Does Flood Affect Property Values? A Hedonic Analysis of Residential Property Values in Peninsular Malaysia

Nur Hafizah Ismail [*a], **Mohd Zaini Abd Karim** [b], **Bakti Hasan Basri** [c]
[a,b] *Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia*
[c] *School of Economics, Finance and Banking, Universiti Utara Malaysia*

Abstract

The hedonic pricing model (HPM) has been used to identify the values of residential property due to flood impact. Most of the previous studies had been conducted using flood frequency and flood depth to measure flood variables rather than flood duration. The hedonic pricing study presented here investigated the effect of flood duration on residential property value in Peninsular Malaysia. We measured the housing attributes involving location, structural, and neighborhood attributes. We also developed the interaction variable between flood and structural attributes to determine whether the effect of flood duration on residential property value differs across house age, size of land area, and number of bedroom. The results suggest that the sale price of residential property is significantly decreased by 0.015 percent due to flood.

Keywords: Hedonic pricing, property values, flood duration

1.0 Introduction

The report by Global Facility for Disaster Risk Reduction (2012) shows that flood is one of the natural disasters that have a disastrous effect on the economy, society, and the environment. Flood is also reported as among the most frequent natural disasters causing substantial human, livestock and asset losses. Regarding asset loss, a flood can destroy infrastructure and buildings such as houses. People have to leave their homes, disrupting their normal life. According to Queensland Floods Science, Engineering and Technology Panel (2012), the consequences of a flood on properties vary depending on its nature such as frequency, depth, velocity, and duration. The speed of flood recovery depends on whether the flood is major or minor. A country that experiences a major flood, the recovery of assets takes a long time and incurs high repair costs. This may result in the depreciation of property value. However, a minor flood tends to involve quick damage recovery (Eves, 2004; Soentato & Proverbs, 2004).

* Corresponding Author
E-mail Address: hafizah19@live.com

The impact of the flood on property has been analyzed from various perspectives such as residential property value. However, the findings are mixed. The impact of food on the value of the residential property varies depending on the frequency, depth, and duration of the flood. According to Bin and Kruse (2006), flood reduces the value of residential property. However, Babcock and Mitchell (1980) found otherwise. They demonstrated no significant impact of the flood on residential property values. Meanwhile, Tobin and Montz (1990) found a positive relationship between flood and house value where there was a small increase in house price sold in the flooded area.

This study focuses on Malaysia because Malaysia experiences flood every year due to the periodic monsoon seasons. Even though flood events in Malaysia are not classified as an extreme disaster, the annual flood occurrence affects the population and causes damage to the properties such as residential property, factory building, and land. Therefore, it is pertinent to study the effect of the flood on residential property values. Also, studies on the relationship between flood and property are limited in Malaysia and do not focus on the effect of the flood on residential property value. Furthermore, existing studies focused on disaster management and preparedness (Singh & Subramaniam, 2009), causes and solution (Chan, 1996; Khalid & Shafiai, 2015) and the level of understanding and practice policy regulation (Abdul Rahman, 2009; Rahman, 2012). Evidence related to the hedonic pricing model and its application to the property research in Malaysia is very little and does not incorporate flood (e.g., Keng, 2008; Othman, Othman, & Md. Noor, 2006; Mar Iman, Hamidi, & Liew, 2009). To the date, the effect of flood and property in Malaysia using the hedonic pricing method remains unexplored.

This study contributes to the literature in predicting residential property values in Malaysia, which helps decision makers to own a property in a flood-prone area or a flood-free area. Besides that, it also contributes towards a new perspective of the property literature regarding the impact of flood in Malaysia whereby the application of the hedonic pricing model is integrated to predict the effect of flood on residential property values. Hence, the main objective of this paper is to determine the effect of flood, measured in flood duration, on the residential property value in Malaysia. By using the hedonic pricing model (HPM) in estimating the flood impact on residential property values, this study could inform policymakers in designing and allocating a residential property development project efficiently to ensure that residential property loss is minimized in the case of flood.

