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Analysis urban green space classification using landscape pattern analysis based on GIS and remote sensing in Pattaya, Thailand

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ABSTRACT

This research explores the urban green space (UGS) classification and analyze the quantity and distribution of UGS using landscape pattern analysis based on GIS and remote sensing in Pattaya city, Thailand. The useful of the classification for UGS planning and management was interpreted through landscape pattern analysis. In this study, use satellite image interpretation, land use map of Pattaya City was used as a based. Digitization for six criteria have natural green space, amenity green space, function green space, linear green space, economy green space and abandoned green space were identified to explore the classification. field survey provided information to validate the interpretations. Landscape pattern was based on landscape metrics analyzed using FRAGSTAT 4.2. The result show that the land scape structure of the Pattaya city is unreasonable, the amenity green space is seriously lacking and the distribution is not balanced. The proportion of abandoned green space is high but useless and the landscape diversity index is low. Landscape pattern analysis has allowed to interpret what category needs attention to improve their quality and quantity as well as to protect them from any land use development, guideline to manage the sustainable green space in Pattaya.

1. INTRODUCTION

Urban green space (UGS) is one of the important elements in cities for environmental conservation and it has a good impact on the environment and its accurate estimation is of significance to guide the future urban planning management and environmental protection. UGS provides benefits to the city that helps mitigate these negative effects (Ridder, 2004),

During the process of urbanization flocked into the ever-expanding cities and created artificial and impervious surfaces to substitute natural areas. The proportion of urban green space did not keep up with the speed of urban growth (Pauleit et al., 2005), which brought large pressure to the urban environment and led to a gradual reduction in the quality of life (Grimm et al., 2008; Johnson, 2001).

The Thai government established a mega project called the Eastern Economic Corridor (EEC) with 3 model provinces, including Chachoengsao, Chonburi and Rayong provinces. Pattaya is a part of ECC in Chonburi, Thailand. EEC is a pilot project for the economic development of Thailand's Eastern Seaboard. The result will enhance Pattaya's accessibility, will make Pattaya the heart of the eastern region, with the number of tourists visiting the EEC region to rise to 46.7 million over the next few years. Moreover, most of the land use of Pattaya is urban and built-up land, on the other hand, forest and water are the low proportion. As the population growth increases over time, the green space should be developed along with the ECC project for the good quality of life of the people in Pattaya.

Due to the long-term effects of many factors such as human activities and urban development. Due to its strong real-time performance, high precision and visualization, Geographic Information System, Global Positioning System and Remote Sensing Technology (3S) technology are widely used in the research on urban green space landscape pattern. Many scholars have made outstanding achievements in the research on green space landscape patterns in megapolises and provincial capitals (Liao, 2019). But the exploration of green-land landscape patterns in small and medium-sized cities is still rare.

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The objective are to explore the UGS classification that represent the structure and function and to analyze the quantity and distribution of UGS using landscape pattern analysis in Pattaya, Thailand.

2. METHOD

2.1. Study area

The study area is Pattaya, a city in Thailand "Fig. 1". It is on the east coast of the Gulf of Thailand, within, but not part of, Bang Lamung District in the province of Chonburi, which is located in the coordinates of 12° 55' 39.3888'' N and 100° 52' 37.4988'' E. Pattaya city is a self-governing municipal area. A total area of 50.19 square kilometers. As of 2019 it had a population of 119,532. Therefore, the population density is around 2,238 per square kilometers. There are 4 - 5 times latent population more than the number of reality (about 400,000 - 500,000 people) without reporting to Civil Registration. The annual average temperature is 27.7 °C and the average humidity is 77% during the year. The annual rainfall is 1117.6 mm. km2. Pattaya is at a low altitude of only 1.5 meters above sea level, and the temperatures are warm throughout the year. The topography is flat with a lack of hills and mountains, and most of the agriculture lands were marshlands earlier.

