

A review of climate change (floods) and economic attributes response to residential property value in Malaysia

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ABSTRACT

The art and science of determining residential property value has evolved due to the changing external factors, such as the economy, environmental (climate change) and social aspects. This research aims to identify the impact of climate change (floods) to determine residential economic attributes that could affect the value for residential property in flood risk areas. The case study covers all residential housing schemes in Langat River Basin area, which has been considered as the highest flood risk area in the State of Selangor, Malaysia. The methodology of this research is based on the conceptual analysis from previous studies from local and international scenarios. The systematic analysis of previous literature of real estate valuation theory consists of economic attributes such as structural, locational and environmental attributes involved in residential property valuation in relation to flooding. The findings reveal that the economic attributes' response to flood hazards for residential properties can be divided into three conditions, and they are: positive, negative or no effect on the climate change factor.

Key words | climate change, economic attributes, floods, property value, residential property

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INTRODUCTION

Considering the climate change scenario in Malaysia during extreme weather, flood events can produce impact, directly and indirectly, a threat to human safety, properties, environment, economy, make fertile land unusable, destroy road transport and infrastructure. Malaysia is a country very prone to flood risk, mostly by nature of its physical as well its human geography as land use patterns of settlements (Chan 2015). Compared to other types of disaster in Malaysia, a flood is the most frequent and results in the greatest damage to properties annually. Floods have been divided into three types: river flooding, flash flooding and coastal flooding (Shafapour Tehrani *et al.* 2017).

The worst flood that occurred on the northeast coast of Malaysia is a flood that is called by locals the

Kelantan Big Yellow Flood 2014. In December 2014, Kelantan was hit by the worst floods recorded in the history of flooding of up to 5 to 10 m. Buildings were flooded up to levels three and four and many people could not be evacuated from their homes. People in evacuation centres also faced a lack of necessities for daily life (Eliza *et al.* 2016).

Flooding has been more significant in recent years due to increased urban development, with subsequent increases in water run-off and changes in world weather patterns as a consequence of climate change. The occurrence of such heavy rainfall and subsequent flooding has not only raised the issues of climatic change and the effect on the

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environment, but also more local issues of the impact on residential property development, residential property prices (Lamond *et al.* 2007) and the ability of residential property owners to gain both finance and insurance for their properties.

The frequent occurrence of flooding in Peninsular Malaysia has caused significant damage in relation to both property and to service disruption. Property with physical damage requires a higher operating cost of repair and maintenance which might directly affect the value of the property. The impact of the flood on damage to residential property can be divided into two types, flood and property characteristics. Based on previous studies identified, there is little or no consideration given to the flood characteristic when assessing or valuing residential property to determine the current market. This indicates that the damage caused by floods is considered by many to be a simple problem to resolve, whereas, in reality, it is a complex phenomenon for the valuer and property owner. Due to the rapid development of residential projects, the property players and government need to assume responsibility to avoid developing residential projects in the flood-prone risk areas.

PROBLEM STATEMENT

In Malaysia, the potential for climate change is caused by a combination of natural and human factors. Combined with natural factors such as heavy monsoon rains, intense rains causing great distress, poor drainage and other local factors, floods have become a common feature in the lives of many Malaysians. Various activities carried out by humans will have a negative impact on the environment. Among them are unplanned development, unmanaged construction work, as well as major changes in the pattern of harmful land use. There are several factors that contribute to the terrestrial flood problem in terms of topography, geomorphology, drainage, engineering and climate structure, as described by Khan *et al.* (2014). According to the authors, floods are mostly caused by a storm where the amount of rainfall is high. Heavy rains for long periods of time are factors that contribute to floods which endanger local communities. Since the Kelantan flood was the worst event occurring in decades, it is appropriate to provide knowledge and assess public awareness and perceptions

associated with flood warnings and their dissemination during a flood event (Alias *et al.* 2019).