The remainder of the paper is organized as follows. Section 2 reviews the related literature on the effect of flood on residential property value. Section 3 discusses the methodology. Section 4 and section 5 provide the empirical results and discussion. Finally, section 6 concludes and provides some recommendation.

2.0 Review of Literature

The impact of flood on residential property value has been analyzed by considering the seriousness of the flood event measured in terms of flood frequency, depth, and duration. Soentato and Proverbs (2004) found a negative relationship between flood depth and property value. Overflooding can result in significant damage to the property and hence a decline in value. Generally speaking, minor flooding causes little damage on the property. However, if the water rises above the floor level, it can cause much damage to the houses and reduce the property price in the flooded area. In general, the longer the duration of the flood, the greater the cost needed for repair works on the damaged property, resulting in a further decline in the property value. Besides, properties that frequently experience flooding tend to be perceived as having a higher risk. As a result, the residential property market significantly declines in value due to the flood occurrence.

However, the literature shows that flood duration is an important variable in studying the impact of the flood on residential properties value (Eves, 2004; Soentato & Proverbs, 2004). Soentato and Proverbs (2004) found a positive connection between the duration of flood and house damage. In general, the longer the duration of flood, the greater the cost is needed for repair works on the damaged property resulting in a higher decline in property value. Eves (2004) categorized the flood duration into three types: minor, major, and severe. He demonstrated that flood duration decreased the value of flood affected residential property in Sydney. All areas that reported a decline in house value of over 20% were subject to severe flooding in the 2000-2001 floods in Sydney.

In the analysis of the flood effect on property values, the hedonic pricing model (HPM) and the repeat-sales method are the two methods that have been applied extensively in studies in the United States, Europe, and Australia. For example, Holway and Burby (1990) applied the HPM in the United States while Lamond, Proverbs, and Antwi (2007) used the repeat-sales method in the United Kingdom. Even though HPM and repeat-sales methods use the estimates of house price to measure the value of property on particular attributes, the application of both methods differs.

Triplett (2004) opined that HPM is a comprehensive and practical approach to estimating property values. HPM investigates the relationship between sale prices and property characteristics. Ridker and Henning (1967) were among the earliest researchers who used HPM in determining house price by investigating the relationship between air pollution and property values. Later, Rosen (1974) and Freeman (1979) used the approach to estimating the values of conveniences on goods such as structural attributes.

Results of previous studies by Francke, Vos, and Janssen (2000) and Clapham et al. (2004) suggested that HPM is the best method for estimating housing values.

HPM is widely used to study the relationship between property values and property attributes such as location attributes (Kruse & Ahmann, 2009; Yu, Wei, & Wu, 2007), structural attributes (Chau, Ng, & Hung, 2001; Fletcher et al., 2000), neighborhood attributes (Chang & Lin, 2012; Espey & Lopez, 2000), and environment attributes (Chattopadhyay, 1999; Leggett & Bockstael, 2000).

3.0 Methods

3.1 Hedonic Pricing Model

Hedonic pricing theory originated from Lancaster's (1966) consumer theory and Rosen's model (1974). Both works explain the relationship between the prices of products and the characteristics associated with the products but from different perspectives. The hedonic pricing model is used to measure the influence of amenities and disamenities on property values. Hedonic pricing assumes that individuals perceive housing units as bundles of housing attributes and derive different levels of utility from different combinations of these attributes. When transactions are made, individuals make tradeoffs between money and attributes that reveal the marginal values of these attributes. Measuring the housing attributes involves several classes of attributes such as location, structure, neighborhood, and the environment. Each of these classes of attributes may include elements of variables such as proximity to city center (Des Rosiers et al., 1996), number of bedrooms (Fletcher et al., 2000), house age (White & Leefers, 2007), and proximity to a recreational park. Structural attributes such as house age, number of bedrooms, and size of land have been found to affect positively property values with the use of the hedonic pricing model.