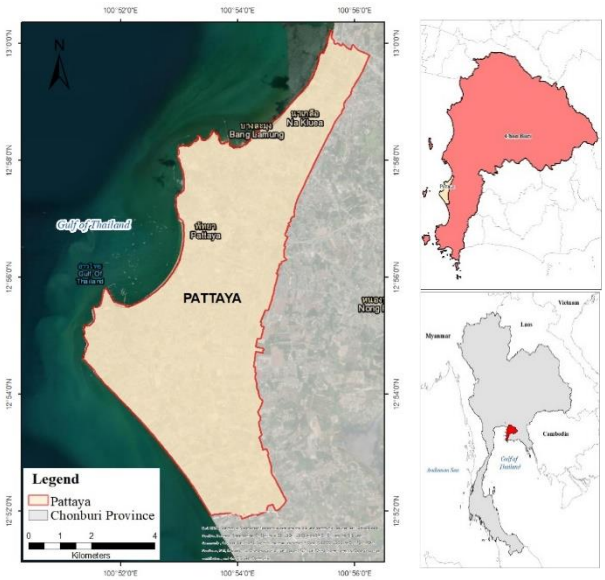

Figure 1. Location of study area in Pattaya, Thailand.

2.2. Methodology

Research designed to study urban green space classification using landscape pattern analysis. The main procedure of the proposed methodology is diagrammatized in "Fig. 2" and a detailed depiction is given in the following four sub-sections. This thesis has 4 conceptual frameworks which are data acquisition, data pre-processing, data analysis and data result.

2.2.1. Data acquisition

A Pléiades satellite data to study the urban green space map was downloaded from EOS are available at https://eos.com/pleiades-1/, on December 12th, 2019. This dataset has a spatial resolution (pixel size) of 2m., for the multispectral waveband images. Additionally, the Pleiades datasets includes a very high-resolution 0.5m panchromatic image. Also, a 30m resolution Digital Elevation Model was produced from the Pleiades stereo images in "Table 1".

This study was collected Land use data (Shape files), on October, 2018. That source from Land Development Department (LDD) in Thailand was shown in "Table 2". most of the land use of Pattaya is urban and built-up land with an area 44.86 km2 or 90.13% of the total area in Pattaya, on the other hand, forest and water are the low proportion. This data support the next steps to make it accurate.

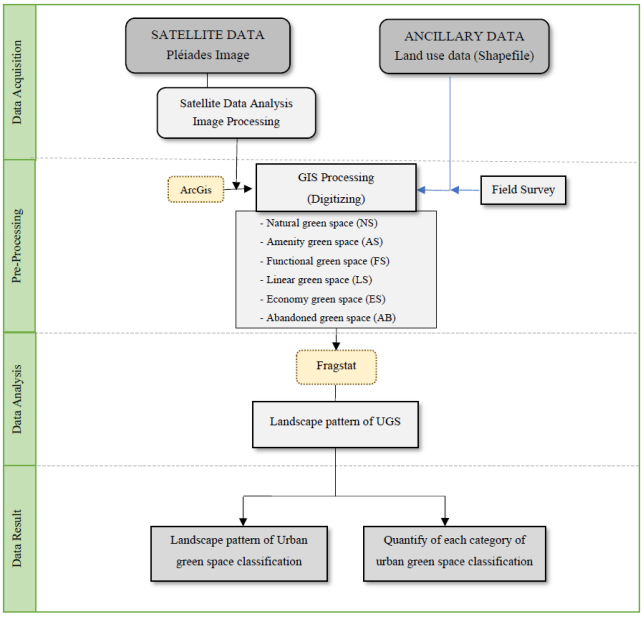

Figure 2. Diagram framework in this research.

Table 1. Characteristics of the utilized satellite data.

Dataset	Spectral channels	Spatial resolution (m)
Pleiades	Panchromatic (470-830nm)	0.5
	Blue (430-550nm)	2
	Green (500-620nm)	2
	Red (590-710nm)	2
	Near-infrared (740-940nm)	2

Table 2. Proportion of Land use types in Pattaya.

Type of LS	Area (km²)	Area (&)
A: Agriculture	0.69	1.38
F: Forest	0.28	0.56
U: Urban	44.86	90.13
W: Water	0.10	0.21
M: Miscellaneous	3.84	7.72
Total	49.77	100

2.2.2. Data pre-processing

Digitizing is the process of interpreting and converting paper map or image data to vector digital data. In manual digitizing you trace the lines or points from the source media. The UGS classifications were digitized by using digital instrument with the ArcMap10.2.2.

