The Effect of Seasonal Flood on Agricultural and Industrial Land Values in Malaysia: A Hedonic Pricing Model (HPM) Approach

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Abstract

Flood disasters have raised critical issues for landowners as they might affect land values. The argument of possible decline in the value of land located in flood-liable areas has been discussed in previous literature. However, existing studies on flood impact in Malaysia are few and do not focus on land property as a main issue of study. Therefore, in this study, we investigate the effect of flood on agricultural and industrial land property values in Malaysia by using the Hedonic Pricing Model (HPM). The results of this study suggest that flood duration significantly reduced the value of agricultural and industrial land property. The results from this study has benefits for landowners in terms of understanding the effect of flood duration on agricultural and industrial land values and factors responsible for decreasing land value. This will help the landowners to make contingency arrangement on the property assets to ensure that loss due to flood is minimized.

Keywords: *Flood, land property, Hedonic Price Model (HPM), valuation*

1.0 Introduction

Floods can cause devastating effects on communities, environment and the economy. According to the Centre for Research on the Epidemiology of Disasters (2005), flood is the most common disaster that occurs in many countries compared to others. Many disaster experts such as Tobin and Montz (1990), Eves (2002), and Lamond and Proverbs (2006) claim that floods cause great impact in terms of economic loss and property damage. Queensland Floods Science, Engineering and Technology Panel (2012) stated that the effect of floods on properties and economy vary depending on the flood attributes such as depth, duration, frequency and velocity. Nevertheless,

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the degree of recovery of damages depends on the type of flood. For example, a country that experienced major floods, deal with massive destruction of property and assets. Therefore, it takes a long time to recover and also incur high repair cost. This will result in a decline of value of property (Soentato & Proverbs, 2004).

Past studies on flood impact and property values have been analysed from the aspect of land property or residential property (Bin & Polasky, 2004; Saptutyningsih & Suryanto, 2011). In any attempt to ascertain the effect of flood damage on land property values, an important consideration is that the price of a piece of land greatly exceeds the value of any buildings on it (Zhai, Fukuzono, & Ikeda, 2003). The authors proposed that the land and building values should be evaluated separately. Generally, flood that hits a land at random intervals will demolish the assets as well as interrupts economic activity on the landed property. Thus, landowners must take responsibility of puting the land and its assets to their best use during the flood event.

Previous studies indicate that many researchers have examined the effect of floods on residential property values. However, studies of flood impact on landed property values are still considered limited because the topic is less explored by researchers, in the view of the fact that it is difficult to measure land value itself. Usually, the price of the land sold includes capital value (Case, 1994). Thus, it is not easy to separate the land price and its capital value. For example, all property taxes in the United States are imposed on the combined value of land and capital. Thus, it is difficult to measure and to obtain data on the residential and land property values separately.

Among the earliest researchers who examined the impact of flood land property price were Damianos and Shabman (1976) and Greenberg, Levin, and Schlottmann (1974). For example, Damianos and Shabman (1976) studied the land price in the flood hazard areas in Virginia, United States using land comparison method. The authors used the degree of flood hazard and flood location (flood-prone or flood-free) as the flood indicators in their regression analysis. Besides that, Zhai, Fukuzono, and Ikeda (2003) and Saptutyningsih and Suryanto (2011) have also studied the effect of flood on land property values in some Asian countries such as Tokai, Japan and Yogyakarta, Indonesia. However, the reseachers only focus on flood impact based on a single flood event. For example, a case study of Tokai flood which had occurred in September 2000 has been selected by Zhai, Fukuzono, and Ikeda (2003) to analyse the impact of flood on land property prices in Tokai area. In addition, both authors used flood indicator of height level of flood inundation (flood depth) in their study. Meanwhile, this paper employed a different indicator of the flood variable which is flood duration in the study.

Rapid economic development has stimulated the use of land in Malaysia. Land become essential parameters to determine appropriate places for particular uses such as for agricultural, industrial, commercial or residential purposes. Due to the rapid development in agricultural and industrial sectors, demands on agricultural and industrial land are increasing. The high demands have to be offset by the availability of sufficient land for the industrial and agricultural development activities which are also growing.

Seasonal floods occur almost annually in Malaysia. Continuous rain in many peninsular states during the northeast monsoon season cause flood events in Malaysia. Even though the scale of flood events in Malaysia is not serious compared to other countries and neither considered as extreme natural disasters, nevertheless, the repeated flood events have affected the economy, ecosystem, population and also caused severe damage to assets and properties. Several studies on flood events in Malaysia have been conducted by Chan (1996), Abdul Rahman (2009), and Khalid and Shafiai (2015). However, those researchers did not study the flood impact on property value; hence, topic on the effect of flood on land property values remains unexplored. Existing studies have focused on the aspect of flood risk, flood preparedness and flood management such as level of understanding and policy regulation practiced (Chan, 1996), causes and solution (Chan, 1997) and health preparedness (Singh & Subramaniam, 2009).

