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To cite this article: A N M Nor *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1102** 012011

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Spatial Characterization of Green Space Landscape Structure in Kota Bharu for Sustainable Tourism Planning

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Abstract. Globally, green space landscape structure has been used as tourist attraction in cities to increase the economy of the country in the tourism sector. However, lack of characterization of green space landscape structure has led to poor management of green space landscape such as lack of information on green space landscape structure to tourists and younger generations, thereby decreasing tourism revenue. The purpose of this study is to characterize three sites of green space landscape structures with potential for tourism in Kota Bharu, Kelantan, Malaysia for future sustainable ecotourism site management and planning. The three sites are Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park. To characterize the green space landscape structure in Kota Bharu, Kelantan, remotely-sensed data of 2016, Geographical Information System (GIS) and landscape metrics were used in this study. The results found that Taman Perbandaran Tengku Anis has the most potential to be developed as an ecotourism site compared to K4 Riding Horse and Splash Water Theme Park with the low number of patches, high mean patch area, high largest patch index and favorable ecotourism activity. A map of spatial distribution and characterisation of green space landscape has been produced, which is useful for future sustainable ecotourism planning, development and management of green space landscape structure.

1. Introduction

In an urban setting, green space landscape structure is especially important for ecosystem services [1]. Additionally, it often refers to green spaces, including places with a hard surface made up of soil, grass, and trees. There is a variety of green space landscape structures in urban such as parks, city farms, sports fields, gardens and agricultural areas. But the type of green space landscape structures may have similar or different in many countries which depending on the geography, location, environment, socioeconomic and culture of the countries. Besides that, the characteristics of green space landscape structures are not standardized or inconsistent between states, and districts and have different management zones of a city and will give impact the sustainable planning and management of green



space landscape structure. Inadequate management of green space landscape structure would have a negative economic impact on the nation and tourism potential.

Peninsular Malaysia and Malaysian Borneo, the State of Sarawak, and the State of Sabah represent the two regions of the tropical country of Malaysia. This nation boasts a wide variety of environments and a significant diversity of flora and animals. As a result, the green space landscape structure is highly attractive. Malaysia also features a wide range of traditional values from different ethnic groups, including Malay, Chinese, Indian, and other Bornean ethnicities with distinct cultural, religious, and socioeconomic roots [2]. The landscape structure of green space in Malaysia has become a tourist attraction because of its various types and cultural diversity. Indirectly, it offers an advantage for Malaysia in terms of income generation from the tourism sector such as in Melaka state. It is because Melaka is rich with historic landscapes that consist of heritage tourism resources that had become an attraction for tourism although Melaka is just a small state.

The green space landscape structure is unique and attractive in the region from the tourism perspective because of its characteristics and values. However, there has been lacking in Malaysia in terms of both management of the landscape structure of green space and understanding and appreciation of it. This is due to recent changes in the traditional Kelantan Malay landscape, a lack of documentation, and a lack of categorization of the green space landscape structure. Nasir & Salleh [2], studied the identification of traditional Kelantan Malay landscape of green space in Kota Bharu, Kelantan but the study lacks information on landscape mapping, which is crucial for tourism.

The characterization of green space landscape structure in the urban area based on remote sensing, Geographical Information Systems (GIS) and landscape ecology analytics will help in the management and planning of green space landscape structure [3]. Landscape ecology can be used to identify the ecological applicability of green space landscapes and their capacity [4]. It is related to the patterns of ecological significance that are generated from the processes and with the mutual association between the ecological functioning of landscapes and spatial configuration [5]. In order to better the management of the green space landscape structure, the goals of this study are to characterize the landscape structure of green space in Kota Bharu and build the spatial distribution map of green space.

