in estimating ΔP_L from the hedonic model.

In summary, although there is a clear floodplain location discount, ΔP_L , for the 13 floodplain properties L in the data set, the data set is too small to conclude a discount exists for Dungun real estate market as a whole. Nevertheless, the comparison of ΔP_L with the present worth of the expected annual L damages shows that pricing behaviour varies significantly across the floodplain. There is a clear change in behaviour among those properties within the 100-year floodplain, those within the 100- to 150-year floodplain zone, and the three that had flooded basements in 1978. It is hypothesized that history of flooding, flood plain amenities, and awareness of the flood risk cause the price variability.

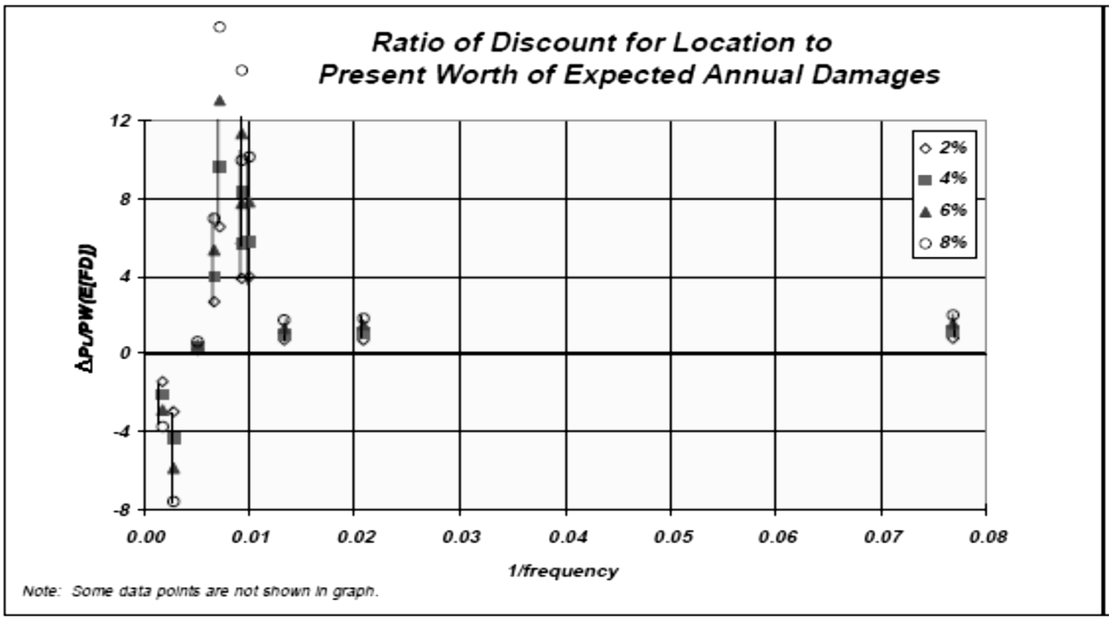


Figure 7-6 Ratio of ΔP_L to ΔP_D for Dungun.

7.3 Validation of model

7.3.1 Rationale

The integrity of the multiple regression analysis models (MRA) presented here will be established based on the following parameters: the coefficient of determination and the F-test of the analysis of variance (Mun, 2010). Data for both Kota Damansara and Dungun will be consolidated as one in order to reduce any locational and property-specific attributes that might influence the model, i.e. the employment of a generic cross-sectional model. This is done to solely test the robustness of the model derived and so the inputs or sample data must be heterogeneous and from random picking.

Furthermore, *n*=50 for control data set and test data set, respectively.