In Malaysia, literature reviews on the Hedonic Pricing Model (HPM) and its application to the property studies are scarce and does not include flood as one of the important factor to be analysed. Besides that, studies on land property in Malaysia are considered limited. In addition to this, studies on flood impact and land property values in Malaysia remain unexplored. Hence, it is pertinent to study the effects of floods on land property values in Malaysia. Landowners will gain advantage from this study by way of information regarding the impact of flood on land property values. The results from this study should benefit landowners in terms of understanding the factors that highly contribute to the loss in land property values during flooding events. Besides that, this study contributes towards a new aspect in the literature, whereby the application of the HPM is included to study the flood impact on land property values in Malaysia.

The main objective of this study is to determine the effect of flood on land property values in Malaysia, measured by flood duration as the flood indicator. By applying the HPM in estimating the impact of floods on land property values, this study provides information to policy makers on the design of policy for flood risk management and to develop strategic frameworks to manage property risk.

The remainder of the paper is organised as follows. Section 2 reviews related literature on the effect of flood duration on land property values. Section 3 describes the methodology in analysing the impact of flood duration on land property values. Section 4 provides the results and analysis of flood impact on land property values. Finally, Section 5 presents conclusions and recommendations.

2.0 Reviews on Relevant Literatures

The effect of flood on property values depends on the seriousness of the flood event such as flood frequency, flood depth and flood duration. Minnery and Smith (1996) and

Handmer and Smith (1990) found that flood depth has a significant effect on property damage. For example, minor flood causes little damage on assets and property. However, if the water rises above floor level, it causes severe damage to assets and property and affects the price of property in the flood prone area. Meanwhile, previous studies by Shultz and Frigden (2001) and Eves, Blake, and Bryant (2010) had applied the issue of frequency of flood to study the impact of flooding on property value. Their findings show that flood frequency has a negative relationship with property value. Generally, property that experienced repeated flood tend to increase the perceived exposure related to the flooding. As a consequence, the market value of property significantly decline due to repeated flooding.

Previous literature show that flood duration has a significant effect on the value of property. Flood duration is widely used as a flood indicator in examining the effect of flood on residential and land property values (Eves, 2004; Soentato and Proverbs, 2004; Saptutyningsih & Suryanto, 2011). In analysing the effect of flood duration on residential property values, Soentato and Proverbs (2004) and Eves (2004) found that flood duration has a negative relationship with the residential property values. Similarly, a study done by Saptutyningsih and Suryanto (2011) in Yogyakarta, Indonesia regarding the effect of flood duration on agricultural land property values also indicates a negative result. Longer time period of flooding will lead to more decline in property values because greater cost of repairing works are needed for the damaged property.

Hedonic Pricing Model (HPM) and the repeat-sales method are the two methods that have been widely used in measuring property values. The application of these methods in measuring property values have been broadly discussed in the United States, Europe and Australia. For example, in the United States, Palmquist and Danielson (1989) applied HPM to determine the value of farmland property in North Carolina. Meanwhile, in North Yorkshire, United Kingdom, researchers Lamond and Proverbs (2006) tested the repeat-sales method in their studies on property values nearby Barlby. Though the main purpose of both methods is the same, which is to estimate property values and particular features and attributes, the application of both methods vary.

According to Shimizu, Takatsuji and Nishimura (2010), repeat-sales method is a low cost method and it requires few details or information regarding the property. Repeat-sales method can control the property features and attributes in measuring the property price. However, Hansen (2006) claimed that this method likely to have a sampling bias issue. The author stated that the change of property price movements tends to have biased samples of overall property price. Besides that, according to Shimizu, Takatsuji and Nishimura (2010), the issue of sample bias also happened because properties that were traded several times have difference characteristic and attributes from the typical one. Another weakness of this method is that it can only measure a property that has constant attributes and quality (Palmquist, 1982; Dorsey, Haixin, Walter, and Hui-chen, 2010). As a result of these limitations, Harrison, Smersh, and Schwartz (2001) prefers to employ HPM in estimating the value of property.

Generally, HPM estimates the relationship between property price and its characteristics. According to Triplett (2004), HPM can overcome the limitation of sampling bias in the repeat-sales methods. The author stated that HPM is considered to be a more practical and more comprehensive approach. This is because, all the available data of property price and property attributes can be used in estimating the property value using HPM. Among the earliest researchers who proposed HPM in determining the residential property price was Ridker and Henning (1967). The authors investigate the relationship between house price and environmental attributes. Later, Rosen (1974) and Freeman (1979) help to established HPM by measuring people's values for their conveniences on property such as structural, location and neighbourhood attributes.

