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Analysis of Fragmented Green Spaces in Kuala Lumpur, Malaysia

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Issues concerning urban resilience have now become a great challenge to the world as a result of rapid urbanisation. Malaysia is ranked among East Asia's most urbanised countries and its urban population has continued to increase rapidly from 27 % in 1970 to 74 % in 2014. To cope with the issue of sustainability, urban planning has emerged at creating and managing network of green spaces. The establishment of green corridor has accelerated as a response to global concern about issues regarding the fragmentation, climate changes and loss of landscape connectivity resulted from the urbanisation. To ensure that network of green spaces can be established, the fragmented of green spaces must be first identified and located. An analysis of fragmented green spaces has been conducted by using Object Oriented procedure to the high-resolution satellite image of SPOT-6 dated June 2016. Results showed that big and small fragmented green spaces existed with the total area of 84 km^2 out of 243 km^2 total areas of Kuala Lumpur. The highest total area of green spaces was recorded to be in the Damansara Penchala zone which is 26 km^2 and the lowest record is in the Kuala Lumpur City Center area which is only 5 km^2 in area. It was concluded that urban green spaces are more fragmented where there are more built-up areas. In this paper, city center has the least ratio of area of green to the urban area compared to the other five zones because the green space in the area was smaller and fragmented.

1. Introduction

To ensure a sustainable urban setting, one of the crucial factors is keeping environment at the best condition and reducing the environmental pollution. Sustainable approaches include important impact to the resolution of reusing and recycling materials, reducing emissions and saving energy to reduce the intimidating impacts on the environment (Mahdiyar et al., 2016). Sustainable development depends on conservation and the growth of ecosystem facilities (Askerlund and Almers, 2016). Southeast Asian countries including Malaysia have undergone rapid urbanisation. To realise the vision of becoming a developed country, the activities of industry, transportation and residential has led these countries to develop at the expense of large-scale land clearances. Unfortunately, these clearances have led to fragmentation of green spaces where open spaces, forest reserves, parks, cemeteries and water bodies (lakes and rivers) constitute as part of green infrastructure in cities. As green infrastructure provides various ecosystem functions and services to urban populations, they must be protected and conserved. Moreover, as the human population will grow in the future, the Earth needs enough green spaces for the people as it is important for the livability of the city. One of the effective strategies is to connect the fragmented patches providing enough green space by forming larger and connected spaces through green corridors. Such spaces are essential not only to provide a linked space for fauna to move freely but also to provide a green network for urban dwellers to walk from one place to another in the city. Accessibility is the most crucial issue for walkability. The equal chances for all in using public spaces makes the place accessible (Zakaria and Ujang, 2015). This will reduce the use of vehicles in the city center which will subsequently lower CO_2 emission. On another note, United Nation (UN) Sustainable Development Goal (SDG), Goal 11 is making cities and human settlements comprehensive, harmless, sustainable and resilient where by the year 2030, the goal is to offer common access to safe, inclusive and

