



# Assessing the economic value of urban green spaces in Kuala Lumpur

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## Abstract

This study assessed the economic value of public urban green spaces (UGSs) in Kuala Lumpur (KL) city by using the hedonic price method (HPM). It involves 1269 house units from eight sub-districts in KL city. Based on the hedonic price method, this study formulates a global and local model. The global model and local model are analyzed using ordinary least square (OLS) regression and geographically weighted regression (GWR). By using the hedonic price method, the house price serves as a proxy for public urban green spaces' economic value. The house price is regressed against the set of three variables which are structural characteristics, neighborhood attributes, and environmental attributes. Measurements of interest in this study are environmental characteristics, including distance to public UGSs and size of public UGSs. The results of the OLS regression illustrated that Taman Rimba Kiara and Taman Tasik Titiwangsa provide the maximum economic value. On average, reducing the distance of the house location to Taman Rimba Kiara by 10 m increased the house price by RM1700. Similarly, increasing the size of the Taman Tasik Titiwangsa by 1000 m<sup>2</sup> increases the house price by RM60,000. The advantage of the GWR result is the economic value of public UGSs which can be analyzed by the specific location according to sub-district. From this study, the GWR result exposed that the economic values of Taman Rimba Bukit Kiara and Taman Tasik Titiwangsa were not significant in each of the sub-district within KL city. Taman Rimba Bukit Kiara was negatively significant at all sub-districts except Setapak and certain house locations located at the sub-district of KL. In contrast, Taman Tasik Titiwangsa was positively significant at all sub-districts except certain house locations at the sub-districts of Batu, KL, Setapak, and KL city center. In conclusion, results show that the house price is influenced by the environmental attribute. However, even though both of these public UGSs generate the highest economic value based on distance and size, its significant values with an expected sign are only obtained based on the specific house location as verified by the local model. In terms of model comparison, the local model was better compared with the global model.

**Keywords** Economic valuation · Ordinary Least Square regression · Geographically weighted regression · Hedonic pricing method · Public urban green space · House Price

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## Introduction

### Urban green space

Urban green space is referred to as any vegetation that exists in the connection between urban and nature. It includes parks, open spaces, street trees, residential gardens, golf course, and any other vegetation involved around the urban environment (Nur Syafiqah et al. 2018; Pietsch 2012). In Malaysia, the Federal Department of Town and Country Planning Peninsular Malaysia refers green space as a recreational space. Therefore, Mohd Yusof (2013) stated that the green space in KL city only covers spaces that are meant for recreational purposes. He opined that the types of green space could be further categorized into three main categories, namely,

public green space, private green space, and natural or seminatural green space.

The total area for all types of UGSs in KL city in 1984 is 586 ha. However, due to several efforts and concerns by the government, the total area of UGSs increased up to 1580 ha. This represents 6.5% of the city's total area of 244 km<sup>2</sup> or 24,400 ha (City Hall Kuala Lumpur (CHKL) 2016). In addition, Mohd Yusof (2013) reported that the government plans to add 246 green spaces by 2020, representing an additional green space area of 728.6 ha. With this plan, KL will yield 2308.6 ha of green space which represents 9.5% of the city's surface. From 2308.6 ha, at least 1347.4 ha are officially gazetted as green spaces. Even though the statistics revealed an increase in size of UGSs, it actually declines in public UGSs largely because of the conversion to other uses such as residential, industrial, and other commercial developments which could reduce the amenity value of UGSs (Mohd Yusof 2013). In addition, City Hall Kuala Lumpur (2016) also mentioned that KL is facing the shortage of public UGSs.

There is an obvious evidence of public UGSs being relieved for other developments. One of them is at Bukit Nanas Forest Reserves (Teh 1994). About 4.4 ha of the hill of this forest reserve was lost in order to build up the KL Tower. A similar issue was also mentioned by Yusof (2012) and Yusof and Rakhshandehroo (2016). Yusof (2012) stated that almost 50% of public UGSs was lost within the year 1958 until 2012. It was proved by remote sensing and aerial photography with high spatial resolution. Yusof and Rakhshandehroo (2016) reported that the extensive use of central land in recent decades leads to a great loss of public UGSs.

By looking at the scenario that happened in KL city, the major causes of the loss of public UGSs are the rapid urbanization in Malaysia especially in KL city and the increase in KL's population. KL, officially the Federal Territory of KL and commonly known as KL, is the national capital and largest city in Malaysia. KL was recorded as having the highest level of urbanization at 100%. With 1.76 million of the total population, KL city was recognized as having the highest population density with 6891 people per square kilometer (Department of Statistic, Malaysia 2016).

As recorded in Annual Report Economic Transformation Programme, the amount of green space per person in the city center is only 12 m<sup>2</sup> in the year 2012, which is below the World Health Organization (WHO) standards of 16 m<sup>2</sup> per person (PEMANDU 2014). By 2020, KL is projected to have 2.2 million of the total population. At the current trajectory of population growth, the amount of green space per person will still be below than the WHO standards at 10 m<sup>2</sup> per person by 2020. Although the number and size of UGS are planned to be added, it is still much less than the ratios of green space enjoyed by the residents of many cities in North America and Europe (20 m<sup>2</sup> per person in Toronto and 40 m<sup>2</sup> per person in London).

Unfortunately, it will be less than the current projection if the public UGSs are just taken into account.

The increasing number of KL populations led the KL city under pressure, and the size of public UGSs decreased. Yaakup et al. (2005) and Gairola and Noresah (2010) also believed that increasing urbanization and human population growth have resulted in significant loss of public UGSs. This issue cannot last since UGS as well as public UGSs bring various benefits especially in terms of social, economic, environment, and health aspects to the community, neighborhood, and city, in both private and government sectors. Specifically, UGSs serve as an attractive location for business and for improving property value, boosting social and community development, creating new jobs, creating healthy lifestyle supporting physical activities, reducing air and noise pollutions, and preventing excessive heat and natural disasters like landslide and flood (Urban Green Space Task Force, 2002). In addition, the demand for green space in KL is high as the residents always express a high level of dissatisfaction about the accessibility of recreational facilities and the low level of social interaction in KL (Ting 2012).

Related to this matter, the government is always proactive in identifying and solving environmental issues. The government then announced its further vision to become the Most Beautiful Garden Nation and turned KL into a Tropical Garden City by the year 2020. In order to realize the vision, CHKL created a network in cooperation with MARDI and signed the MOU for a garden-in-city program on April 7, 2014, with the objective of improving the quality of landscape (PEMANDU 2014). Based on the draft Kuala Lumpur Structure Plan 2020, the city aims to provide a high quality of accessible green spaces and parks which offer recreational areas, hence assisting KL to become a more attractive city in which to live and work.

However, it is remarked that existing plans and policies were not adequately strong to protect the existing public UGSs. In addition, some people appealed that it was difficult to reach to the definite conclusion on the usefulness of the current policies or management to preserve public UGSs without information on monetary value. It seems that a balanced assessment would need to be taken into account not only on the government's responsibilities. From these concerns, many scholars from local and international perspectives have contributed their knowledge and findings about the UGSs. The economic analysis of UGSs clearly figured out about the strong information on monetary value. Nevertheless, the economic analysis of UGSs specifically public UGSs in Malaysian context has not received much attention so far. Most of the previous studies just focused on the environmental, ecological, and social aspects of the UGSs (Gairola and Noresah 2010; Hussein 2006; Mazlina and Ismail 2007, 2008).

In Malaysia, a study about the economic valuation of the UGSs has been conducted by Noor et al. (2015) at Subang Jaya, Selangor. After a few years, Nur Syafiqah et al. (2018) extended the study conducted by Noor et al. (2015). Nur

Syafiqah et al. (2018) noticed that KL City was recognized as having the largest loss of green space especially public UGSs. Therefore, a study on the economic valuation of public UGSs in KL City was conducted. However, they claimed that the study needs to be further improved as they only include one neighborhood variable (distance to town) instead of including some other important attributes of neighborhood variables such as the existence of a school, crime rate, and distance to the hospital. In terms of sample size, they highlighted that the number of samples should be expanded to more than 1000 samples in order to have a better analysis. Hence, it will be much more interesting if the extension analysis of Nur Syafiqah et al.'s (2018) study which is about the economic valuation of public UGSs is carried out. It is targeted that this study will offer valuable information to real estate developers and government authorities especially in terms of monetary value. Other than that, the findings of this study will be a new contribution to the body of knowledge. Therefore, the objective of this study is to assess the economic value of public UGSs in KL City. The monetary value obtains in the form of house price will represent the economic value of public UGSs.

### Economic valuation of urban green spaces

Public UGS is a public good that can be characterized as non-rival and non-excludable. Non-rival refers to the notion that the benefits related to individual consumption are indivisible. In other words, the consumption of a public good by one individual does not reduce the amount of the good available for the consumption of others at the same time. Meanwhile, non-excludable means it is impossible to prevent others from using and accessing a good (Callan and Thomas 2013). Samuelson (1954) mentioned that any number of people who walk under a splendid street tree could enjoy its beauty and shade immediately or over the course of several decades, irrespective of who pays for the planting and maintenance of the tree.

Market and non-market goods and services are fundamental in economics. In the marketing economy, goods and services are sold for prices that reflect a balance between the costs of production and what people are willing to pay. Environmental goods and services like fish and seaweed are traded in the market. Hence, their monetary value can be directly observed. However, as reported in Green Facts (2016), most environmental goods and services including public green space are not traded in the market; hence, they are known as non-market goods or services. They are neither bought nor sold directly. Their monetary value, which is how much people would be willing to pay for them, is not revealed in market prices.

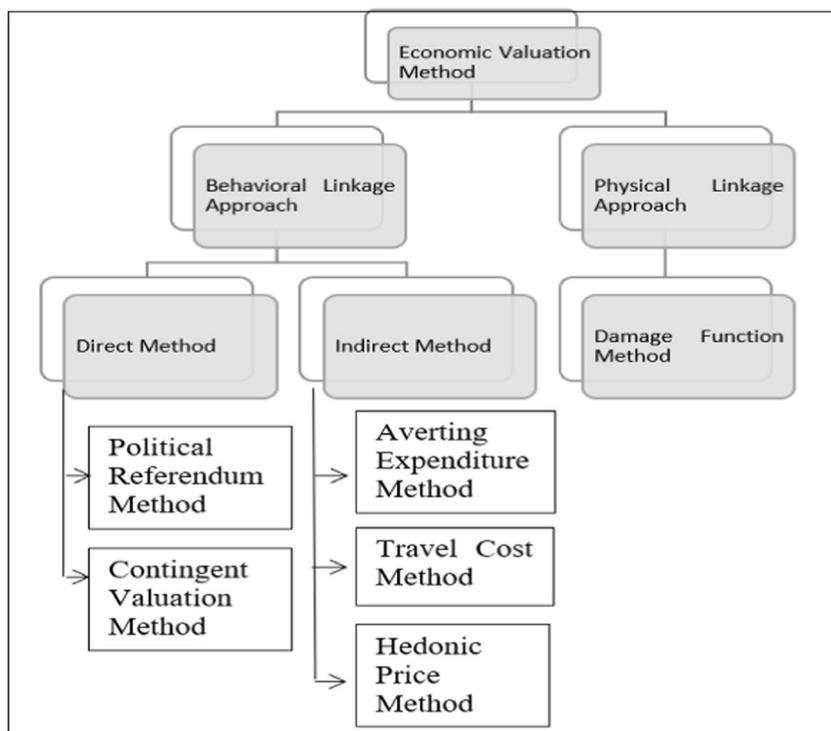
Samuelson (1954) stated that it is challenging to do a monetary valuation for non-market goods and services like public green space and open space. However, in order to avoid any non-market goods or services being implicitly undervalued

and provide inaccurate value to the society, economic valuation should be properly measured. Therefore, the only option for assigning monetary values to them is to rely on non-market valuation methods. Valuation specifically helps policymakers and the government to improve decision-making and ensure that a new policy delivers net benefits when the policy aims at altering the condition of an ecosystem. In addition, it is important since it can help the local government to evaluate costs against returns from development or prioritize payments for green versus gray infrastructure. Other than that, non-market valuation is also helpful in the private sector. The pursuit of profit is based on the evaluation of costs and revenues. Non-market valuation provides economic information to developers and land managers in order to estimate the return on investment for land development projects. For instance, there may be extra costs related to taking greater care to protect trees during site preparation, but those costs may be offset by higher purchase prices for the building lots.

In general, the economic valuation of public UGSs can be measured by various economic valuation methods, including damage function method, political referendum method, contingent valuation method (CVM), averting expenditure method, travel cost method, and hedonic price method (HPM). Smith and Krutilla (1982) classified these various economic valuation methods into two broad categories: physical linkage approach and behavioral linkage approach (direct method and indirect method). The physical linkage approach is used to estimate benefits based on the technical relationship between environmental resources and the users of that resources. The behavioral linkage approach is used to estimate benefits using observations of behavior in actual markets or survey responses about hypothetical markets. Direct method is a technique that assesses responses immediately related to environmental changes, while indirect method is a technique that examines responses about a set of market conditions related to environmental goods. Figure 1 shows the measurement techniques for the two categories.

Based on Fig. 1, among those methods, the hedonic price model and contingent valuation method are widely used to measure different aspects of the social value provided by green space (Zhou and Parves Rana 2012). However, Kong et al. (2007) stated that the economic value obtained by CVM does not involve actual market purchase. CVM heavily relies on hypothetical rather than the actual market price. In contrast, the economic value of an environmental amenity obtained by HPM can be predicted from the prices of related actual market house transactions. The method is the revealed preference method in order to differentiate it from the stated preference methods such as CVM which are based on intended rather than actual behavior (Tyrvaainen and Miettinen 2000). Based on this argument, Kong et al. (2007) opined that HPM is the most suitable technique used to estimate the economic value of environmental attributes such as UGS attributes.

**Fig. 1** Economic valuation technique (Source: Smith and Krutilla 1982)



The economic valuation of UGSs using HPM is popular and has been used by researchers across the globe such as China, Finland, Netherlands, Spain, and USA (Jim and Chen 2006; Saz-Salazar and Rausell-Koster 2008; Brunson and Reiter 1996; Tyrvainen 2001; Tyrvainen and Vaananen 1998). However, most of them assumed stationary assumption in their studies. Thus far, there are a limited number of studies focusing on spatial analysis. Orford (2000) highlighted that stationary specification ignores the operational processes and structures that can lead to disequilibrium in the supply and demand for housing. This will make the biased or misleading parameter estimates of the hedonic model. In order to avoid this issue, Orford (2000) suggested that further studies should assume the non-stationarity relationship between house prices and its attributes.

