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Urban Forest Cover Change and Sustainability of Malaysian Cities

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Despite their significant role for biological diversity, ecosystem stability and human comfortability, tree coverage in cities is continuously destructed and degraded to cater to increasing urbanisation in developing countries, including Malaysia. Cities are more susceptible to environmental change impacts and become unlivable. Thus, monitoring and mapping tree cover is critical (i) for conserving trees and (ii) for making decisions to increase green cover in cities. Mapping and monitoring urban green cover can be done routinely using remote sensing technologies. In this study, tree cover data produced by the University of Maryland, USA using Landsat satellite imagery was used to assess the tree cover changes in four cities, namely Penang Island, Kuala Lumpur and two cities in Iskandar Malaysia in Peninsular Malaysia. The 30 m x 30 m ground resolution tree cover data were overlaid onto the city boundaries to calculate the losses and gains in tree cover relative to the tree cover in the year 2000. Results of the study show that over a period of 12 years (2000-2012), Penang, Kuala Lumpur, Johor Bahru and Pasir Gudang lost about 6.9 %, 3.5 %, 9.5 % and 17.4 % of tree cover from their total land area. Nevertheless, these areas also gained some tree cover over the same period, which resulted in a net loss of 723 ha, 494 ha, 2,366 ha and 3,678 ha. From 2012 to 2014, the total loss of tree cover in the 4 cities were 138 ha, 64 ha, 626 ha and 1,159 ha, respectively. The loss of tree cover in cities needs to be controlled and efforts should be taken to plant more trees in Malaysia. Although the importance of green space within urban areas is more noticeable recently in Malaysia, no specific policies and legislation relevant to the protection and management of urban forests are available. Clear and detailed urban forest strategies and policies must be formulated to protect, plant and manage the urban forests in Malaysia.

1. Introduction

By the year 2020, 75 % of Malaysian population is expected to live in the urban areas (United Nation Habitat, 2011). This may exacerbate the existing environmental problems including air pollution (Amalin and Kanniah, 2016), urban heat island (Sheikhi et al., 2015) and traffic congestion. Although cities are developed at the expense of reduced forest coverage, cities around the world have started to consider and integrate urban forests in city planning as the need for climate change mitigation has increased. Urban forest is defined as linkages consisting all woodlands/forests, groups of trees (trees in parks and gardens), and individual trees (streets and derelict corners) located in the urban and peri-urban areas (FAO, 2016). Urban forests are an essential component of cities in making cities a liveable place. They improve the quality of life of the urban residents and enhance the environmental footprint of a city. Urban forests have been demonstrated to filter the polluted air (Nowak et al., 2013), sequester atmospheric CO_2 in Canada (McGovern and Pasher, 2016) and Malaysia (Kanniah et al., 2014; Kanniah, 2016), manage storm water to reduce flash floods (Kok et al., 2016; FAO, 2016),

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support local wildlife (Karuppanan et al., 2014), mitigate urban heat (Zölch et al., 2016) and increase property values (Siriwardena et al., 2016).

Similar to other fast developing country, Malaysia has been undergoing high rates of urbanisation as it intends to become a developed country by 2020. With the growing cities and demand for more lands, urban green areas have been undergoing destruction and degradation despite their numerous benefits (Kanniah et al., 2015). Some cities have initiated various efforts to increase their tree canopy cover, others have minimal tree cover due to the lack of space. The main objective of this study was to analyse the urban forest cover change in four rapidly growing cities in Malaysia, and subsequently analysing the existing policies to protect and manage the urban forests in a better way in Malaysian cities.

Mapping urban forest cover (layer of leaves, branches, and stems of trees that cover the ground when viewed from above (Sexton et al., 2013)) is essential for assessing the current scenario of urban tree canopy. This is crucial to set goals to effectively manage the resources of urban forest. Tree canopy cover data can assist and guide urban planners and landscape architects to add more trees at the needy locations to reduce air and noise pollution, improve water quality, reduce surface runoff and urban flooding.