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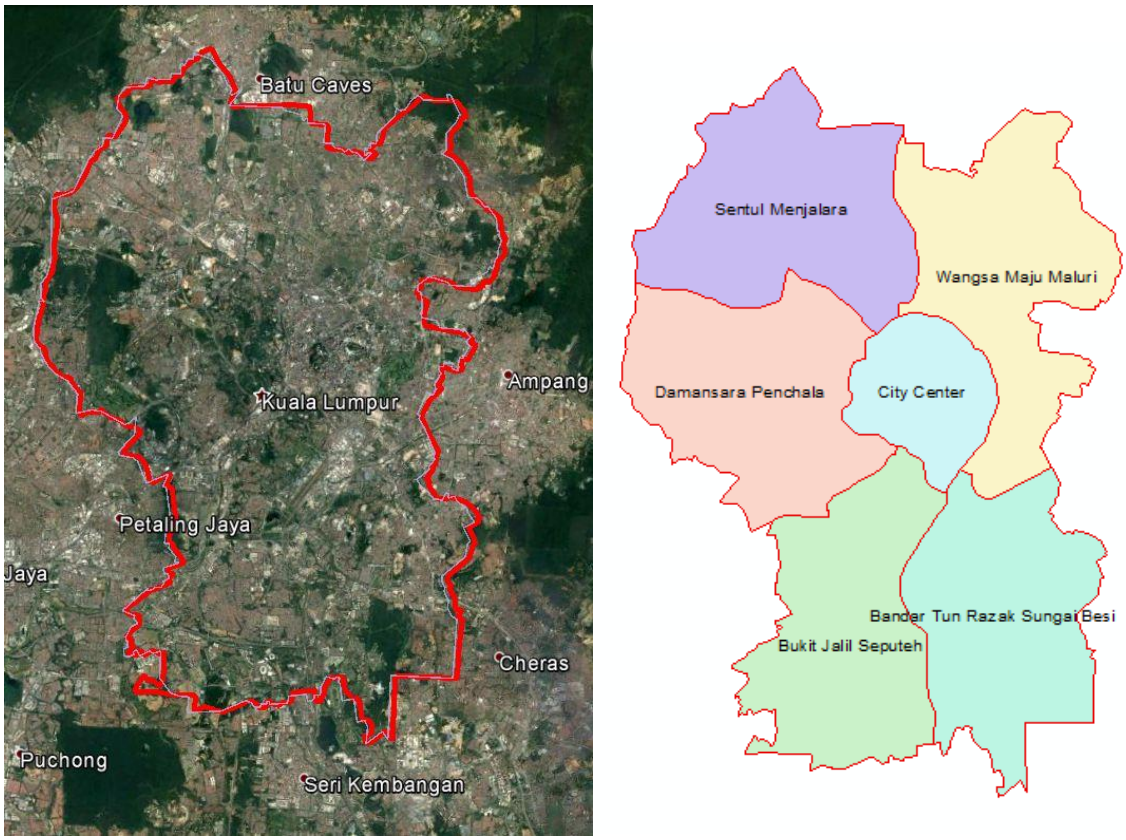
reachable green and public places, where the built- up area of cities is the open space for community use for all, by sex, age and persons with disabilities. Most Southeast Asian countries have undergone rapid urbanisation and global development (Daniels et al., 2018). It was reported that the green spaces have been decreasing with time and many cities in Southeast Asia have low coverage of green spaces (Richard et al., 2017). In Kuala Lumpur, Malaysia, the open space reduction and exceptional rise in the population density caused the total green space per capita to decrease from 13 m^2 in 2010 to 8.5 m^2 in 2014 (Kanniah, 2017). Ramakreshnan et al. (2018) have proved the decrease of KL land use changes from 1990 to 2016 where the urbanisation is outstanding with a remarkable vanishing of green areas over the past decades.

2. Study area

The study area focused in Kuala Lumpur (Figure 1a) which covers 24,300 hectares or 243 km^2 in area. Kuala Lumpur was studied because it is a rapidly developing city that has witnessed a great loss of green space due to high industrial activities (Kanniah and Ho, 2017). In this paper, green space fragmentation was analysed based on six zones in Kuala Lumpur, which consist of Sentul Manjalara, Wangsa Maju Maluri, Damansara Penchala, City Center, Bukit Jalil Seputeh and Bandar Tun Razak Sg Besi zonal area (Figure 1b).



(a) *(b)*

Figure 1: The study areas which are (a) Kuala Lumpur area and (b) its 6 Zones

3. Method

Object based image classification was applied in this study where e-Cognition software (Trimble, 2017) was used to adopt hierarchical rule-based classification. Segmentation rule sets were developed in this software beginning with image segmentation and image classification. In image classification phase, two steps were required, which was image object feature creation (unclassified, water, tree, grass, bare land and urban) followed by threshold identification and execution. The details of rule sets developed for image segmentation and image classification was shown in Figure 2. After classification methods were applied, the accuracy of the result was assessed using ENVI software version 5.0 (Exelis, 2017) by computing the confusion matrix table and further validated by selecting polygons from Google Earth (Google Earth Pro, 2017) layer to further cross check the accuracy.