In Malaysia, the study about the economic valuation of public UGSs using non-stationarity regression has only been conducted by Nur Syafiqah et al. (2018) thus far. However, they claimed that the study needs to be further improved due to some limitations highlighted earlier. Therefore, by considering the limitations of the previous study, the economic valuation of public UGSs in KL city using HPM together with spatial non-stationarity analysis is conducted in this study. Therefore, the main objective of this study is to estimate the economic value of public UGSs in KL city using HPM. The HPM was regressed using both stationarity and non-stationarity analysis or known as global and local analysis, respectively. An OLS regression and GWR are applied to capture the stationarity and non-stationarity analysis, respectively. The rationale for using

two regressions is due to several reasons. GWR is used to capture the spatial non-stationarity analysis or known as local analysis, while OLS is used to capture stationary analysis or known as global analysis. In other words, OLS regression can reveal the economic value of public UGSs in KL city in average value. However, GWR can reveal the economic value of public UGSs in KL city at a specific location (sub-district) or individually. Means, the information about the economic value obtained through GWR is more in details. This study is crucial, because instead of providing insightful information to developers and the government, this study will make a contribution to the literature since there are scarce studies on the economic valuation of public UGSs using HPM with GWR in Malaysia. At the end of the study, it is expected that the local analysis is better and informative than the global analysis which will contribute to the new body of knowledge from the international perspective.

## Literature review

### Empirical studies of the economic valuation of UGSs by using the hedonic pricing method

Hedonic pricing studies have been done since the 1960s. Most of the studies use regression analysis as the statistical tool. Property prices are regressed against sets of control variables which include environmental attributes, neighborhood variables, and structural characteristics of the house.

Chin and Chau (2003) believed that property prices are associated with their structural attributes. The valuation of these attributes contributes to higher property prices if a property has more desirable attributes than others (Ball 1973). Previous studies showed that the number of rooms and bedrooms (Li and Brown 1980; Fletcher et al. 2000), the number of bathrooms (Linneman 1980; Garrod and Willis 1992), lot size, and the existence space at the garage and basement (Forrest et al. 1996) are also positively related to the house price. Buyers are willing to pay more for a house that has more functional space. Residential properties with bigger floor areas and many rooms are preferred by big families and affordable buyers in order to live comfortably.

The building age is recorded as negatively related to property prices (Straszheim 1975; Clark and Herrin 2000). According to them, older houses are valued lesser due to additional costs for maintenance services. It also has decreased usefulness due to changes in design, technology, mechanical, and electrical systems. Kain and Quigley (1970) revealed that the price for a new house is \$3150 more than a 25-year-old house, subjected to the same size of house. However, Li and Brown (1980) found a contradicting finding, in which the age of a house is positively significant with house price. They presumed that the historical element of the house leads to an increase in house price. In short, it can be summarized that all of the functional spaces of the house structure attributes have a significant relationship with house price. However, Chin and Chau (2003) pointed out that the buyer's opinion about the structural attributes of the house may not always be the same. It can change over time and condition and may contrast between nations (Kohlhase 1991).

Apart from house attributes, the neighborhood attributes also play an important role in the determination of the house price (Goodman 1989). Goodman (1989) pointed out that neighborhood attributes cannot be explicitly valued in the marketplace. However, they could be implicitly valued through HPM by assessing the house's price with different neighborhood attributes. The existence and quality of public schools have a positive impact on house prices especially for those who have children (Clark and Herrin 2000; Ketkar 1992; and Anderson and West 2006). The quality of schools is measured based on school input variables, for instance student achievement level or Standardized Aptitude Test (SAT) scores and expenditure per student or average cost per student.

Huh and Kwak (1997) indicated that the presence of health centers such as hospital at the residential area in Seoul has a negatively significant relationship with house price due to increased congestion and noise coming from ambulance siren. However, Palmquist (1992) believed that the reaction towards the noise, or quiet, is dissimilar among different groups of people. Palmquist (1992) found that the marginal willingness to pay for the quietness of lower-income groups is higher compared with the higher-income groups. However, it also has disadvantages such as noise pollution, high crime rate

and vandalism, and traffic congestion (Li and Brown 1980). Clark and Herrin (2000) revealed that house price in California is 7.28% lower in areas with additional murder per 10,000 people. Most of the previous studies measured the crime rate based on variables like robbery, rape, and motor vehicle theft per 1000 residents (Haurin and Brasington 1996).

The environmental attribute also may influence the house price. The international studies conducted in China, Finland, Netherlands, Spain, and USA indicated that residents are willing to pay to use UGSs (Jim and Chen 2006; Saz-Salazar and Rausell-Koster 2008; Brunson and Reiter 1996; Tyrvaainen 2001; Tyrvaainen and Vaananen 1998). The houses near green spaces have higher prices of 8 to 20% than houses located elsewhere (Crompton 2001). Mahan et al. (2000) reported that house price increases by \$436 if the distance between the residential area and the nearest wetland is reduced by 1000 ft. It was believed that urban people are willing to pay more as long as the house is located close to parks or any types of green space. The value of this willingness to pay represents the economic value of UGSs. In Boston, Tajima (2003) proved that the proximity to UGSs and proximity to highways have positive and negative impacts on property prices, respectively. The study implied that UGSs are a desirable environmental public good that benefits the property owners in the form of capital gains and by attracting a wealthier population. Kain and Quigley (1970) demonstrated that higher-income households with more education prefer to live in relatively high-quality dwelling units located further away from the central business district. However, Tajima (2003) highlighted that low-income groups who rent the house in the neighborhoods will be affected. The proximity to UGSs and house market price have also been studied by other researchers (Morancho 2003; Conway et al. 2010; Gibbons et al. 2014). Most of them revealed that there is an inverse relationship between the selling price of the dwelling and its distance from the UGSs.

Instead of applying proximity in valuing the property price, Morancho (2003) also proved that the size of UGSs has a positive relationship with the house price. In Minnesota, Lupi et al. (1991) found that the housing value increases by \$19 as the size of the nearest wetland increases by 1 ha. Other than that, Mahan et al. (2000) found a \$24 increase in house value with an increase in the size of the nearest wetland in Oregon City. An increase by 1-ha wooded recreation areas and proportion of total forested area within the residential area has a positive influence on apartment price (Tyrvaainen 1997). Lutzenhiser and Netusil (2001) also found a similar result by proving that the natural area's parks require a large acreage to maximize the property price. Based on their findings, they concluded that the size of wetlands and wooded recreation areas are significant factors in determining housing price. Laverne and Winson-Geideman (2003) also proved that the rental rates of commercial offices facing the tree are about 7% higher than other commercial offices. Wolf (2003) demonstrated that people are willing to pay

about 10% more in price for products in a shopping area with trees, as compared with shopping area without trees.

The most recent on this study can be referred in Latinopoulos (2018), Ali et al. (2015), Noor et al. (2015), Czembrowski and Kronenberg (2016), and Gibbons et al. (2014). Latinopoulos (2018) indicated that hotel rooms facing a sea view have a higher price compared with hotel rooms without a sea view. Ali et al. (2015) and Noor et al. (2015) revealed that the existence of a park in dwelling areas in Faisalabad, Pakistan, and Subang Jaya, Selangor, are positively associated with the housing price. The study also was supported by Czembrowski and Kronenberg (2016). They believed that UGS attributes have economic value by agreeing that the largest forest and parks were the most important and positively influenced the apartment price.

Previous studies have proven that environmental attributes greatly contribute towards the increase in property price, indicating that UGSs has economic value. This shows that environmental attributes are essential and valuable as people are willing to pay more for it. Overall, property price is influenced by its structural attributes, as well as neighborhood and environmental attributes.

### Hedonic pricing method (ordinary least square regression versus graphically weighted regression)

Basically, the linear function of the hedonic model specification is assessed by OLS regression. Based on the assumption from the linear equation, the coefficients denote the implicit market price of the house. The estimation of the linear HPM arises from the instantaneous equilibrium unitary housing market theory (Orford 2000; Maclennan and Tu 1996). This theory posits a relation between house prices and associated attributes. Specifically, Orford (2000) highlighted that a stationary specification does not take into account the operational processes and mechanisms that could probably lead to a housing supply and demand. This will result in the hedonic model's biased or misleading parameter estimates. In order to avoid this issue, Orford (2000) suggests that further study should be conducted on the non-stationarity relation of house prices and its attributes. Some of the empirical studies state that the functional imbalance and segmentation can characterize house prices (Case and Mayer 1996; Goodman and Thibodeau 1998) because the housing bundle supply is typically inelastic. The segmentation of house prices occurs when relatively many households share the demand for a specific structural or neighborhood attribute (Schnare and Struyk 1976). A non-stationary housing market is a direct consequence of market segmentation. The house price might be varied and changed over a geographic location, whereas structural differentiation in a similar geographical location could be largely discounted. They believed that the result could be more accurate and consistent if the spatial non-stationarity analysis is assumed. Latinopoulos (2018) proved

that the relationship between room prices and the majority of the selected variables (explanatory) vary over space, suggesting that the use of the OLS hedonic model could be inaccurate and inappropriate for this kind of analysis.

The economic value of the UGSs varies based on the specific location of the UGSs and demographic factor (Anderson and West 2006; and Jaimes et al. 2010). Cho et al. (2008) applied both regressions (OLS and GWR) to study the economic value of quantity and quality of UGSs. The quantity of the UGS is measured by its proximity and size, whereas the spatial configuration and species composition were used to capture the element of the UGS's quality. The empirical evidence proved that the local model offered a better model than the global model due to the higher adjusted  $R^2$  and lower residual sum of square value. This statement was also proved by Nur Syafiqah et al. (2018) through their study on the economic valuation of public UGSs in KL city. Other than that, Jaimes et al. (2010) also believed that the local analysis is performed better and more precise than global analysis because the local analysis yields an estimated coefficient for each location, not an average coefficient, as offered by global analysis.

Generally, both regressions are applicable for HPM in valuing the economic value of UGSs. The main idea is the global model known as stationarity analysis did not consider a geographic coordinate of each observed location, but a geographic coordinate of each observed location is taken into account in the local model (non-stationarity analysis). Due to this specification, the global model would offer average value parameter estimation, but a local model would offer an estimate for each parameter. Hence, the local model estimated that GWR can provide a specific location that offers the highest house price which is reflected the economic value of the public UGSs.

## Methodology

### Data collection

The objective of the study is to estimate the economic value of public UGSs in KL city by using HPM. HPM is formulated as global and local model. KL city is 243 km in area and is subdivided geographically into eight sub-districts, namely, Kuala Lumpur city center, Kuala Lumpur, Setapak, Batu, Ampang, Petaling, Hulu Kelang, and Cheras. Figure 2 shows the distribution of UGSs in KL according to sub-districts. Based on Fig. 2, the public UGSs consist of district parks, city parks, local parks, neighborhood parks, playground, and playing field. The public UGSs are equally distributed among these eight sub-districts. Taman Botani Perdana, Hutan Simpan Bukit Nanas, and Taman Datuk Keramat are located in sub-district of KL city center. Taman Tasik Titiwangsa are located between the sub-district of KL city center and Setapak. Taman Pudu Ulu is located at the boundary of 3 sub-districts which is

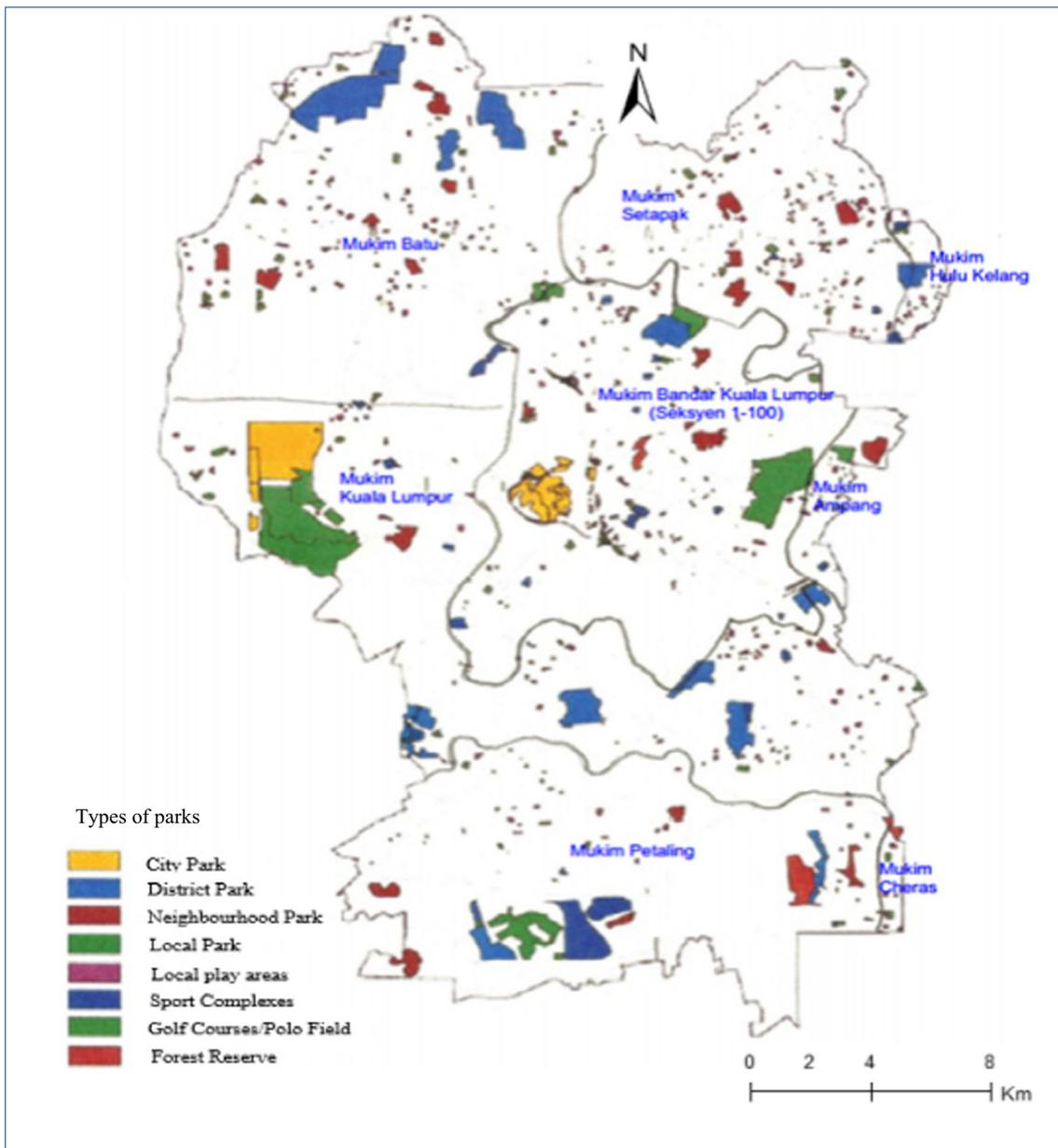


Fig. 2 The distribution of urban green space in KL according to sub-district (source: City Hall Kuala Lumpur 2016)

sub-district of KL, KL city center, and Ampang. Taman Ampang Hilir is located in the sub-district of Ampang. Taman Rimba Kiara and Tasik Permaisuri are located in sub-district of KL, while Taman Tasik Menjalara, Taman Metropolitan Kepong, and Taman Metropolitan Batu are located in sub-district of Batu. Taman Bukit Jalil, Taman Alam Damai, and Hutan Simpan Bukit Sg. Besi are located in a sub-district of Petaling. Lastly, Hutan Simpan Bukit Sg. Putih is located at the boundary of Selangor state and two sub-districts, namely, sub-district of Petaling and Cheras.