2. Data and Methodology

2.1 Study area

Four cities located in the Peninsular Malaysia, namely Penang Island, Kuala Lumpur, Johor Bahru and Pasir Gudang are considered in this study (Low Carbon Society, 2013) as shown in Figure 1. Johor Bahru and Pasir Gudang are located within the rapidly developing southern economic development region of Iskandar Malaysia. These areas represent the highly urbanised regions in Peninsular Malaysia. The results would demonstrate how cities were developed at the expense of trees and the present condition of tree cover in these cities.

2.2 Data and methods

In this study, tree cover data produced by the Landsat satellite imagery (University of Maryland, 2016) was used to assess the tree cover in 2000 and its changes between 2000 and 2014. Tree cover is estimated as the vertically projected area of woody plants above 5 m height. The detailed methods by Sexton et al. (2013) were used to derive the percentage of tree cover from the Landsat satellite imageries. A continuous classification scheme is used to produce the Vegetation Continuous Fields (VCF) cover layers that contain the percentage of ground that is covered by woody vegetation in each 30-m pixel. All seven bands of Landsat data (Landsat 5 and Landsat Enhanced Thematic Mapper Plus) (Sexton et al., 2013) were used to derive the percentage of tree cover. This layer is also used to detect and monitor the forest changes i.e. loss (deforestation and degradation) and gain over a period of time. In this study, the tree cover data at 30 m x 30 m were overlaid onto the city boundaries (Penang, KL, Johor Bahru and Pasir Gudang) to calculate the losses and gains in tree cover relative to the tree cover in the year 2000. Secondary sources including the published materials and discussions with the officers from the forestry department of Federal Territory Kuala Lumpur and Kuala Lumpur City Council were referred for urban forest policy analysis.

3. Results

The total tree cover and their spatial distribution in Penang Island, Kuala Lumpur, Johor Bahru and Pasir Gudang in 2000 are shown in Figure 2. The total tree coverage in 2000 in these cities was 16.8 %, 18.8 %, 34,7 % and 50.9 %. Over a period of 12 y (2000-2012), Penang, Kuala Lumpur, Johor Bahru and Pasir Gudang lost about 6.9 %, 3.5 %, 9.5 % and 17.4 % of tree cover from their total land area (Figure 3). Nevertheless, these areas also gained some tree coverage over the same period, which resulted in a net loss of 723 ha, 494 ha, 2,366 ha and 3,678 ha (Figure 3) which corresponded to 16 %, 16.7 %, 27 % and 41 % of tree cover in these areas in 2012. Based on the data of tree cover loss, it was found that between 2012 and 2014, the total loss of tree cover in the 4 cities were 138 ha, 64 ha, 626 ha and 1,159 ha (data not shown).

