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CHARACTERISATION OF GREEN SPACE LANDSCAPE STRUCTURE IN KOTA BHARU USING LANDSCAPE ECOLOGICAL APPROACH

By

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A final year report submitted in fulfillment of the requirement for the degree of Bachelor of Applied Science (Sustainable Science) with Honours

FACULTY OF EARTH SCIENCES

UNIVERSITI MALAYSIA KELANTAN

2020

DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

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I certify that the report of this final year project entitled "**Characterisation of Green Space Landscape Structure in Kota Bharu Using Landscape Ecological Approach**" by Siti Zulaikha Binti Fakuruddin, matric number E16A0277 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Sustainable Science) Faculty of Earth Sciences, University Malaysia Kelantan.

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Characterisation of Green Space Landscape Structure in Kota Bharu Using Landscape Ecological Approach

Abstract

Globally, green space landscape structure has been used as tourism attraction in city that can increase the economy of the country in tourism sector. However, lack of management for green space landscape structure because of no characterisation of green space landscape structure have been made and give the impacts such as lack of information about green space landscape for young generation and tourism. Besides, the values of green space landscape and economy of the country will decrease. In this study, the purposes is to characterize three sites of green space landscape structure that have potential for tourism, Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park in Kota Bharu, Kelantan, Malaysia for future sustainable ecotourism site management and planning. To characterize the green space landscape structure in Kota Bharu, Kelantan, remote sense data of 2016, Geographical Information System (GIS) and landscape metric are used in this study. From the result in this study, Taman Perbandaran Tengku Anis is found as the most potential ecotourism site compare to K4 Riding Horse and Splash Water Theme Park with low number of patches, high in mean patch area, high in largest patch index and favorable in ecotourism activity. This study is useful for management and development of the green space landscape structure and had produced map of spatial distribution and characterisation of green space landscape which is also can be used for future sustainable ecotourism planning of the green space landscape structure.

Keywords: Green space landscape, Geographical Information System (GIS), landscape ecological approach, management, planning, sustainable, Kota Bharu, Kelantan, Malaysia

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Pencirian Struktur Landskap Kawasan Hijau di Kota Bharu Menggunakan Pendekatan Ekologi Landskap

Abstrak

Di peringkat global, struktur landskap kawasan hijau telah digunakan sebagai tarikan pelancongan di bandar yang dapat meningkatkan ekonomi negara dalam sektor pelancongan. Walau bagaimanapun, kekurangan pengurusan untuk struktur lanskap kawasan hijau kerana tidak ada ciri struktur lanskap kawasan hijau telah dibuat dan memberikan impak seperti kekurangan maklumat mengenai landskap kawasan hijau untuk generasi muda dan pelancongan. Selain itu, nilai-nilai landskap kawasan hijau dan ekonomi negara akan berkurangan. Dalam kajian ini, tujuan untuk menonjolkan tiga tapak struktur landskap hijau yang berpotensi untuk pelancongan, Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park di Kota Bharu, Kelantan, Malaysia untuk pengurusan dan perancangan tapak ekopelancongan masa depan yang mampan. Untuk mencirikan struktur lanskap kawasan hijau di Kota Bharu, Kelantan, data penderiaan jarak jauh dari 2016, Sistem Maklumat Geografi (GIS) dan metrik lanskap digunakan dalam kajian ini. Dari hasil kajian ini, Taman Perbandaran Tengku Anis dijumpai sebagai tapak ekopelancongan yang paling berpotensi berbanding dengan K4 Riding Horse dan Splash Water Theme Park dengan jumlah tompok yang rendah, purata kawasan tompok yang tinggi, tinggi dalam indeks tompok terbesar dan menguntungkan ekopelancongan aktiviti. Kajian ini berguna untuk pengurusan dan pembangunan struktur landskap kawasan hijau dan telah menghasilkan peta pengagihan ruang dan pencirian landskap kawasan hijau yang juga boleh digunakan untuk perancangan ekopelancongan masa depan struktur lanskap kawasan hijau.

Kata kunci: Landskap kawasan hijau, Sistem Maklumat Geografi (GIS), pendekatan ekologi landskap, penggunaan tanah, pengurusan, perancangan, mampan, Kota Bharu, Kelantan, Malaysia

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LIST OF ABBREVIATIONS

ArcGIS 10.3	Aeronautical Reconnaissance Coverage Geographic Information System 10.3
AREA_MN	Mean patch area
EE	EarthExplorer
ENN	Euclidean nearest neighbor distance
ENVI 4.5	Environment for Visualizing Image 4.5
FRAGSTAT 4.2	Forest Service General Technical Report 4.2
GIS	Geographical Information System
GPS	Global Positioning System
LPI	Largest Patch Index
LULC	Land Use and Land Cover
NP	Number of patches
PAREA	Percentage of area
PD	Patch Density
USGS	United States Geological Survey

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LIST OF SYMBOLS

%	Percentage
ha	Hectare
m	Meter

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Green space landscape structure is particularly essential for the proper function of the ecosystem in an urban environment (Byomkesh *et al.*, 2012). Besides, it generally refers to green patches including the hard-surface areas that consists of soils, grass and trees. Therefore, variety of green space landscape structure in urban such as parks, city farms, sport field, gardens and agricultural areas. But the type of green space landscape structures may be have similar or different in many countries which are depends on the geography, location, environment, socio-economic and culture of the countries. Besides that, the characteristics of green space landscape structures are not standardize or inconsistent between states, districts and have different management zones of a city and will give impact to the sustainable planning and management of green space landscape structure. Economy of the country also will decrease and low values of green space landscape structure because of lack management of green space landscape structure that can affect the potential for tourism.

To avoid from the inconsistency of management and planning of green space landscape structure, the characterisation of green space landscape structure in urban area using remote sense, Geographical Information System (GIS) and landscape ecology which is landscape metric is one of the approaches (Nor & Abdullah, 2019). According to Farina

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(2000), to inform and guide the human activities, especially in the economic field, using the landscape ecology can be used to approach the ecological applicability of green space landscapes and their capacity. It is because the landscape ecology which is research field and practice related with the patterns of ecological significance that generated from the processes and also related with the mutual association between the ecological functioning of landscapes and spatial configuration (Christensen *et al.*, 2017).