The house prices in the year 2016 for 1269 housing units represent a dependent variable. For the independent variables, there were three main attributes involved. There are house

attributes, neighborhood attributes, and environmental (UGS) attributes. The property data, structural, neighborhood, and environmental attributes were collected from a variety of sources. Data related to the house structures and house price were collected from the Valuation and Property Service Department. The data about the attributes of neighborhood were collected from Bahagian Siasatan Jenayah, Ibu Pejabat Polis Bukit Aman, Jabatan Pendidikan Wilayah Kuala Lumpur, and Ministry of Health. While the data on the public UGSs attributes are collected from DBKL and measured by GIS software. The data about the house attribute consist of the size of the building lot ( $m^2$ ), number of rooms, lot size ( $m^2$ ), and age of the house (year). The neighborhood attributes

consist of the distance between house location and hospital, number of public schools, and crime rate at each sub-district, whereas the environmental attribute consists of the distance from the public UGSs to the house location (km) and the size of public UGSs per houses (m<sup>2</sup>). Since GWR analysis involved in this study, the coordinates of the center of each public UGSs are this captured. It is used to measure the public UGS distance from the house location. The distances between them are measured individually. For the size of public UGSs per house, it is measured based on the following calculation:

$$\text{Size of each UGS per house} = \frac{\text{size of UGS}}{\text{size of each building lot}} \quad (1)$$

### Hedonic pricing model formulation: global model

The hedonic pricing method is used to estimate an implicit price for the public UGSs attributes. The implicit prices represent the economic value of the public UGSs. It is estimated by regressing price on measures of attributes, and the assessed coefficients denote the implicit price for the associated attribute. The implicit price (IP) is calculated by

$$IP(X_i) = \frac{\partial P_h}{\partial X_i} = \frac{\beta_i}{CX_i} \quad (2)$$

HPM will be regressed by using the global model and local model. By adopting and modifying the model from Kong et al. (2007), the appropriate global hedonic pricing equation for this study can be formulated as

$$\begin{aligned} \ln P_i = & \alpha + a_1 \ln NR_i + a_2 \ln SBL_i + a_3 \ln AGE_i + a_4 \ln SL_i + b_1 \ln DHOSP_i + b_2 \ln SCHOOL_i \\ & + b_3 \ln CRIME_i + c_1 \ln DTBP_i + c_2 \ln DTRK_i + c_3 \ln DTTT_i + c_4 \ln DTTM_i \\ & + c_5 \ln DTMK_i + c_6 \ln DTMB_i + c_7 \ln DTDK_i + c_8 \ln DTTP_i + c_9 \ln DTBJ_i \\ & + c_{10} \ln DTPU_i + c_{11} \ln DTAH_i + c_{12} \ln DTAD_i + c_{13} \ln DHBN_i + c_{14} \ln DHBSP_i \\ & + c_{15} \ln DHBSB_i + d_1 \ln STBP_i + d_2 \ln STRK_i + d_3 \ln STTT_i + d_4 \ln STTM_i \\ & + d_5 \ln STMK_i + d_6 \ln STMB_i + d_7 \ln STDK_i + d_8 \ln STTP_i + d_9 \ln STBJ_i \\ & + d_{10} \ln STPU_i + d_{11} \ln STAH_i + d_{12} \ln STAD_i + d_{13} \ln SHBN_i + d_{14} \ln SHBSP_i \\ & + d_{15} \ln SHBSB_i + \varepsilon_i \end{aligned} \quad (3)$$

where  $i$  is number of homes,  $P_i$  is the house price at the  $i$ th home,  $NR_i$  is the number of rooms at the  $i$ th home,  $AGE_i$  is the age of house (years) at the  $i$ th home,  $SBL_i$  is the size of building lot (m<sup>2</sup>) at the  $i$ th home,  $SL_i$  is the size of lot (m<sup>2</sup>) at the  $i$ th home,  $DHOSP_i$  is the nearest distance between hospital and house location (km) at the  $i$ th home,  $SCHOOL_i$  is the number of public school per sub-district at the  $i$ th home,  $CRIME_i$  is the crime rate per 1000 population,  $DTBP_i$  is the nearest distance between Taman Botani Perdana and house location (km) at the  $i$ th home,  $DTRK_i$  is the nearest distance between Taman Rimba Kiara and house location (km) at the  $i$ th home,  $DTTT_i$  is the nearest distance between Taman Tasik Titiwangsa and house location (km) at the  $i$ th home,  $DTTM_i$  is the nearest distance between Taman Tasik Menjalara and house location (km) at the  $i$ th home,  $DTMK_i$  is the nearest distance between Taman Metropolitan Kepong and house location (km) at the  $i$ th home,  $DTMB_i$  is the nearest distance between Taman Metropolitan Batu and house location (km) at the  $i$ th home,  $DTDK_i$  is the nearest distance between Tasik Datuk Keramat and house location (km) at the  $i$ th home,  $DTTP_i$  is the nearest distance between Taman Tasik Permaisuri and house location (km) at the  $i$ th home,  $DTBJ_i$  is the nearest distance between Taman Bukit Jalil and house location (km) at the  $i$ th home,  $DTPU_i$  is the nearest distance between Taman Pudu Ulu and house location (km) at the  $i$ th

home,  $DTAH_i$  is the nearest distance between Taman Ampang Hilir and house location (km) at the  $i$ th home,  $DTAD_i$  is the nearest distance between Taman Alam Damai and house location (km) at the  $i$ th home,  $DHBN_i$  is the nearest distance between Hutan Simpan Bukit Nanas and house location (km) at the  $i$ th home,  $DHBSP_i$  is the nearest distance between Hutan Simpan Bukit Sg.Puteh and house location (km) at the  $i$ th home,  $DHBSB_i$  is the nearest distance between Hutan Simpan Bukit Sg.Besi and house location (km) at the  $i$ th home,  $STBP_i$  is the size of Taman Botani Perdana per house (m<sup>2</sup>) at the  $i$ th home,  $STRK_i$  is the size of Taman Rimba Kiara per house (m<sup>2</sup>) at the  $i$ th home,  $STTT_i$  is the size of Taman Tasik Titiwangsa per house (m<sup>2</sup>) at the  $i$ th home,  $STTM_i$  is the size of Taman Tasik Menjalara per house (m<sup>2</sup>) at the  $i$ th home,  $STMK_i$  is the size of Taman Metropolitan Kepong per house (m<sup>2</sup>) at the  $i$ th home,  $STMB_i$  is the size of Taman Metropolitan Batu per house (m<sup>2</sup>) at the  $i$ th home,  $STDK_i$  is the size of Tasik Datuk Keramat per house (m<sup>2</sup>) at the  $i$ th home,  $STTP_i$  is the size of Taman Tasik Permaisuri per house (m<sup>2</sup>) at the  $i$ th home,  $STBJ_i$  is the size of Taman Bukit Jalil per house (m<sup>2</sup>) at the  $i$ th home,  $STPU_i$  is the size of Taman Pudu Ulu per house (m<sup>2</sup>) at the  $i$ th home,  $STAH_i$  is the size of Taman Ampang Hilir per house (m<sup>2</sup>) at the  $i$ th home,  $STAD_i$  is the size of Taman Alam Damai per house (m<sup>2</sup>) at the  $i$ th home,  $SHBN_i$  is the size of Hutan Simpan Bukit Nanas per house (m<sup>2</sup>) at the  $i$ th home,

SHBSP<sub>*i*</sub> is the size of Hutan Simpan Bukit Sg. Puteh per house (m<sup>2</sup>) at the *i*th home, and SHBSB<sub>*i*</sub> is the size of Hutan Simpan Bukit Sg. Besi per house (m<sup>2</sup>) at the *i*th home. The variables are represented in natural logarithm form.

**Hedonic pricing model formulation: local model**

The local model was analyzed by using GWR. The technique of GWR is a methodology used to explore and describe spatial data, particularly if non-stationary spatial relationships emerge

(Brunsdon et al. 1998; Yu 2007; Jaimes et al. 2010). This regression takes place via localized points in the geographic area. Thus, the relationship is assumed to present variations depending on the location, which is well defined by a pair of prototype coordinates (*u, v*) (Fotheringham, Brunsdon & Charlton, 2003).

By adopting and modifying the local model from Jaimes et al. (2010), the appropriate local HPM for this study can be formulated as

$$\begin{aligned} \ln P_i = & \alpha(u_i, v_i) + a_1(u_i, v_i) \ln NR_i + a_2(u_i, v_i) \ln SBL_i + a_3(u_i, v_i) \ln AGE_i + a_4(u_i, v_i) \ln SL_i \\ & + b_1(u_i, v_i) \ln DHOSP_i + b_2(u_i, v_i) \ln SCHOOL_i + b_3(u_i, v_i) \ln CRIME_i + c_1(u_i, v_i) \ln DTBP_i \\ & + c_2(u_i, v_i) \ln DTRK_i + c_3(u_i, v_i) \ln DTTT_i + c_4(u_i, v_i) \ln DTTM_i + c_5(u_i, v_i) \ln DTMK_i \\ & + c_6(u_i, v_i) \ln DTMB_i + c_7(u_i, v_i) \ln DTDK_i + c_8(u_i, v_i) \ln DTTP_i + c_9(u_i, v_i) \ln DTBJ_i \\ & + c_{10}(u_i, v_i) \ln DTPU_i + c_{11}(u_i, v_i) \ln DTAH_i + c_{12}(u_i, v_i) \ln DTAD_i + c_{13}(u_i, v_i) \ln DHBN_i \\ & + c_{14}(u_i, v_i) \ln DHBSP_i + c_{15}(u_i, v_i) \ln DHBSB_i + d_1(u_i, v_i) \ln STBP_i + d_2(u_i, v_i) \ln STRK_i \\ & + d_3(u_i, v_i) \ln STTT_i + d_4(u_i, v_i) \ln STTM_i + d_5(u_i, v_i) \ln STMK_i + d_6(u_i, v_i) \ln STMB_i \\ & + d_7(u_i, v_i) \ln STDK_i + d_8(u_i, v_i) \ln STTP_i + d_9(u_i, v_i) \ln STBJ_i + d_{10}(u_i, v_i) \ln STPU_i \\ & + d_{11}(u_i, v_i) \ln STAH_i + d_{12}(u_i, v_i) \ln STAD_i + d_{13}(u_i, v_i) \ln SHBN_i + d_{14}(u_i, v_i) \ln SHBSP_i \\ & + d_{15}(u_i, v_i) \ln SHBSB_i + \varepsilon_i \end{aligned} \tag{4}$$

where (*u<sub>i</sub>, v<sub>i</sub>*) is the *x-y* coordinate of each house. Note that the difference between the global model and the local model is on the presence of the house coordinate.

A detailed description of each variable in Eq. (3) and Eq. (4) is explained in Table 1.

**Results and findings**

**Global model**

The global model’s adjusted R<sup>2</sup> and *t* statistics values have been examined. Table 2 provides a summary of statistical variables.

Table 3 shows the result of the global model. Based on the global model, all the house structures were statistically significant with an expected sign except the number of room. Results show that housing prices increase by 81%, 63%, and 0.3% for each unit increase in size of building lot, size of lot, and decrease in house age, respectively. For neighborhood attribute, only the number of public school was statistically significant with the expected sign. The housing price grows by 0.9% for every unit increase in the number of public schools.