Previous studies on HPM categorised property attributes into four: location attributes, structural attributes, neighbourhood attributes, and environmental attributes (So, Tse, & Ganesan, 1996; Chattopadhyay, 1999; Fletcher, Gillimore, & Mangan, 2000; Espey & Lopez, 2000). For location attributes, the accessibility is measured in terms of frequent transportation access and accessibility to the city centre. These two elements that are associated with cost and time are used in determining the effect on property value (So et. al, 1996). In structural attributes, a property that has more desirable attributes than others would have a higher market price (Ball, 1973). The valuation of property attributes can be measured according to their attributes such as number of bathroom and bedroom for residential property (Kain & Quingley, 1970), or infrastructure development of land property (Zhai, Fukuzono,& Ikeda, 2003). For neighbourhood attributes, the determinants in evaluating the property value can be classified as social amenities such as hospitals and schools (Huh & Kwak, 1997), and externalities such as airport noise (Espey & Lopez, 2000). Meanwhile, environmental attributes refer to the environmental quality such as quality of air and quality of water possessed in the residential property living area (Leggett & Bockstael, 2000).

In spite of limited studies regarding flood and land property, a few researchers such as Zhai, Fukuzono, and Ikeda (2003) and Saptutyningsih and Suryanto (2010) had successfully applied HPM in estimating the effect of flood and land property price in Japan and Indonesia. Both results indicate that land in a flooded area tends to show lower value and it has less variance compared to the land in flood-free area. Saptutyningsih and Suryanto (2011) also found that flood duration significantly affect land property value in Yogyakarta. The result shows that the as the flood duration increased by eight days, the land price declined of nearly USD46.43.

3.0 Methodology

The study builds on the existing literature that deals with flood duration as the flood indicator into HPM. Previous literatures prove that HPM is able to measure flood impact on property values. Some researchers have successfully employed HPM to investigate the effect of flood duration on land property value. HPM enables the potential influence of each property attribute on the property price to be tested and examined. In general, the foundation of HPM suggests a systematic use of data on property to explain the connection between price and its attributes. Detailed discussion on the relationship between the price of a property and its attributes are explained in Equation 1;

$$P = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 \ldots \ldots + \alpha_k X_k \tag{1}$$

X_1 through X_k represent the attributes of a property such as locational, structural, environment and neighbourhood. α_j refers to the weight or coefficient for each of the X 's. *P* is the price of the property. HPM uses mathematical procedures to calculate each α value of α_j. For example, X_1 represents the build-up area in square foot. The linear function in Equation 1 implies that if X_1 goes up by one square foot, the price of the property rises by α_1 dollar. This can be explained in Equation 2;

$$\frac{\partial P}{\partial X_i} = \alpha_i \tag{2}$$

where the change in P due to a change in X is constant and is equal to α_i. In other words, it shows that the price of a square foot of land is α_i dollars.

There are various factors that determined the land property value. These factors are classified into four; flood duration *(Duration)* , location *(Location)* , neighbourhood *(Neighbourhood)*) and structural *(Structural)* as shown in Table 1. The property price *(P)* is a function of flood duration, location, neighbourhood and structural attributes as written in is shown in Equation (3);

$$P = f(Duration, Location, Neighbourhood, Structural) \tag{3}$$

In this study, the selection elements for the independent variables is carefully chosen. The measures of flood indicator is flood duration; the measures of location attributes are proximity to bus station and city centre; the measures of structural attributes are size of land area, dummy infrastructure facilities and telecommunication area; the measures of neighbourhood attributes are proximity to the airport and river. These variables are selected based on the existing literatures. Besides that, it is essential to take into consideration that these elements must be fit to be tested in Malaysia. According to Basu and Thibodeau (1998), the semi-log functional form can correct the problem of heteroscedasticity between residuals. Therefore, this study proposed the log-linear functional form (dependent). Hence, the final log-linear equation for this study is as in Equation (4);

$$\begin{gathered} lnP_i = \beta_0 + \Sigma\beta_j\, DURATION_{ij} + \Sigma\beta_k\, LBUS_{ik} + \\ \Sigma\beta_l\, LCITY_{il} + \Sigma\beta_m\, SLAND_{im} + \\ \Sigma\beta_n\, DSINFRA_{in} + \Sigma\beta_p\, DSTELE_{ip} + \\ \Sigma\beta_r\, NAIRPORT_{ir} + \beta_s\, NRIVER_{is} + \mu_i \end{gathered} \tag{4}$$

where lnP is land property price. Meanwhile, $\beta_j, \beta_k, \beta_l, \beta_m, \beta_n, \beta_p, \beta_r$ and β_s are the parameters to be estimated and ε is the error term.