Figure 7-7-0 Regression Diagnostics

Diagnostic Results

	Heteroskedasticity		Micronumerosity	Nonlinearity	
Variable	W-Test p-value	Hypothesis Test result	Approximation result	Nonlinear Test p-value	Hypothesis Test result
Y			no problems		
Variable X1	0.2543	Homoskedastic	no problems	0.2458	linear
Variable X2	0.3371	Homoskedastic	no problems	0.3444	linear
Variable X3	0.3649	Homoskedastic	no problems	0.3733	linear
Variable X4	0.3066	Homoskedastic	no problems	0.9298	linear
Variable X5	0.2495	Homoskedastic	no problems	0.2727	linear
Variable X6	0.3233	Homoskedastic	no problems	0.3389	linear
Variable X7	0.2122	Homoskedastic	no problems	0.2987	linear

A common violation in forecasting and regression analysis is heteroscedascity, that is, the variance of the errors increases over time. Visually, the width of the vertical data fluctuations increases or fans out over time, and typically, the coefficient of determination (R-squared coefficient) drops significantly when heteroscedascity exists. If the variance of the dependent variable is not constant, then the error's variance will not be constant.

Unless the heteroscedascity of the dependent variable is pronounced, its effect will not be severe: the least-squares estimates will still be unbiased, and the estimates of the slope and intercept will either be normally distributed if the errors are normally distributed, or at least normally distributed asymptotically (as the number of data points becomes large) if the errors are not normally distributed. The estimate for the variance of the slope and overall variance will be inaccurate, but the inaccuracy is not likely to be substantial if the independent-variable prices are symmetric about their mean. In this case, using the Wald test, all the independent variables' $(X_1,X_2,X_3,X_4,X_5,X_6,X_7)$ p-price is less than 0.05,hence they are all homoscedastic.

If the number of data points is small (micronumerosity), it may be difficult to detect assumption violations. With small samples, assumption violations such as non-normality or heteroscedascity of variances are difficult to detect even when they are present. With a small number of data points, linear regression offers less protection against violation of assumptions. With few data points, it may be hard to determine how well the fitted line matches the data, or whether a nonlinear function would be more appropriate. Even if none of the test assumptions are violated, a linear regression on a small number of data points may not have sufficient power to detect a significant difference between the slope and zero, even if the slope is nonzero.

The power depends on the residual error, the observed variation in the independent variable, the selected significance alpha level of the test, and the number of data points. Power decreases as the residual variance increases, decreases as the significance level is decreased (i.e., as the test is made more stringent), increases as the variation in observed independent variable increases, and increases as the number of data points increases.

Prices may not be identically distributed because of the presence of outliers. Outliers are anomalous prices in the data. Outliers may have a strong influence over the fitted slope and intercept, giving a poor fit to the bulk of the data points. Outliers tend to increase the estimate of residual variance, lowering the chance of rejecting the null hypothesis, i.e., creating higher prediction errors.

They may be due to recording errors, which may be correctable, or they may be due to the dependent-variable prices not all being sampled from the same population. Apparent outliers may also be due to the dependent-variable prices being from the same, but non-normal, population. However, a point may be an unusual price in either an independent or dependent variable without necessarily being an outlier in the scatter plot.

In regression analysis, the fitted line can be highly sensitive to outliers. In other words, least squares regression is not resistant to outliers, thus, neither is the fitted-slope estimate. A point vertically removed from the other points can cause the fitted line to pass close to it, instead of following the general linear trend of the rest of the data, especially if the point is relatively far horizontally from the centre of the data.

However, great care should be taken when deciding if the outliers should be removed. Although in most cases when outliers are removed, the regression results look better, a priori justification must first exist. For instance, if one is regressing the performance of a particular firm's stock returns, outliers caused by downturns in the stock market should be included; these are not truly outliers as they are inevitabilities in the business cycle, for example. (Mun, 2010).

Forgoing these outliers and using the regression equation to forecast one's retirement fund based on the firm's stocks will yield incorrect results at best. In contrast, suppose the outliers are caused by a single nonrecurring business condition (e.g., merger and acquisition) and such business structural changes are not forecast to recur, then these outliers should be removed and the data cleansed prior to running a regression analysis. The analysis here only identifies outliers and it is up to the user to determine if they should remain or be excluded.