2. Materials and methods

2.1. Study area

Kota Bharu is the capital city of the state of Kelantan situated in the northeastern part of Peninsular Malaysia (figure 1). The city lies near the mouth of the Kelantan River at 6°8'N 102°15'E. Kelantan is synonymous with Malay arts and crafts and has become a popular center for a variety of green space landscape structures such as traditional arts and craft activities of Kelantan Malay. The description of three sites of green space landscape structure in Kota Bharu is the major input to characterize the green space landscape structure using a landscape ecological approach. Thus, the three sites were identified based on the criteria and attributions of the green space landscape structure development. Taman Perbandaran Tengku Anis (N 6°08'32.6", E 102°15'52.0") is located in about 3km from Kota Bharu City Centre. The main attraction is the various types of facilities that are provided such as a jogging track, bicycle track and playground. The area is surrounded by agriculture and built-up area. K4 Riding Horse (N 6°04'45.0", E 102°13'45.7") is located near Rural Trade Centre (RTC) Kelantan. The main attraction is the riding horse activity. Splash Water Theme Park (N 6°06'43.2", E 102°14'29.8") is in the Indera Petra Kota Bharu which is next to Kota Darul Naim. The main attraction is a water park. The area is surrounded by a built-up and cleared land area.

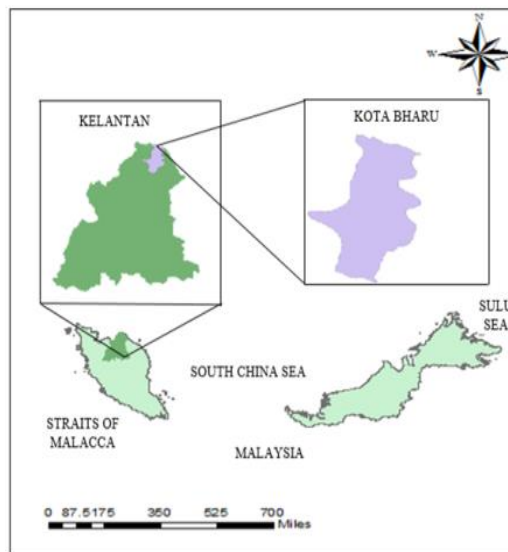


Figure 1. Location Map of Kota Bharu, Kelantan

2.2. Data collection

Data were collected at the three sites of the green space landscape structure based on survey criteria of checklist assessment. The information about the green space landscape structure was obtained by observing physical features, infrastructure and accessibility such as open space, landscape maintenance, vegetation, design concept, design materials, use of the building, public access and conflict or harmony with surroundings [6]. The land use map of Kota Bharu in the year 2016 is used to analyze the data on landscape structure.

2.3. Data processing

Environment for Visualizing Image 4.5 software (ENVI 4.5) in Remote Sensing and Aeronautical Reconnaissance Coverage Geographic Information System 10.3 software (ArcGIS 10.3) in Geographic Information System (GIS) was used in this study. The satellite image was downloaded from Earth Explorer (EE) which is the discovery and online search tool that had been developed by the United States Geological Survey (USGS) [7]. Then, the satellite image was processed and subset using Landsat in ENVI 4.5 software. In addition, image processing is used in visualization by observing the invisible object and image recognition that distinguished the objects in an image [8]. Landsat image processing also used spectral and spatial resolution that is very adequate and required in classifying a single scene covered a large area because it can give a clear image.

In ENVI 4.5 software, five types of land use and land cover (LULC) (agriculture, built-up areas, cleared land, forests, and water bodies) were categorized using supervised classification [9]. The determination of land cover provided information that help in understanding the current landscape. Apart from that, the maps of land cover are required to observe the change over time. This information is very useful because it can increase the understanding of the impact of development on the landscape [10].

The accuracy assessment was then carried out to measure the accuracy of image classification and the quality of the classification outputs [11], [12]. The next analysis will proceed with the accuracy assessment, which was 80% or above. Data from the ground truth were used to generate a collection of random points, and these were compared to the categorized data in a confusion matrix. That was the typical assessment for evaluating the correctness of a classified map. To support the processes, this method additionally employed three geoprocessing tools: construct accuracy assessment points, update accuracy assessment points, and calculate confusion matrix. Finally, ArcGIS 10.3 was used to transform the raster data generated by ENVI 4.5 software to vector format. It aims to characterise the green space landscape structure in the mapping process by analysing the Kota Bharu land use map [13].