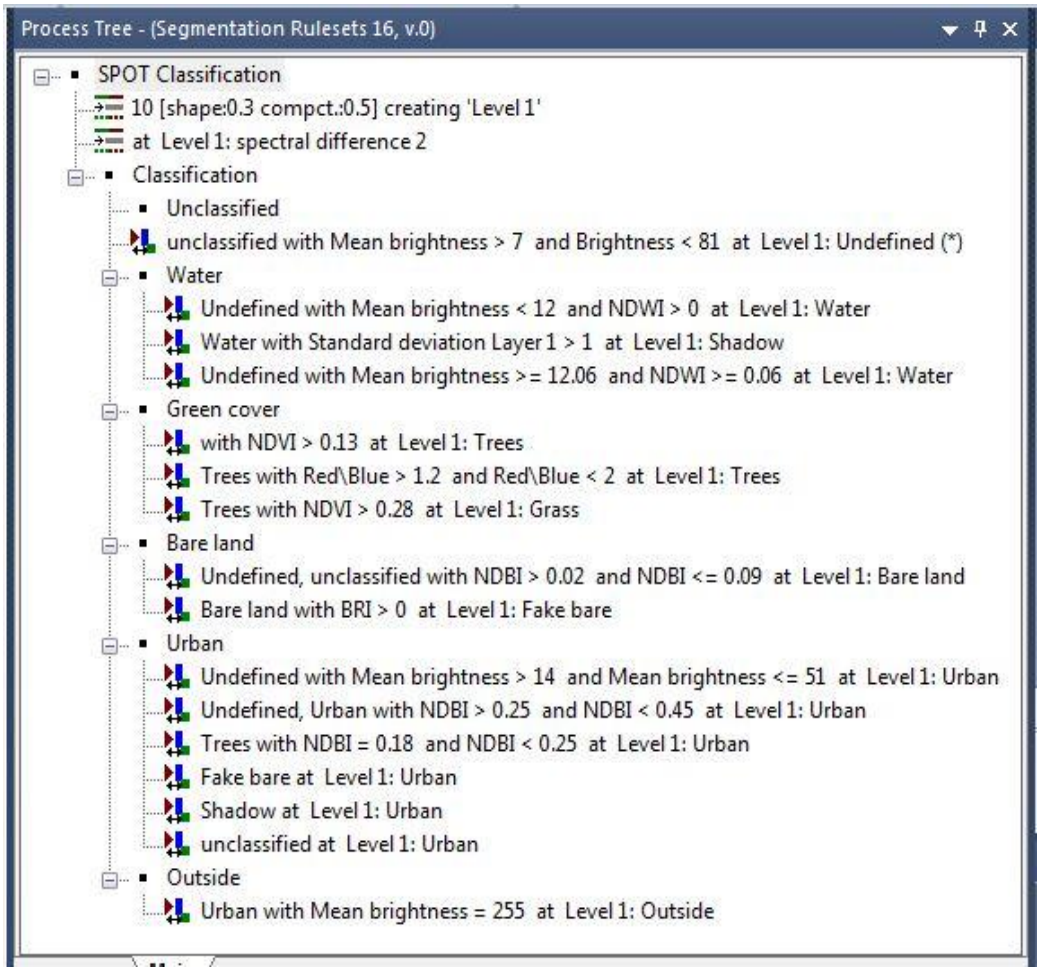


Figure 2: Rule sets for image segmentation and image classification developed

4. Results and discussion

Image classification using object oriented (OO) enable more detailed classification to be done. For example, in this paper trees and grass can be differentiated by determining threshold in the rule sets as shown in Section 3. Figure 3 visually shows that urban is dominating the area in Kuala Lumpur and was proved in Table 1 as urban covers 59.7 % of the whole area.

Table 1: The area OO results for each class

ID	Class	No of points	Area in m^2*	Area in km^2	Area (ha)	%
1	Water	4,720,264	10,620,594.00	10.621	1,062.1	4.4
2	Urban	63,765,806	143,473,064.00	143.473	14,347.3	59.7
3	Tree	32,828,194	73,863,436.50	73.863	7,386.3	30.7
4	Grass	4,297,439	9,669,237.75	9.670	967.0	4.0
5	Bare Land	1,099,865	2,474,696.25	2.475	247.5	1.2
TOTAL		106,711,568	240,101,028.00	240.102	24,010.2	100.0

* = No of points multiply by 2.25 m (the pixel area for SPOT image)

Urban was recorded the highest in city center part (Table 2) as KL development is primarily in the form of compact housing blocks in the largest city center of KL (Ramakreshnan et al., 2018). Nearly 66 % of industrial as well as commercial activities are presently consolidated within KL city center (KLCH, 2016).