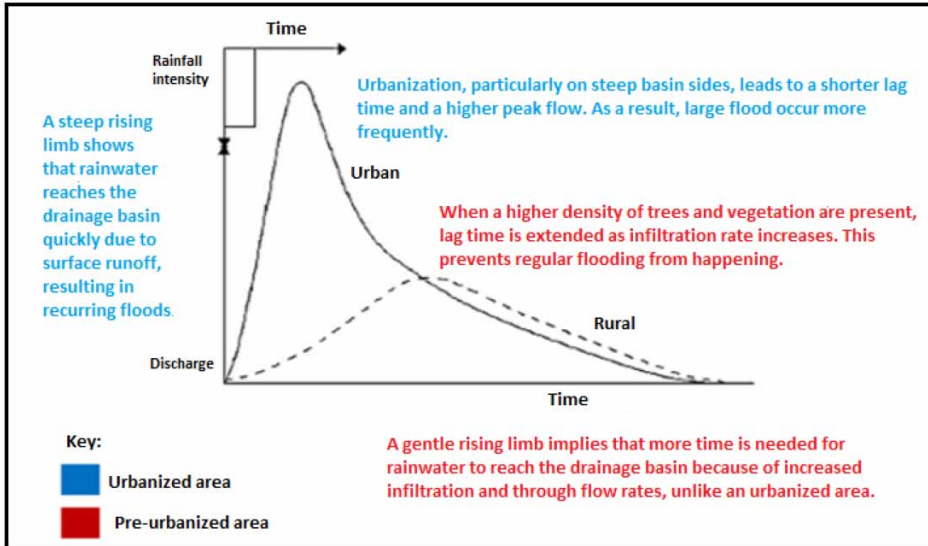
Human activity factors that cause floods are affected by changes in land use. Changes in land use from agriculture to various types of development can cause changes in the pattern of the ecosystem and land structure. Rapid and uncontrolled development will contribute to the occurrence of floods in the vicinity. In addition, the impact of urbanisation is considered a threat to the environment due to rapid development and the increase of population in urban areas (Figure 1).

According to the Department of Irrigation and Drainage (DID) Malaysia (2009), uncontrolled townships are often accompanied by poor infrastructure planning, especially in developing countries. The poor management of drainage infrastructure and irrigation channels reduce the storage capacity of the city drainage system, which causes flash floods (Li-An *et al.* 2018). Although Kuala Lumpur's drainage system is well-designed, maintenance and cleaning deficiencies allow mud collection, rubbish and debris to reduce storage capacity by 50%, thereby enhancing the strength of the flood (Abidin *et al.* 2015).

As shown in Figure 2, the effects of development and municipalities will also increase the construction, population, economic and industrial activities and extraction of groundwater. All of these factors will cause land degradation in urban development areas. Therefore, due consideration should be made before development such as land use planning, groundwater extraction rules, building codes and infrastructure. Controls in flood management and seawater aggression should also be implemented. In addition, environmental conservation needs to be taken into account before these factors can affect the rapid development of the city. Due to frequent flood hazard occurrences in Malaysia, this research is focused on predicting the impact of economic attributes in residential property valuations in flood risk areas.

OBJECTIVE OF RESEARCH

The aim of this research is to identify a conceptual study on the economic attributes' factors in determining the impact of climate change (floods) on residential property value.



Therefore, to achieve this aim, a list of research objectives are identified and listed as follows:

- To identify climate change (floods) economic attribute factors on residential property.
- To analyse the impact of climate change (floods) on residential property valuation.

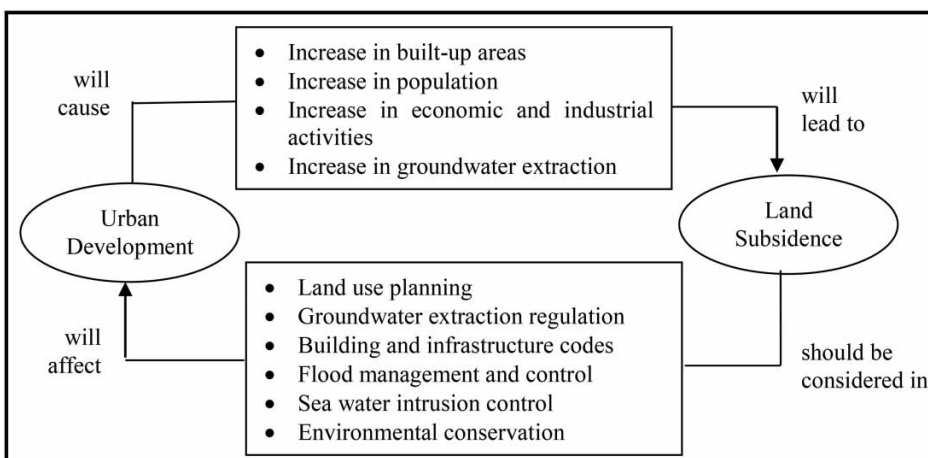
RESEARCH METHODOLOGY

The research methodology is presented in Figure 3. The research aims and objectives were achieved through a literature

review and analysis of previous research from local and international studies. The methodology is designed by separating this research work into three main stages, as shown below.