2.4. Data analysis

2.4.1. Landscape structure analysis.

The landscape structure of Kota Bharu's green spaces was examined in order to connect various ecosystems or landscape features with their geographical distribution. Additionally, the interaction between ecosystems, commonly referred to as the "land mosaic," was also established. Landscape structure analysis was used to compute changes in the spatial structures of green space at the landscape, class, and patch levels [14].

2.4.2. Landscape metric analysis.

Landscape metrics are crucial tools for evaluating the landscape structure. It can be used as supporting management and planning decisions of the landscape. Numeric data which was produced from satellite images were used for landscape metrics as it compatible with GIS [15]. There are six parameters for landscape structure analysis using landscape metric, which are mean patch area (AREA_MN /ha), largest patch index (LPI /%), number of patches (NP /number of patch in landscape), percentage of area (PAREA /%), Euclidean nearest neighbour distance (ENN /m) and patch density (PD; number of patches /100 ha). All these parameters are in the Forest Service General Technical Report 4.2 (FRAGSTAT 4.2) software which were used to characterize the changes in green space landscape criteria such as shape, isolation of patches and size of green space landscape structure [16]. But in this study, only four landscape metrics were used, mean patch-area (AREA MN /ha), number of patches (NP /number of patch in landscape), patch density (PD; number of patches /100 ha) and largest patch index (LPI / %) and calculated using FRAGSTAT 4.2 software. Hence, to determine the landscape ecological approaches for sustainable management and planning of green space landscape structure, all those analyses for three green space landscape structures in Kota Bharu, Kelantan must be completed.

3. Results and discussion

3.1. Checklist assessment

Based on the checklist assessment such as physical features, infrastructure and accessibility adopted from Nor et al. [17], the findings of this study is shown in table 1.

Table 1. Checklist assessment on study areas based on physical features, infrastructure and accessibility adopted from Nor et al. [17].

No.	Checklist Assessment	Results		
		Taman Perbandaran Tengku Anis	K4 Riding Horse	Splash Water Theme Park
1.	Physical features			
	• Current physical condition	+	+	-
	• Topography of environment (very attractive, attractive, not attractive)	+	+	-
	• The development of potential of land use (build up area, water body, forest, agriculture, cleared land)	+	+	+

2.	Infrastructure			
	• Information centre	+	+	+
	• Public toilet			
	• Prayer room	+	-	+
	• Signage, parking	-	-	+
	• Water supply (washing, bathing, drinking)	+	+	+
	• Food stall (small stall)	+	+	+
		+	-	+
3.	Accessibility			
	• Activity (jogging, walking, trekking, riding)	+	+	+
	• Road category (clear, smooth)			
		+	+	+

Note: + = favorable, existing, high, positive ; - = unfavorable, lacking, low, negative

The checklist assessment was conducted to establish the relationship between the landscape structure on land use pattern and green space landscape structure for all three sites in Kota Bharu, Kelantan. From this checklist, there are significantly different in these three sites, as the sign (+) shown is favorable, existing, high and positive on the enhancement of land use activity while (-) shown is unfavorable, lacking, low and negative on the enhancement of land use activity. Based on Table 1, the characteristics of Taman Perbandaran Tengku Anis are mostly positive and exist in physical features, infrastructures and accessibility that have a potential for tourism which can increase the economy in Kelantan, Malaysia. While the characteristics of Splash Water Theme Park and K4 Riding Horse are negative and lacking in physical features and infrastructures that need sustainable management and planning of a green landscape.