3.2 Study Area Description

In Malaysia, like any other disasters, flood often results in significant human and economic losses. According to the World Bank report, an estimated 29,800 square kilometers of Malaysia are flooded every year, affecting almost five million people with damages of almost USD300 million. Therefore, this study is carried out to estimate the effect of flood on residential property value across Peninsular Malaysia. The study covered 11 states in the peninsula. The scope area was narrowed down further to certain districts commonly hit by floods. Two districts from each state were selected based on the parameters:

i. Major flooding/minor flooding occurred in the big city
ii. Major flooding/minor flooding occurred in the small city

3.3 Data Collection

For the collection of primary data on house price, the target population was a group of flood victims who had experienced a flood event within a five-year period (2008-2013)

in Malaysia. Information regarding flood and property sales price was obtained from the Department of Irrigation and Drainage Malaysia, Malaysia Property Valuation Centre, the Department of Social Welfare, and the Municipal Council.

A total of 1500 participants among the flood victims were selected and interviewed. However, only 90.7 percent or 1360 participants responded to the interview requests. Another 9.3 percent were removed from the list because of missing assessment records and inconsistent answers on assessment valuation.

3.4 Developed Model

In the developed model, the dependent variable is the property sales price. The independent variables selected for inclusion in the models are those consistent in influencing the purchase price of a residential property. Besides that, we also wanted to know whether the effect of flood depends on structural attributes. To incorporate the effect, we included the interaction term in the model. A model with a single-log dependent variable was fitted. According to Basu and Thibodeau (1998), a semi-log functional form can be used to correct heteroscedasticity problem between house price and the residuals. The equation to be estimated is shown in Equation 1;

$$Log\ SPRICE_i = \beta_0 + \Sigma\beta_j\ FLOOD_{ij} + \Sigma\beta_u\ LOC_{iu} + \Sigma\beta_l\ STR_{il} + \Sigma\beta_k\ NGH_{ik} + \Sigma\gamma_1\ FLOOD * STR_i + \mu_i \quad (1)$$

Where *SPRICE* is the residential property sales price, *FLOOD* is the matrix of flood duration, *LOC* is the matrix of location attributes, where the elements of distance to the nearest bus station (BUS) and city center (CITY) were used, and *STRSTR* is the matrix of structural attributes. This study applied house age (AGE), size of land area (AREA), and number of bedrooms (BEDROOM) as the elements of attributes. *NGH* is the matrix of neighborhood attributes which used the proximity to the nearest airport (AIRPORT) and hospital (HOSPITAL) as the factor elements. *FLOOD * STR* is the matrix of the interaction term to indicate whether the effect of flood duration on the value of residential property is influenced by structural attributes of the property. Therefore, this study incorporated the elements of flood duration and house age (DURATION*AGE), flood duration and size of land area (DURATION*LAND), and flood duration and number of bedroom (DURATION*BEDROOM) as the measurement of the interaction term variables. Hence, the final equation to be estimated is shown in Equation 2;

$$\begin{aligned} Log\ SPRICE_i = {} & \beta_0 + \Sigma\beta_j\ DURATION_{ij} + \Sigma\beta_k\ BUS_{ik} + \Sigma\beta_l\ CITY_{il} + \Sigma\beta_m\ AGE_{im} + \\ & \Sigma\beta_n\ LAND_{in} + \Sigma\beta_p\ BEDROOM_{ip} + \Sigma\beta_r\ AIRPORT_{ir} + \\ & \Sigma\beta_s\ HOSPITAL_{is} + \Sigma\gamma_1\ DURATION * AGE_{i1} + \\ & \Sigma\gamma_2\ DURATION * LAND_{i2} + \Sigma\gamma_3\ DURATION * BEDROOM_{i3} + \mu_i \end{aligned} \quad (2)$$