In Malaysia, the green space landscape structure is very attractive because it is a tropical country that consists of two regions, peninsular Malaysia and Malaysian Borneo, State of Sarawak and State of Sabah. This country has a high biodiversity of flora and fauna and various types of ecosystems. In addition, Malaysia has a wide variety of traditional values from various ethnic groups which are Malay, Chinese, Indian and other Bornean ethnics that have different cultural, religious, and socio-economic backgrounds. (Nasir & Salleh, 2015). Green space landscape structure in Malaysia has become a tourism attraction among the tourism because of the variety types of green space landscape structure and culture diversity. Indirectly, it offers advantage for Malaysia in terms of income generation from the tourism sector. For instance, Melaka had enhanced the economic growth of Malaysia in tourism sector. It is because Melaka is rich with historic landscapes that consist heritage tourism resources that had become attraction for the tourism although Melaka just a small state. Therefore, the characterisation of green space landscape structure must be made to improve the management of the green space landscape structure (Apan *et al.*, 2002).

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1.2 Problem Statement

Green space landscape structure is one of the uniqueness and attractiveness in the region from the tourism perspectives because of its characteristics and values. But in Malaysia, there is a lack of improvement in understanding and appreciation of the green space landscape structure, as well as the lack of management of the green space landscape structure. This is because the traditional Kelantan Malay landscape have seen many recent changes, lack of documentation and no characterisation of green space landscape structure have been made. Nasir & Salleh (2015), 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.

In this study, enhancement from the previous journal has been made by identify and observing the characteristics of green space landscape structure through observation of survey criteria such as design concept, existing character, vegetation, landscape maintenance, open space, design materials, use of building and public access which are criteria in checklist assessment such as physical features, infrastructure and accessibility at the site survey. Besides, literature review, document analysis and content analysis also have been done to observe the characteristics of the green space landscape structure. Last but not least, the characterisation of green space landscape structure has been made and the map of spatial distribution of green space landscape structure in Kota Bharu also have been developed using remote sensing and geographic information system applications for the sustainability of management and the planning of the green space landscape structure.

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1.3 Objectives

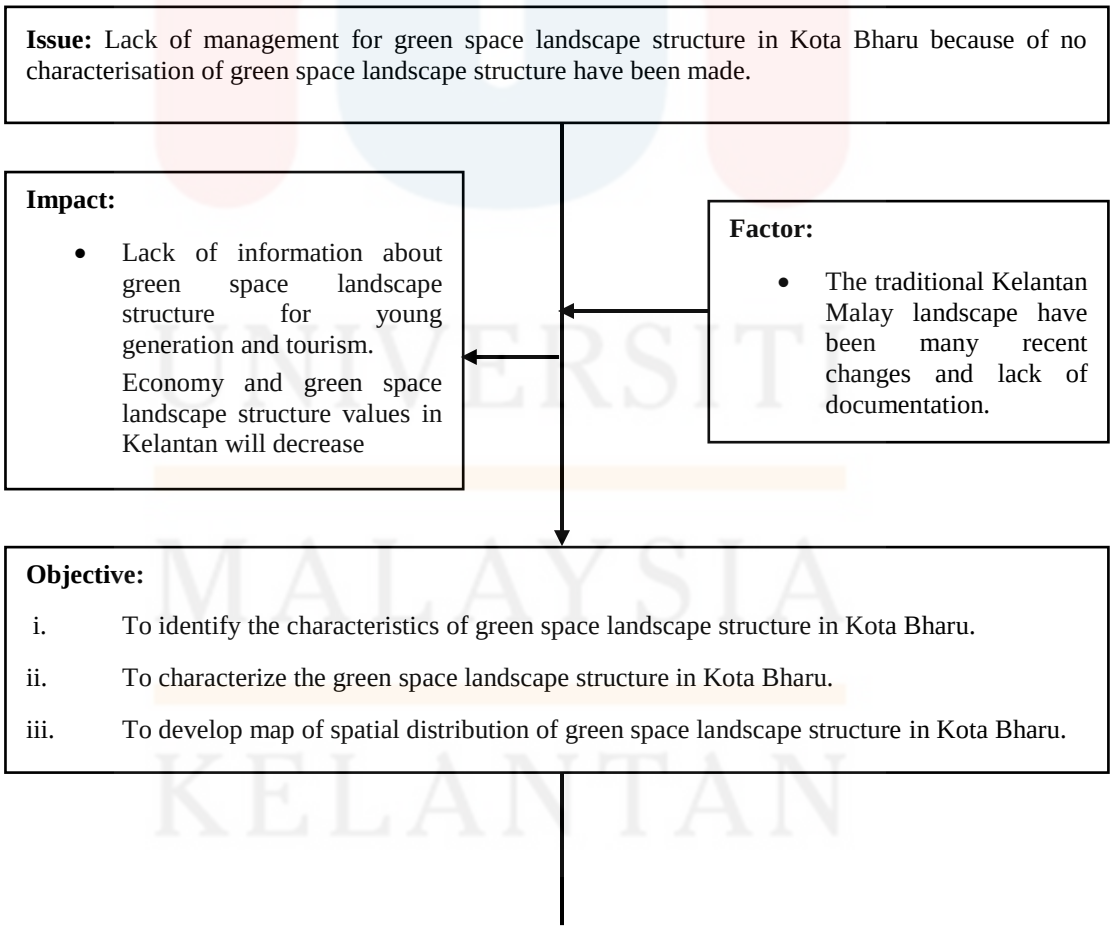
i. To identify the characteristics of green space landscape structure in Kota Bharu.

ii. To characterize the green space landscape structure in Kota Bharu.

iii. To develop map of spatial distribution of green space landscape structure in Kota Bharu.