Stage 1

During the first stage, a problem statement, objectives and research methodology will be determined. The research begins with a literature review relating to flood risk and property, examining previous research journals and reports. The literature review covers overseas and local experience



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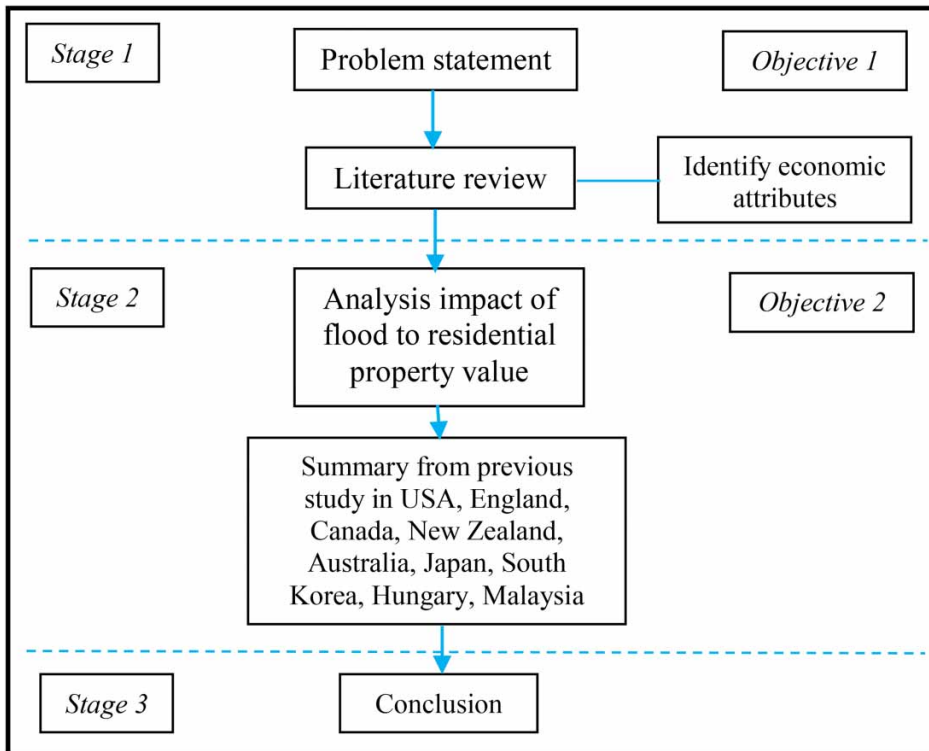


Figure 3 | Research methodology flowchart.

and focuses on climate change (flood disaster) and the impact on property value.

Stage 2

The impact of flooding on property value needs to be determined at this stage. The literature review analysis and summary of prediction on economic attribute factors that have affected property value due to flood disasters needs to be analysed based on previous studies from local and international scenarios. The analysis summary from previous studies involved flood scenarios in the USA, UK, Canada, New Zealand, Australia, Japan, South Korea, Hungary and Malaysia.

Stage 3

The determination of economic attributes that are significant in valuing residential properties needs to be considered in the valuation process. In addition, the impact of flooding also needs to be determined to make sure that

valuers have a full understanding and knowledge of the value, starting from the initial inspection towards preparing the valuation report.

As the final stage, these findings can be a benchmark to valuers and property players while carrying out a valuation inspection and assessing flood risk for residential property.

ECONOMIC ATTRIBUTES IN DETERMINING RESIDENTIAL PROPERTY VALUE

Residential property is a unique product that needs to meet the buyer's need to own or purchase a home for investment purposes. The complexity of residential development now yields more challenges for developers to produce more comprehensive developments in residential areas, which include a conducive environment and excellent facilities for the residents. Many factors involved in determining the market value of residential real estate are not just a matter of supply and demand as a key determinant of property prices.

A summary of the literature overview reflects several studies related to factors affecting the value of residential property that focuses on local and international scenarios. Based on previous studies, the factors affecting property values are: location, structural, neighbourhood, community, environment, age of the property, size of land and buildings of built-up areas (Zhang 2016).

A very important feature will be used in identifying the significant economic valuation in determining the value of residential property in view of the impact of floods. Based on a summary study of literature reviews, the economic attributes can be divided into three categories, and they are (i) structural, (ii) locational and (iii) environment.