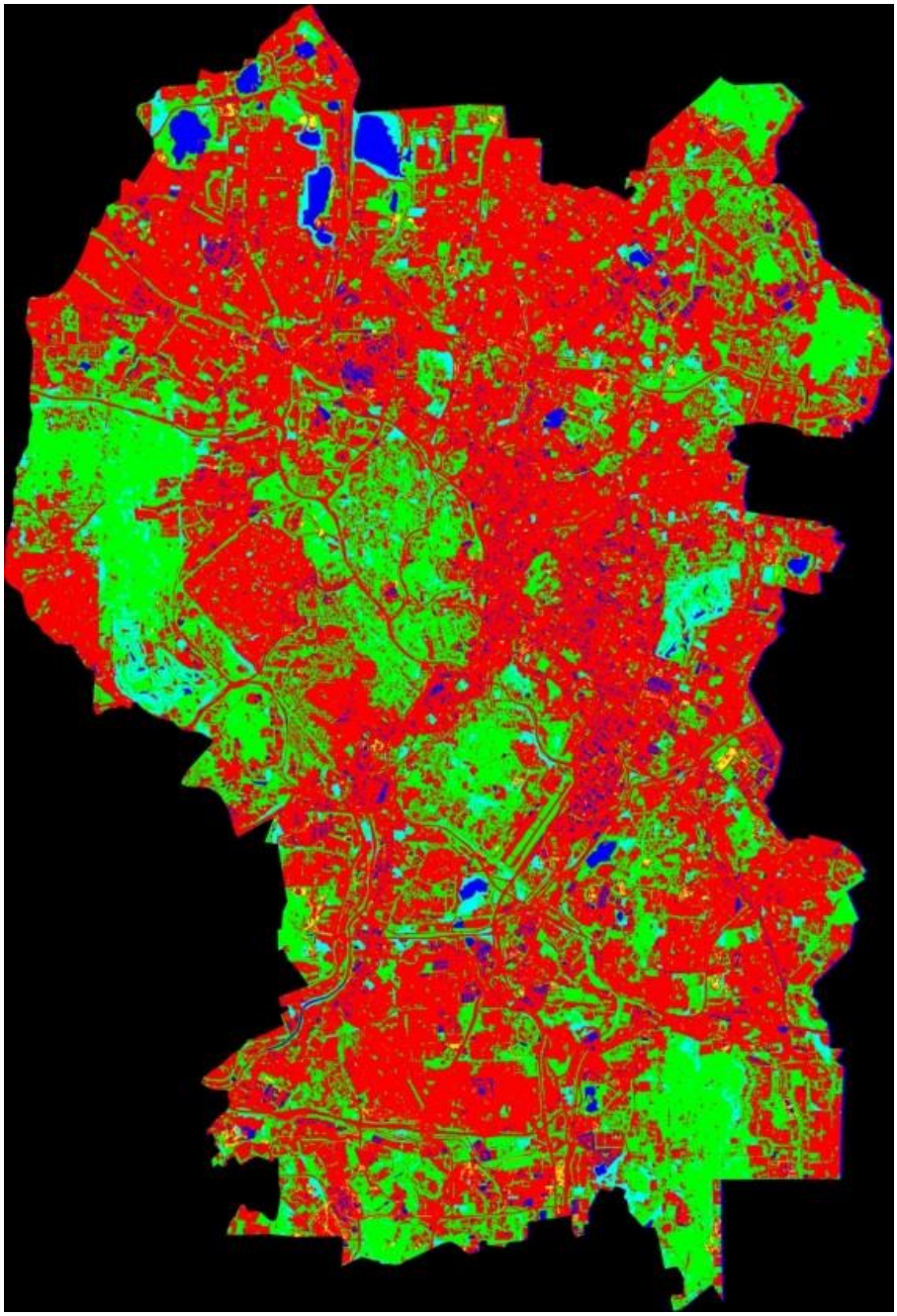


Figure 3: Classified image of Object-Oriented SPOT KL

Despite the rapid urbanisation of KL city and dominated by the urban area, there are still 34.7 % of green areas covered, which has become the second largest area after urban, including three forest reserves and nine main recreational parks. Within 4 km driving distance from KLCC, there are pocket parks such as KLCC Park, Bukit Nanas Forest Reserve and Taman Tasik Titiwangsa (KL Calling, 2016). A study conducted by Chan and Vu (2017) concluded that urban green spaces are generally more fragmented where there are more built-up areas. City center has the least ratio of area of green to the urban area compared to the other five zones because the green space in the area was smaller and fragmented as shown in Table 2. Figure 4 shows the combined graph for OO zonal statistic SPOT- 6 of Kuala Lumpur.

