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Analysis of Land Use in the Banyuasin District Using the Image Landsat 8 by NDVI Method

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Abstract. Land use is one important factor in the planning of infrastructure development. The development that does not consider land use may cause an impact to environmental degradation. In minimizing the time and costs, the introduction of land use in an area could be done with remote sensing technology, one of the methods that could be used is the Normalized Different Vegetation Index (NDVI). NDVI is a combination of a multi-spectral band by using a wavelength Red and Near Infra-Red (NIR) on image Landsat 8 to estimate the vegetation cover. Than each classification of vegetation density will provide the reflectance value. In this study, the land cover classification result based on vegetation density by NDVI method, namely 0.5120 – 0.3706 for the low-density vegetation area; 0.3706 – 0.6149 for the moderate density vegetation area; and 0.6149 – 0.8677 for the high-density vegetation area. While the overall accuracy percentage of land use classification was 80%.

INTRODUCTION

Land use is the most fundamental in determining road trace for a residential area, industrial area, or another space area. The road class will be determined on the existing spatial plan, where the existence of a new road does not destroy the existing spatial. The existence of the road should be able to increase the harmony of existing land space, however, if the land does not have a spatial, then makes the road as a means to form the spatial orientation and the existence of the road could be a corridor buffer space [1].

The expansion of city limits and infrastructure networks, the rejuvenation of urban centers, as well as the growing and disappearance of the centralization of certain activities are the factors that cause land use. Changes in land cover have a very significant impact on climate, hydrology, water sources, soil, and biota [2]. The use of remote sensing technology and Geographic Information System (GIS) could facilitate the introduction of potential land us /land cover. Remote sensing data was one of the most economical alternatives in analyzing land use or land cover [3,4].

Landsat is one of the remote sensing satellites that could be used in remote sensing technology. Currently, image Landsat 8 has been used in remote sensing technology. The Landsat 8 features Onboard Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) sensors, which have a total of 11 channels, consisting of 9 channels (band 1 - 9) located on OLI and 2 channels (bands 10 and 11) on TIRS [5].

NDVI (Normalized Different Vegetation Index), NDWI (Normalized Different Wetness Index), and NDSI (Normalized Different Soil Index) are methods for interpreting satellite imagery [7, 8, 9]. NDVI is a satellite-based optical sensor image that is able to monitor the development of green vegetation on the surface of the wide land, namely using a combination of spectral bands on remote sensing to estimate vegetation cover. NDVI could be used

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to identify indicators of green vegetation activity that also correlate with some vegetation biophysical characteristics such as leaf area index, green cover, green biomass, and chlorophyll content. [7, 10].

The land cover classification result based on vegetation density using image Landsat 8 by NDVI method was obtained the reflectance value of each land cover class and the thematic map on the swamp area in District of Banyuasin. This land use classification would be used as the initial stage of determining road planning in swamp areas.

METHODOLOGY

Study Area

In this study was taken some swamp areas in District of Banyuasin as the study area, since most areas are swamp areas, both tidal swamp and nontidal swamp are spread along the east coast to the hinterland. And 80 % of its topographic is lowland. Moreover, a formulation of spatial planning policies of Banyuasin district is developed a hierarchical road network connecting the centers of urban services with each service area [12]. Study area position as seen in Figure 1.

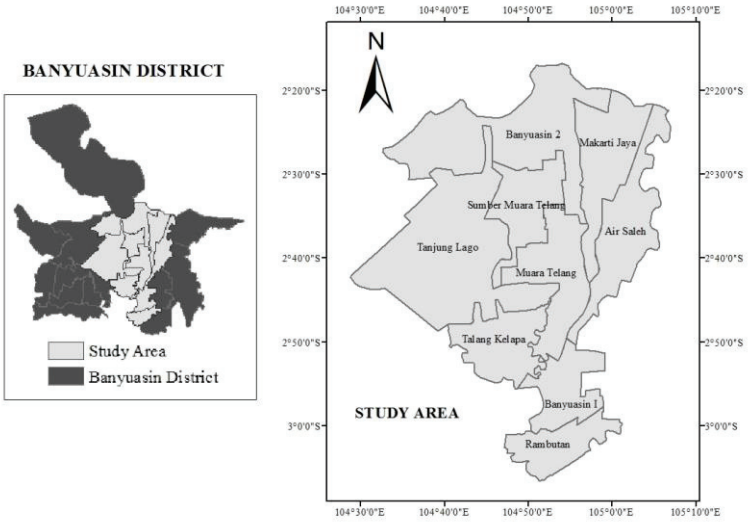

FIGURE 1. Study area

Classification Method

The classification was performed to obtain thematic map of land use using an interpretation of image Landsat 8 downloaded from United States Geological Survey [6] at the scene: path 124 / row 062. Data processing was done using ArcGIS 10.3 software.