Structural attributes

Structural attributes refer to building designs (internal and external), ownership, spaces, and materials used for residential property. The specifications of the building for residential properties comprise several bathrooms, bedrooms, parking spaces, living rooms, swimming pools, house age and building size (McKenzie & Levendis 2010).

Some types of property titles have positive effects while others have a negative impact on property values. For example, on the land alone (Mitchell *et al.* 2015), free real estate has a positive effect on the value of property over leased properties. House age also has a negative impact on property value. Many studies reveal that residential house specifications including the number of bedrooms, bathrooms, potential floor areas are associated with house prices. Most house buyers are willing to buy a home and pay for more space, especially functional space.

Structural properties are the key factors in determining property value; model development has assessed the most important features to be age of house, size of buildings, land size and property conditions in this study.

Locational attributes

In a valuation, the nature of the location refers to the distance of each facility and amenity in the neighbourhood to the residential property. These features comprise neighbourhood-quality facilities provided by the government to residential areas, such as schools, convenience stores,

hospitals, LRT/MRT, mosques and recreation areas. Basically, all the facilities provided in the neighbourhood have a positive impact on the value of the property. The development of an industrial estate near the residential area will have a negative impact on property value (Ismail *et al.* 2016). In summary, this study considers distance factors to highways and convenience stores as an important factor in determining residential property value.

Environment attributes

Environmental attributes refer to external factors such as crime rates, disaster-prone areas (floods and earthquakes) and green areas. Environmental attributes are more often evaluated and believed to have a major impact on natural disasters (floods) and property values in relation to flood-prone areas. Basically, the nature of the environment and residential areas with the highest crime rate will also have a negative impact on property values (Sasaki & Yamamoto 2018).

Flood characteristics generally refer to flood levels that will impact the structure of the building or area. Many studies have shown flood levels based on the frequency, depth and duration of flood events. Basically, flood events will have a negative impact on the value of the property (Aliyu *et al.* 2016), as the flood itself will damage buildings and areas affected by the floods (Osti & Nakasu 2016).

UK-based research shows that although recent flood events affected property values, their impact was marginal where the properties had not been flooded even though they were considered at risk. Recent flood events may result in discounts to the open market value of about 12%, although severe flooding in 2001 led to a 20% reduction in house prices in Maidstone, Kent, while the less severe flood in Sussex had minimal impact (Kenney *et al.* 2006). Flood characteristics are the most important attributes in the development of a rating model that consists of periods of flood, frequency and depth. Flood data from the Department of Irrigation and Drainage Malaysia are the main source of this study.

This study assesses the nature of natural disasters (floods) as an important feature in this study. The relationship between each attribute category is shown in Table 1.

There are so many factors involved in determining the value of residential properties that may vary between one property and another in the same area. Based on the

Table 1 | Summary of economic attributes from the previous research

Author (Year)	Structural attributes										Locational attributes										Environmental living quality attributes						
	Age of house	Floor/building size	Land size	Tenure/title	Types of house/building	Number of bathrooms	Number of bedrooms	Parking space	Living area	Air conditioning	Education institution	Park/lake	Golf	Mosque/Church	Convenience store	Hospital	MRT/LRT Station	Bank	Bus Rapid Transit (BRT)	Industrial area	Commercial Area/Mall	Sea/River	Highway/road	Neighbourhood greenery	Crime rate	Earthquake zone	Floodplain
Lam <i>et al.</i> (2008)	✓	✓				✓	✓			✓	✓						✓					✓					✓
Zhang (2016)	✓					✓	✓				✓	✓					✓					✓					
Chiang <i>et al.</i> (2015)	✓	✓				✓	✓				✓	✓					✓										
Cupal (2015)	✓	✓	✓																								
Candas <i>et al.</i> (2015)	✓	✓		✓	✓																					✓	
Schulz <i>et al.</i> (2014)	✓	✓	✓		✓																						
Mimis <i>et al.</i> (2013)	✓	✓																									
Dziauddin <i>et al.</i> (2013)	✓						✓				✓	✓															
McGreal & Taltavull de La Paz (2012)	✓	✓									✓	✓															
McMillen (2008)	✓	✓	✓																								
Sirmans <i>et al.</i> (2006)	✓	✓																									
Bowes & Ihlanfeldt (2001)	✓	✓																									✓
Luttik (2000)																											
Clapp & Giaccotto (1998)	✓																										✓
Faris (1985)	✓	✓			✓						✓	✓															✓

analysis of the literature review, a summary of the factors of economic characteristics affecting the value of the property due to floods can be categorised into three types: (i) structural, (ii) locational and (iii) environmental quality. Details of each property factor are in [Table 2](#).