1.4 Scope of Study

This study focuses on the characterisation of green space landscape structure in Kota Bharu that is not exposed widely among citizens and tourisms. Below is the framework for this research study:



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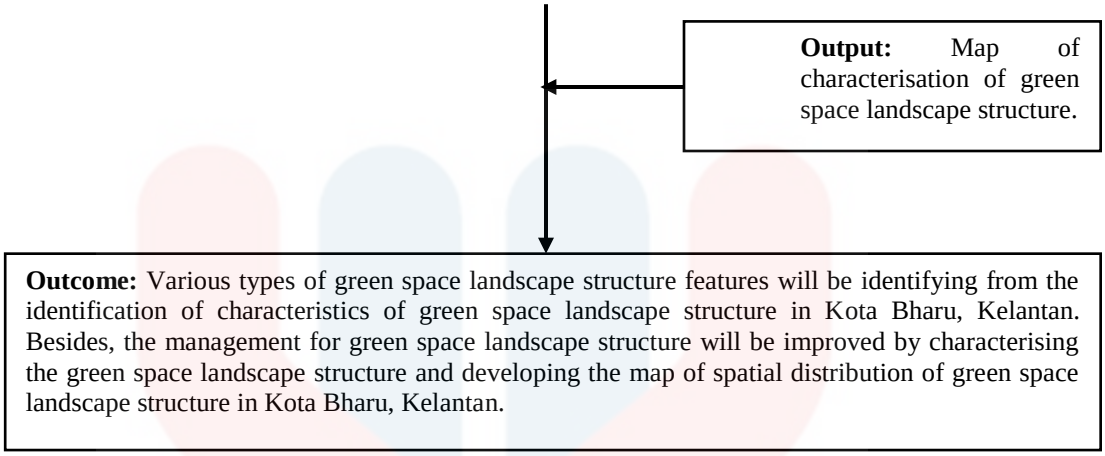

Figure 1.1: Research Framework

1.5 Significance of Study

In this study, green space landscape structure in Kota Bharu, Kelantan has a variety types of characteristics and values that become attraction for the tourism. Green space landscape structures are a legacy for everyone because these sites reveal aspects of the country's origins and development as well as human's evolving relationships with the natural world which provide scenic, economic, ecological, social, recreational, and educational opportunities. Besides, to enhance the previous journal about the traditional Kelantan Malay landscape in Kelantan that had been studied, map of spatial distribution and characterisation of green space landscape structure have been made using remote sense data of 2016, Geographical Information System (GIS) and landscape metric for the sustainable management and planning of the green landscape.

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CHAPTER 2

LITERATURE REVIEW

2.1 Green Space Landscape Structure

The green space landscape structure in urban area covered with natural and artificially grown trees, flowers, grass and shrubs. The functionality of those green spaces is equally influenced by the location and distribution in the urban area (Herzele & Wiedeman, 2003). Primarily the green space landscape structure covered by vegetation, forest and waterbody which are directly, active or passive recreation or indirectly, positive influence on the urban environment available for the utilization and agreed on by ecologists, economists, social scientists and planners. There are various types of green space landscape structure in urban areas such as parks, gardens, agricultural areas, city farms and sport field. Green space area can be categorized in three levels which are at the regional level, at city level and at neighborhood level. To maintain urban sustainability, green spaces is required to maintain the appropriate areas, have connectivity among green spaces and make these accessible to public at each level sustainability. Besides, green space has two main characters that affect urban sustainability which are structure and pattern. Structure is the characteristics of landscapes including plant species, habitat types, and ecological forms. While pattern is the characteristics such as spatial arrangement, size and connectivity of landscape habitat patches (Karade *et al.*, 2013).

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Green space landscape structure provides many functions in urban area that benefits people's quality of life, and environment. For instances, green space landscape structure can act as pollution control. Commonly, air and noise pollution occur in the urban areas. Noise and air pollutants such as carbon dioxide and carbon monoxide are produce from the presence of many motor vehicles and emission from factories such as sulphur dioxide and nitrogen oxides in urban area which are very toxic to both human beings and environment. The most affected by such detrimental contaminants are children, the elderly and people with respiratory problems (Sorensen *et al*., 1997). The air pollutants can be reduced directly when dust and smoke particles are trapped by green space landscape structure in urban area through vegetation. Research has shown that in average, 85% of air pollution in a park can be filtered. Besides, green space landscape structure in over crowded cities can reduce the levels of noise from traffic and other sources that can be stressful and creates health problems for people, depending on their quantity, quality and the distance from the source of noise pollution. Lastly, the value of green space landscape structure represents the sustainable development in the urban area and areas of the city with enough greenery are attractive to both residents and tourism that increase the economy growth of the country.

2.2 Remote Sensing and Geographic Information System

Remote sensing is the acquisition of information about an object without making physical contact with the object such as the Earth. It is to detect and classify objects on Earth, including on the surface and in the atmosphere and oceans, based on electromagnetic radiation which is propagated signals using satellite- or aircraft-based sensor technologies. There two types of remote sensing which are active and passive.

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Active remote sensing is when a signal is emitted by a satellite or aircraft and its reflection by the object is detected by the sensor while passive remote sensing is the reflection of sunlight is detected by the sensor (GISgeography, 2019). The quality of remote sensing data consists of its spatial, spectral, radiometric and temporal resolutions which are used to represent the resolving power, which includes not only the capability to identify the presence of two objects, but also their properties.

While Geographic Information System (GIS) is a computer system analyzing that enable to view all types of information and data from variety types of sources such as land use maps and Global Positioning System (GPS). Remote sensing and GIS are used as a modern tool that allows for determination of the land use spatial distribution by multi temporal analysis (GIStandards, 2018). It is because the advantages of remote sensing on land use management that have higher spatial and temporal resolution imagery, an easier access to this information, an improved absolute images location and to lower cost. Geographic Information System (GIS) also functioning in developing map of spatial distribution of landscape.

2.3 Landscape Metrics

Landscape metrics are used for the categorical map patterns which are the algorithms that quantify specific spatial characteristics of patches, classes of patches, or entire landscape mosaics (Herold *et al.*, 2002). Two characteristics of landscape structure which are composition and configuration have been calculated using landscape metrics. Metrics are used with regard to the importance of each patch type to perceive the composition and the characteristics such as rate, richness (patch richness), regularity, dominance and diversity (patch number) with metrics related composition. It was

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defined physical distribution of patches in mosaic structure with landscape configuration.

Metrics are size and shape, neighborhood (the distance to the nearest neighborhood) and distribution related configuration. Landscape metrics help us to understand changes in landscape from different perspectives such as visual, ecological and cultural. Contributions of the landscape metrics have been provided to the landscape ecology studies.

2.4 Landscape Ecological Approach

Studying and improving the relationship between urban development and ecological process of the environment and ecosystems is the definition of the landscape ecology that had been done such as development spatial patterns and variety types of landscapes scales. Landscape ecological focus on the role of human impacts on landscape structures and functions. It also proposes ways for restoring degraded landscapes. The landscape stability principle is one of the landscape ecology theories, which emphasizes the importance of landscape structural in reducing the disturbances and promoting total system stability (Biologyreferences, 2019).