Sometimes, a nonlinear relationship between the dependent and independent variables is more appropriate than a linear relationship. In such cases, running a linear regression will not be optimal. If the linear model is not the correct form, then the slope and intercept estimates and the fitted prices from the linear regression will be biased, and the fitted slope and intercept estimates will not be meaningful.

Over a restricted range of independent or dependent variables, nonlinear models may be well approximated by linear models (this is in fact the basis of linear interpolation), but for accurate prediction a model appropriate to the data should be selected. A nonlinear transformation should first be applied to the data before running a regression. One simple approach is to take the natural logarithm of the independent variable (other approaches include taking the square root or raising the independent variable to the second or third power) and run a regression or forecast using the nonlinearly-transformed data (Mun, 2010).

7.3.2 Mechanics

$$\boldsymbol{ln\,P_{i,l,t} = \sum_{j=1}^{J} \beta_j\, lnX_{j,l,i,t} + \sum_{k=1}^{K} \gamma_k C_{k,l,t} + e_{i,l,t}} \; (\boldsymbol{Equation\,3.5})$$

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}.

γ_k= vector of coefficients representing the elasticity of price with respect to the matrix of the number of houses located in different flood category *k* where *k*= *f(floodB,floodC, floodD, floodE),* location and time

ε_{ilt}, the error term is distributed mean 0 and variance σ^2

Visiting the cross-sectional hedonic Equation 3.5, the usual property and location specific variables are employed.

Regression Analysis Report	
R-Squared	0.638
Adjusted R-Squared	0.623
Multiple R	0.568
SE	55613.451
Observations	100

Figure 7-7-1 Regression Statistics

Worthy of mention is Rao (2003) view on confidence interval where he stated that the wider a confidence interval, the less precise the estimate. Precision depends upon sample size. Therefore the larger the sample sizes of a study, the narrower the confidence interval and the better the estimate.

Further, the 90% (or lower) confidence interval for an estimate is narrower than the 95% confidence interval; a 99% confidence interval is wider. This makes sense, since we are surer that a true price lies between 2 widely separated numbers than 2 more narrowly separated numbers (Ibid, 2003).

Hence, riding on this rationale, with a rather large n=100, it is hardly surprising that results from the computer output clearly chose and I concur, that 90% confidence interval be used as the benchmark for the performed t-test, F-test and hypothesis test.

The R-Squared or Coefficient of Determination indicates that 0.638 of the variation in the dependent variable can be explained and accounted for by the independent variables in this regression analysis.

However, in a multiple regression, the Adjusted R-Squared takes into account the existence of additional independent variables or regressors and adjusts this R-Squared price to a more accurate view of the regression's explanatory power. Hence, only 0.623 of the variation in the dependent variable can be explained by the regressors.

The Multiple Correlation Coefficient (Multiple R) measures the correlation between the actual dependent variable (Y) and the estimated or fitted (Y) based on the regression equation.

This is also the square root of the Coefficient of Determination (R-Squared).

The Standard Error of the Estimates (SEy) describes the dispersion of data points above and below the regression line or plane. This price is used as part of the calculation to obtain the confidence interval of the estimates later.

Regression Results

	Intercept	AREA	GRAD	AGE	FA	FB	FC	FD
Coefficients	301857.1076	385.7930812	303.487738	-175.11033	-1327.5742	-1589.4719	-2995.0217	-3151.7089
Standard Error	249.5611	107.4376	385.4301	542.9863	174.3332	77.9401	144.8763	286.5301
t-Statistic	1.8825	1.6694	1.8635	1.7896	1.8545	1.8793	1.9033	1.7928
p-Value	0.0399	0.0452	0.0437	0.0499	0.0502	0.0542	0.0489	0.0511

Degrees of Freedom		Hypothesis Test	
Degrees of Freedom for Regression	7	Critical t-Statistic (99% confidence with df of 92)	2.6303
Degrees of Freedom for Residual	92	Critical t-Statistic (95% confidence with df of 92)	1.9861
Total Degrees of Freedom	99	Critical t-Statistic (90% confidence with df of 92)	1.6616

Figure 7-7-2 Regression Results

The Coefficients provide the estimated regression intercept and slopes. The Standard Error measures how accurate the predicted Coefficients are, and the t-Statistics are the ratios of each predicted Coefficient to its Standard Error.