Variable *DURATION* represents flood duration and the measurement unit is hours. Under the location attributes, variables *LBUS* and *LCITY* represent proximity to the bus station and city centre. Both variables are using the same measurement unit of kilometres (km). This study investigate whether proximity to the bus station and city centre do affect the value of agricultural and industrial land. The overall result can be either positive or negative affect on land property value. For example, Fujita and Thisse (2002) found a negative relationship between proximity to city with the property market value. Meanwhile, Baldwin (2001) found that the distance to transportation facility can increase the property price.

This study applies variables of *SLAND* (size of land), *DSINFRA* (presence of infrastructure facilities) and *DSTELE* (presence of telecommunication area) as the determinants of the structural attributes. Hectare (ha) is the measurement unit for *SLAND*. Dummy variables *DSINFRA* and *DSTELE* are used for the presence of infrastructure facilities and telecommunication area. Dummy equals one (1) if the variable is present or otherwise zero (0). Maddison (2000) and Zhai, Fukuzono, and Ikeda (2003) also applied variables of size of land and presence of infrastructure facilities as an important variables to be studied under the structural attributes. Both authors found that size of land and development of infrastructure facilities, such as road system, have a significant relationship with the property value. However, to date, study on effect of telecommunication area and land property value is still unexplored. Therefore, this study hopes to contribute to new perspective and knowledge on land property value as well as to fill the gap in the literature. In this study, the existence of telecommunication network coverage such as Telekom, Digi, Maxis and Celcom in the study areas are tested to determined the presence of telecommunication facilities.

In the neighbourhood attributes, variables *NAIRPORT* and *NRIVER* represent proximity to the airport and river and the measurement unit for both variables are kilometres (km). This study examines whether the proximity of airport and river nearby might affect the agricultural and industrial land property values. Previous study indicates that the value of a land situated nearby airport likely to increase more compared to other areas (Gautrin, 1975). However, Espey and Lopez (2000) found a negative relationship between distance to nearest airport and land property price due to noise pollution. There have been limited studies on land property value and proximity to the river. Among the study is Saptutyningsih and Suryanto (2010), who applied the variable of distance to the river and drainage to study the relationship between land price and neighbourhood attributes. The existence of the river and drainage near land has become a major concern to landowners especially for cropping and farming in the agricultural lands and orchards.

The expected signs of variables flood duration, proximity to the bus station and city centre, size of land, presence of infrastructure facilities and telecommunication area, proximity to the airport and river are suggested as in Table 1.

Table 1

Expected Sign of Variables

Attribute	Variable	Description	Measurement	Expected Sign
Flood indicator	DURATION	Flood duration	Hours (hours)	Negative
Location attributes	LBUS	Proximity to the bus station	Kilometres (km)	Positive/Negative
	LCITY	Proximity to the city centre	Kilometres (km)	Positive/Negative
Structural attributes	SLAND	Size of land	Hectare (ha)	Positive
	DSINFRA	Presence of infrastructure facilities	Dummy – 1: Yes, 0: otherwise	Positive
	DSTELE	Presence of telecommunication area	Dummy – 1: Yes, 0: otherwise	Positive
Neighbourhood attributes	NAIRPORT	Proximity to the airport	Kilometres (km)	Positive/Negative
	NRIVER	Proximity to the river	Kilometres (km)	Positive/Negative

3.1 Data and Sources

This study used secondary data sources. The study area covered eleven states of Peninsular Malaysia. The scope of the study were two districts in each state that were affected by flood from 2008 to 2013. Two districts from each state were selected based on the parameters;

i) major flooding occurred in a big city and a minor flooding occurred in a small city

ii) major flooding occurred in a small city and a minor flooding occurred in a big city.

There are 410 set of secondary data collected in this study. All data and information regarding land property were collected from various government bureau and private agencies. The list of information regarding land property was taken directly from Malaysian Department of Irrigation and Drainage, Land and District Municipal Council, Valuation and Property Services Department, National Property Information Centre (NAPIC), Malaysian Department of Statistics and Malaysian Department of Social Welfare.

4.0 Results and Discussions

A total sample of 410 observations of agricultural and industrial land properties in Peninsular Malaysia that experienced flood in 2008 to 2013 were collected from the Malaysian Department of Irrigation and Drainage, Land and District Municipal Council and National Property Information Centre. The descriptive statistics of the variables are shown in Table 2.