Human activities including land transformation and development had produced negative impacts to the environment (Breuste *et al*., 2008) but it can be overcome by the integrity of landscape components because it can help in maintaining the resistance to external threats. Besides, analysis of land use change has included a strongly geographical approach which has led to the acceptance of the idea of multifunctional properties of landscapes.

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CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area

Kota Bharu is a city in Malaysia which serves as the state capital of Kelantan. It is also the name of the territory or district in which Kota Bharu City is situated. Kota Bharu is situated in the northeastern part of Peninsular Malaysia, which is 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 structure such as traditional arts and craft activities of Kelantan Malay.

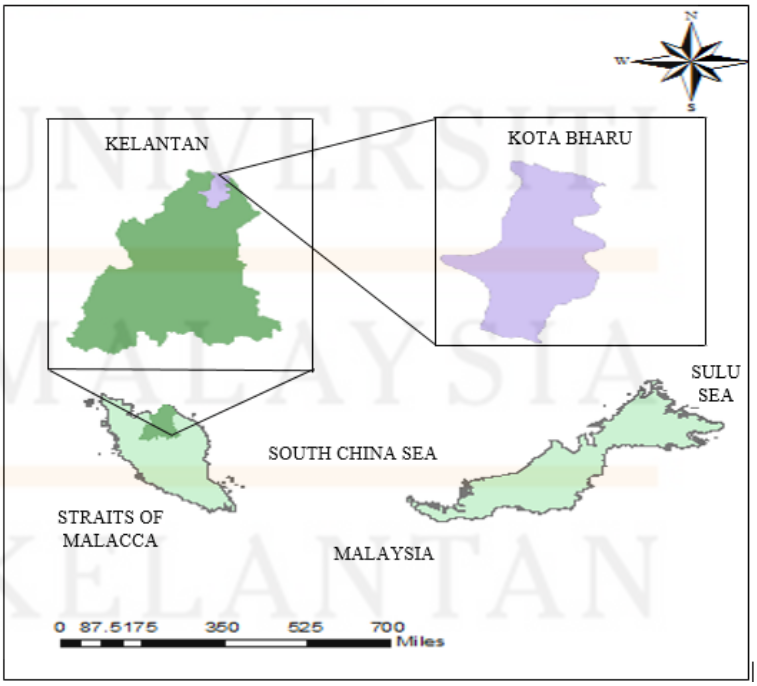

Figure 3.1: Location Map of Kota Bharu, Kelantan.

3.2 Data Collection

Data was collected through survey criteria of checklist assessment by observing physical features, infrastructure and accessibility such as open space, landscape maintenance, vegetation, design concept, design materials, use of building, public access and conflict or harmony with surroundings, of three sites of green space landscape structure which are Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park and in Kota Bharu to obtain the information about the green space landscape structure.

Observation is the common and simplest method for the data collection. It does not require much technology tools and it is also one of the methods for framing hypothesis. Through observation, the accuracy of data will be greater because the directly observation from the site (Choudhury, 2019). Besides, document analysis, content analysis and literature review also had been done to get the accurate data of the green space landscape structure. While land use map 2016 of Kota Bharu is used to analyze the data of landscape structure.

3.3 Data Processing

There were two applications that had been used in this study which were 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). Satellite image was downloaded from EarthExplorer (EE) which is the discovery and online search tool that had been developed by United States Geological Survey (USGS) (USGS, 2019). Then, the satellite image was processed and subset using Landsat in ENVI 4.5 software. The

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image was subset to get larger image while image processing converted the satellite image to digital form and performed the operation on it which can sharpen and restore the image to get better image. In addition, image processing used in visualization by observing the invisible object and image recognition that distinguished the objects in an image (Mary, 2019). Landsat image processing also used spectral and spatial resolution that very adequate and required in classifying a single scene covered a large area because it can give the clear image.

Image classification is one of the parts in digital image analysis and it illustrated various type of features that underlying terrain by showing the magnitude of colours (Caicedo *et al*., 2009). Besides, thematic maps of the land cover in an image will be produced from the image classification. It is because in image classification, all the pixels in a digital image will be categorized into one of the land cover classes (Faculty of Science Chulalongkorn University, 1999). There were five features for the data type which were agriculture, built up, cleared land, forest and water body that are land use and land cover (LULC) types in this study and had been classified by using supervised classification in ENVI 4.5 software (Nagendra *et al*., 2004). Land cover is more like physical land type such as forest, built up and agriculture while land use shows on how people use the land. ENVI 4.5 software can identified the land use and land cover (LULC) types because the satellite and aerial imagery can analyze the determination of land cover but satellite imagery cannot determine the land use. The determination of land cover had 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 impact of development on the

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landscape. Besides that, it can improve the management and planning for the landscape before implement any development that can affect the landscape by evaluating the past management decisions (NOAA, 2018).

Google Earth is one of the ground truth, which is a computer program that used as a reference in the classification process in order to ensure the validity of the result. It is because the Earth was shown in 3-Dimensions by Google Earth based on satellite imagery in GIS data that allowed the users to see the landscapes from various angles. Other than that, the collection data of ground truth on the location can support the interpretation and analysis on the sensed object and enabled the calibration of remote sensing (Malvernpanalytical, 2019). Then, for the accuracy assessment which is an essential part in image classification and the quality of the classification results that processed in the ENVI 4.5 software will be checked by this assessment (Congalton, 1991). Besides, the comparison between the classified image and another data that reviewed to be accurate or ground truth. The collection data of ground truth can be provided in the target field and created the GIS data layers or classified imagery that had been derived from interpreting imagery in high resolution. But it is expensive and time consuming. Data of ground truth created a set of random points and the classified data in a confusion matrix has been compared with it. That was the common way for accuracy assessment of classified map. This process also used three geoprocessing tools which were create accuracy assessment points, update accuracy assessment points and compute confusion matrix to accommodate the workflows. Lastly, the raster data that produced in the ENVI 4.5 software will be converted to vector format using ArcGIS 10.3. It is to

analyze the land use map of Kota Bharu for the characterisation of the green space landscape structure in mapping process (Esri, 2019).