From the prices of the respective coefficients in Figure 7-7-2 we get

$$\boldsymbol{P_{i,t} = 301857.1076 + 385.7930812(AREA) + 303.487738(GRAD) - 175.11033(AGE) - 1327.5742(FA) - 1589.4719(FB) - 2995.0217(FC) - 3151.7089(FD)}$$ **(Equation 7-7-2)**

From Figure 7-7-5, the coefficient Intercept has a corresponding price of 301857.1076 and the coefficient AREA has a price of 385.7930812. While coefficient GRAD has a corresponding price of 303.487738 and AGE is -175.11033.For the coefficient AGE, it is hardly surprising that age or rather, the negative effect of inter-temporal issue has on price; the older a particular structure is, the lower price it is going to fetch, assuming there has been no general upkeep and almost perpetual neglect. For coefficients FA, FB, FC and FD have corresponding prices of -1327.5742,-1589.4719,-2995.0217,-3151.7089, accordingly. Thus, these prices not only prove but satisfy the aims of this thesis, i.e. flooding negates and erodes house prices in Malaysia.

The t-Statistic is used in hypothesis testing, where we set the null hypothesis (H_o) such that the real mean of the Coefficient = 0, and the alternate hypothesis (H_a) such that the real mean of the Coefficient is not equal to 0. A t-test is performed and the calculated t-Statistic is compared to the critical prices at the relevant Degrees of Freedom for Residual. The t-test is very important as it calculates if each of the coefficients is statistically significant in the presence of the other regressors. This means that the t-test statistically verifies whether a regressor or independent variable should remain in the regression or it should be dropped.

But, a caveat must be issued here with regards to the employment of t-statistics to test the utility of the model to predict y by conducting individual t−tests on each individual β (Mun, 2010). Even if we conduct each test at the α = 0.05 level, for example, the overall probability of incorrectly rejecting H_0 (the probability of a Type I error) is larger than 0.05.

Even if we begin with an α level of, for example α= 0.05 on each individual test for β's, the overall probability of an error will always be larger than the probability of Type I error on individual tests. The larger the numbers of predictors are in the model, the higher the probability that at least one of those hypotheses tests will lead to the wrong conclusion (*Ibid*, 2010).

For example, supposed we a conduct a t-test on two parameters, β_1 and β_2 and take $\alpha = 0.05$, we get

	Correct decision for β_1	**Incorrect decision for β_1**
Correct decision for β_2	0.95x0.95	0.95x0.05
Incorrect decision for β_2	0.95x0.95	0.95x0.05

Table 7-6: Comparison Matrix

The probability of a correct decision on both parameters is only 0.95 × 0.95 = 0.90. So our individual Type I error rate (α) is eroded in multiple tests. In general, for an individual Type I error rate of α , the overall error rate on k tests is $(1-\alpha)^k$. For example, for k = 4 and α = 0.05, the probability that we will reach the correct conclusion for all four β is only $(0.95)^4$=0.81; hence the experiment-wise $\alpha = 0.19$.

Notwithstanding any shortcomings, it is only prudent that other test batteries be engaged to appraise the utility of the model concerned.

The Coefficient is statistically significant if its calculated t-Statistic exceeds the Critical t- Statistic at the relevant degrees of freedom (df). If a

Coefficient's t-Statistic exceeds the Critical level, it is considered statistically significant. Alternatively, the p-Price calculates each t-Statistic's probability of occurrence, which means that the smaller the p-Price, the more significant the Coefficient. Looking at the respective p-price of all coefficients, from Intercept to FD, all the corresponding p-prices are more than the price of Critical t-statistic at 90%, i.e. 1.6616 but lower than the p-price at 95%, i.e. 1.9861. So, in this case, the significant level for the p-Price is 0.1 corresponding to the 90% confidence level.