Table 2

Descriptive Analysis of Variables

Variable	Minimum	Maximum	Mean
Land Property Price (in RM)	33,488.00	3,050,000.00	165682.63
DURATION (in hours)	1.00	72.00	15.04
LBUS (in kilometres)	0.20	43.80	15.77
LCITY (in kilometres)	0.23	36.60	13.57

(continued)

Variable	Minimum	Maximum	Mean
SLAND (per hectare)	0.0152	11.0000	1.30
NAIRPORT (in kilometres)	1.90	203.00	50.18
NRIVER (in kilometres)	0.20	17.20	2.94

Table 2 shows that 72 hours is the maximum number of hours of variable *DURATION* that hit the study areas. The average prolonged period of flood duration recorded is 15 hours. The maximum proximity to the bus station (*LBUS*) and city centre (*LCITY*) were about 43.8 and 36.6 kilometres, respectively. The proximity to both bus station and city centre were about 0.20 and 0.23 kilometres respectively. Meanwhile, the average proximity to the bus station and city centre recorded were 15.7 and 13.5 kilometres, respectively. Usually, the accessibility of public transport near the property area makes a positive impact on property price (So, Tse, & Ganesan, 1996).

Elements of structural attributes used in this study were variable *SLAND* (size of land), variable *DSINFRA* (infrastructure facilities) and variable *DSTELE* (telecommunication area). Based on the result above, the maximum agricultural and industrial land size is 11.0 hectares and the minimum land size recorded in this study is 0.0152 hectares. The average of agricultural and industrial land size is 1.3 hectares. Meanwhile, variables of infrastructure facilities and telecommunication area were used to examine the relationship between the presence of infrastructure or telecommunication development and land value.

Variables of *NAIRPORT* and *NRIVER* under neighbourhood attributes show that the maximum proximity to the airport and river were about 203 and 17.20 kilometres, respectively. The minimum proximity to the airport and river were 0.9 and 0.2 kilometres, respectively, and the average proximity to airport and river were 50.1 and 2.9 kilometres, respectively. Basically, the main function of rivers or drainage is to act as a source of irrigation water for agricultural activities on the land. Therefore, proximity to the river factor might greatly affects agricultural land price.

Table 3

Estimates of Hedonic Regression on Agricultural and Industrial Land Property Value

Variable	Coefficient	Standard Error
(Constant)	12.484***	0.303
DURATION	-0.029***	0.004
LBUS	0.077**	0.034
$LBus^2$	-0.002***	0.001
LCITY	-0.031	0.040
$LCity^2$	0.001	0.001
SLAND	0.234***	0.053
DSINFRA (have infrastructure facilities = 1)	0.328*	0.179
DSTELE (have telecommunication area = 1)	-0.172	0.175
NAIRPORT	-0.028***	0.006
$NAirport^2$	0.000143***	0.000033

(continued)

Variable	Coefficient	Standard Error
NRIVER	0.520***	0.074
$NRiver^2$	-0.037***	0.004
R^2	0.479	
Adjusted R^2	0.459	
F-Statistic	24.124	

Note. *,**,*** denote the significance at 10%, 5% and 1% respectively

There is no multicollinearity issue as the Variance Inflation Factors of all coefficients are below 10. Based on the result above, coefficient *DURATION* shows negative and significant sign. This indicates that the agricultural and industrial land values decreases by 2.9 per cent as the duration of flood increased by an hour, Clearly, a land property which experienced a longer flood duration tends to have decrease in value. Longer period of flooding can cause serious damage and severe destruction to assets on land such as factory, business building and crops. For example, the major flood incident that hits Johor in 2006 caused a massive destruction to the farmlands and lead to decrease in crop productivity. As a consequence, farmers and landowners lost revenue for about six months to a year (Rosli, 2007). This incident also caused the value of agricultural land property to decline due to the damage and loss of assets on land.

Besides that, industrial activities are also affected due to the long term flooding. The prolonged period of flood causes massive damage to the premises or factories that operates in industrial land. As reported in Bernama (2015), major flood incident that hits Terengganu in 2014 caused serious damage to the industrial plants and business premises and paralyzed industrial activities. This caused a low demand for agricultural or industrial land situated in the flood-prone areas because it involves high repair cost for restructuring and it will reduces land property value. The result supports the finding by Saptutyningsih and Suryanto (2010).

The positive sign of coefficient *LBUS* suggests that a unit increase in the proximity to the bus station can increase agricultural and industrial land property values by 7.7 per cent. Meanwhile, coefficient $LBus^2$ shows that the land property values will increase until the proximity to bus station reaches a certain limit, then the land property values will significantly fall at 0.2 per cent. It shows that agricultural and industrial lands located near the bus station have a lower value. This is because, in Malaysia, public transportation such as bus is widely available throughout the residential land areas and cities rather than the agricultural or industrial lands. According to Malaysia's Land Public Transport Comission (2014), the percentage of public transport users in Malaysia is increasing by 10.8 per cent, especially in the residential areas. Due to the reduced demand for public transports near agricultural and industrial land areas, it will also affect the value of both lands.