For the environmental attribute that is the distance between house locations and public UGSs, only five of the public UGSs were statistically significant with a negative sign. They were Taman Botani Perdana, Taman Rimba Kiara, Taman Datuk Keramat, Taman Ampang Hilir, and Hutan Simpan Bukit Nanas. In general, the results reveal that the

distance between house locations and public UGSs mentioned above negatively influences house price. Based on Table 3, Taman Botani Perdana, Taman Rimba Kiara, and Taman Datuk Keramat were significant at 1% while Taman Ampang Hilir and Hutan Simpan Bukit Nanas were significant at 10%. The results show the reduction of 1 km of the distance from the house locations to nearest public UGS (Taman Botani Perdana) will increase the price of the house by RM30,000. The reduction of 1 km of distance from the house locations to the nearest public UGS (Taman Rimba Kiara) will increase the price of the house by RM170,000. Reducing 1 km from the house locations to the nearest public UGS (Taman Datuk Keramat) will raise the house’s price by RM40,000. Reducing 1 km from the house locations to the nearest public UGS (Taman Ampang Hilir) will raise the house’s price by RM16,000. Then, reducing 1 km from the house locations to the nearest public UGS (Hutan Simpan Bukit Nanas) will raise the house’s price by RM90,000. The distance between the house locations and other public UGSs including Taman Tasik Titiwangsa, Taman Metropolitan Kepong, Taman Metropolitan Batu, Taman Tasik Permaisuri, Taman Tasik Bukit Jalil, Hutan Simpan Bukit Sg. Besi, and Hutan Simpan Bukit Sg. Puteh were also statistically significant, but with a positive sign. This may happen due to several possible reasons. According to the statistic revealed by Ibu Pejabat Polis Bukit Aman, these public UGSs are located in the sub-district of KL city center, Batu, Petaling, and Kuala Lumpur, which are recorded to be among the highest crime rates in KL Federal Territory. It was supported

**Table 1** Variable explanations and their expected sign

Variables	Definition of the variables	Expected sign
Size of building lot	Size of house building itself	+
Number of rooms	Number of house rooms	+
Age of house	The house age from completed construction to 2016	-
Size of lot	Size of total land for each house	+
The distance between the hospital and house location	The distance between Hospital Kuala Lumpur and house location	-
Number of public schools	Number of public school per sub-district	+
Crime rate	Index crime per 1000 population. It includes 2 categories of crimes: violent crimes (murder, attempted murder, rape, incest, armed/unarmed summons, armed guards/guns, armed guards/no weapons, severe injuries), and property crimes (broken houses and stolen day/night, steal motorcycles, stolen vehicles, snatches, others stolen).	-
The distance between house location and public UGSs	The distance between the center of public UGSs and house location for 1269 houses units in KL city	-
Size of public UGSs per house	Size of each public UGSs for each 1269 houses unit	+

by Troy and Grove (2008) which also claimed that this situation happens due to the high crime rate. Other than that, it is correlated to an omitted, positive neighborhood attribute. These public UGSs are located in the sub-district that provides a high number of schools. For instance, houses that are far away from public UGSs may tend to be located within the number of school, which could increase the house price. It was supported by Donovan and Butry (2011). In another point of view, Saphores and Li (2012) perceived contradicting effects to be reflected in the landscaping taste. In contrast, Czembrowski and Kronenberg (2016) assumed that those public UGSs are mostly used for recreational purposes by the elderly and the retired who relatively rarely buy houses or apartments.

For the environmental attribute that is the size of public UGSs, only Taman Tasik Titiwangsa was statistically significant with a positive sign. The results show that an increase in the size of Taman Tasik Titiwangsa by 1000 m<sup>2</sup> led to an increase at RM60,000 in the house price. Ishikawa and Fukushige (2012) supported this expected outcome. DBKL mentioned that Taman Tasik Titiwangsa which is located in the north-eastern fringe of Kuala Lumpur is a recreational park with a large lake as its main attraction. In addition, it is developed based on an “inclusivity” concept. The activities provided at this park are suitable for all age groups of people including disable people, for example, tennis courts, an exercise area, playground, remote control car track, cycling track, football field, water sport activities, viewing KLCC tower, playground, water sports, and helicopter ride. The size of UGSs (Taman Tasik Permaisuri and Hutan Simpan Bukit Sg.Besi) was also statistically significant but have a negative correlation. Similarly, Czembrowski and Kronenberg (2016) indicated that the decrease in size of UGSs would lead to an increase in house price. They opined that what especially counts in the

case of UGSs may be the kind of a label that a particular good has, or at least its familiarity (Lariviere et al. 2014). The size of UGSs (Taman Rimba Kiara, Tasik Menjalara, Taman Metropolitan Kepong, Taman Pudu Ulu, Taman Tasik Ampang Hilir, and Hutan Simpan Bukit Sg Puteh) would lead the house price to increase; however, these UGSs were statistically insignificant. All global models’ performance was overall satisfactory, as reflected in the analysis by adjusted R<sup>2</sup> and AIC.

The global OLS regression proved that the environmental attributes of UGSs have an economic value as represented by the marginal implicit price. The findings of this study contributed to the new body of knowledge especially on the issue regarding the economic value of UGSs from a local and international perspective. The marginal implicit prices which represent monetary information as well as economic value for each of the environmental attributes variable that are significant are presented in Table 4.

### GWR result

Global model results highlighted the significant relationship between several of the housing attributes, neighborhood attributes, and public UGS attributes and house prices. However, the relationship was constructed upon the theory of a stationary housing price, which is likely untenable. Hence, a local model using GWR was conducted to examine and explore such non-stationarity. Tables 5 and 6 present the ANOVA test of the local model against the global model and the results of the GWR model, respectively.

The adjusted R<sup>2</sup> values and AIC in Table 5 showed that there was a significant improvement in local models compared than the global model. The AIC value for the local model is smaller than the global models. This finding suggests even

**Table 2** Model variables and basic statistic

Variables	Mean	Standard deviation	Minimum	Maximum
<b>Dependent variable</b>				
Housing price (RM)	1,453,109.74	1,775,967.14	100,000	27,000,000
<b>Housing attribute variables</b>				
Size of building lot	183.11	145.95	45.98	1978.97
Size of lot	356.06	4020.29	170	143,066
Age of house	22.24	12.57	1	55
Room numbers	3.65	0.95	1	10
<b>Neighborhood attribute variables</b>				
Distance between hospital and house location	12.21	4.31	2.8	26.6
Crime rate	11.57	8.18	6	55
Number of public school	49.31	10.95	5	66
<b>Environmental attribute variables</b>				
The distance between house location and public UGSs (km)				
1. Taman Botani Perdana	11.75	3.35	3.3	27.5
2. Taman Rimba Bukit Kiara	14.22	5.23	0.4	28.9
3. Taman Tasik Titiwangsa	12.25	4.89	0.4	28.2
4. Taman Tasik Menjalara	15.35	8.64	13	38.2
5. Taman Metropolitan Kepong	17.98	6.75	4.1	39.6
6. Taman Metropolitan Batu	13.87	6.48	0.45	35
7. Taman Datuk Keramat	8.15	4.21	22.2	0.1
8. Taman Tasik Permaisuri	14.53	6.24	0.75	33.9
9. Taman Bukit Jalil	19.05	8.53	41.9	1.2
10. Taman Pudu Ulu	15.57	5.79	0.29	32.5
11. Tasik Ampang Hilir	15.26	5.03	33.1	2.2
12. Taman Alam Damai	17.7	7.99	0.02	27.7
13. Hutan Simpan Bukit Nanas	11.46	3.51	3.8	30.2
14. Hutan Simpan Bukit Sg.Besi	17.39	7.52	1.2	38.1
15. Hutan Simpan Bukit Sg. Puteh	18.66	4.88	2.4	36.1
Size of public UGSs per house (m <sup>2</sup> )				
1. Taman Botani Perdana	6784.82	4680.90	7.07	59,482.35
2. Taman Rimba Bukit Kiara	12,748.38	8795.21	13.28	111,764.7
3. Taman Tasik Titiwangsa	2952.26	2036.79	3.08	25,882.35
4. Taman Tasik Menjalara	1006.45	694.36	1.05	8823.53
5. Taman Metropolitan Kepong	7850.32	5415	8.18	68,823.53
6. Taman Metropolitan Batu	1744.52	1203.56	1.82	15,294.12
7. Taman Datuk Keramat	228.13	157.39	0.24	2000
8. Taman Tasik Permaisuri	2683.87	1851.62	2.80	23,529.41
9. Taman Bukit Jalil	2214.19	1527.59	2.31	19,411.76
10. Taman Pudu Ulu	1878.71	1296.13	1.96	16,471
11. Tasik Ampang Hilir	1073.55	740.65	1.19	9411.77
12. Taman Alam Damai	677.68	467.53	0.71	5941.18
13. Hutan Simpan Bukit Nanas	628.70	433.74	0.65	5511.8
14. Hutan Simpan Bukit Sg.Besi	2837.52	1957.63	2.96	24,876
15. Hutan Simpan Bukit Sg. Puteh	973.57	671.68	1.01	8535.3

Notes: these statistics relate to 1269 housing unit observations in KL City

after the GWR's complexity is taken into account, the local model performed better than the global model. Furthermore,

the increase in the adjusted  $R^2$  confirms that the local model explains the variance much better than the global model which

**Table 3** Global OLS regression result

Variable	Estimate	Standard error	<i>t</i> value (Est/SE)
Intercept	61.9209	67.5773	0.9163
Housing structure variables			
Age of house	-0.0033	0.00088	-3.7932***
Num of room	0.003	0.0142	0.2089
Ln size of lot area	0.6338	0.4682	1.3536*
Ln size of building lot area	0.8080	0.0310	26.0145***
Neighborhood attribute variables			
Ln distance to hospital	-0.1405	0.0763	-1.8408**
Crime rate	0.004	0.0016	2.4586***
Number of school	0.0086	0.0014	6.355***
Environmental attribute variables			
Ln distance between house locations and public UGSs (km)			
1. Taman Botani Perdana	-0.1716	0.0669	-2.5637***
2. Taman Rimba Bukit Kiara	-0.1299	0.0277	-4.6928***
3. Taman Tasik Titiwangsa	0.1713	0.052	3.2949***
4. Taman Tasik Menjalara	0.0057	0.0211	0.2684
5. Taman Metropolitan Kepong	0.2735	0.0674	4.0591***
6. Taman Metropolitan Batu	0.1497	0.0310	4.8232***
7. Taman Datuk Keramat	-0.06	0.0182	-3.2921***
8. Taman Tasik Permaisuri	0.111	0.0486	2.2832**
9. Taman Bukit Jalil	0.081	0.0315	2.5747***
10. Taman Pudu Ulu	0.0419	0.0485	0.8645
11. Tasik Ampang Hilir	-0.125	0.0942	-1.323*
12. Taman Alam Damai	-0.0591	0.0567	-1.0429
13. Hutan Simpan Bukit Nanas	-0.0826	0.0607	-1.3605*
14. Hutan Simpan Bukit Sg.Besi	0.0921	0.0687	1.3403*
15. Hutan Simpan Bukit Sg. Puteh	0.1394	0.0885	1.575*
Ln size of public UGSs per house (m <sup>2</sup> )			
1. Taman Botani Perdana	-0.2192	5.8293	-0.0376
2. Taman Rimba Bukit Kiara	8.9429	7.5253	1.1884
3. Taman Tasik Titiwangsa	20.9934	5.8587	3.5833***
4. Taman Tasik Menjalara	11.1798	15.6702	0.7134
5. Taman Metropolitan Kepong	2.6268	10.6804	0.2459
6. Taman Metropolitan Batu	-10.12	15.6759	-0.6456
7. Taman Datuk Keramat	-0.0088	0.099	-0.089
8. Taman Tasik Permaisuri	-10.149	5.3342	-1.9027**
9. Taman Bukit Jalil	-0.7	7.5492	-0.0928
10. Taman Pudu Ulu	2.9389	11.7018	0.2511
11. Tasik Ampang Hilir	4.1035	10.646	0.3854
12. Taman Alam Damai	-11.3090	11.2421	-1.0060
13. Hutan Simpan Bukit Nanas	-7.7164	6.2299	-1.2386
14. Hutan Simpan Bukit Sg.Besi	-18.6822	8.8885	-2.1018***
15. Hutan Simpan Bukit Sg. Puteh	1.3232	7.5442	0.1754
Adjusted <i>R</i> <sup>2</sup>		0.83	
AIC		916.92	

\*\*\*, \*\* and \* denote significance at the 1%, 5%, and 10% significance levels, respectively. A critical value for *t* test is assigned on 1269 degrees of freedom = 1.282 (10%), = 1.645 (5%), and = 2.326(1%)

**Table 4** Marginal implicit price for each public UGS for two environmental attributes (distance between house locations and public UGSs and size of public UGSs per house)

Environmental attributes variables	Marginal implicit price
The distance between residential areas and UGSs (1 m)	
1. Taman Botani Perdana	RM30
2. Taman Rimba Bukit Kiara	RM170
3. Taman Tasik Titiwangsa	-RM1070
4. Taman Tasik Menjalara	*
5. Taman Metropolitan Kepong	-RM410
6. Taman Metropolitan Batu	-RM520
7. Taman Datuk Keramat	RM40
8. Taman Tasik Permaisuri	-RM125
9. Taman Bukit Jalil	-RM50
10. Taman Pudu Ulu	*
11. Tasik Ampang Hilir	RM160
12. Taman Alam Damai	*
13. Hutan Simpan Bukit Nanas	RM90
14. Hutan Simpan Bukit Sg.Besi	-RM150
15. Hutan Simpan Bukit Sg. Puteh	*
Size of UGSs per house (m <sup>2</sup> )	
1. Taman Botani Perdana	*
2. Taman Rimba Bukit Kiara	*
3. Taman Tasik Titiwangsa	RM60
4. Taman Tasik Menjalara	*
5. Taman Metropolitan Kepong	*
6. Taman Metropolitan Batu	*
7. Taman Datuk Keramat	*
8. Taman Tasik Permaisuri	-RM30
9. Taman Bukit Jalil	*
10. Taman Pudu Ulu	*
11. Tasik Ampang Hilir	*
12. Taman Alam Damai	*
13. Hutan Simpan Bukit Nanas	*
14. Hutan Simpan Bukit Sg.Besi	-RM20
15. Hutan Simpan Bukit Sg. Puteh	*

\*Statistically insignificant coefficient and therefore no marginal implicit price estimated

is consistent with the finding in the previous studies (Jaimes et al. 2010, Oliveira et al. 2014; Hu et al. 2016). The level of explanation for variance increased significantly, resulting in an adjusted value of 86% which was 3% higher than the global model.

Table 6 shows the local model’s results. The parameter estimates of the local parameter vary at each of the 1269 housing unit. They are elaborated in terms of their mean, maximum (max), and minimum (min) values and lower and upper quartile. Table 6 illustrates that all of the variables are significant and have geographical/spatial variability except the size of Hutan Simpan Bukit Sg. Puteh. The obtained results are in

**Table 5** ANOVA test of GWR against the global model

Source	SS	DF	MS	F
Global residuals	143.10	129.000		
GWR improvement	42.707	165.518	0.258	
GWR residuals	100.434	1063.482	0.094	2.7321

GWR Akaike information criterion (AIC) = 768.367746 (OLS = 916.92); GWR adjusted R<sup>2</sup> = 0.86 (OLS = 0.83)

SS sum of squares, DF degree of freedoms, MS residual mean square

line with the empirical work from Latinopoulos (2018). They are significant at 1% except for the distance between house locations and Taman Rimba Kiara which is at 10%. The spatial variability of the variables is determined based on the value of DIFF of Criterion. The negative value of DIFF of criterion suggests there exist spatial variability. However, it is still considered that there exists spatial variability if the positive value is less than or equal to two (Nakaya 2014).