Analysis of Variance

	Sums of Squares	Mean of Squares	F-Statistic	p-Value	Hypothesis Test	
Regression	279255035895.39	3035380824.95	2.01	**0.07**	Critical F-statistic (99% confidence with df of 7 and 92)	2.8399
Residual	2099508110.05	485644015.72			Critical F-statistic (95% confidence with df of 7 and 92)	2.1108
Total	283354544005.44				Critical F-statistic (90% confidence with df of 7 and 92)	1.7832

Figure 7-7-3 Analysis of Variance

The Analysis of Variance (ANOVA) table provides an F-test of the regression model's overall statistical significance. Instead of looking at individual regressors as in the t-test, the F-test looks at all the estimated Coefficients' statistical properties. The F-Statistic is calculated as the ratio of the Regression's Mean of Squares to the Residual's Mean of Squares. The numerator measures how much of the regression is explained, while the denominator measures how much is unexplained. Hence, the larger the F-Statistic, the more significant the model is.

The corresponding p-Price is calculated to test the null hypothesis (H_o) where all the Coefficients are simultaneously equal to zero, versus the alternate hypothesis (H_a) that they are all simultaneously different from zero, indicating a significant overall regression model. If the p-Price is smaller than the $\alpha = 0.1$ (in this case), then the regression is significant. The p-price as per Figure 7-7-3 is 0.07; hence the regression is significant. The same approach can be applied to the F-Statistic by comparing the calculated F-Statistic with the critical F prices at various significance levels.

In conclusion, there is sufficient evidence to reject the null hypothesis in favour of the alternative hypothesis. At least one of the β is not equal to zero. Thus, at least one explanatory variable is linearly related to y. This linear regression model is valid.

7.4 Reconciliation of the evidences obtained

At the heart of any research are the findings and this sub-chapter collates all the different piecemeal of findings and analyses from the literature reviews and data examination into a complete and digestible pie so that an overall taste can be obtained. Perusing the individual concerned chapters in isolation will not provide an insight into the relationships that exist between the findings in literature reviews and data analysis and the whole thrust of this research. This sub-chapter has the aforementioned niche to perform and does not seek to duplicate the existence and role of the subsequent chapter.

None of the 13 reviewed studies found in the literature attempted to directly search for evidence that flood damages borne by flood plain activities are or are not capitalized into the fair market price of floodplain properties. Most of the studies attempted to detect a discount for properties located in the floodplain (without regard to where in the 100-year floodplain). However, a discount for location in the floodplain is different than a discount for flood damages because there are other negative and positive attributes of a floodplain property. Positive attributes, such as access to the water and nice views may result in a premium for floodplain properties. As outlined in Chapter 2, in order to separate a discount for flood damages from a discount for floodplain location, a hedonic price model must include all floodplain attributes.

As a result, the principal study question could not be answered through the results of the literature review. Nevertheless, the literature review offered insights on factors that affect floodplain property prices.

Eight of the studies used a model that employed the dummy variable of location in or out of the 100- year floodplain. Half of the eight studies show a discount for location (in the floodplain) exists, and half do not. These studies are inconclusive and expected to be so because this model implies that the flood risk is constant across the 100-year floodplain. Flood risk, and therefore any corresponding discount, will vary between properties deep in the floodplain, say within the 25-year floodplain, and those just within the 100-year floodplain.

Four studies examined the effect of flood insurance premiums. All four found property prices discounted by the capitalized price of flood insurance premiums (only where premiums actually are paid). None of these studies distinguished between subsidized and actuarial premiums. Furthermore, only about a fourth of floodplain property owners purchase flood insurance.