Under structural attributes, coefficient *SLAND* shows positive relationship where a unit increase in agricultural and industrial land property area will raise the land property value by 23.4 per cent. Coefficient *DSINFRA* also indicates a positive relationship where the value of agricultural and industrial land equipped with proper road system and electricity will increase by 32.8 per cent more than other land in the absence of any facilities. Road system and electricity are very important to provide basic access to the land as well as to increase the capacity of land. In addition, infrastructure facilities also has positive impact to the land propery value as well. This is supported by Jacoby (2000). The author found that a proper road system will encourage economic growth near the area as well as the value of land. Therefore, buyers will be more attracted to own land that has complete infrastructure. The result also supports the finding of Zhai, Fukuzono, and Ikeda (2003).

Coefficient *NAIRPORT* is negative and significant, indicates that a unit increase in proximity to the airport, the agricultural and industrial land property values decrease by 2.8 per cent. However, when the proximity to the airport reaches a certain level, the land property values will significantly increase by 0.0143 per cent. This is shown in the result of the positive sign of coefficient $NAirport^2$. This indicates that a land situated near an airport area has a high value. The existence of the airport near the industrial land helps to boost the economy and development in the industrial areas. For example, the price of land in the Bayan Lepas industrial area, which is located near the Penang International Airport, has risen to RM60 per square foot compared to the price of land in the Sungai Petani industrial area, which is only RM15 per square foot (Tan, 2014 and The Sun, 2014). Clearly, this shows that the value of industrial land near the airport area is higher than others. The result supports the finding of Tomkins, Topham, Twomey, and Ward (1998).

Coefficient *NRIVER* shows a positive and significant result. It indicates that as the proximity to the river increase by one unit, the agricultural and indstrial land property value also increase by 52.0 per cent. However, the land property value will significantly decrease by 3.7 per cent when the proximity to the river reaches a certain level. This suggests that the values of agricultural and industrial land located near rivers are getting smaller because river is also said to be one of the causes of flooding, even though the agricultural sector will be more developed through the irrigation system as rivers allow farming and crop production to be carried out. Land near river is said to be at great risk of flooding. According to Wee and Ariffin (2011), river erosions can cause the collapse of river banks, as happened in Sungai Kelantan. This will affect the value of land near the river.

5.0 Conclusions and Recommendations

This study investigates the effect of flood duration on agricultural and industrial land property values. Based on the analysis on previous section, those results are consistent with the previous studies done by Zhai, Fukuzono, and Ikeda (2003) and Saptutyningsih and Suryanto (2011). This study found that flood duration had adversely affected the value of agricultural and industrial land property. It suggests that prolonged period of flood cause a serious damage to the assets on land such as factories and crops and suffered reduction in land property values. Therefore, landowners must put the assets on their land to their best use when the flood occurs. In order to reduce flood problems, immediate action must be taken like improving the structural and non-structural features such as build more extensive drainage system and improved current Flood Forecasting and Warning System (FFWS). These approaches can help policy makers in designing policies for flood risk management and to develop an efficient land management for industrial and agricultural activites as well as to manage land property risk.

Past studies show that the HPM is considered to be a more comprehensive and practical approach to study the relationship between property prices and its attributes. In this study, HPM gives accurate information on attributes of land property that influenced the property value. From data in this study, it shows that flood duration has a negative relationship with the land property values. Besides that, the value of land property is determined by neighbourhood, structural and location attributes. This study found that coefficients of variables in structural, location and neighbourhood attributes are significant and have a positive sign. Therefore, as with other countries, the attributes of location, neighbourhood and structures could also be priced in a similar way in Malaysia.

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References

Abdul Rahman, H. (2009). Global climate change and its effects on human habitat and environment in Malaysia. *Malaysian Journal of Environmental Management, 10*(2), 17-32.

Baldwin, R. E. (2001). Core-periphery model with forward-looking expectations. *Regional Science and Urban Economics, 31*(1), 21-49.

Ball, M. (1973). Recent empirical work of the determinants of relative house prices. *Urban Studies, 10*, 213-233.

Basu, A., & T. G. Thibodeau. (1998). Analysis of spatial autocorrelation in house prices. *Journal of Real Estate Finance and Economics, 17*(1), 61–85.

Bernama. (2015, January 8). *Terengganu anggarkan nilai kerosakan prasarana lebih RM14 juta*. Bernama Malaysia News (online). Retrieved from http://www.astroawani.com/berita-banjir/Terengganu

Bin, O., & Polasky, S. (2004). Effects of flood hazards on property values: Evidence before and after Hurricane Floyd. *Land Economics, 80*(4), 490-500.