This shows a proof that housing prices within KL city are not constant and can vary across space. Table 6 also shows that the min, max, lower quartile, and upper quartile value of the local GWR estimates were counterintuitive in some of the cases. They were the size of lot, number of rooms, distance to the hospital, crime rates, number of schools, distance between house locations, and all of the public UGSs and the size of the public UGSs. It is estimated that the size of lot, number of room, distance to hospital, crime rate, and number of school range from - 25.53 to 6.08, - 0.09 to 0.1, - 0.42 to 0.16, - 0.02 to 0.04, and - 0.0005 to 0.02, respectively. The negative values for the size of lot, number of rooms, and number of schools depict that the reduction in the size of the lot, number of rooms, and number of school will increase the house price at certain house locations, while the positive values for the distance to hospital and crime rate depict that the increase in the distance to the hospital and crime rate will increase the house price at certain locations. The positive values for the distance between house locations and public UGSs depict that the raising of the distance between them will increase the house price at certain house locations, while the negative values for the size of public UGSs show that the reduction in the size of public UGSs will increase the price of the house at a certain house location.

Statistical tests revealed that significant spatial non-stationarity exists between house prices and all the selected house attributes, neighborhood attributes, and environmental attributes except the size of Hutan Simpan Bukit Sg. Puteh. One advantage of the GWR is that spatial distribution is inherent in the parameter estimates and can easily be visualized in map form using GIS software. These parameter estimates are a measurement for the economic value of each public UGS subjected to each house location. Figure 3a–n shows the parameter estimate surfaces of each attribute’s coefficient at

**Table 6** Test for non-stationarity and GWR result

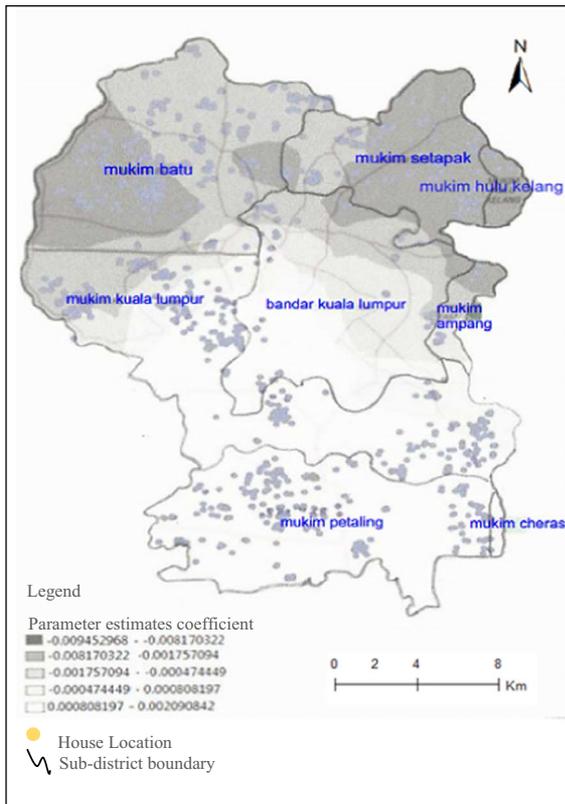
	Min	Lower quantile	Med	Upper quantile	Max	DIFF of criterion	F value
Intercept	-136.8576	-15.9875	11.2576	81.7651	283.9535	-554.7053	164.0369***
<b>Housing structure variables</b>							
Ln size of building lot	0.6225	0.7377	0.7773	0.8194	0.8534	-25.9458***	8.3691***
Ln size of lot	-25.5330	-12.9759	-2.5253	-0.8071	6.0799	-438.9879***	109.6386***
Ln age of house	-0.0095	-0.0076	-0.0058	0.0010	0.0021	-15.554***	6.6643***
Ln number of room	-0.0904	-0.012	0.0235	0.0312	0.1026	-10.9667***	4.8771***
<b>Neighborhood attribute variables</b>							
Ln distance to hospital	-0.4158	-0.2188	-0.1114	-0.0165	0.1639	-145.1994***	53.5497***
Ln crime rate	-0.0241	0.0020	0.0045	0.0103	0.0405	-15.345***	6.5797***
Ln number of school	-0.0005	0.0036	0.0094	0.0125	0.0230	-11.6605***	5.1673***
<b>Environmental attribute variables Ln distance between house location and public UGSs (km)</b>							
1. Taman Botani Perdana	-0.5624	-0.206	-0.0256	0.1625	0.3770	-106.4175***	49.9552***
2. Rimba Bukit Kiara	-0.6307	-0.3364	-0.1904	-0.0254	0.1208	0.404*	2.1843*
3. Taman Tasik Titiwangsa	-0.1526	0.0064	0.0456	0.0919	0.2886	-30.2018***	12.4211***
4. Taman Tasik Menjalara	-0.3646	-0.0331	0.0219	0.0663	0.4638	-30.8389***	13.1676***
5. Taman Metropolitan Kepong	-0.8522	0.0831	0.2224	0.3109	0.7620	-42.6574***	16.0019***
6. Taman Metropolitan Batu	-0.1693	0.0457	0.1116	0.1936	0.8971	-20.3849***	10.9359***
7. Taman Datuk Keramat	-0.1445	-0.0854	-0.0204	0.0630	0.1899	-5.5171***	4.6935***
8. Taman Tasik Permaisuri	-0.1286	0.0522	0.0918	0.1679	0.4880	-14.0039***	8.0252***
9. Taman Bukit Jalil	-0.7490	-0.3008	-0.0977	0.0877	0.1652	-11.8639***	6.1856***
10. Taman Pudu Ulu	-0.6713	-0.4447	-0.0482	0.0930	0.3227	-23.3972***	9.2639***
11. Tasik Ampang Hilir	-1.1137	-0.0806	0.1860	0.4304	1.0733	-5.7798***	4.1613***
12. Taman Alam Damai	-0.6046	-0.2187	-0.0948	-0.0071	0.1215	-8.1556***	4.3395***
13. Hutan Simpan Bukit Nanas	-0.4948	-0.2579	-0.0373	0.1789	0.2899	-50.0172***	18.8970***
14. Hutan Simpan Bukit Sg.Besi	-0.3031	-0.0115	0.1777	0.2831	0.7163	-8.2209***	4.2836***
15. Hutan Simpan Bukit Sg. Puteh	-0.2593	-0.0885	0.0891	0.4441	1.1526	-66.5605***	24.2511***
<b>Ln Size of public UGSs per house (m<sup>2</sup>)</b>							
1. Taman Botani Perdana	-26.3584	-11.3184	1.6074	5.1885	31.5007	-3890.9175***	5297.8988***
2. Rimba Bukit Kiara	-19.2707	0.5136	14.8073	24.0277	35.7548	-6338.1852***	61,460.4166***
3. Taman Tasik Titiwangsa	-17.2466	9.6581	16.2482	20.8806	41.6654	-1685.1919***	1003.3955***
4. Taman Tasik Menjalara	-58.2546	1.6429	21.8309	30.0048	52.8863	-937.9524***	506.3244***
5. Taman Metropolitan Kepong	-34.4545	-20.2141	2.7345	16.9846	36.0789	-830.6363***	518.9419***
6. Taman Metropolitan Batu	-39.6035	-26.963	-9.1121	8.6546	66.1276	-971.6605***	495.5006***
7. Taman Datuk Keramat	-21.44578	-11.3461	-7.3488	-0.0093	2.0410	-4897.6444***	9663.3776***
8. Taman Tasik Permaisuri	-36.3017	-21.963	-6.2552	-3.7612	1.1616	-1007.5607***	307.9848***
9. Taman Bukit Jalil	-30.9792	-11.8991	4.0906	12.1224	62.2446	-2709.5624***	2119.1651***
10. Taman Pudu Ulu	-46.6912	-19.9605	5.4972	37.5075	48.8732	-786.1136***	514.1115***
11. Tasik Ampang Hilir	-29.2552	-3.4195	3.8892	11.3937	38.4867	-627.7219***	289.3176***
12. Taman Alam Damai	-62.0166	-29.1027	-3.0962	1.2750	31.8830	-846.8263***	429.3090***
13. Hutan Simpan Bukit Nanas	-41.1490	-22.4488	-15.82	-4.9809	10.1286	-6673.3616***	35,119.7897***
14. Hutan Simpan Bukit Sg.Besi	-57.0867	-35.1188	1.7281	10.3199	55.8511	-3640.5138***	6529.1244***
15. Hutan Simpan Bukit Sg. Puteh	-61.0224	-14.3415	-6.3159	21.2693	27.3017	-11,073.3020***	-408,480.4879

Positive value of diff-Criterion (AICc, AIC, BIC/MDL, or CV) suggests no spatial variability in terms of model selection criteria

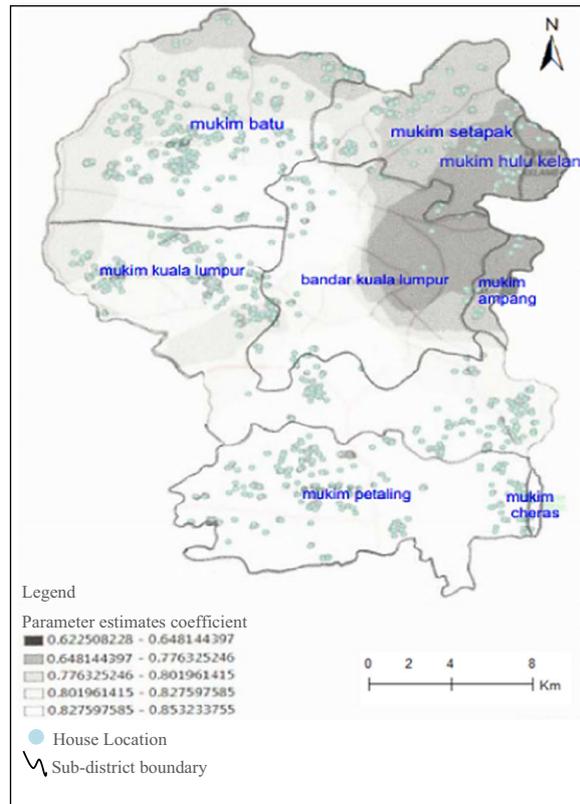
eight sub-districts in KL city that were significant. It is determined based on the *F* value. The maps shown in Fig. 3a–n reveal that the relationship between the houses attributes, neighborhood attributes, and environmental attributes and

the house prices is not necessarily significant with the expected sign at each of the sub-district of Federal Territory of KL. It provides the specific locations according to the sub-districts which yield to the economic value of each public UGSs.

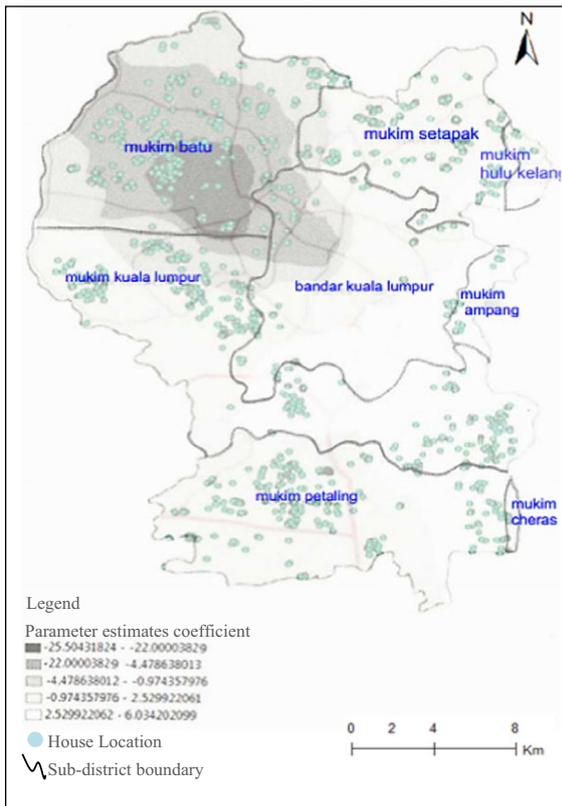
a: Parameter estimates of age of house



b: Parameter of size of lot



c: parameter estimates of size of building lot



d: Parameter estimates of number of room

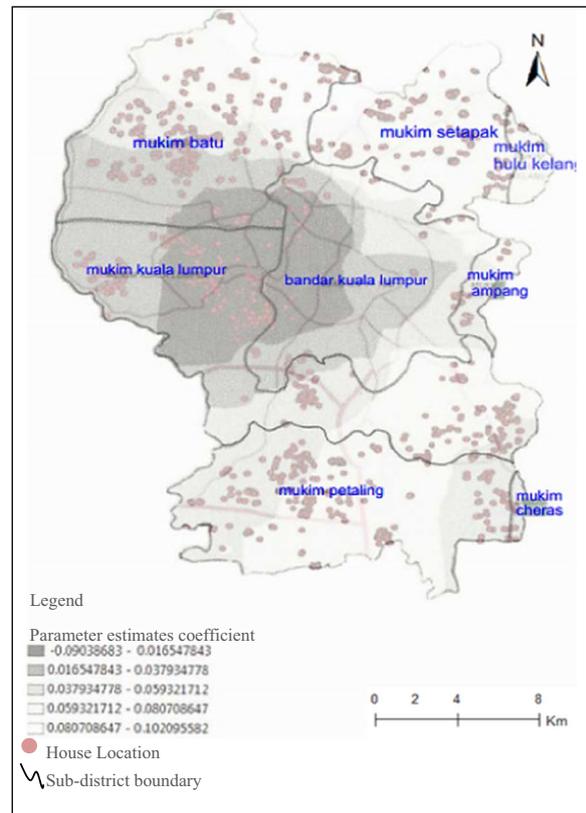


Fig. 3 a Parameter estimates of age of house. b Parameter of size of lot. c Parameter estimates of size of building lot. d Parameter estimates of number of room

For house attributes (Fig. 3a–d), the age of house and size of building lot were statistically significant with an expected sign at the whole locations in Federal Territory of KL. The number of the room was statistically significant with an expected sign at all of the sub-district of Federal Territory of KL except sub-district of KL and KL city center. The size of the lot was statistically significant with an expected sign at most of the house located at sub-district of Ampang, Cheras, and certain location at sub-district of KL.