Stages of data processing, including: (1) pre-processing stage (the image cutting that serves to limit the study area and reduce the size of image files, geometric and radiometric correction); (2) data processing stage (color composite, digital image interpretation for sharpening, smoothing filter, contrasting, multispectral classification in Image Landsat 8, then NDVI transformation); (3) the field test stage to check the validity of the classification results using GPS navigation.

Transformation of NDVI method by using the equation:

$$NDVI = (NIR - RED)/(NIR + RED) \quad (1)$$

NDVI values range of -1.0 to 1.0. Values representing vegetation in the range 0.1 to 0.7, above 0.7 shows the health level of vegetation cover. A large value means a large difference between red and NIR waves indicating high

photosynthetic activity. A low value means that there is a slight difference between red and NIR waves, this is due to the small amount of photosynthetic activity or at least NIR light reflectance, for example, water which reflectance very slight NIR light.

TABLE 1. Characteristics of OLI and TIRS sensors on image Landsat 8 [6] in [5]

Sensors	Band	Spectrum	Wavelength (μm)	Spatial Resolution
	1	Coastal aerosol	0.433 – 0.453	30 m
	2	Blue	0.450 – 0.515	30 m
OLI	3	Green	0.525 – 0.600	30 m
	4	Red	0.630 – 0.680	30 m
	5	NIR	0.845 – 0.885	30 m
	6	SWIR 1	1.560 – 1.660	30 m
	7	SWIR 2	2.100 – 2.300	30 m
	8	Panchromatic	0.500 – 0.680	15 m
	9	Cirrus	1.360 – 1.390	15 m
TIRS	10	TIRS 1	10.6 – 11.19	100 m
	11	TIRS 2	11.5 – 12.51	100 m

TABLE 2. Band characteristics for object imagery on image Landsat 8 [6] in [5]

Band	Description
1	Aerosol studies and coastal areas
2	Bathymetric mapping, differentiates soil from vegetation and leaves from conifer vegetation
3	Emphasize the peak of vegetation to assess the strength of vegetation
4	Differentiate the vegetation angle
5	Emphasize the content of biomass and coastline
6	Discriminates soil water content and vegetation; penetrate a thin cloud
7	Enhancement soil moisture content and vegetation, thin cloud penetration
8	Resolution 15 m, image sharpening
9	Enhancement detection of contaminated sirus clouds
10	Resolution 100 m, temperature mapping and soil moisture counting
11	Resolution 100 m, enhancement of temperature mapping and soil moisture counting

RESULTS AND DISCUSSION

Results

Classification of Land Cover Based on Vegetation Density

Interpretation of land cover based on NDVI values was obtained from a combination of band 4 (Red) with wavelengths of 0.63 to 0.68 μm and band 5 (NIR) which has a wavelength of 0.845 - 0.885 μm in an image Landsat 8. Vegetation would absorb lots of energy from the wavelength on the Red spectrum so that the reflected spectral value would be lower, however on the NIR spectrum would absorb a slight energy from the wavelength so as the reflectance of the spectral value would be higher.

NDVI method used in classifying vegetation density was a combination of band 4 (Red) and band 5 (NIR). Combination results showed the difference from the brightness of the color. The brighter the color the lower the vegetation density and the darker the color the higher the vegetation density. The greater the difference between NIR and Red, the higher NDVI value indicated that the vegetation was gain higher density. The denser the vegetation, the NIR released would be the greater and more absorbing red color since the process of photosynthesis would be absorbed by the red color and released the infrared.

Samples were taken at several points representing the vegetation density, using a 54 band composite representing the two color to obtain the average value of reflectance of band 4 (Red), band 5 (NIR), and NDVI value. The sample points were taken to determine the average reflectance as seen in Figure 2.