Case, K., & Shiller, R. (1987). Prices of single-family homes since 1970: New indexes for four cities. *New England Economic Review*, 45-56.

Case, K. E. (1994). *Land prices and house prices in the United States*. National Bureau of Economic Research. 29-48. Retrieved on February 2, 2013, from http://www.nber.org/chapters/c8820.

Centre for Research on the Epidemiology of Disasters. (2005). *Disaster data: A balance perspective*. CRED-CRUNCH Newsletter, Issue N1. Retrieved March 20, 2016, from http://www.emdat.be/publications?field_publication_type_tid.

Chan, N. W. (1996). Flood disaster management in Malaysia: An evaluation of the effectiveness of government resettlement schemes. *Disaster Prevention and Management, 4*(4), 22 – 29.

Chan, N. W. (1997). Increasing flood risk in Malaysia: Causes and solutions. *Disaster Prevention and Management, 6*(2), 72-86.

Chattopadhyay, S. (1999). Estimating the demand for air quality: New evidence based on the Chicago housing market. *Land Economics, 75*(1), 22-38.

Damianos, D., & Shabman, L. A. (1976). *Land prices in flood hazard areas: Applying method in land value analysis*. Virginia Water Resources Research Centre. Bulletin 95.

Department of Irrigation and Drainage Malaysia. (2012). *Flood Annual Report 2008-2012*. Malaysia.

Dorsey, R. E., Haixin, H., Walter, J. M., & Hui-chen, W. (2010). Hedonic versus repeat-sales housing price indexes for measuring the recent boom-bust cycle. *Journal of Housing Economics, 19*(2), 75-93.

Espey, M., & Lopez, H. (2000). The impact of airport noise and proximity on residential property values. *Growth and Change, 31*, 408-419.

Eves, C. (2004). The impact of flooding on residential property buyer behaviour: An England and Australian comparison of flood affected property. *Structural Survey, 22*(2), 84-94.

Eves, C. (2002). The long-term impact of flooding on residential property values. *Property Management, 20*(4), 214-227.

Eves, C., Blake, A., & Bryant, L. (2010). *Assessing the impact of floods and flood legislation on residential property prices*. International Real Estate Research Symposium (IRES), 27-29 April, Putra World Trade Centre, Kuala Lumpur.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London: Sage Publication Ltd.

Fletcher, M., Gallimore, P., & Mangan, J. (2000). Heteroskedasticity in hedonic house price models. *Journal of Property Research, 17*(2), 93-108.

Freeman, A. M. (1979). Hedonic prices, property values, and measuring environmental benefits: A survey of the issues. *Scandinavian Journal of Economics, 81*, 154-173.

Fujita, M., & Thisse, J. F., (2002). *Economics of agglomoration: Cities, industrial location, and regional growth*. Cambridge: Cambridge University Press.

Gautrin, J. F. (1975). An evolution of impact of aircraft noise on a property values with a simple model of urban land rent. *Land Economics, 51*, 80-86.

Greenberg, E., Levin, C. L., & Schlottmann, A. (1974). *Analysis of theories and methods for estimating benefits of protecting urban flood plains*. St. Louis: Washington University, Institute for Urban and Regional Studies.

Handmer, J. W., & Smith, D. I. (1990). Adjustment factors for flood damage curves. *Journal of Water Resources Planning and Management, 116*(6), 843-5.

Hansen, N. (2006). An analysis of mutative -self-adaptation on linear fitness functions. *Evolutionary Computation, 14*(3), 255-275.

Harrison, D. M., Smersh, G. T., & Schwartz, A. L. (2001). Environmental determinants of housing prices: The impact of flood zone status. *Journal of Real Estate Research, 21*(1), 1-20.

Huh, S., & Kwak S. J. (1997). The choice of functional form and variables in the hedonic price model in Seoul. *Urban Studies, 34*(7), 989-998.

Jacoby, H. (2000). Access to markets and the benefits of rural roads. *Economic Journal, 110*(465), 713–737.

Kain, J. F., & Quigley, J. M. (1970). Measuring the value of housing quality. *Journal of the American Statistical Association, 65*, 532-548.

Khalid, M. S., & Shafiai, S. (2015). Flood disaster management in Malaysia: An evaluation of the effectiveness flood delivery system. International *Journal of Social Science and Humanity, 5*(4), 398-402.

Lamond, J., & Proverbs, D. (2006). Does the price impact of flooding fade away? *Structural Survey, 24*(5), 363-377.

Lamond, J., Proverbs, D., & Antwi, A. (2007). The impact of flood insurance on residential property prices: Towards a new theoretical framework for the United Kingdom market. *Journal of Financial Management of Property and Construction, 12*(3), 129-138.