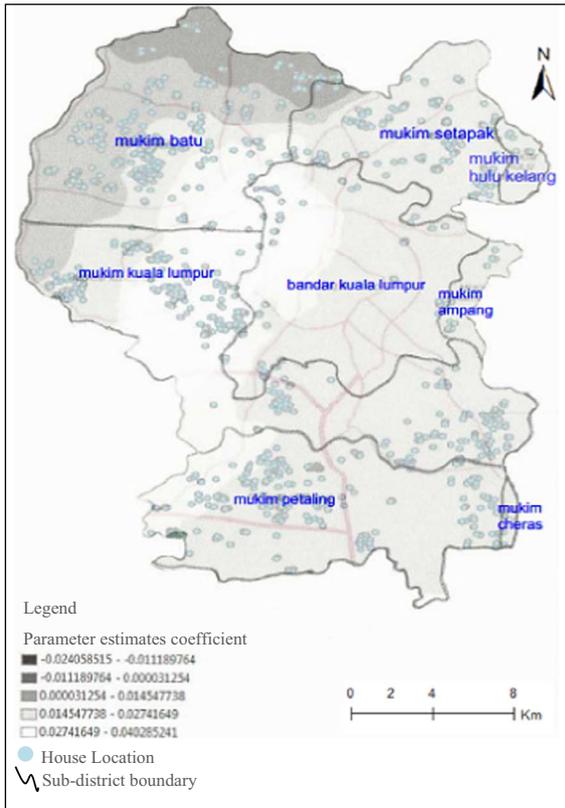
For the neighborhood attributes (Fig. 4a–c), the number of schools has a positive significant relationship with the house price at all of the sub-districts in KL except certain locations at the sub-district of Batu. The distance between the hospital and house location was positively significant at most of the house locations at the sub-districts of Hulu Kelang and Ampang and certain house locations at sub-districts of Setapak and Petaling. The crime rate was negatively significant at most of the house locations at the sub-district of Batu and certain locations at sub-districts of Setapak and KL.

For the environmental attributes, Fig. 5a–o shows that the house price affected by the distance between house locations and 15 public UGSs varied among the sub-districts. Based on the parameter estimate coefficients in Fig. 5a, the distance between Taman Tasik Botani Perdana and house location negatively influenced the house price for the house located in sub-districts of Batu, Setapak, Hulu Kelang, Ampang, and the certain location at sub-districts of KL and KL city center. The result revealed that the economic value of Taman Botani Perdana is only reliable within these sub-districts. The map depicted that not all of the house units located in the sub-district of KL and KL city center have a negative relationship with the house price even though Taman Botani Perdana is located within these two sub-districts. This is because both of these sub-districts are often facing traffic congestion problems. Figure 5b shows the distance between house locations and Taman Tasik Menjalara negatively influenced the house price for the house located in sub-districts of Kuala Lumpur, Batu, and KL city center. Figure 5c shows the distance between house locations and Taman Tasik Titiwangsa which negatively influenced the house price in the sub-district of Petaling and certain house locations at sub-districts of KL and Batu. Figure 5d shows the distance between house locations and Taman Rimba Kiara which negatively influenced the house price for the house located in all sub-districts except Setapak and certain locations at a sub-district of KL. Figure 5e shows the distance between house locations and Taman Metropolitan Kepong which negatively influenced the house price in a certain location at sub-districts of Petaling, Ampang, and KL. Figure 5f shows the distance between house locations and Taman Metropolitan Batu which negatively influenced the house price for the house located in half of the locations at the sub-district of Petaling and certain locations at the sub-district of Setapak and KL city center.

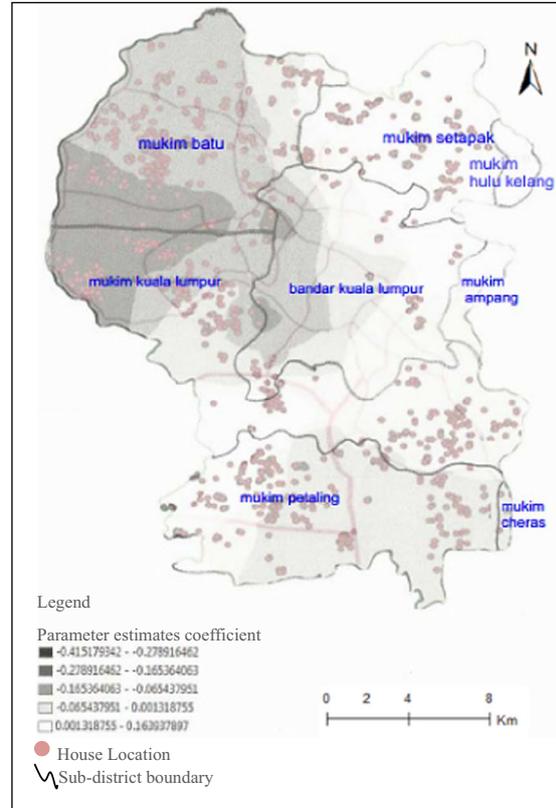
Figure 5g shows the distance between house locations and Taman Datuk Keramat which negatively influenced the house price in most of the houses located at sub-districts of Batu, KL, KL city center, and a certain location at the sub-district of Setapak. Figure 5h shows the distance between house locations and Taman Tasik Permaisuri which negatively influenced the house price in sub-district of Cheras, Batu, and Petaling, and a certain location at the sub-district of KL. Even though Taman Tasik Permaisuri is located in the sub-district of KL, the result found that the negative relationship between the distances and the house prices was not negatively significant for the whole house location in the sub-district of KL due to the traffic-congested area. Figure 5i shows the distance between house locations and Taman Bukit Jalil which negatively influenced the house prices in sub-districts of Batu, Setapak, Hulu Kelang, and a certain location at the sub-district of KL and KL city center. Next, Fig. 5j shows the distance between house locations and Taman Pudu Ulu which negatively influenced the house prices in the sub-district of Batu and a certain location at the sub-district of Setapak, KL, and KL city center, while Fig. 5k shows the distance between house locations and Taman Ampang Hilir which negatively influenced the house in all sub-districts except certain locations at the sub-districts of Petaling, KL, and Batu. Figure 5l shows the distance between house locations and Taman Alam Damai which negatively influenced the house prices for the house located at sub-districts of Cheras and Petaling and certain locations at sub-districts of Batu and KL. Figure 5m shows the distance between house locations and Hutan Simpan Bukit Nanas which negatively influenced the house prices at all sub-districts except the sub-district of Batu and certain locations at the sub-district of KL and KL city center. Figure 5n shows the distance between house locations and Hutan Simpan Bukit Sg. Besi which negatively influenced the house price at sub-districts of Cheras and Petaling and certain locations at a sub-district of KL and KL city center. Lastly, Fig. 5o shows the distance between house locations and Hutan Simpan Bukit Sg. Puteh which negatively influenced the house price at all sub-districts except Batu, Setapak, KL city center, and a certain location at the sub-district of KL. Figure 5a–o depict that most of the houses located neighborhood to the public UGSs have a significant impact on its prices. These findings are supported by Tajima (2003) in Boston, MA, USA.

The same goes for the size of public UGSs (Fig. 6a–n). The significance of its expected (positive) sign exists in different sub-districts. The size of Taman Botani Perdana positively influenced the house price at all sub-districts except the sub-district of Batu and certain locations at KL and KL city center. The result describes that the economic value of Taman Botani Perdana subjected to the size attribute is significantly accounted for the whole location in KL city except the sub-district of Batu and certain locations at sub-districts of KL and

a: Parameter estimates of crime rate



b: Parameter estimates of distance to hospital



c: Parameter estimates of number of school

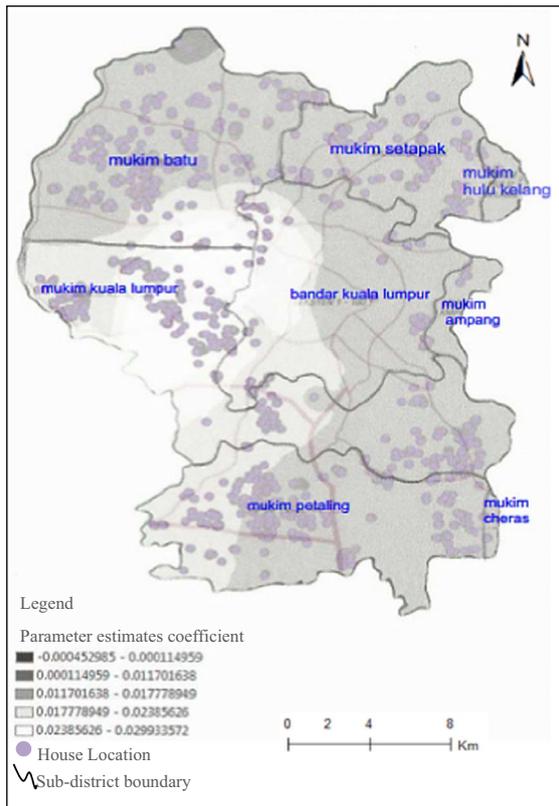
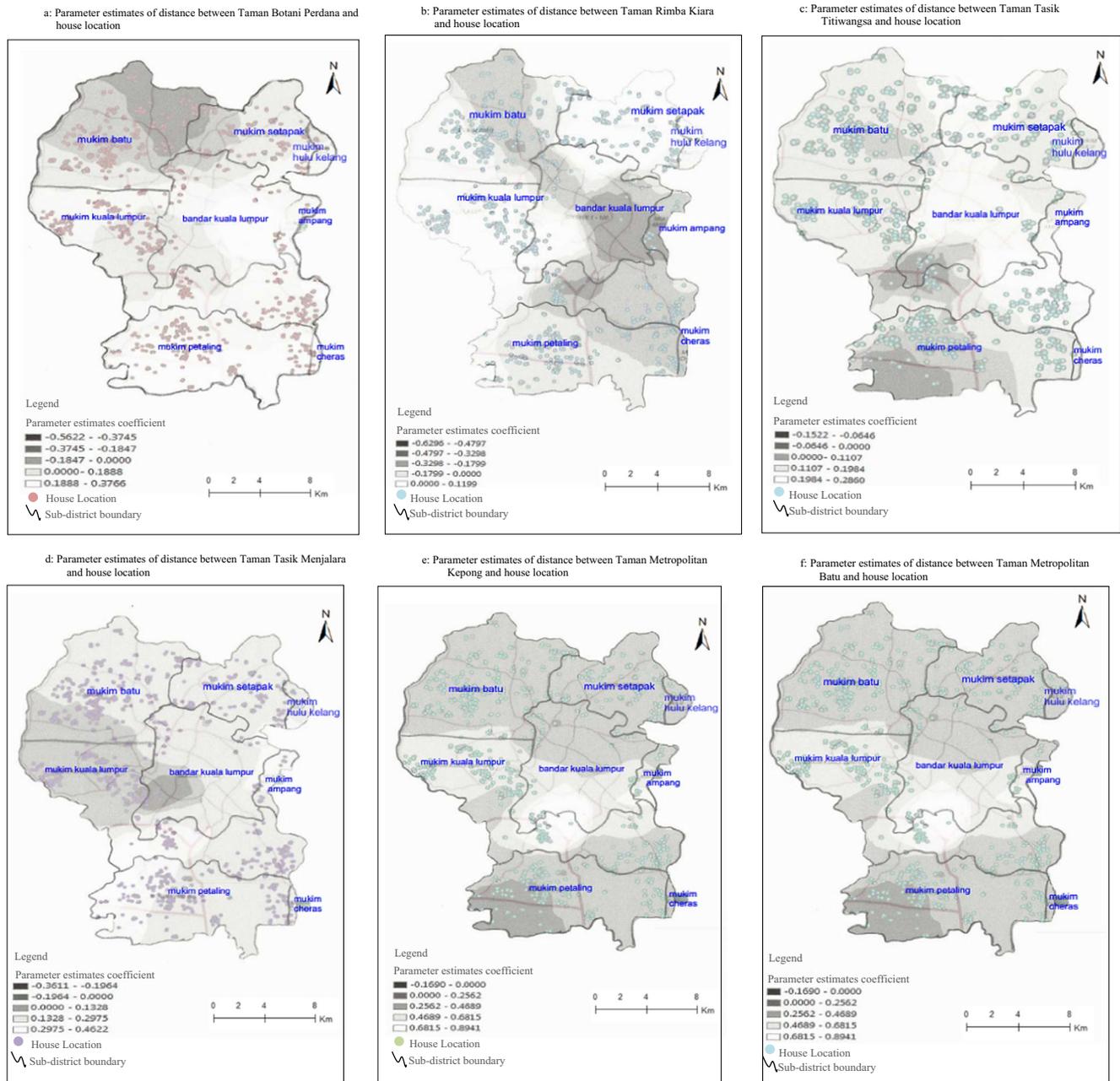


Fig. 4 a Parameter estimates of crime rate. b Parameter estimates of distance to hospital. c Parameter estimates of number of school



**Fig. 5** **a** Parameter estimates of distance between Taman Botani Perdana and house location. **b** Parameter estimates of distance between Taman Rimba Kiara. **c** Parameter estimates of distance between Taman Tasik and house location Titiwangsa and house location. **d** Parameter estimates of distance between Taman Tasik Menjalara. **e** Parameter estimates of distance between Taman Metropolitan and house location Kepong and house location. **f** Parameter estimates of distance between Taman Metropolitan. **g** Parameter estimates of distance between Taman Datuk Keramat Batu and house location and house location. **h** Parameter estimates of distance between Taman Tasik Permaisuri. **i** Parameter

estimates of distance between Taman Bukit Jalil and house location and house location. **j** Parameter estimates of distance between Taman Pudu Ulu. **k** Parameter estimates of distance between Taman Ampang Hilir and house location and house location. **l** Parameter estimates of distance between Taman Alam Damai. **m** Parameter estimates of distance between Hutan Simpan Bukit and house location Nanas and house location. **n** Parameter estimates of distance between Hutan Simpan. **o** Parameter estimates of distance between Hutan Simpan Bukit Sg.Besi and house location Bukit Sg Putih and house location