It is not clear whether consumers are risk averse or risk seeking. Two studies hypothesized that consumers may have a difficult time assimilating the effect of rare events into their willingness-to pay. A contingent valuation study suggests that higher-income consumers may be more risk averse than lower-income consumers.

The price of positive floodplain attributes was addressed in two studies. Both found the price of positive attributes to be larger than the price of negative attributes (including the discount for flood damages). No academic studies were found that have data sufficient to separate the discount for flood damages from positive floodplain attributes.

Three sets of researchers studied property prices in the period following a flood. None found a discount in price over the long-term. One study observed a drop in prices followed by a recovery, with the recovery being slower for houses with more frequent flooding. None of these studies included data on the physical condition of houses, all of which were damaged and then repaired.

The findings from the literature review and the case studies are insufficient to conclude that flood damages borne by floodplain activities either are not capitalized into the fair market price of floodplain properties. The existing studies did not seek and the case studies lacked sufficient data to detect a discount for primary flood damages.

In some cases no discount for location in the floodplain was detected. In other markets, a discount for floodplain location does exist, but varies because of a complex interaction of socioeconomic and flood risk factors, such as relative location within the floodplain, flood insurance, and flood history, and positive floodplain attributes. This complexity limits the possibility of identifying specific conditions for when a discount for primary damages either exists or does not exist.

The variability of these factors across floodplain markets around the country makes the assumption that all properties are discounted for primary flood damage unreasonable.

The assumption that all consumers are fully aware of the flood risk and are risk neutral is not supported by the findings. Although the simplifying assumptions are meant to facilitate project evaluation, in the cases where there is no discount, the benefits of permanent evacuation projects are underestimated.

Although recommendations to improve hedonic price models to detect a discount for primary flood damages are possible based on the findings, it may be profitable to pursue further such studies.

The foremost issue is including positive and negative attributes of floodplain properties in the hedonic price model to separate the discount due to primary flood damages from the discount due to floodplain location. Identifying and gauging all these floodplain traits are exceedingly difficult. The researcher is inundated with all the attributes that property buyers consider when purchasing a floodplain property.

Even if all the attributes were identified, they remain to be measured. Since these attributes are not traded explicitly on the market, their price must be indirectly assessed with methods such as hedonic price models or the contingent valuation method.

Such studies would be expensive and time-consuming because original data surveys would be required. Even if the attributes were measured, several case studies would have to be conducted to establish general conditions for when there is or is not a discount for primary flood damages. Even if several case studies were conducted, their results still may be inconclusive.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The dominant aim of this research is to determine whether flooding has any effect on housing prices in Malaysia. The adjuvant aims of this study are limited to a search for evidence that expected annual flood damages borne by flood plain activities are or are not capitalized into the fair market price of floodplain properties in Malaysia.

The 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 price 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 price 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). 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 8.2. Inadequacies were identified in methodologies previously used in flooding studies and in methods from the wider literature when attempting to measure flood impacts .Achievement of the second objective followed naturally from the methodological issues identified within the review. Key issues arising from these chapters were: the two dimensional nature of the flood status variable; the time varying nature of the response to a flood event and the small sample sizes inherent in studying flood events.

Chapter 6 presented the conceptual developments employed in this research programme to address the key issues within the constraints of available data and resources. The second and third objectives were achieved via the collection and analysis of data for the Malaysian Property market as described in chapter 7. Chapter 7 also described the practical aspects of the empirical research program and also the analysis of the collected data and model estimation .The findings from this analysis are summarised in sections 8.2.

8.2 Research Findings

The findings from the study are divided below into findings from the literature and findings about flood impact.

8.2.1 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 local market because of uncertainties associated with damage estimates.

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 two dimensional with the impact of flood events and property type all having a bearing on home buyers' willingness to pay.

There is no strong evidence as to which has most bearing upon market's willingness to pay any disclosure regimes.

8.2.2 Findings from the flood price impact modelling

From Figure 7-7-1, the R-Squared or Coefficient of Determination indicates that 63.8% of the variation in the dependent variable can be explained and accounted for by the independent variables in this regression analysis.