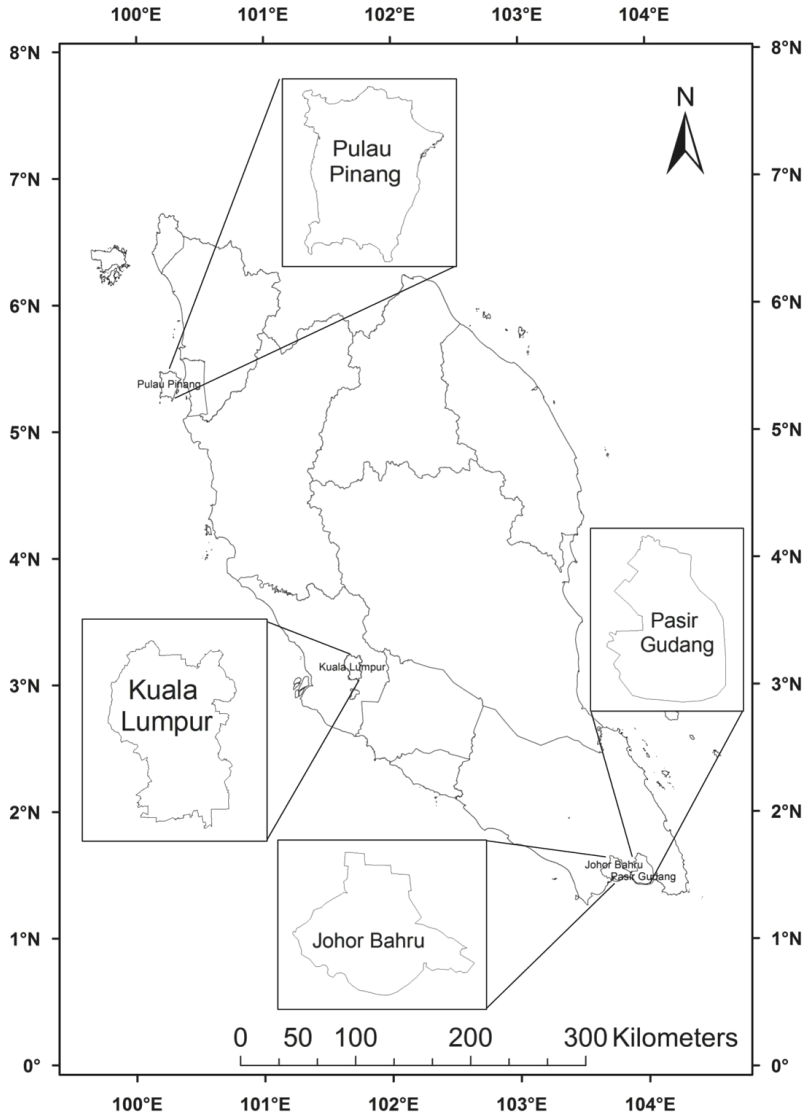

Figure 1: Four cities in Peninsular Malaysia analysed for the urban forest cover.

4. Discussion

The analysis of urban forest cover and its changes between 2000 and 2012 in the four highly urbanised cities in Peninsular Malaysia shows a remarkable loss especially in the two cities located within Iskandar Malaysia region, i.e. a net loss of 7.3 % and 10 % for Johor Bahru and Pasir Gudang from the total land area. A more detailed analysis of tree cover change in Iskandar Malaysia using the satellite data by Kanniah et al. (2015) shows that the urban development has resulted in a loss of 1,565 ha of forest and mangrove cover between 2005 and 2014. This is the period where Iskandar Malaysia has undergone intensive urban development. Urban land use increased by 9,060 ha during the same period. Johor Bahru has also experienced a large-scale urban development, where the Danga Bay development project in Johor Bahru has converted and destroyed a large area of mangroves into the mixed-use waterfront development (Kanniah et al., 2015). Pasir Gudang also witnessed a large-scale urban development that has resulted in the destruction of mangrove for aquaculture activities. Relatively small percentage of tree cover loss has occurred in Penang and Kuala Lumpur, probably due to the saturation state reached by these large cities (Figure 3).