3.4 Data Analysis

3.4.1 Landscape Structure Analysis

The green space landscape structure of Kota Bharu was analyzed the connectivity between the different ecosystems or landscape elements and the spatial pattern of landscape elements. Besides, the relationship between ecosystems that also known as land mosaic such as measure, size, shape and number were also assessed. To compute the changes in the spatial structures of green space, the landscape, class and patch levels were needed to analyze in landscape structure analysis (Gokyer, 2013).

3.4.2 Landscape Metric Analysis

To understand the landscape structure, landscape metrics are very important tools. It is because landscape metric tools are used as supporting management and planning decisions of the landscape. To use metrics, numeric data was obtained related to landscape structure. Numeric data was produced from satellite images and landscape metrics were used as compatible with geographical information systems (Aguilera *et al*., 2011). Landscape metrics allowed doing objective reviews on landscape structure.

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 neighbor 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

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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 (Kupfer, 2012). 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 as shown in Table 3.1. Hence, to determine the landscape ecological approaches to sustainable management and planning for green space landscape structure, all those analyses were needed to be done by referring three green space landscape structures in Kota Bharu, Kelantan.

Table 3.1: Landscape Metric Analysis

Landscape Metrics	**Description**	**Abbreviation**	**Units**	**Range**
Mean patch-area	MN = n $\sum \frac{xij=1}{ni}$ The area occupied by a particular patch type divided by the number of patches of that type.	AREA MN	Hectares (ha)	MPS > 0, no limit
Number of patches	n_i = number of patches in the landscape of patch type (class) i.	NP	Number of patch in landscape	
Patch density	PD = $\underline{n_i}$ (10000) (100) A The number of patches per 100 ha	PD	Number per 100 hectares (ha)	PD > 0, constrained by cell size
Largest patch index	LPI = $\frac{\max(a)ij}{A}$ x 100 LPI equals the area (m2) of the largest patch of the corresponding patch type divided by total landscape area (m2), multiple by 100 (to convert to a percentage)	LPI	Percentage (%)	0 < LPI < 100

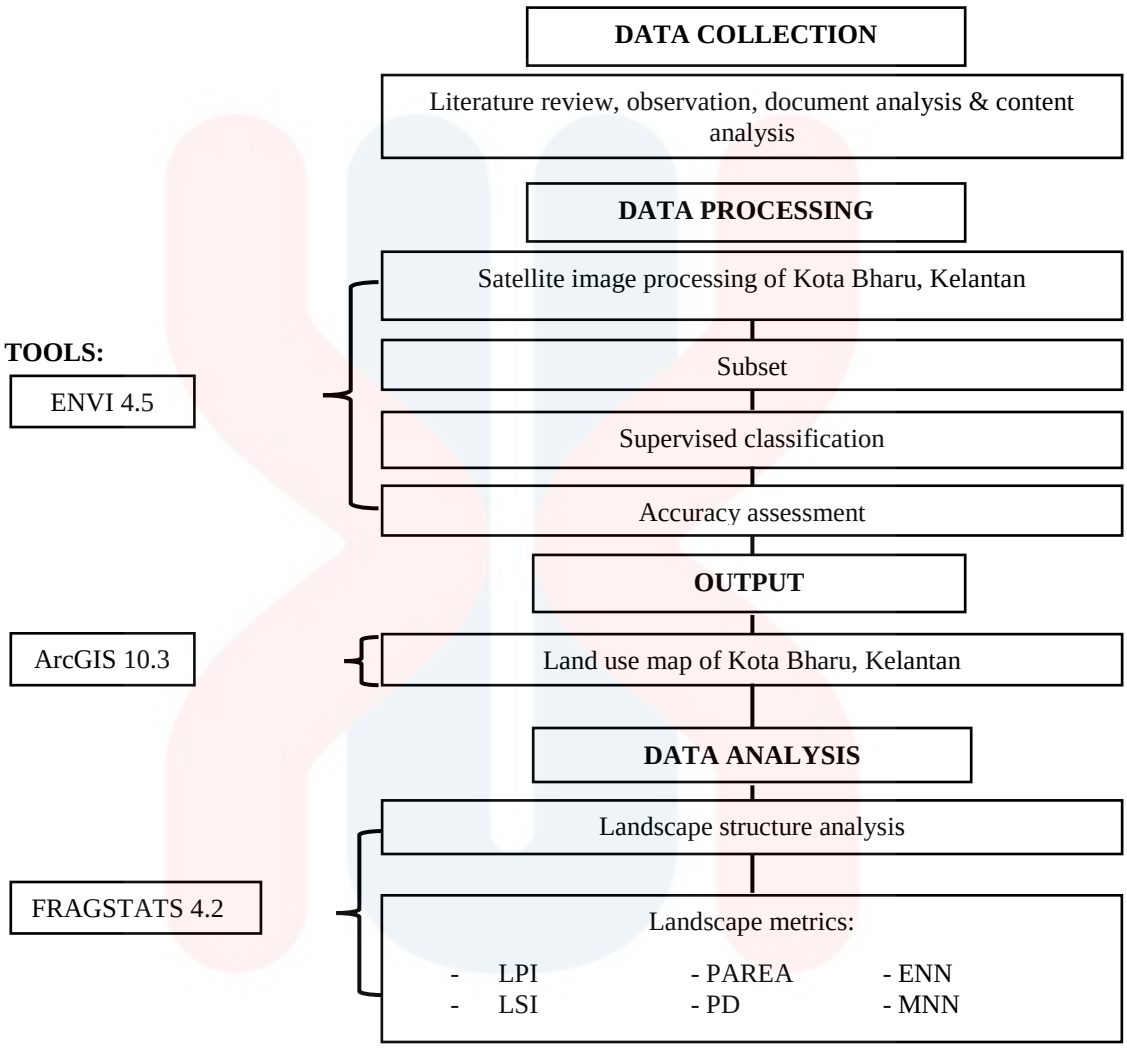

Figure 3.2: Research Framework of Methodology

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CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this study, the significant results from three sites of green space landscape structure which are Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park located in Kota Bharu, Kelantan had been obtained through observation on those three sites, checklist approach, data processing using Geographical Information System (GIS) and data analysis calculated using FRAGSTAT 4.2 software are gathered.