4.0 Results

4.1 Descriptive Statistics

Table 1

Residential Property Value Descriptive Statistics

Variable	Minimum	Maximum	Mean	St. Deviation
SPRICE	69600.00	590000.00	266080.73	199384.95
DURATION	1.00	720.00	15.31	48.26
BUS	0.60	85.60	10.91	9.45
CITY	0.30	69.70	9.30	8.39
AGE	2.00	15.00	15.56	13.56
LAND	1200.00	4000.00	1586.04	672.33
BEDROOM	3.00	6.00	4.04	3.83
AIRPORT	10.00	102.00	48.96	38.62
HOSPITAL	0.50	16.70	9.15	9.06

Table 1 shows that the period of flood duration recorded in this study ranged from 1 hour to the maximum of 720 hours. The residential property in this study, on average, had a moderate to a large size of land (4000 square-foot) located 10.9 and 9.3 kilometers, respectively, from the nearest bus station and city center. The property age surveyed in this study ranged from a minimum of 2 years to the maximum of 15 years, and the number of bedrooms reported ranged from 3 to 6 rooms. Besides that, the residential property is located, on average, approximately 10 and 0.5 kilometers, respectively, from the nearest airport and hospital. The property sales price ranges from RM69,600 to RM590,000.

4.2 General Model Result

The independent variables in the model were statistically significant predictors of residential property sales price with the model *F*-statistic of 76.95 and the p-value for the F-statistic were less than 0.05, indicating that the result was statistically significant. Therefore, the overall models of specification are said to be statistically significant and the equation can be accepted for forecasting. The R^2 showed that 0.462 of the variation in the dependent variable can be explained and accounted for by the independent variables in the regression analysis. However, in a multiple regression, the adjusted R^2 takes into account the existence of additional independent variables and adjusts this R^2 price to a more accurate view of the regression's explanatory power. Hence, only 0.456 of the variation in the dependent variable can be explained by the

regressors. The standard errors in the independent variable coefficient were corrected for heteroscedasticity using White's heteroscedasticity test. The independent variable tolerance values were examined for the indication of multicollinearity in the model.

5.0 Discussion

Table 2

Estimates of Hedonic Regression on Residential Property Value

Variable	Coefficient	St Error
Constant	11.915***	0.084
DURATION	-0.015***	0.003
BUS	-0.001	0.005
BUS^2	0.000141	0.000091
CITY	0.011*	0.007
$CITY^2$	-0.000433**	0.00002
AGE	-0.018***	0.001
LAND	0.00018***	0.000029
BEDROOM	0.298***	0.023
AIRPORT	0.008***	0.001
$AIRPORT^2$	-0.00037***	0.00001
HOSPITAL	-0.015***	0.006
$HOSPITAL^2$	0.001***	0.000134
DURATION*AGE	0.00003	0.000027
DURATION*LAND	0.0007***	0.00002
DURATION*BEDROOM	0.00018**	0.00007
R^2	0.462	
Adjusted R^2	0.456	
F-Value (p-value)	76.95 (0.000)	

5.1 Flood Duration

Table 2 shows that the coefficient of DURATION in the model was negative and statistically significant. It explains that if the flood duration increases by a day, the residential property value significantly decreases by 0.015 percent. This indicates that the value of the residential property that faces a flood risk tends to decline. This is because a prolonged period of flood is associated with more residential property

damage, resulting in an increase in property restoration cost (Soentato & Proverbs, 2004). Longer flood duration incurs a high repair cost for a house to be renovated due to the property damage. Furthermore, much money is needed to repair a damaged house. Besides that, if the prolonged period of flood keeps increasing above the floor level, this will cause much damage to the home furnishing and personal belonging. Also, high reconstructing and rebuilding costs are involved for residential areas that are prone to flooding that causes serious property damage. For example, Majlis Keselamatan Negara recorded that a major flood that hit Kelantan in December 2014 damaged a total of 2,374 houses, and the estimated total cost of repairing the property and rebuilding houses were about RM200 million. This indicates that the massive flood impacts on property damages result in a high cost of property repairs, renovation, and maintenance. Therefore, the damage and destruction of a residential property due to flood will have an effect on the house value. The damage will negatively affect a buyer's decision to buy a property in a flood-prone area, hence reducing the property market price. The result is consistent with the findings by Tobin and Montz (1990), Eves (2004), and Soentato and Proverbs (2004), who found that flood duration caused a decline in housing value and affected the sales of the property market.