Property value is an important aspect of the property market around the world and is determined by various factors. Determining these factors is a significant part of property valuation. Based on previous research analysis, to determine the value of residential property consists of considering the nature of structural, locational and environment factors. Internal factors of housing properties include the physical characteristics of a residential property, legal factors affecting the lease and the legal terms on the property ([Bhattacharya *et al.* 2013](#)).

During a flood, property vulnerability to physical flood damage depends on the amount of property value exposed to flood parameters such as frequency, duration and depth

which, in turn, affects the extent of damage to residential property. Physically damaged property requires a substantial amount of costs for repairs and maintenance and may directly affect the property value.

IMPACT OF FLOOD RESPONSE TO RESIDENTIAL PROPERTY VALUE

The literature surveyed from different points of view, in terms of the impact of a natural disaster (floods) on residential property values across the globe, is evident in the results from various authors, as summarised in [Table 3](#).

The findings from the literature reviews from various countries, such as the USA, UK, Canada, Australia, Hungary, New Zealand, South Korea, Japan and Malaysia particularly, have different disclosure opinions in the particular research scenarios of flood impact on residential

Table 2 | Summary of attribute factors that affected the property value

No.	Attributes factor	Types of attributes factor
1.	Structural attributes	Age of house Floor/building size Land size Tenure/Title Type of house/building Number of bathrooms Number of bedrooms Parking space Living area Air conditioning
2.	Locational attributes	Education institution Park/Lake Golf course Mosque/Church Convenience store Hospital MRT/LRT Station Bank Bus Rapid Transit (BRT) Industrial Area Commercial Area/Mall Sea/River Highway/Road
3.	Environmental living quality attributes	Neighbourhood greenery Crime rate Flood: frequency of flood; depth of flood; duration of flood

Table 3 | Summary of the impact of the flood on residential property value

No.	Country	Author(s)	Impact of flood on residential property value (summary)
1.	United State of America (USA)	Aliyu <i>et al.</i> (2016) Muckleston <i>et al.</i> (1981) McKenzie & Levendis (2010)	Price discounts are observed for some recently flooded areas but they are temporary The impact of the flood had decreased the land value particularly for waterfront land parcel from –19% to –26% compared to non-flooded land parcel as –3%. The impact of this scenario lasts for five to eight years Results indicate that pre-Katrina, there was a premium of only 1.4% per foot in flood-prone areas, and was insignificant in areas not subject to flooding. This increased to 4.6% for flooded areas after Katrina
2.	UK	Lamond <i>et al.</i> (2010) Eves (2004)	Previous studies in the UK and internationally have measured a wide variety of impacts from no impact to discounts of more than 40% of the property price. The results reveal the impact of flood events to be highly variable and temporary and have no effect on flood designation During the flood period year 2000–2001, the residential property value in the Midlands with Gloucester and Welshpool experiences a decrease of 20% in flooded residential property value, compared to the flood-free area. Similar to other cities such as Windsor, Colchester, Upton upon Severn and Worcester, the reduction value ranges from 10% to 20%. Belper and Nottingham were the only cities in the Midlands that did not record any reduction in the value of the flood-prone area. A similar scenario happens in southern counties, with only Maidstone in Kent reporting a very significant (>20%) decrease in the value of flood-prone residential properties compared to non-flood liable properties in the same area. Apart from Salisbury, the reduction value is around 5–10% and all other reported counties in southern England had no reduction in value for a flood-prone area or a minimum of below 5% reduction in value.
3.	Canada	Schaefer (2010) Babcock & Mitchell (1980)	The properties in flood-prone areas significantly decreased in value, in the order of 15% to 20%. In most other locations, properties have increased or remained relatively constant in value. Impact of the flood on property value near the river area in southwestern Ontario. Studies reveal that properties located near a river could be worth 20 to 30% more than another similar property not near a river. When sale prices of properties located in high-risk areas (flooded in 1974) were compared with sale prices of properties located in low-risk areas (not flooded in 1974) before the flood of May 1974, no significant difference in sale prices was found
4.	New Zealand	Montz (1992)	The impact of flood in all three communities are temporary. In Paeroa, properties not flooded experienced significantly increased selling price, while flooded properties did not. In Te Aroha area, the property value declined markedly in the most hazardous areas. The Thames Valley provides a distinct exception to this trend, indeed there is no evidence of a decrease in values during the 1981 flood event
5.	Australia	Rajapaksa <i>et al.</i> (2016)	For such properties in Brisbane, the average property price decreased by 6% in group one (low-income suburbs) and 7% in group two (high-income suburbs). This analysis is followed by examining the impact of releasing flood risk map information and the effect of actual floods on property values
6.	Japan	Zhai <i>et al.</i> (2005) Inoue & Komori (2017)	The price of land for commercial use in flood-prone areas is higher than that for residential or industrial land. When the land price-change trend is set as the difference in land price between 1999 and 2000, the mean flood effects amount to –2,204.7 yen/m ² in 2001 and –8,888.3 yen/m ² in 2002, and the change rates to –1.27% in 2001 and –4.7% in 2002 Identify and analyse the relationship between flood events and transaction price changes in the flood-prone area. The study reveals that flood events induced no price change in frequently flooded areas, and properties in hazard areas are cheaper compared to non-flood hazard areas