3.2. Land use analysis

Most area in Kota Bharu is covered by the agriculture area (13 712.50 ha) followed by forest area and built-up area (table 2, figure 2). The highest percentage area of land use in Kota Bharu is 34% in agriculture area, followed by forest (32%), built up (20%), cleared land (12%) and the least percentage area is 2% in waterbody area. The development of green space landscape structure in Kota Bharu using a landscape ecological approach can generate economic benefit and serve as conservation incentives [18]. It is because economics is one of the main components that have been expressed in green space landscape structure complexity [4].

Table 2. Land Use of Kota Bharu, 2016 Based on Area in Hectares (ha) and Percentage of Area (%) of Land Use Type in Three Sites of Green Space Landscape Structure.

Land Use Type/ Category	Land Use Data of Kota Bharu, 2016	
	Area (ha)	Area (%)
Agriculture	13 712.50	0.34
Built Up	8 083.53	0.20
Cleared Land	5011.00	0.12
Forest	12 815.73	0.32
Waterbody	701.09	0.02
Total	40 432.45	1.00

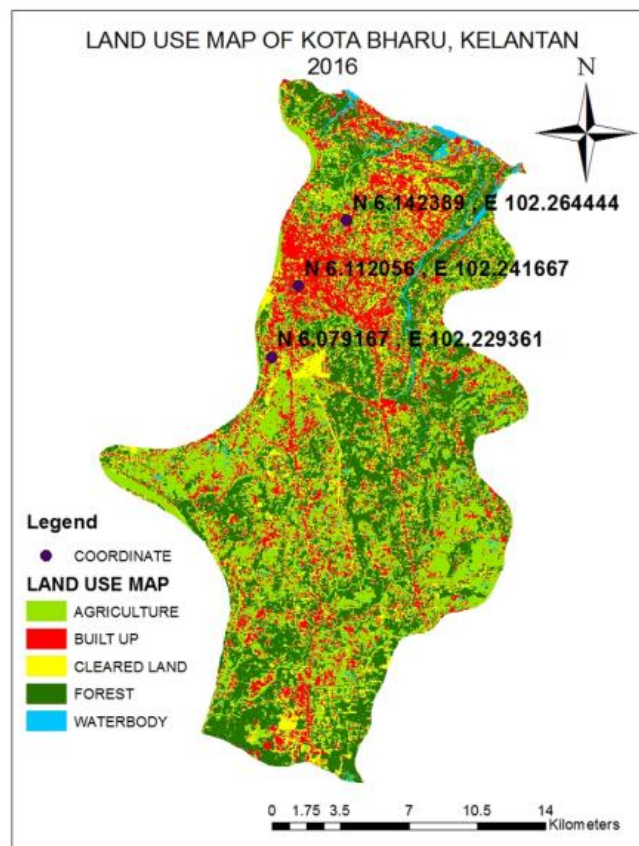


Figure 2. Land Use Map 2016 with Three Sites of Green Space Landscape Structure in Kota Bharu, Kelantan.

3.3. Landscape structure analysis

Class and landscape levels were analyzed to compute the changes in the spatial structures of green space landscape structure in Kota Bharu. To support the management and plan the decisions of the landscape structure analysis, landscape and class metrics are used as compatible with GIS based on land use land cover types which are agriculture, built up, cleared land, forest and water body.

Four landscape and class metrics were used, mean patch-area (AREA MN /ha), number of patches (NP /number of patch in landscape), patch density (PD; number of patches /100 ha) and largest patch index (LPI / %) that have been calculated using FRAGSTAT 4.2 software [19] as shown in table 3.

Table 3. Comparison among Landscape Metrics on Three Green Space Landscape Structures in Kota Bharu Based on Land Use Land Cover Types.