Leggett, C., & Bockstael, N. (2000). Evidence of the effects of water quality on residential land prices. *Journal Environmental Economics and Management, 39*, 121-144.

Maddison, D. (2000). A hedonic analysis of agricultural land prices in England and Wales. *European Review of Agricultural Economics, 27*(4), 519-532.

Malaysia Land Public Transport Comission (2014). *Annual report: Improvement of public transport*. Retrieved November 13, 2015, from http://www.spad.gov.my/sites/default/files/s.p.a.d.laporantahunan.pdf.

McCann, P. (2001). *Urban and regional economics*. Oxford: Oxford University Press.

Minnery, J. R., & Smith, D. I. (1996). *Climate change, flooding and urban infrastructure:* In Bosma, W. J., Pearman, G. I. and Manning, M. R. (Eds), Greenhouse, Coping with Climate Change, CISRO, Australia, 235-47.

Miranowski, J. A., & Hammes, B. D. (1984). Implicit prices of soil characteristics for farmland in Iowa. *American Journal of Agricultural Economics, 66*, 745-749.

Palmquist, R. B. (1982). Measuring environmental effects on property values without hedonic regressions. *Journal of Urban Economics, 11*, 333-347.

Palmquist, R. B., & Danielson, L. E. (1989). A hedonic study of the effects of erosion control and drainage on farmland values. *American Journal of Agricultural Economics, 71*(1), 55-62.

Queensland Flood Science, Engineering and Technology Panel. (2012). *Understanding the flood*. Retrieved January 13, 2013, from http://www.chiefscientist.qld.gov.au/publications.

Ridker, R. G. & Henning, J. A. (1967). The determinants of residential property values with special reference to air pollution. *The Review of Economics and Statistics, 49*, 246-257.

Rosen, S. (1974). Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of political economy, 82*(1), 34-55.

Rosli, N. (2007, January 26). *Bantuan rumah rosak, tanaman musnah akibat banjir diumum Isnin*. Utusan Malaysia News (online). Retrieved from http://ww1.utusan.com.my/utusan/info.asp?y=2007&dt=0126&pub=Utusan_Malaysia.

Saptutyningsih, E., & Suryanto. (2011). Hedonic price approach of flood effect on agricultural land. *Economic Journal of Emerging Markets, 3*(1), 87-96.

Shimizu, C. H., Takatsuji, H. O., & Nishimura, K. G. (2010). Structural and temporal changes in the housing market and hedonic housing price indices: The case of the previously owned condominium market in the Tokyo metropolitan area. *International Journal of Housing Markets and Analysis, 3*(4), 351-368.

Shultz, S. D., & Fridgen, P. M. (2001). Floodplains and housing values: Implications for flood mitigation projects. *Journal of the American Water Resources Association, 37*(3), 595-603.

Singh, H., & Subramaniam, S. (2009). Health emergency and disaster preparedness in Malaysia. *Southeast Asian Journal of Tropical Medicine Public Health, 40*(1), 11-15.

So, H. M., Tse, R. Y. C., & Ganesan, S. (1996). Estimating the influence of transport on house prices: Evidence from Hong Kong. *Journal of Property Valuation and Investment, 15*(1), 40-47.

Soentato, R., & Proverbs, D. G. (2004). Impact of flood characteristics on damage caused to UK domestic properties: The perception of surveyors. *Structural Survey, 22*(2), 95-104.

Tan, D. (2014, December 30). *Land prices continue to be on the rise in Penang*. The Star Malaysia News (Online). Retrieved from http://www.thestar.com.my/news/community/2014/12/30/.

The Sun. (2014, March 21). *Northbound possibilities*. The Sun Daily Malaysia News (Online). Retrieved from http://www.thesundaily.my/news/993326

Tobin, G. A., & Montz, B. E. (1990). *Response of the real estate market to frequent flooding: the case of Des Plaines, Illinois.* Bulletin – Illinois Geographical Society, 11–21.

Tomkins, J., Topham, N., Twomey, J., & Ward, R. (1998). Noise versus access: The impact of an airport in an urban property market. *Urban Studies, 35*(2), 243-258.

Triplett, J. E. (2004). *Handbook on quality adjustment of price indexes for information and communication technology products.* OECD Directorate for Science, Technology and Industry, Paris.

Wee, S. T., & Ariffin, R. (2011). *Kajian terhadap struktur bagi mengawal hakisan dan banjir di tepi Sungai Kelantan.* Retrieved on September 1, 2015 from http://eprints.uthm.edu.my/2017/1/Seow_Ta_Wee_2

Zhai, G., Fukuzono, T., & Ikeda, S. (2003). Effect of flood on megalopolitan land prices: A case study of the 2000 Tokai flood in Japan. *Journal of Natural Disaster Science, 25*(1), 23-36.