5.2 Location Attributes

Table 2 shows that the coefficient of BUS and BUS^2 in the model was statistically insignificant. The possible explanation is that public bus transportation is no longer being the preferred choice due to the poor quality of the public transport management service and the inefficiency of the public transport travel schedule. This makes public transport users preferred to using a bus less as their main transportation. This argument is supported by Almselati et al. (2011) and Nurdden et al. (2007), who found that a disorganized bus schedule and service quality were the contributing factors that influence users to shift from using a public bus to a car in Malaysia. Therefore, the distance to the nearest bus station does not affect the residential property value.

Meanwhile, the coefficient of CITY in the model was positive and statistically significant. The result indicates that a kilometer increase in the distance to the nearest city center will increase the residential property value by 0.011 percent, and the property value is significantly reduced at 0.000433 percent when the distance reaches a certain limit. It shows that the residential property which is located near a city center has a lower market value. This indicates that buyers prefer to buy a residential property located farther away from the city for a better environmental quality. The residential area which is located near a city is exposed to environmental noise, pollution issues, and health disease. This is supported by Lee et al. (2012) who found that city centers such as Johor Bahru have poor air quality because of the air pollution from the industrial activities. In fact, the World Health Organization reported that people who are living near a city center are vulnerable to health diseases such as asthma due to air pollution. This causes

a low demand for a residential property located near a city center, resulting in a decline in the property market value.

5.3 Structural Attributes

The result in the model showed that the coefficient of AGE was negative and statistically significant. It shows that a year increase in house age will reduce the residential property value by 0.018 percent. This indicates that an older house has a lower property market value. An older house incurs more cost of maintenance and repair such as plumbing and electrical and mechanical systems. In fact, an older house in a flood prone area needs double the cost for repair and restoration due to damages and losses caused by flood. This is supported by Clark and Herrin (2000) where they also found that building age was negatively related to property prices.

Also, the coefficient of LAND in the model was positive and significant. It shows that one-square-foot increase in size of the land area will increase the residential property value by 0.00018 percent. This indicates that a residential property with a higher size of land area has a higher market value. This is supported by the Malaysian Property Stock Report where the price of a 1400 square-foot single story house in Ayer Keroh, Melaka is RM150000 higher than the price of a 1300 square-foot single story house in the same town (National Property Information Centre Malaysia, 2014). Therefore, the size of the land area does affect the residential property value.

The coefficient of BEDROOM in the model was positive and statistically significant. A unit increase in the number of bedrooms will increase the residential property value by 0.298 percent. It shows that a residential property with an additional number of bathroom has a higher market value than a standard residential property. This is because an increase in the number of rooms such as bedrooms requires high construction costs, causing an increase in the property value. In fact, an addition of extra bedroom and bathroom is important to the family lifestyles and occupant's privacy. Therefore, many residents will construct an additional room on their property. These results are consistent with the findings by Fletcher et al. (2000).