The data collections of results were based on the survey criteria on those sites such as physical features, infrastructure and accessibility, land use analysis and land structure analysis. Besides, the result based on the relationship between the pattern of land use of landscape structure and management of three green space landscape structures in Kota Bharu, Kelantan using landscape ecological approach.

4.2 Description of Study Areas

The description on three sites of green space landscape structure in Kota Bharu is the major inputs in this study to characterize the green space landscape structure using landscape ecological approach. Thus, the three sites of green space landscape structures in Kota Bharu were identified based on the criteria and attributions of the green space landscape structure development in the Table 4.1.

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Table 4.1: Description and Coordinate on Three Sites of Green Space Landscape Structure in Kota Bharu, Kelantan.

No.	Location	Coordinates	Description
1.	Taman Perbandaran Tengku Anis	N 6°08'32.6" E 102°15'52.0"	• Located in about 3km from Kota Bharu City Centre. • The main attraction is the variety types of facilities that provided such as jogging track, bicycle track and playground. • The area surrounded by an agriculture and built up area based on the Figure 4.1.
2.	K4 Riding Horse	N 6°04'45.0" E 102°13'45.7"	• Located near Rural Trade Centre (RTC) Kelantan. • The main attraction is riding horse activity. • The area surrounded by an agriculture and built up area based on the Figure 4.1.
3.	Splash Water Theme Park	N 6°06'43.2" E 102°14'29.8"	• Located in the Indera Petra Kota Bharu which is next to Kota Darul Naim. • The main attraction is water park. • The area surrounded by a built up and cleared land area based on the Figure 4.1.

The description on the study areas in Table 4.1 and land use map 2016 of three sites green space landscape structure in Kota Bharu in Figure 4.1, explained the reason to choose this three sites as green space landscape structure using landscape ecological approach in Kota Bharu. To characterize the green space landscape structure pattern, the land use activity in this three sites in Kota Bharu were identified. Thus, the accessible by people was predicted.

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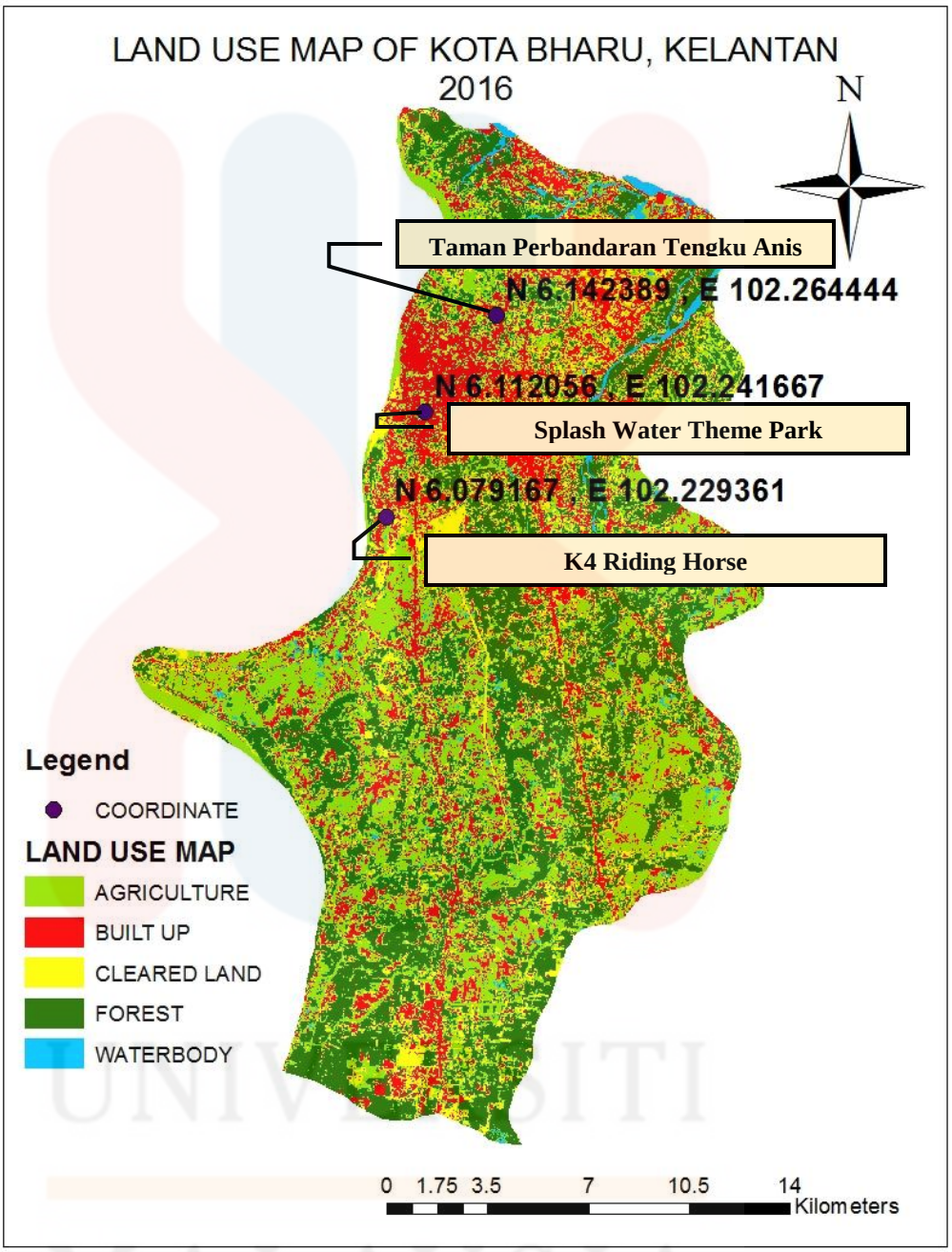

Figure 4.1: Land Use Map 2016 with Three Sites of Green Space Landscape Structure in Kota Bharu, Kelantan.

The information gathered through the observation of this three sites, Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park which are positive on the enhancement of the land use activity. Taman Perbandaran Tengku Anis provides a lot of facilities such as jogging track, water theme park, mini zoo that consists of deer and birds' species, plant species and small food stalls. Splash Water Theme Park also provide water activity since the main activity in the site is water theme park. Besides, Splash Water Theme Park provides playground, small food stall, prayer hall and Islamic art gallery. For K4 Riding Horse, which is famously with riding horse activity. It becomes an attraction to the local people and tourisms that like to spend their time doing this activity in good and fresh environment with the charge price.