Landscape Metrics/ Places	Land Use Land Cover Type				
	Agriculture	Built Up	Cleared Land	Forest	Waterbody
NP					
Taman Perbandaran Tengku Anis	14	7	26	28	3
K4 Riding Horse	64	20	74	29	2
Splash Water Theme Park	85	9	105	26	1
PD					
Taman Perbandaran Tengku Anis	5.74	2.55	10.66	12.11	0.97
K4 Riding Horse	30.53	9.54	35.30	13.83	0.95

Splash Water Theme Park	36.53	3.87	45.12	11.17	0.20
AREA_MN					
Taman Perbandaran Tengku Anis	6.73	7.69	5.76	0.97	0.27
K4 Riding Horse	1.04	3.72	0.52	1.01	0.25
Splash Water Theme Park	0.39	17.50	0.33	0.31	0.11
LPI					
Taman Perbandaran Tengku Anis	34.12	42.15	23.07	6.54	0.21
K4 Riding Horse	8.35	25.38	7.40	8.51	0.19
Splash Water Theme Park	1.84	67.17	0.98	0.49	0.05

Note: NP: Number of Patches, PD: Patch Density, AREA_MN: Mean Patch Area, LPI: Largest Patch Index

Table 3 shows the comparison among landscape metrics of three green space landscape structures in Kota Bharu based on land use land cover types. From the result in table 3, Taman Perbandaran Tengku Anis has the lowest land use for agriculture, which is a decrease in the number of patches, an increase in mean patch area, and an increase in the largest patch index and which is more attractive with geographical structure compared to other study areas. Next comparison between K4 Riding Horse and Splash Water Theme Park on land use of agriculture. The number of patches of Splash Water Theme Park is higher than K4 Riding Horse while the mean patch area and largest patch index of Splash Water Theme Park is lower compared to K4 Riding Horse. To conclude, Splash Water Theme Park has the highest land use for agriculture compared to other study areas. This is believed due to an increase in the number of patches, a decrease in mean patch area and the reduction of the largest patch index in contact with human development and their activity. This effect the connectivity of Splash Water Theme Park is the least to nature and more toward the socio-economic of local people [20]. This is similar to the study by Nor et al. [17] that indicate the size of patches could attract tourist and increase tourism activities.

The local community distributes its land, crops, facilities, and management to improve the overall condition of ecotourism in Kota Bharu, Kelantan. Therefore the potential of sustainable ecotourism in sustaining ecotourism would be impacted by this distribution. When unmanaged development occurred, it increased landscape fragmentation due to high accessibility and the demand for ecotourism. Economic benefit will be decreased due to the high demand for tourism, and high accessibility of people and the development should be monitored and controlled to achieve a sustainable ecotourism site [21]. Therefore, the green space landscape structure in Kota Bharu that has the most potential for tourism is Taman Perbandaran Tengku Anis.

4. Conclusion And Recommendation

This study sought to identify the characteristics of green space landscape structure in the three sites of green space landscape structure; Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park in Kota Bharu, Kelantan throughout checklist assessment which is consisting of physical features, infrastructure and accessibility. Taman Perbandaran Tengku Anis is the most potential for tourism because of the low number of patches, high mean patch area and the largest patch index and favorable ecotourism activity. While Splash Water Theme Park is highly covered by built-up area which affects the green space in Kota Bharu, Kelantan. The green space landscape structures are characterized using remote sensing, GIS and landscape metrics to develop a map of the spatial distribution of green space landscape structures in Kota Bharu. The landscape ecological approach is potential for the future sustainable management and planning of the green space landscape structure.

Acknowledgement

Special thanks to Universiti Malaysia Kelantan for providing grants, facilities, and support for this research. This research is supported by a short-term grant UMK Rising Star 2021 (R/STA/A0800/00793A/004/2021/00939), UMK Matching Grant (R/MTCH/A1300/00692A/003/2021/00947), UMK Grant (R/FUND/A0800/01745A/001/2020/00814), (R/FUND/A0800/00131A/0032020/00811) and (R/COM/A0800/01598A/002/2021/00998).