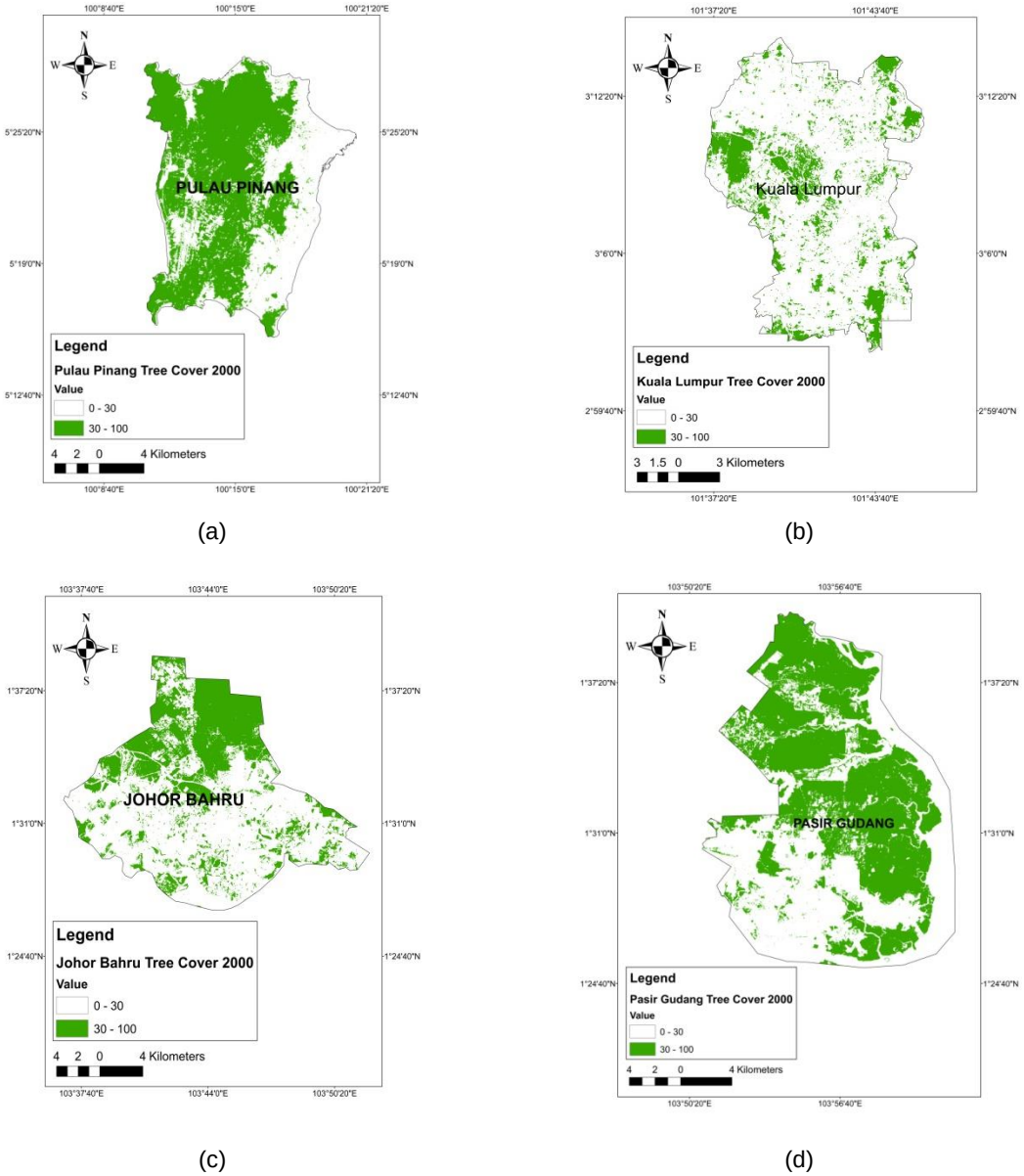

Figure 2: Tree cover distribution in (a) Pulau Pinang, (b) Kuala Lumpur, (c) Johor Bahru and (d) Pasir Gudang in 2000.

The loss of tree cover in cities needs to be controlled and efforts should be taken to increase the number of trees in an urban environment in Malaysia. While the significance of tree planting or increasing green space in cities is recently more noticeable in Malaysia, specific policies and legislation pertinent to the management and protection of urban forests are not available. Urbanisation policies such as the National Urbanisation Policy Malaysia prepared by the Department of Town and Country Planning, Peninsular Malaysia, requires that 10 % of any development (residential, industry and commercial) areas should be allocated for open space. Some cities like Penang and Kuala Lumpur have considered roof garden in the 10 % allocation because the development has reached the saturation stage in these cities (Department of Town and Country Planning, Peninsular Malaysia, 2011).