4.3 Checklist Assessment

Based on the checklist assessment such as physical features, infrastructure and accessibility adopted from Nor *et al.* (2018), the findings of this study have been explained and shown in Table 4.2.

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Table 4.2: Checklist Assessment on Study Areas Based on Physical Features, Infrastructure and Accessibility Adopted from Nor *et al.* (2018).

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 done is to establish the relationship between the landscape structure on pattern of the land use and green space landscape structure in Taman

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Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park in Kota Bharu, Kelantan.

From this checklist, there are significant different in this three sites, as the sign (+) shown is favorable, existing, high and positive on enhancement of land use activity while (-) shown is unfavorable, lacking, low and negative on enhancement of land use activity. As the results shown above, the characteristics of Taman Perbandaran Tengku Anis are mostly positive and existing in physical features, infrastructures and accessibility that has a potential for tourism which can increase the economy in Kelantan, Malaysia. While, the characteristics of K4 Riding Horse and Splash Water Theme Park are negative and lacking in physical features and infrastructures that need a sustainable management and planning of green landscape.

4.4 Land Use Analysis

The result in Table 4.3 shows 5 types of land use namely agriculture, built up, cleared land, forest and water body as it is located the three sites of location, Taman Perbandaran Tengku Anis, K4 Riding Horse and Splash Water Theme Park in Kota Bharu, Kelantan as shown in Figure 4.1.

Table 4.3: 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 Data of Kota Bharu, 2016	
Land Use Type/ Category	**Area (ha)**	**Area (%)**
Agriculture	13 712.50	34
Built Up	8 083.53	20
Cleared Land	5011.00	12
Forest	12 815.73	32
Waterbody	701.09	2
Total	40 432.45	100

Based on the Figure 4.1 and Figure 4.2, there is relationship between data that have been processed in ENVI 4.5 and ArcGIS 10.3 tools to investigate the landscape structure on pattern of the land use and green space landscape structure. The most area in Kota Bharu is covered by the agriculture area about 13 712.50 hectares. Second highest is covered by forest area and third is covered by built up area that shown in Figure 4.2. It is shown that the green space landscape structure in Kota Bharu can be characterized using landscape ecological approach.

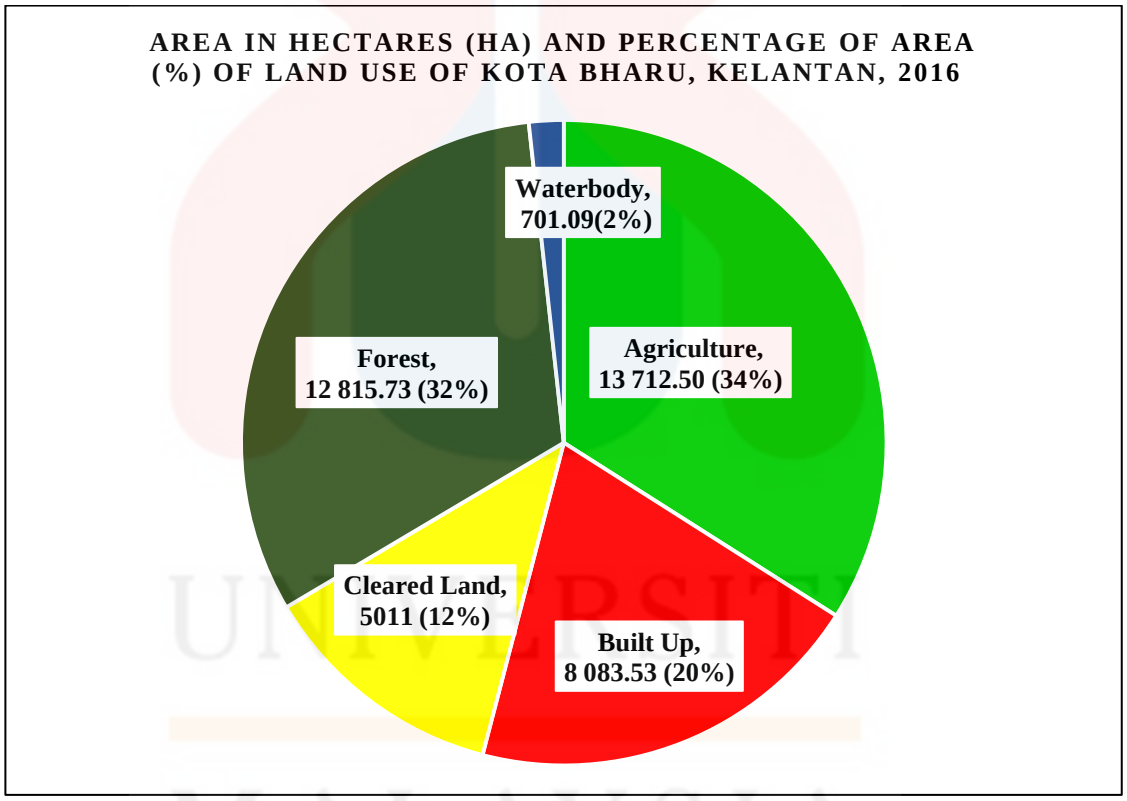

Figure 4.2: Area in Hectares (ha) and Percentage of Area (%) of Land Use of Kota Bharu, Kelantan (2016).

As refer to the Figure 4.2, each of percentage (%) area of land use, 2016 of Kota Bharu, Kelantan is calculated manually by dividing the area in hectares with total area of land use Kota Bharu and multiply with 100. The highest percentage area of land use 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. It is shown that the agricultures are still preserved and should be monitored and conserved for the future generation. Besides, the development of green space landscape structure in Kota Bharu using landscape ecological approach can generate economic benefit and serve as conservation incentives (Wunder, 2000). It is because economic is one of the main components that have been expressed in green space landscape structure complexity ((Farina, 2000).

4.5 Landscape Structure Analysis

The green space landscape structure of Kota Bharu was analyzed the connectivity between the different landscape elements and the spatial pattern of landscape elements. Besides, the relationship between ecosystems that also known as land mosaic such as measure, size, shape and number were also assessed (Gokyer, 2013). Class and landscape levels were analyzed in landscape structure analysis 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 geographical information system 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 (McGarigal & Marks, 1995) as shown in Table 4.4.