(continued)

Table 3 | continued

No.	Country	Author(s)	Impact of flood on residential property value (summary)
7.	South Korea	Jung & Yoon (2018)	Investigate the past flooding affected single-family housing values in Gyeonggi, South Korea. The research reveals that the impact of distance of a flooding disaster is within 300 m from an inundated area. Market values of housing located 0–100 m, 100–200 m and 200–300 m from inundated areas were lower by 11.0%, 7.4% and 6.3%, respectively, and the effect lasted for 12 months only after the disaster and then disappeared. During the first month, 1–3 months, and 3–6 months after a flood, housing units in the disaster-influenced area (within 300 m of the inundated area) were worth, on average, 57.6%, 49.2% and 45.9% less than control units, respectively. Also, within the following six months, the discount effects were reduced to 33.2%. On the other hand, the results showed no statistically significant effects on market values for more than 12 months after the disaster.
8.	Hungary	Békés <i>et al.</i> (2016)	Flood risk reduces housing prices substantially driven by being in close proximity of major rivers. While riverside areas have an overall price premium in Hungary, risk areas lose this advantage to flood risk. In ZIP code areas where the inundation depths are 10% higher, housing prices tend to be 1% lower, on average, plus another 1% lower along the major rivers.
9.	Malaysia	Ismail <i>et al.</i> (2016)	The variable of flood duration in urban and rural areas are negative and statistically significant. The research reveals that if the flood duration is increased by an hour, the land value in urban and rural areas decreased by 4.2% and 4.7%. It shows that the land value in the urban and rural areas where prolonged periods of flooding tend to decrease property market value. Prolonged periods of flooding continuously caused damage to property.

property values in the respective countries. A summary based on the research from the previous studies found that residential property value has a significant impact on floods and normally the property value will be decreased and the impact will be temporary.

CONCLUSION

These findings are very useful as a benchmark to valuers and property players while carrying out a valuation inspection and assessing the flood risk for residential property due to climate change. The characteristics of flood events in several places is varied and critical in determining the impact of floods on property value. These findings are an important outcome of the research and will encourage further research in this area of study.

The effects of a flood will be different within a location and compared to those who have often experienced severe incidents in floods. In addition, floods are experienced differently by different people. The experience of flood impact is determined by the characteristics of people, such

as social vulnerability and exposure, and by the characteristics of floods. Previous studies from various studies around the globe reveal that there is a wide variety of impacts of flood on property value. The duration of the flood that increases by hours will produce a negative impact on property value. The longer the period of the flood the more damage will be caused to property, and the maintenance cost should be significantly high. Besides that, price discounts are observed for some recently flooded areas, but they are temporary and have no effect on flood designation.

The main conclusion is that economic attributes of flood vulnerabilities vary between districts and, at the same time, a relationship exists between flood and property damage and between depths of flood and property loss. In addition, a prediction of the impact of a flood is a very useful tool for decision-makers about which factor is the most significant to focus on when determining residential property value. This study is the first step regarding the impact of flood in the context of climate change to determine residential property value. Further studies are intended to focus on enhancing understanding of the relationship between flood

characteristics, structural and locational attributes with the integration of a geographical information system (GIS) in producing flood property maps. This knowledge can contribute to a more customisable flood risk area and property market scenario.

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