References

- [1] Byomkesh T, Nakagoshi N and Dewan A M 2012 Urbanization and green space dynamics in Greater Dhaka, Bangladesh *Landsc. Ecol. Eng.* **8** 1 45-58.
- [2] Nasir M R M and Salleh I H 2015 Kelantan malay cultural landscape: the concept of Kota Bharu islamic city **4** 17.
- [3] Nor A N M and Abdullah S A 2019 Developing urban green space classification system using multi-criteria: The case of Kuala Lumpur City, Malaysia *J. Landsc. Ecol.* **12** 1 16-36.
- [4] Farina A 2000 The Cultural Landscape as a Model for the Integration of Ecology and Economics *Bioscience* **50** 4 313–320.
- [5] Christensen A A, Brandt J and Svenningsen S R 2017 Landscape ecology Retrieved from <https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118786352.wbieg1168>
- [6] Choudhury A 2019 advantages and limitations ‘observation’ method for data collection Retrieved May 28, 2019, from <http://www.yourarticlelibrary.com/social-research/data-collection/advantages-and-limitations-observation-method-for-data-collection/64507>
- [7] USGS 2019 EarthExplorer Retrieved May 28, 2019, from <https://www.usgs.gov/earthexplorer-0>
- [8] Mary R 2019 Introduction to image processing Retrieved May 28, 2019, from <https://www.engineersgarage.com/articles/image-processing-tutorial-applications>
- [9] Caicedo J C, Cruz A and Gonzalez F A 2009 Histopathology image classification using bag of features and kernel functions In conference on artificial intelligence in medicine in Europe 126-135 Springer, Berlin, Heidelberg.
- [10] NOAA 2018 What is the difference between land cover and land use? Retrieved May 28, 2019, from <https://oceanservice.noaa.gov/facts/lclu.html>
- [11] Malvernpanalytical 2019 Ground truthing Retrieved May 29, 2019, from <https://www.malvernpanalytical.com/en/products/measurement-type/ground-truthing>
- [12] Congalton R G 1991 A review of assessing the accuracy of classifications of remotely sensed data *Remote Sens. Environ.* **37** 1 35-46.
- [13] Esri 2019 Accuracy assessment Retrieved May 29, 2019, from <http://desktop.arcgis.com/en/arcmap/latest/manage-data/raster-and-images/accuracy-assessment-for-image-classification.htm>
- [14] Gokyer E 2013 Understanding landscape structure using landscape metrics (M. Ozyavuz, Ed.). <https://doi.org/DOI: 10.5772/55758>
- [15] Aguilera F, Valenzuela L M and Botequilha-Leitão A 2011 Landscape metrics in the analysis of urban land use patterns: a case study in a Spanish metropolitan area *Landsc. Urban Plan.* **99** 3-4 226-238.
- [16] Kupfer J A 2012 Landscape ecology and biogeography: rethinking landscape metrics in a post-FRAGSTATS landscape *Prog. Phys. Geogr.* **36** 3 400-420.
- [17] Nor A N M, Isnorm R A, Abas M A, Malek N H A, Hassin N H, Aziz H A, ... and Rafeai N H 2018 Landscape ecological assessment of potential ecotourism in Malaysia *Tech.* **9** 10 969-979.
- [18] Wunder S 2000 Ecotourism and economic incentives—an empirical approach *Ecol. Econ.* **32** 3 465-479.
- [19] McGarigal K and Marks B J 1995 FRAGSTATS: spatial pattern analysis program for quantifying landscape structure. Gen. Tech. Rep. PNW-GTR-351. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station 122 p 351.
- [20] Gillingham S and Lee P C 1999 The impact of wildlife-related benefits on the conservation attitudes of local people around the Selous Game Reserve, Tanzania *Environ. Conserv.* **26** 3 218-228.
- [21] Bramwell B, Richards G, Henry I, Jackson G, van der Straaten J, van't Zelfde J, ... and Evans D M 1996 Sustainable tourism magement: principles and practice.