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Table 4.4: 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 4.4 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 4.4, Taman Perbandaran Tengku Anis has the lowest land use of agriculture which is decrease in the number of patches, increase in mean patch area and increase in largest patch index and which is more attracted 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 compare to K4 Riding Horse. To conclude, Splash Water Theme Park has the highest land use of agriculture compared to other study areas. This is believed due to increase in the number of patches, a decrease mean patch area and the reduction of largest patch index in contact with human development and their

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activity. This effect the connectivity of Splash Water Theme Park is the least to nature and more toward the socio-economic of local people (Gillingham & Lee, 1999).

The potential of sustainable ecotourism in sustaining the ecotourism will be affected by the population distribution of local community because the local community distributes their land, agriculture, facilities and management to improve the overall condition of ecotourism in Kota Bharu, Kelantan. High accessibility and demand for ecotourism leads to the increasing of landscape fragmentation when the uncontrolled development happened. Economic benefit will be decreased due to the high demand on tourism, high accessibility of people and the development should be monitored and controlled to achieve the sustainable ecotourism site (Bramwell *et al*., 1996). So, the green space landscape structure in Kota Bharu that has the most potential for tourism is Taman Perbandaran Tengku Anis.

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CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

From this study, the objectives have been achieved. Firstly, the characteristics of green space landscape structure in Kota Bharu, Kelantan have been identified by observing 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. The result is shown that Taman Perbandaran Tengku Anis is the most potential for tourism because of low in number of patches, high in mean patch area and in largest patch index and favourable in ecotourism activity. Besides, the green space landscape structures are characterized using remote sensing, Geographical Information System (GIS) and landscape metric and area of Splash Water Theme Park is highly covered by built up area which affect the green space in Kota Bharu, Kelantan. Lastly, a map of spatial distribution of green space landscape structure in Kota Bharu have been developed using landscape ecological approach for the future sustainable management and planning of the green space landscape structure.

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5.2 Limitations of study and recommendation

There are a few limitations in this study such as variability of available data from different sources and data errors. In order to process the data, many types of software that required long time to understand and learn the different and various types' techniques involved. This will lead to the time constraint to a researcher and the next for collecting data and processing or analyzing data will be dragged. Besides, the process from the software will be slowed or not responding to produce output because of the size of data and the size of software that disturb the computer operating system. The data also need to be checked before download it to avoid from error occur. To get the accurate data, the process or step for analyzing data need to undergo repeating process two or three times more. Lastly, for checklist assessment should be improved by supporting or adopting from other researchers to avoid from biased occur. Researcher be recommended to use high resolution satellite imagery when downloading the data in order to produce an accurate of land use maps and a detailed classification image for the next process.

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APPENDIX A

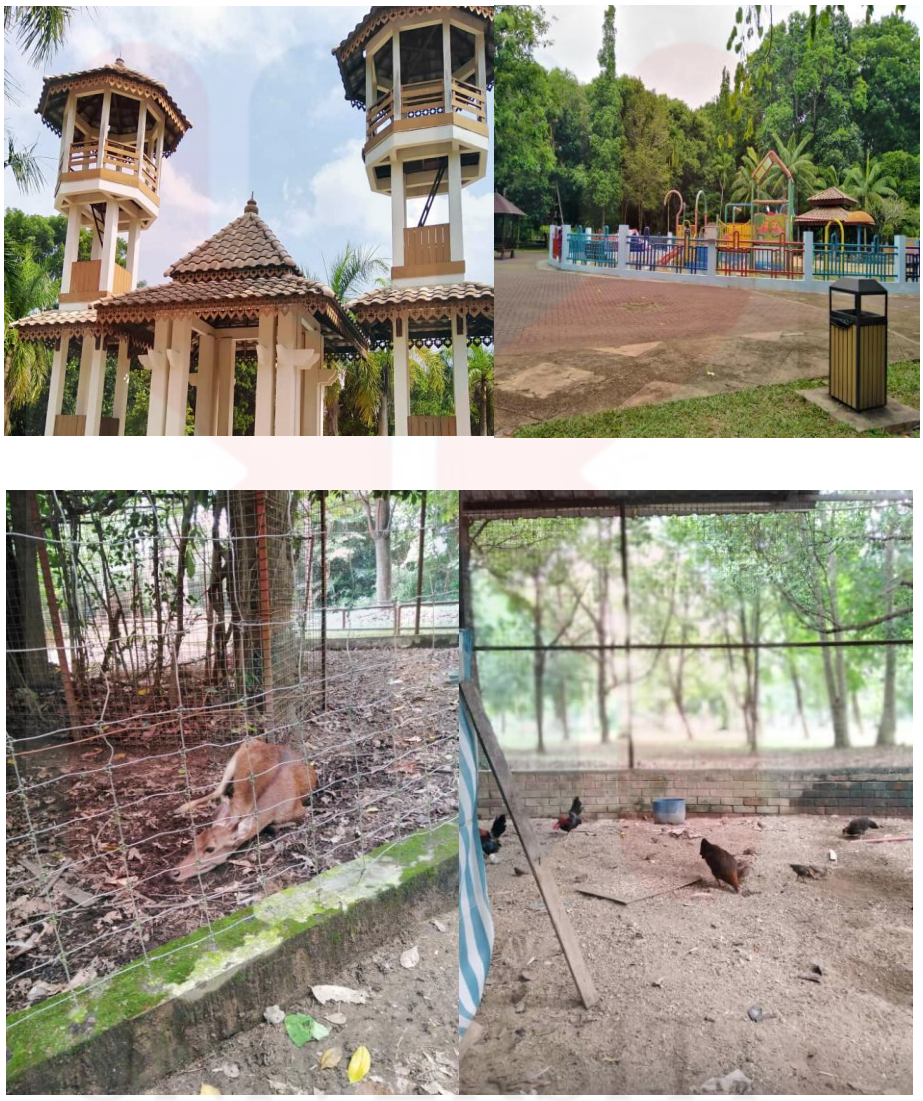

Figure A.1: Water Park and Mini Zoo Provided in Taman Perbandaran Tengku Anis

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Figure A.2: Prayer Hall and Playground Provided in Splash Water Theme Park

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Figure A.3: Riding Horse Activity Provided in K4 Riding Horse

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