KL city center. For the size of Taman Rimba Bukit Kiara, it positively influenced the house prices for the house located at sub-districts of Petaling, Cheras, and Batu and certain locations at sub-districts of Setapak, KL, and KL city center. The

size of Taman Tasik Titiwangsa was positively influenced the house prices at all sub-districts except certain locations at sub-districts of Batu, KL, Setapak, and KL city center. The size of Taman Tasik Menjalara positively influenced the house prices

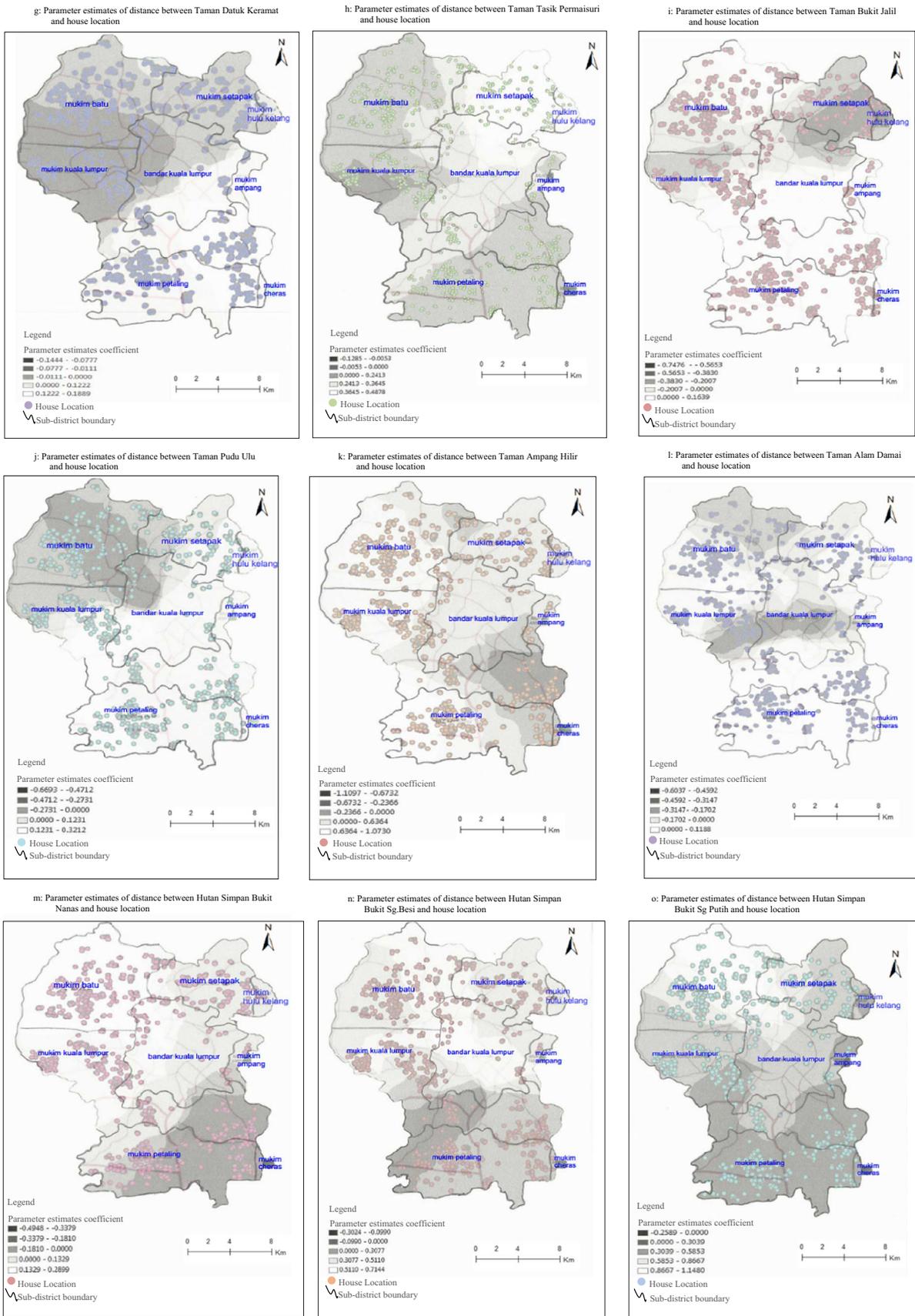
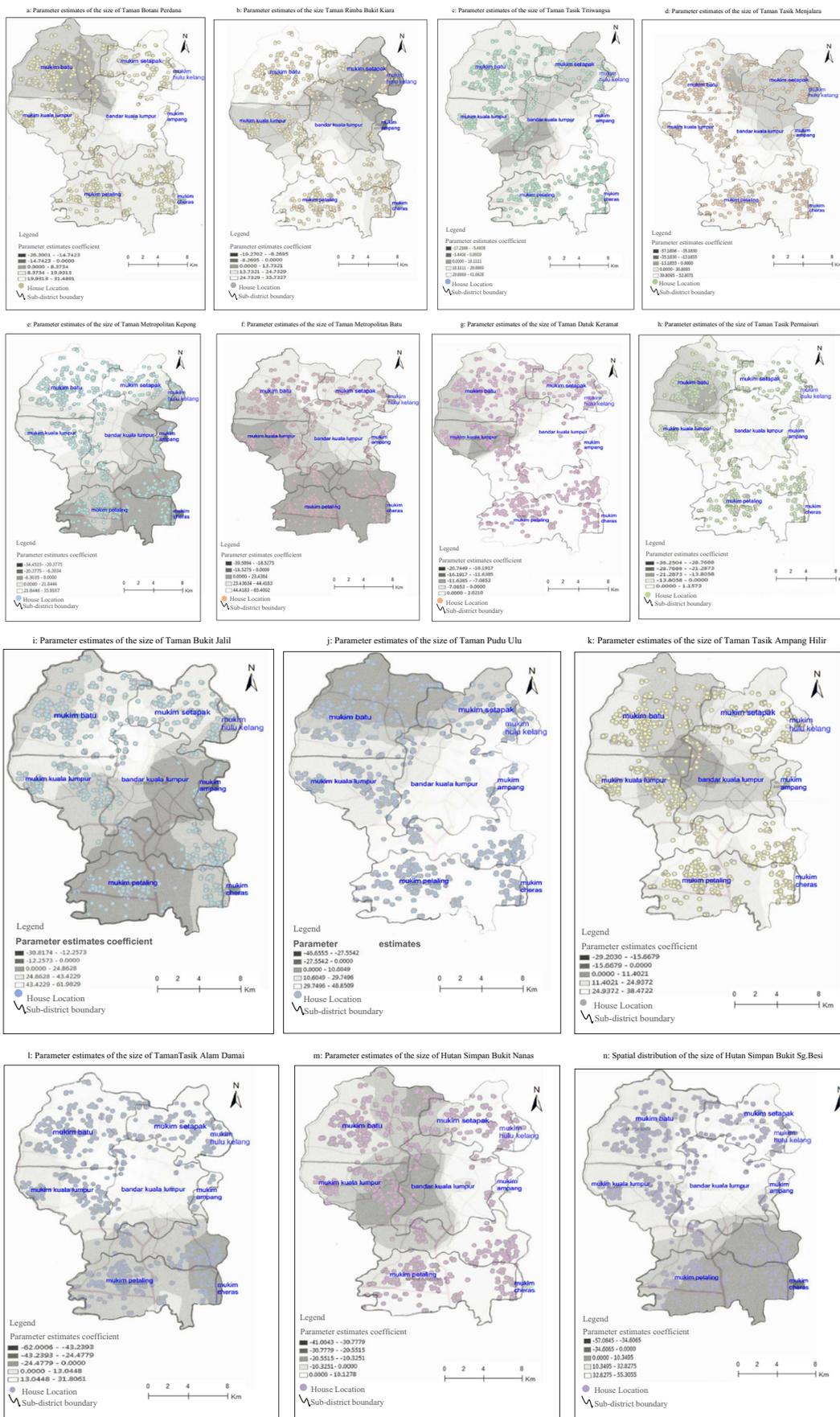


Fig. 5 (continued)



◀ **Fig. 6** **a** Parameter estimates of the size of Taman Botani Perdana. **b** Parameter estimates of the size of Taman Rimba Bukit Kiara. **c** Parameter estimates of the size of Taman Tasik Titiwangsa. **d** Parameter estimates of the size of Taman Tasik Menjalara. **e** Parameter estimates of the size of Taman Metropolitan Kepong. **f** Parameter estimates of the size of Taman Metropolitan Batu. **g** Parameter estimates of the size of Taman Datuk Keramat. **h** Parameter estimates of the size of Taman Tasik Permaisuri. **i** Parameter estimates of the size of Taman Bukit Jalil. **j** Parameter estimates of the size of Taman Pudu Ulu. **k** Parameter estimates of the size of Taman Tasik Ampang Hilir. **l** Parameter estimates of the size of Taman Tasik Alam Damai. **m** Parameter estimates of the size of Hutan Simpan Bukit Nanas. **n** Spatial distribution of the size of Hutan Simpan Bukit Sg. Besi. **o** Parameter estimates of distance between Hutan Simpan Bukit Sg Putih and house location

at sub-districts of KL, Petaling, and Cheras and certain locations at sub-districts of Batu and KL city center. The size of Taman Metropolitan Kepong positively influenced the house prices at the sub-district of Batu and certain locations in sub-districts of Setapak and KL. The size of Taman Metropolitan Batu positively influenced the house prices at sub-districts of Ampang, Hulu Kelang, Setapak, and Batu and certain locations at sub-districts of Batu and KL city center. The size of Taman Datuk Keramat positively influenced the house prices at sub-districts of Cheras, Petaling, and Ampang and certain locations at sub-districts of KL and KL city center. The size of Taman Tasik Permaisuri positively influenced the house prices at all sub-districts except the sub-district of Batu and certain locations at a sub-district of KL. The size of Taman Bukit Jalil positively influenced the house price at sub-districts of Setapak and Batu and certain locations at sub-districts of KL and KL city center. Next, the size of Taman Pudu Ulu positively influenced the house prices at all sub-districts except certain locations at sub-districts of Batu and Setapak. The size of Taman Tasik Ampang Hilir positively influenced the house prices at all sub-districts except certain locations at KL city center, KL, and Batu. The size of Taman Alam Damai positively influenced the house prices at sub-districts of Hulu Kelang, Setapak, Batu, and KL city center and certain locations at sub-districts of KL. For the size of Hutan Simpan Bukit Sg. Besi, it positively influenced the house prices at sub-districts of Petaling and Cheras and certain locations at sub-districts of KL. Lastly, the size of Hutan Simpan Bukit Nanas positively influenced the house prices for the houses located at sub-districts of Hulu Kelang and certain locations at sub-districts of Setapak and Ampang, and KL city center. The size of Hutan Simpan Bukit Sg. Puteh was found to be not statistically significant even though it has 14.51 ha in area. Its location sits on the outskirts of KL and spills over to Selangor which resulted to an insignificant impact on the house price located within the KL city. However, the size of Hutan Simpan Bukit Sg. Puteh might statistically influence the house price located in Selangor state especially the house located at the boundary of the sub-district of Cheras. The second reason is that the activities provided at this park are mostly suitable

for the adults especially the ones who love hiking. Other than that, people claimed there is lack of facility such as limited number of parking. The visitors need to park the vehicle along the main roads outside the housing area and then trek in.

Based on both environmental attributes, the findings showed that each public UGS was significant with its expected sign and mostly within the sub-districts that the public UGSs are located in. The influence of each public UGS varies through space, linking to the spatial variation of accessibility and socioeconomic profiles (Noor et al. 2015). Specifically, this study comes out with two key conclusions. First, KL's housing value could contain many types of submarket based on locations, structural housing attributes, neighborhood attribute, and environmental attribute. It is essential for recognition and delineation of housing values in the city of KL to take into account more than just housing structural attributes. Instead, the housing markets in the city of KL are a combined result of all these influential factors. Second, the local modeling technique employed in this study revealed that all selected variables except the size of Hutan Simpan Bukit Sg. Puteh can add to house value, whereas for the global model, such a subtle effect was masked by the averaging process of the significant spatial non-stationarity. These results provide obvious different findings as compared with the global model result. The ANOVA test could recommend that local analysis technique is more accurate in the study of the urban housing market than global ones. Hence, the findings obtained through the local model are more convincing than the global model. The economic values of the public UGSs in KL city attained through the local analysis are considered as a new finding. Therefore, it was contributed to the new body of knowledge especially in the field of economic valuation of public UGSs using spatial analysis in the case of KL city. The findings also proved that the economic values of public UGSs in KL city which are derived from the HPM are influenced by the combination attributes including house structure, neighborhood attributes, and environmental attributes as well as its locational factor. Other previous studies such as Anderson and West (2006), Cho et al. (2008), Jaimes et al. (2010), and Hu et al. (2016) also believed that the spatial analysis of HPM needs to be taken into account in measuring the economic value of UGSs.

## Conclusion

This study investigated the economic value of public UGSs in KL City. HPM aided by OLS regression and GWR were used to achieve the objective. The rationale behind using these two methods is as follows. The OLS regression is a global model which is assumed to be stationary and location independent, while GWR is a local model which is assumed to be non-stationary and location dependent. The global model reveals

the result in average value, but the local model reveals the result specifically across the sub-districts.

Based on the HPM, house price is used to estimate the marginal implicit price of environmental (public UGSs) attribute in KL city. The environmental attributes include the distance between house locations and public UGSs and the size of public UGSs per house. For the distance variables, the global model suggested that there are only five public UGSs (Taman Botani Perdana, Taman Rimba Kiara, Taman Datuk Keramat, Taman Ampang Hilir, and Hutan Simpan Bukit Nanas) which have a significant negative relationship with house price. The results show that decreasing the distance between the public UGSs and house locations is unambiguously associated with increasing the house price. The marginal implicit prices for the distance between house location and Taman Botani Perdana, Taman Rimba Kiara, Taman Datuk Keramat, Taman Ampang Hilir, and Hutan Simpan Bukit Nanas are RM30, RM170, RM40, RM160, and RM90, respectively. It is subjected to a decrease by 10 m for the distance between the public UGSs and house locations. For the size of public UGSs, only Taman Tasik Titiwangsa has a significant positive relationship with house price. The result shows that an increase in the size of Taman Tasik Titiwangsa by 1000 m<sup>2</sup> led to an RM60 increase in the house price. Therefore, the marginal implicit price for size of Taman Tasik Titiwangsa is RM60. The findings revealed there were some of the relationships between environmental attributes and house price that were not statistically significant with the expected sign. This happens due to several reasons such as high crime location, existence of the number of schools around the house location, landscaping view, park familiarity, and socioeconomic profile.