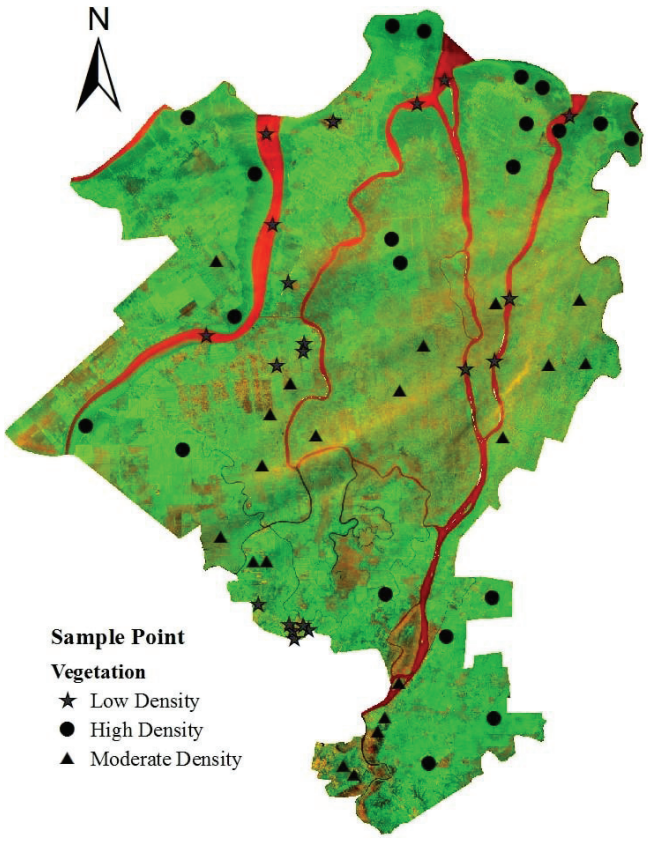

FIGURE 2. Sample point determination of reflectance value of land cover on band composite 54

The average reflectance values on band 4 (Red), band 5 (NIR), and NDVI values in each land cover as shown in Figure 3.

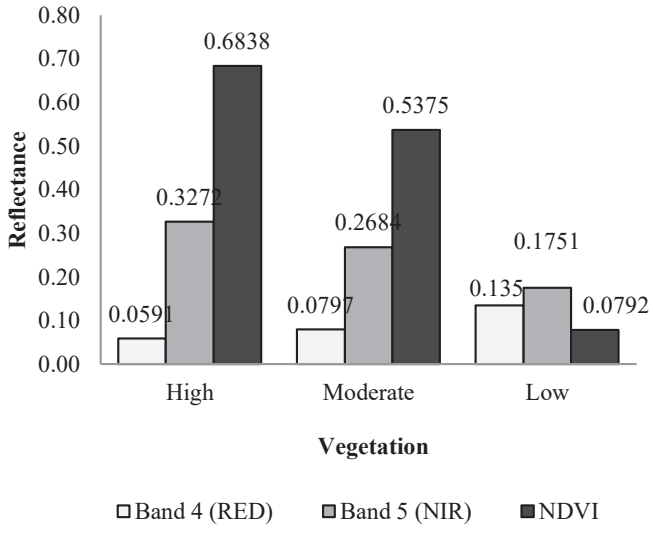

FIGURE 3. The average reflectance value on band 4 (Red), band 5 (NIR), and NDVI

From the graph in Figure 3, we could see the average value of reflectance and NDVI value on swamp area in Banyuasin District. Vegetation that tends to absorb Red in band 4 would give smaller reflectance value in high-density vegetation areas namely 0.0591, whereas low-density vegetation areas would have higher reflectance value that was 0.135. Different from the red spectrum, the NIR spectrum at band 5 would have a higher reflectance values on high-density vegetation area that was 0.3272, whereas on low-density vegetation areas the would have lower reflectance value namely 0.1751.

The bigger the difference between NIR and Red, the greater the NDVI value and the higher the vegetation density, the average was 0.6838, whereas the smaller the difference between NIR and Red the NDVI value would be smaller and show low-density vegetation, that was 0.0792. The classification of land cover based on the vegetation density was taken from the average of the reflectance values by using the NDVI method. The classification of reflectance values based on vegetation density as shown in Table 3.

TABLE 3. Classification of reflectance values based on density of the vegetation

Vegetation Classification	Reflektan Value
Low density	- 0.5120 – 0.4015
Moderate density	0.4015 – 0.5919
High density	0.5919 – 0.8677

Classification of land cover based on vegetation density as seen in Figure 4.