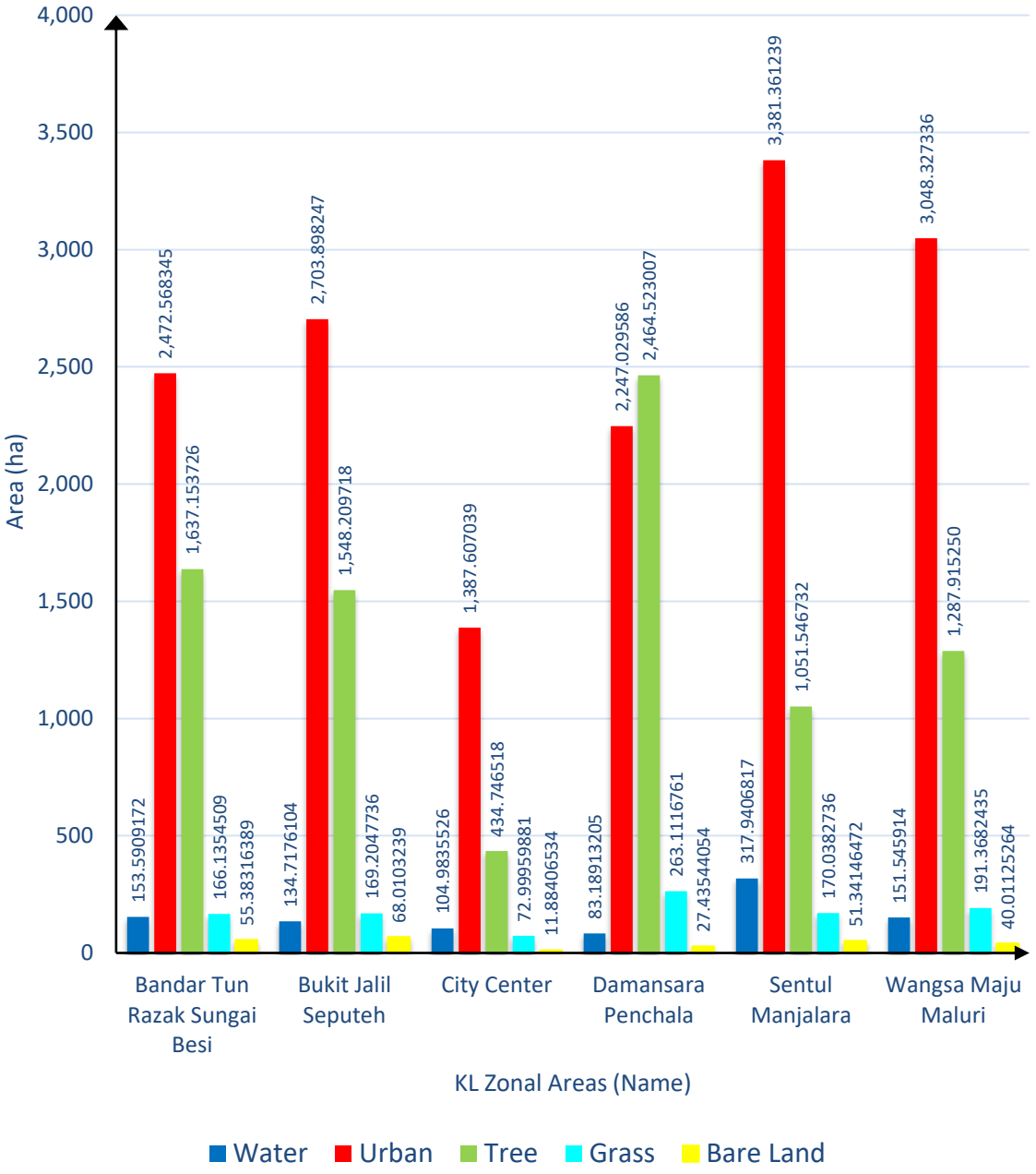


Figure 4: The combined graph for OO zonal statistic SPOT- 6 of Kuala Lumpur

Kuala Lumpur shows variety of green space shape and the distance between patches had increased and it is predicted that in the year 2030, Kuala Lumpur would experience green space reduction and built-up area increment resulting in the green space disorder, scattering and remoteness which then led to green space area with less connectivity and shape complication (Nor et al., 2017).

5. Conclusion

Results showed that big and small fragmented green spaces existed in Kuala Lumpur, occupying 84 km^2 out of a total area of 243 km^2. The highest green spaces total area was recorded in Damansara Penchala zone, which is 26 km^2, while the lowest record is in the City Center area, which is only 5 km^2 in area. The constant green space decline in the master plan suggests that the presently inadequate policies caused urban expansion to continue lacking green space. This is because in the Kuala Lumpur Structure Plan 2020, the

conservation of green spaces looks uncoordinated and absences tenacious monitoring and this problem must be solved so that the decline and decrease of the KL green spaces can be overcome.

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