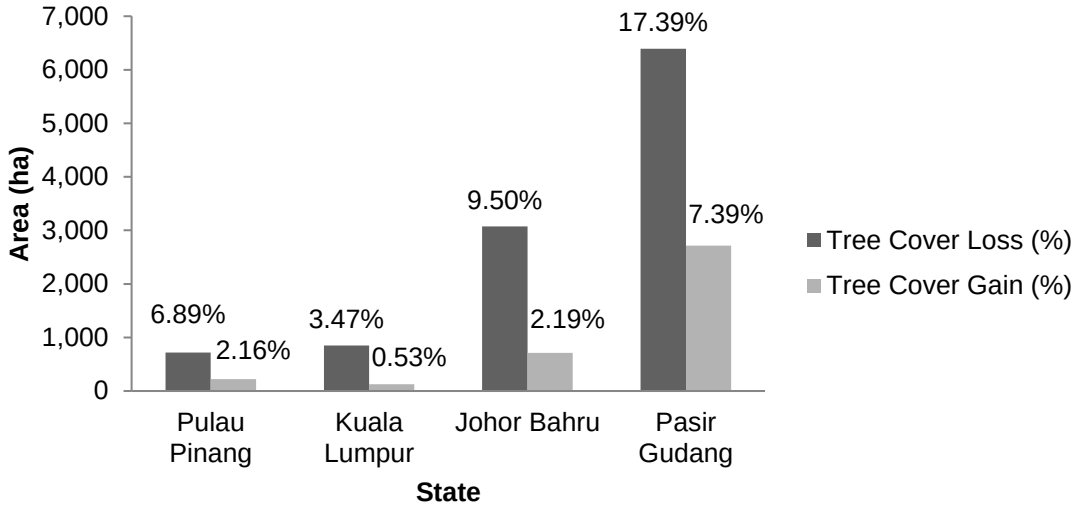

Figure 3: Tree cover change (% loss and gain) between 2000 and 2012 in Pulau Pinang, Kuala Lumpur, Johor Bahru and Pasir Gudang

The National Forestry Act 1984 is an important legislation directly related to forest protection in Malaysia, the act is also applied to the forests found within the cities. This act empowers the state government to constitute any land as a permanent reserved forest (Section 7). Once the forest has been gazetted as a permanent reserved forest, various forms of protection can be given to the forest (Mustafa, 2009). However, conflict of policies exist between the economic development and environmental protection where there is a possibility for excision of land from the permanent reserved forests (Section 11) when the land is no longer required for the purpose for which it was classified (Section 10); and where it is required for economic use higher than that for which it is being utilized. This is one of the key challenges faced by the urban planners to protect urban forests in Malaysia.

Other issues for urban forestry in Malaysia include the lack of planting space for street trees, lack of coordination by different agencies, lack of manpower to manage the existing urban forests and irregular funding for long term monitoring (Yahya and Mohd Noor, 2016). In order to manage and protect urban forests more efficiently in Malaysia, it is vital to formulate clear and detailed urban forest strategies and policies to plant, protect, manage/maintain and to engage all layers of the community. The community includes large private landowners, citizens at neighborhood levels, business community, local nurseries, arborists and landscapers. Such strategies are available in other developed cities such as London, Vancouver, and Melbourne and they should serve as the role models for the developing countries.

5. Conclusion

Analysis of the forest and tree cover in the four main cities in Malaysia shows that all cities have lost trees over time at different rate. Johor Bahru and Pasir Gudang had the higher tree cover loss compared to Penang and Kuala Lumpur as they are located within the Iskandar Malaysia, which is a rapidly developing region to be transformed into an economic hub in Southeast Asia. Since urban forests have proven to provide various ecosystem services to the urban dwellers, this invaluable resource must be maintained and well protected. The formulation of specific and detailed urban forest strategies and policies may help to retain and enhance the functions of urban forest. It is recommended that these cities set their urban tree canopy cover targets of at least 40 % in order to enjoy the maximum benefits of urban forests (Siriwardena et al., 2016). Such target can help the cities and the country to achieve a standard of 2 ha of open space for every 1,000 population by 2020.

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