Digitization can visual interpretation on the color difference, roughness of texture, size, shape, pattern of

dispersion, relationship with surrounding objects and digitize the data, modify data and make a database in the geographic information system. Manual Digitizing is still a useful technique because of its ability to accurately copy maps in poor condition. Computers have a higher risk of error when interpreting information contained on a faded, stained or poor quality map or image. Manual Digitization is limited by the visual acuity and accuracy of the digitizer. In this research, urban green space classification was digitized into 6 type. Detail, definition and second class were shown in "Table 3".

Table 3. Classification of UGS system in Thailand

First Class	Second class
NS	rivers, streams, canals, lakes, mountains, forests.
AS	park, garden, sports field, outdoor activity, botanical garden, zoo, golf course
FS	domestic garden, housing estate, institutional ground (school yards, college yards), burial ground, landfill space
LS	green buffer, green belt, green traffic island, other linear features.
ES	Perennial garden, Economic forest gardens, shopping mall, housing estate.
AB	Abandoned green space, waiting for development.

Note: NS: Natural green space, AS: Amenity green space, FS: Function green space, LS: Linear green space, ES: Economy green space, AB: Abandoned green space

2.2.3. Data analysis

Analysis of landscape pattern of each category of UGS. In the FRAGSTATS (McGarigal et al., 2012), was conducted to quantify of each criteria of urban green spaces and to interpret the useful of the classification for UGS planning and management. In this analysis, landscape pattern analysis was conducted for the whole city in Pattaya. This paper selects relevant landscape pattern index, outputs indexes which can reflect the landscape space accurately and comprehensively. Six landscape metrics were chosen that we are describing. The numeric characters in "Table 4".

Table 4. Landscape metrics used in the analysis.

Class-level	
metrics	Description
CA	Total Class Area
AREA_MN	Mean Patch Area
NP	Number of patches
PD	Patch density

Landscape-level	
metrics	Description
SHDI	Shannon's Diversity Index
SHEI	Shannon's Evenness Index

3. RESULTS

The study area in Pattaya have total area of 50.19 km^2. According to tha data in "Table 5". The total area covered by urban green space is 8.3174 km^2 or 16.57% of the total area in Pattaya. The proportion of abandoned green space (AB) is the highest (63.69%), followed by functional green space (FS) (19.84%), natural green space (NS) (8.44%), Linear green space (LS) (4.96), Amenity green space (AS) (2.43) and economy green space (ES) is the lowest (0.64%).

Table 5. Analysis of the proportion of each category of urban green space in Pattaya, Thailand

Type of UGS	Area (km^2)	Area%
NS	0.7018	8.44
AS	0.2020	2.43
FS	1.6499	19.84
LS	0.4128	4.96
ES	0.0533	0.64
AB	5.2976	63.69
Total	8.3174	100

Table 6. Analysis of the composition and patches type level of urban green space landscape

Type of UGS	CA (ha)	NP	PD	Area_MN	SHDI	SHEI
NS	68.40	167	3.37	0.41		
AS	20.23	68	1.37	0.30		
FS	164.60	479	9.67	0.34		
LS	36.80	207	4.18	0.18		
ES	5.29	14	0.28	0.38		
AB	504.27	509	10.28	0.99		
Total	799.60	1444	29.15	2.60	0.30	0.20

According to the data in "Table 6", Landscape pattern analysis revealed that abandoned green space has the highest number of patches and patch density, followed by functional green space, linear green space, natural green space, and amenity green space while economy green space is the lowest. Also abandoned green space has the highest mean patch area, followed by natural green space, economy green space, functional green space and amenity green space while the lowest is linear green space.

As previously mentioned, most of the abandoned green space, area is much larger than other green space but this type of green area does not benefit the environment, that unuse land for waiting develope and useless in city. For functional green space and linear green space are not bad. There is a lack of public land or amenity green space and economy green space.

4. DISCUSSION AND CONCLUSION

This study intended to explore and distribution the UGS classification that represent the structure and function using landscape pattern analysis in Pattaya, Thailand. It was digitized from high resolution image satellite into 6 type of UGS and use FRAGSTAT to compute landscape pattern with the indices found that the analysis showed the proportion of amenity green space and economy green space are 2.43%, 0.64%, respectively, also the landscape pattern value it indicates that these type of Pattaya is extremely scarce. also

The function of amenity green space overlaps with many others, in particular parks and gardens and natural

areas can also provide informal opportunities for children's play where there are no other facilities. It is important therefore to consider the provision of amenity green spaces in the context of urban planning and management.

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