Based on the local model, all of the environmental attributes variables tested are significant except the size of Hutan Simpan Bukit Sg. Putih. GWR captured that the significant value with the expected sign of each environmental attributes variables is located at different sub-districts. Hence, each of the environmental attributes has an implicit house price which varies over a geographic location. Most of them are statistically significant with an expected sign within the sub-districts that in which the public UGSs are located which was supported by Tajima (2003). In terms of model comparison, ANOVA test reveals the local model is performed better than the global model. This finding was supported by the previous studies conducted by Anderson and West (2006), Cho, Bowker and Park (2006), Cho et al. (2008), and Jaimes et al. (2010). Thus, the findings of this study contributed to the body of knowledge especially in the field of spatial analysis of the economic valuation of the public UGSs especially in the case of KL city.

The study has some policy implications. First, since HPM have proved that public UGSs in KL city have hedonic values as represented by marginal implicit price; therefore, the local authorities need to intensify their commitment to conserve and

preserve the public UGSs. They need to develop a thorough adjustment in the monitoring of public UGS provision and condition so that the existing public UGSs cannot be accessed easily from any irresponsible party. In addition, the government can come out with new policies related to quit-rent, for example by imposing 5–10% higher than the current quit-rent for property located within a 1-km radius from public UGSs. The implementation of this policy means more income for the country. This study not only provides a better understanding of the relationship between house prices and parks in KL city but also offers a new perspective of investment strategy on to the property developers. The findings will help the property developers to discover potential project locations that enable them to generate high revenues. This study shows that the environmental dimension plays an important role in the spatial structure of residential house prices.

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## References

- Ali G, Bashir MK, Ali H (2015) Housing valuation of different towns using the hedonic model: a case of Faisalabad city, Pakistan. *Habitat Int* 50:240–249
- Anderson ST, West SE (2006) Open space, residential property values, and spatial context. *Reg Sci Urban Econ* 36:773–789
- Ball MJ (1973) Recent empirical work on the determinants of relative house prices. *Urban Stud* 10(2):213–233
- Brunsdon C, Fotheringham S, Charlton M (1998) Geographically weighted regression. *J Roy Stat Soc D-Sta* 47:431–443
- Brunson MW, Reiter DK (1996) Effects of ecological information on judgments about scenic impacts of timber harvest. *J Environ Manag* 46(1):31–41
- Callan SJ, Thomas JM (2013) *Environmental economics and management: theory, policy, and applications*. Cengage Learning
- Case KE, Mayer CJ (1996) Housing price dynamics within a metropolitan area. *Reg Sci Urban Econ* 26(3):387–407
- Chin TL, Chau KW (2003) A critical review of literature on the hedonic price model. *International Journal for Housing and Its Applications* 27(2):145–165
- Cho S, Poudyal NC, Roberts RK (2008) Spatial analysis of the amenity value of green open space. *Ecol Econ* 66:403–416
- City Hall Kuala Lumpur (2016). *Land Use and Development Strategy*. Retrieved from [http://www.dbkl.gov.my/pskl2020/english/land\\_use\\_and\\_development\\_strategy/index.htm](http://www.dbkl.gov.my/pskl2020/english/land_use_and_development_strategy/index.htm)
- Clark DE, Herrin WE (2000) The impact of public school attributes on home sale price in California. *Growth Chang* 31:385–407
- Conway D, Li CQ, Wolch J, Kahle C, Jerrett M (2010) A Spatial Autocorrelation Approach for Examining the Effects of Urban Green Space on Residential Property Values. *J Real Estate Financ*
- Crompton JL (2001) The impact of parks on property values: a review of the empirical evidence. *J Leis Res* 33(1):1
- Czembrowski P, Kronenberg J (2016) Hedonic pricing and different urban green space types and sizes: insights into the discussion on valuing ecosystem services. *Landsc Urban Plan* 146:11–19
- Department of Statistic, Malaysia (2016) *Population Distribution and basic Demographic Characteristic Report 2010*. Retrieved from

- [https://www.statistics.gov.my/index.php?r=column/cthemebycat&cat=117&bul\\_id=MDMxdHJzWtk1SjFzTzNkRXYzcVZjd09&menu\\_id=L0pheU43NWJwRWVzSkWdzQ4TthUUT09](https://www.statistics.gov.my/index.php?r=column/cthemebycat&cat=117&bul_id=MDMxdHJzWtk1SjFzTzNkRXYzcVZjd09&menu_id=L0pheU43NWJwRWVzSkWdzQ4TthUUT09)
- Donovan GH, Butry DT (2011) The effect of urban trees on the rental price of single-family homes in Portland, Oregon. *Urban For Urban Green* 10(3):163–168
- Fletcher M, Gallimore P, Mangan J (2000) Heteroskedasticity in hedonic house price models. *J Prop Res* 17(2):93–108
- Fotheringham, A. S., Brunson, C., & Charlton, M. (2003). Geographically weighted regression: the analysis of spatially varying relationships. John Wiley & Sons
- Forrest D, Glen J, Ward R (1996) The impact of a light rail system on the structure of house prices. *J Transp Econ Policy* 31(4):15–29
- Gairola S, Noresah MS (2010) Emerging trend of urban green space research and the implications for safeguarding biodiversity: a viewpoint. *Nat Sci* 8(7):43–49
- Garrod G, Willis K (1992) Valuing the goods characteristics – an application of the hedonic price method to environmental attributes. *J Environ Manag* 34(1)
- Gibbons S, Mourato S, Resende GM (2014) The amenity value of English nature: a hedonic price approach. *Environ Resour Econ* 57(2):175–196
- Goodman AC (1989) Topics in empirical urban housing research. In: Muth, Goodman (eds) *Regional and Urban Economics*. Harwood Academic Publisher, pp 49–146
- Goodman AC, Thibodeau TG (1998) Housing market segmentation. *J Hous Econ* 7(2):121–143
- Green Facts (2016) Non-Market Value. Retrieved from <http://www.greenfacts.org/glossary/mno/non-market-value.htm>
- Haurin DR, Brasington D (1996) School quality and real house prices: inter and intra metropolitan effects. *J Hous Econ* 5:351–368
- Hu S, Yang S, Li W, Zhang C, Xu F (2016) Spatially non-stationary relationships between urban residential land price and impact factors in Wuhan city, China. *Appl Geogr* 68:48–56
- Huh S, Kwak SJ (1997) The choice of functional form and variables in the hedonic price model in Seoul. *Urban Stud* 34(7):989–998
- Hussein H (2006) Barrier-free park design for the disabled persons: a case study of the KLCC Park. *J Des Built Environ* 2(1):57–67
- Ishikawa N, Fukushige M (2012) Effects of street landscape planting and urban public parks on dwelling environment evaluation in Japan. *Urban For Urban Green* 11(4):390–395
- Jaimes NBP, Sendra JB, Delgado MG, Plata RF (2010) Exploring the driving forces behind deforestation in the state of Mexico (Mexico) using geographically weighted regression. *Appl Geogr* 30:576–591
- Jim CY, Chen WY (2006) Recreation-amenity use and contingent valuation of urban green space in Guangzhou, China. *Landsc Urban Plan* 75(1–2):81–96
- Kain JF, Quigley JM (1970) Measuring the value of housing quality. *J Am Stat Assoc* 65:532–548
- Ketkar K (1992) Hazardous waste sites and property values in the state of New Jersey. *Appl Econ* 24:647–659
- Kohlhase JE (1991) The impact of toxic waste sites on housing values. *J Urban Econ* 30:1–26
- Kong F, Yin H, Nakagoshi N (2007) Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: a case study in Jinan City, China. *Landsc Urban Plan* 79: 240–252
- Lariviere J, Czajkowski M, Hanley N, Aanesen M, Falk-Petersen J, Tinch D (2014) The value of familiarity: effects of knowledge and objective signals on willingness to pay for a public good. *J Environ Econ Manag* 68(2):376–389
- Latinopoulos D (2018) Using a spatial hedonic analysis to evaluate the effect of sea view on hotel prices. *Tour Manag* 65:87–99
- Laverne RJ, Winson-Geideman K (2003) The influence of trees and landscaping on rental rates at office buildings. *J Arboric* 29(5):281–290
- Li MM, Brown HJ (1980) Micro-neighborhood externalities and hedonic housing prices. *Land Econ* 56(2):125–141
- Linneman P (1980) Some empirical results on the nature of the hedonic price function for the urban housing market. *J Urban Econ* 8(1):47–68
- Lupi F, Graham-Tomasi T, Taff SJ (1991) A hedonic approach to urban wetland valuation (no. 13284). University of Minnesota, Department of Applied Economics
- Lutzenhiser M, Netusil NR (2001) The effect of open space on a home's sale price. *Contemp Econ Policy* 19(3):291–298
- MacLennan D, Tu Y (1996) Economic perspectives on the structure of local housing systems. *Hous Stud* 11(3):387–406
- Mahan BL, Polasky S, Adams RM (2000) Valuing the urban wetlands: a property price approach. *Land Econ* 76(1):100–113
- Mazlina M, Ismail S (2007). Green infrastructure as network of social spaces for well-being of urban residents: a review. In: *Proceedings of International Conference on Built Environment in Developing Countries*. Universiti Sains Malaysia
- Mazlina M, Ismail S (2008) Green infrastructure as network of social spaces for well-being of urban residents in Taiping, Malaysia. *Jurnal Alam Bina* 11(2):1–18
- Mohd Yusof MJ (2013) True colours of urban green spaces: identifying and assessing the qualities of green spaces in Kuala Lumpur. University Of Edinburgh, Malaysia
- Morancho AB (2003) A hedonic valuation of urban green area. *Landscape Urban Plan* 66:35–41
- Nakaya T (2014) GWR4 Windows Application for Geographically Weighted Regression Modelling: GWR4 User Manual. GWR4 Development Team
- Noor NM, Asmawi MZ, Abdullah A (2015) Sustainable urban regeneration: GIS and hedonic pricing method in determining the value of green space in housing area. *Procedia Soc Behav Sci* 170:669–679
- Nur Syafiqah AS, Abdul-Rahim AS, Mohd Johari MY, Tanaka K (2018) An economic valuation of urban green spaces in Kuala Lumpur City. *Pertanika J Soc Sci Hum* 26(1):469–490
- Oliveira S, Pereira JM, San-Miguel-Ayaz J, Lourenço L (2014) Exploring the spatial patterns of fire density in southern Europe using geographically weighted regression. *Appl Geogr* 51:143–157
- Orford S (2000) Modelling spatial structures in local housing market dynamics: a multilevel perspective. *Urban Stud* 37(9):1643–1671
- Palmquist RB (1992) Valuing localized externalities. *J Urban Econ* 31: 59–68
- PEMANDU (2014) Economic transformation programme (ETP) annual report 2013. Retrieved From [https://www.pmo.gov.my/dokumenattached/NTP-Report-2013/ETP\\_2013\\_ENG.pdf](https://www.pmo.gov.my/dokumenattached/NTP-Report-2013/ETP_2013_ENG.pdf)
- Pietsch M (2012) GIS in landscape planning. INTECH Open Access Publisher
- Samuelson P (1954) The pure theory of public expenditure, review of economics and statistics. 36(4):387–389
- Saphores JD, Li W (2012) Estimating the value of urban green areas: a hedonic pricing analysis of the single family housing market in Los Angeles, CA. *Landsc Urban Plan* 104:373–387
- Saz-Salazar SD, Rausell-Koster P (2008) A double-hurdle model of urban green areas valuation: dealing with zero responses. *Landsc Urban Plan* 84(3–4):241–251
- Schnare AB, Struyk RJ (1976) Segmentation in urban housing markets. *J Urban Econ* 3(2):146–166
- Smith VK, Krutilla JV (1982) *Explorations in natural-resource economics*. John Hopkins University Press, Baltimore
- Straszheim MR (1975) *An econometric analysis of the urban housing market*. National Bureau of Economic Research, New York
- Tajima K (2003) New estimates of the demand for urban green space: implications for valuing the environmental benefits of Boston's big dig project. *J Urban Aff* 25(5):641–655
- Teh TS (1994) Current state of green space in Kuala Lumpur. *Malays J Trop Geogr* 25(2):115–127

- Ting TP (2012) Urban green spaces and liveability in Southeast Asia. *Urbanization in Southeast Asia: Issues & Impacts*, 262
- Troy A, Grove JM (2008) Property values, parks, and crime: a hedonic analysis in Baltimore, MD. *Landsc Urban Plan* 87:233–245
- Tyrvaäinen L (1997) The amenity value of the urban forest: an application of the hedonic pricing method. *Landsc Urban Plan* 37(3):211–222
- Tyrvaäinen L (2001) Economic valuation of urban forest benefits in Finland. *J Environ Manag* 62(1):75–92
- Tyrvaäinen L, Miettinen A (2000) Property prices and urban forest amenities. *J Environ Econ Manag* 39(2):205–223
- Tyrvaäinen L, Vaananen H (1998) The economic value of urban forest amenities: an application of the contingent valuation method. *Landsc Urban Plan* 43(1–3):105–118
- Wolf KL (2003) Public response to the urban forest in inner-city business districts. *J Arboric* 29(3):117–126
- Yaakup A, Johar F, Abu-bakar SZ, Sulaiman S, Baharuddin MN (2005) Integrated land use assessment: the case of Klang valley region, Malaysia. Universiti Teknologi Malaysia. Working Paper (No.223)
- Yu D (2007) Modelling owner-occupied single-family house values in the city of Milwaukee: a geographically weighted regression approach. *GISci Remote Sens* 44:267–282
- Yusof MJM (2012) Identifying green space in Kuala Lumpur using higher resolution satellite imagery. *Alam Cipta, International Journal of Sustainable Tropical Design Research and Practice* 5: 93–106
- Yusof MJM, Rakhshandehroo M (2016) The nature, functions, and management of urban green space in Kuala Lumpur. *J Archit Plan Res* 33(4):347–360
- Zhou X, Parves Rana M (2012) Social benefits of urban green space: a conceptual framework of valuation and accessibility measurements. *Manag Environ Qual Int J* 23(2):173–189

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