However, in a multiple regression, the Adjusted R-Squared takes into account the existence of additional independent variables or regressors and adjusts this R-Squared price to a more accurate view of the regression's explanatory power. Hence, only 62.3% of the variation in the dependent variable can be explained by the regressors. Though the Adjusted R-Squared figure is hardly flattering, the regression results (Figure 7-7-2) are highly reassuring.

The magnitude and sign of the individual coefficients correctly reflect their very individual function and nature. The variable AGE with the coefficient of -175.11033 shows that for every 1% increase in age, the corresponding price is decreased by the magnitude of RM 175.11; while for the variable GRAD, for an increase of 1 % in the number graduates staying in the area results in the corresponding increase of RM 385.79 in price. Hence, the coefficient lends further credence to the belief by the masses, of the esteem attached to and stamp of approval for a specific residential area by the number of graduates staying in that area, Kota Damansara is a case in point.

The variables FA, FB, FC and FD reflect the per cent probabilities of one, two, four, and ten corresponding to location within the 100, 50, 25, and 10 year floodplain zones, respectively.

With the coefficient for FA is at –RM1327.57 and bottoming out at –RM3151.7089 for FD, correctly underlining the snowballing magnitude of price erosion in symmetry with the increasing likelihood of flooding.

But the magnitudes and corresponding signs of the aforementioned variables palpably manifest the inverse relationship between flooding and house prices; thus, concurrently satisfying the main aim of this thesis. *En outré*, evidence was found to establish the fact that expected annual flood damages borne by flood plain activities are not capitalized into the fair market price of floodplain properties in Malaysia, propping the second aim of this thesis.

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.

8.3 Contribution

This program of research was designed to make contributions in two areas: in novel methodological approaches which could be utilised in future studies and in understanding of the Malaysian market for floodplain property.

8.3.1 Contribution to methodology

The recently discussed utility of Equation 3.5 will inexorably spawn Equation 3.6 which measures the time-varying nature of flood response by modifying the simple flooding term the growth in price of property i between time t and t+k. As time elapses after a flood event the memory of the event fades (Penning-Rowsell and Peerbolte, 1994). The rate of forgetting will vary with the stability of the local area and post-flood mitigation project. This is a fresh contribution to methodology in this context; this model accommodates time-varying nature of flooding.

$$\ln P_{i,l,t+k} - lnP_{i,l,t} = \sum_{j=1}^{J} \beta_j lnX_{j,i,l,t+k} - \sum_{j=1}^{J} \beta_j lnX_{j,i,l,t} - \gamma Z_{i,l,t+k} + \gamma Z_{i,l,t} + \varepsilon_{i,t} \qquad (Equation\ 3.6)$$

β_j = a vector of coefficients representing the elasticity of price with respect to the matrix of
locational and property specific explanatory variable, $X_{j,i,t}$

$Z_{i,l,t}$ is the flood status variable at time t with coefficient $-\gamma$

$\varepsilon_{i,t}$ the error term is distributed mean 0 and variance $\sigma_{i,t}^2$

8.3.2 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 price by some authors in the literature review. By contrast this study found infinitesimal 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 government of Malaysia should introduce a government-run flood or disaster related insurance *ala* National Flood Insurance Programme for the obvious reasons. Since it has already been established that flooding and house price make a strange bedfellow, an insurance framework must be quickly founded so that flood victims can be adequately insured, in a hope that any physical rehabilitation can be done to their houses and decrease the probability of any displacement. Although the generosity and welfare of the government concerned in giving out hand-outs cannot be disputed, the speed of disbursement and quantum of the hand-outs may be insufficient to affect any proper repairs to their houses or put these poor victims back into the swing of things again.

8.4 Limitations

This study has been concerned with the impact of flooding on the price of residential property in a Malaysian context. 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 two Malaysian cities: Kuala Lumpur and Dungun, sites which flooded, frequently and the worst episode of the decade was the 2006-2007 flooding; type of flooding 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.