5.4 Neighborhood Attributes

The result in the model showed a positive and statistically significant coefficient of AIRPORT. It indicates that if the distance to the nearest airport increases by a kilometer, the residential property value also increases by 0.008 percent. However, the property value significantly declines by 0.00037 percent when the distance reaches a certain level. It shows that buyers are not interested in buying a property near an airport because they will be exposed to the noise pollution. This is supported by the finding of the United States Civil Aviation Authority. People who are exposed to aircraft noise at 57decibels

(dB) for an average over 16 hours will have their health adversely affected. In fact, if people are exposed to the aircraft noise at 95 decibels and above for 4 or more hours per day, they will experience distraction, sleep disturbance, and permanent hearing impairment. This is evidenced by the lower price of single story houses nearby the Penang International Airport compared to the average price of houses in Georgetown (Malaysia Property Stock Report, 2014). The result supports the findings by Espey and Lopez (2000) and Feitelson, Hurd, and Mudge (2006), who found that proximity to the airport affected the property value nearby.

A significant result of coefficient of HOSPITAL in the model showed that if the distance to the nearest hospital increases by a kilometer, the residential property value will reduce by 0.015 percent. However, the property value will start to increase at 0.001 percent when the distance reaches a certain level. It shows that a residential property located near a hospital has a higher value than other properties located farther away from the hospital. The availability of a hospital near to the residential property area allows residents to get a fast emergency treatment. This raises the demand for a residential property nearby hospital and affects the property market value. Bertam Property Development Sdn Bhd reported that the price of a single-story house in Taman Bertam located 26.6 kilometers from Hospital Seberang Jaya is lower than the house in Taman Arowana nearby a hospital. However, Huh and Kwak (1997) found that the availability of a hospital had a negative impact on house buyers in Seoul Korea. The majority of buyers in Seoul Korea avoid buying a house nearby hospital due to superstitious beliefs. However, in Malaysia, the superstition related to a hospital does not affect the choices of buying a residential property nearby a hospital.

5.5 Interaction Term

Apart from the flood, location, structural and neighborhood attributes, we also wanted to know whether the effect of flood on property value depends on structural attributes. To incorporate the effect, we included the interaction term in this study. The interaction variables in Table 2 indicate whether the effect of flood on the value of residential property is influenced by structural attributes of the property. The coefficient DURATION*AGE showed an insignificant result. Meanwhile, the coefficients of DURATION*LAND and DURATION*BEDROOM were positive and statistically significant. It shows that as the size of land area increases by a square-foot, the effect of flood on residential property value increases by 0.0007 percent. Similarly, if the number of bedrooms increases by one, the effect of flood on residential property value also increases by 0.00018 percent. These results revealed that flood events had a bigger effect on the residential property value as the size of land area and number of rooms increase. For example, a larger size of land area allows the property owner to make full use of the space for gardening activities or to construct an additional room such as a bedroom and a bathroom. Thus, if a flood hits the area, it will significantly cause huge damage to the asset on the land. This will consequently reduce the demand and cause a decline in the property value.

6.0 Conclusion

This study supports the result of earlier studies that the flood duration adversely affected residential property value. The result suggests that residential property prices in the flood prone area suffered a reduction in property market value as well as serious property damage. Thus, structural and non-structural solutions such as flood mitigation projects like river improvement work and the widening and deepening of the river, drainage and river bund should be carried out in residential areas that experience severe flood, especially during the monsoon seasons. Such projects could help reduce repeated floods in their areas and ensure the property loss caused by the flood is minimized. Besides that, the government should also introduce a proper flood insurance program since flooding and property market worry buyers and developers in Malaysia. A flood insurance program in Malaysia does not exist, and many insurance policies do not cover loss or damage caused by flood. Therefore, an insurance framework must be carefully designed to make sure flood victims can be adequately insured for recovery and restoring their residential property.

Previous literature has demonstrated that the hedonic pricing model (HPM) is a very useful method to study the relationship between property attributes and their prices. HPM tends to indicate that residential property values are correlated with the location, structural, and neighborhood attributes. Based on the results, most of the coefficients for the locational, structural and neighborhood attributes were significant and of the expected sign. Therefore, based on these attributes, properties in Malaysia could be priced in a way similar to other countries. HPM gives an accurate portrayal of information of a buyer's preference of attributes of a residential property in the housing sector which helps developers to provide quality property, as they can better predict what the buyers want.

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