Where more detailed lists were available from the JPPH and JPSM it became clear that a more accurate categorisation is possible and this would have lent better precision to the 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.

Within the current economic conditions in Malaysia the housing market has been highly buoyant. Housing markets may react differently to perceived risks in times with lower growth.

Use of the hedonic multiple regression analysis model implies the assumption that property details, other than the focus variables remain constant over time, i.e. static. 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. The risk remains that short term impacts measured by the study may be due to property sold before restoration.

8.5 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 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 price 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.

8.6 Scope for future research

Recent and future flood events can be analysed in a relatively quick and inexpensive manner using the methods employed here. 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 author is in the midst of preparing a research paper which uses Autoregressive Integrated Moving Average (ARIMA) and Generalized Autoregressive Conditional Heteroscedascity (GARCH) to determine the ex-ante turning points in the house price movements.

The model derived from this research exercise will be useful in conjecturing quantitatively when the house price will bottom out during any natural catastrophe and recover. Quintessentially, the sum of this on-going research exercise is to purge any uncertainty as to when will the price recover and by how much.

This thesis has identified that the impact of flood on property price 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 what was available to this research. This research was limited by the current economic conditions. If these conditions change as experts have suggested, the short term analysis could be extended to the static market.

8.7 Concluding remarks

It is imperative to fundamentally revise the conventional full-information, efficient-market interpretation of house price responses to floods, by drawing on the literature on behavioural economics and sociology of risk.

Perhaps in estimating the risk of flood damage to a particular property, market actors evince myopia and amnesia and that these effects, in the context of climate change, will take on a derived and transformative dynamic. These insights may be used to outline an alternative framework where perceived flood risk (and observed home prices) probably diverge considerably from actual risk (and risk-adjusted prices), particularly if a long period has passed since the last flood. In the framework, home price adjustment to ever increasing levels of risk associated with global climate change evinces an uneven pattern of inertia followed by rapid, tipping-point declines.

Maybe it can be shown how any new discoveries or perspective may hold important implications for the estimation and interpretation of empirical models of house prices and flood risks, as well as for public policy. Given the huge potential dislocations associated with these catastrophic adjustments, it behoves housing economists to map out the relationship between risk-adjusted prices and flood severity for floods of varying frequency.

To predict the dynamics of market behaviour accurately, behavioural factors must be incorporated into models of the housing economy in a way that captures the complex, inter-connected nature of the system. Only by understanding the nature of this system will governments be able to identify appropriate policy responses. Although the analysis has been couched in terms of floods, it is hoped that the framework is applicable to housing market responses to a range of other natural disasters.

Many disaster experts recognize that there are no natural disasters. All disasters have social and technological contexts. While heavy prolonged rains contribute to extreme floods with long-term impacts, not all unusually heavy rains have catastrophic consequences. People in poverty are more vulnerable because they live in hazardous areas including floodplains and steep hillsides.

They have fewer resources and this lack of resources affects all levels of the disaster vulnerability. They are less likely to receive timely warnings and they have fewer options for reducing losses even if a warning does arrive in a timely fashion. Poverty is also linked to resilience and speed of recovery.

Disaster prevention needs to address economic and political issues, not only geological and meteorological aspects. The links between social and physical science must be developed.

These links will help in the assessment of the actual long-term impacts of extreme floods and other disasters. The recognition of the inequitable distribution of vulnerable populations must be recognized and research efforts and policies must account for the spatial distributions if actual reductions in disaster losses are to occur.

There also must be vast reconsideration of long term policies for flood mitigation for rivers that experience slow-rise or flash floods if the spiralling economic and social costs, or even the increases in annual costs, are to be reduced. Nothing short of a thoughtful and critical revamping of land use polices at all scales holds promise for reduced loss of lives and property.

This study had the stated aim of improving the understanding of the impact of flooding on the price of Malaysian 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 Malaysian 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.