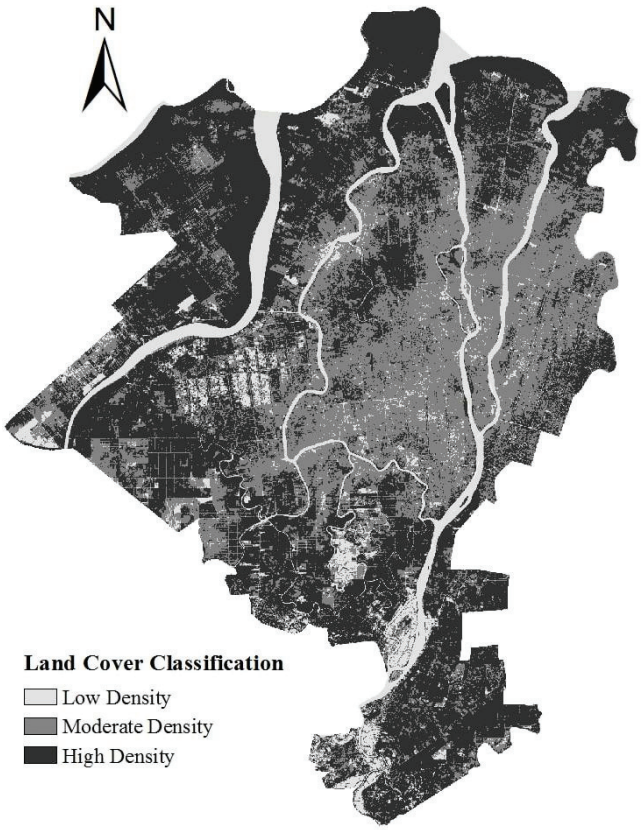

FIGURE 4. Classification of land cover based on density of the vegetation

Classification of Land Use

Land use classification was done by using land cover classification based on vegetation density using NDVI method and supervised classification based on existing land use from RTRW Banyuasin 2011 - 2031. The results of land use classification as seen in Figure 5.

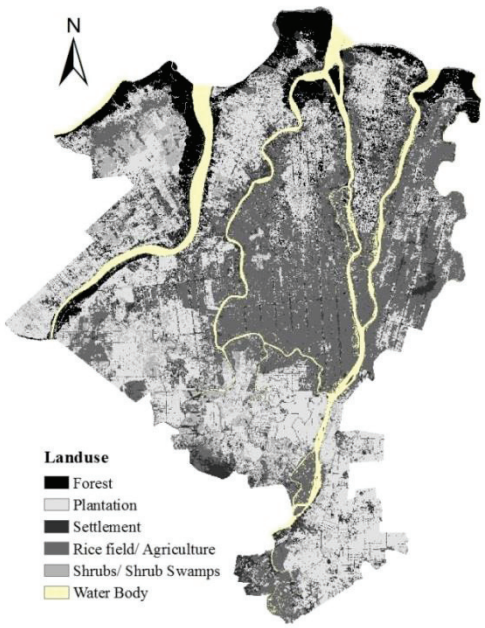

FIGURE 5. Landuse classification

The accuracy in interpreting land cover and land use was done using confusion matrix by matching the data of land use classification with the result of cross-check of the field.

Land Use Accuracy Test

Field cross checks on land use classification results were conducted in February and March 2017 at several locations in the study area, namely Talang Kelapa sub-district, Tanjung Lago sub-district, Muara Telang sub-district, Rambutan sub-district and Banyuasin I sub-district. The survey location points as seen in Figure 6. And the accuracy of the classification results was tested using a confusion matrix, as shown in Table 4.

TABLE 4. Confusion matrix on landuse classification

	Description	Reference Data (Field Data)						Sum	User Accuracy (%)
		Water Body	Settlement	Rice Field/ Agriculture	Shrub/ Shrub Swamp	Plantation	Forest		
Classification Data	Water Body	7	0	2	0	1	0	10	70
	Settlement	2	27	1	0	0	0	30	90
	Rice Field/ Agriculture	0	7	57	0	10	0	74	77
	Shrub/ Shrub Swamp	0	0	0	37	3	1	40	90
	Plantation	0	1	3	10	34	0	48	71
	Forest	0	0	1	0	0	5	6	83
	Sum	9	35	64	47	48	5	209	
Produser's Accuracy (%)		78	77	89	79	71	83		80

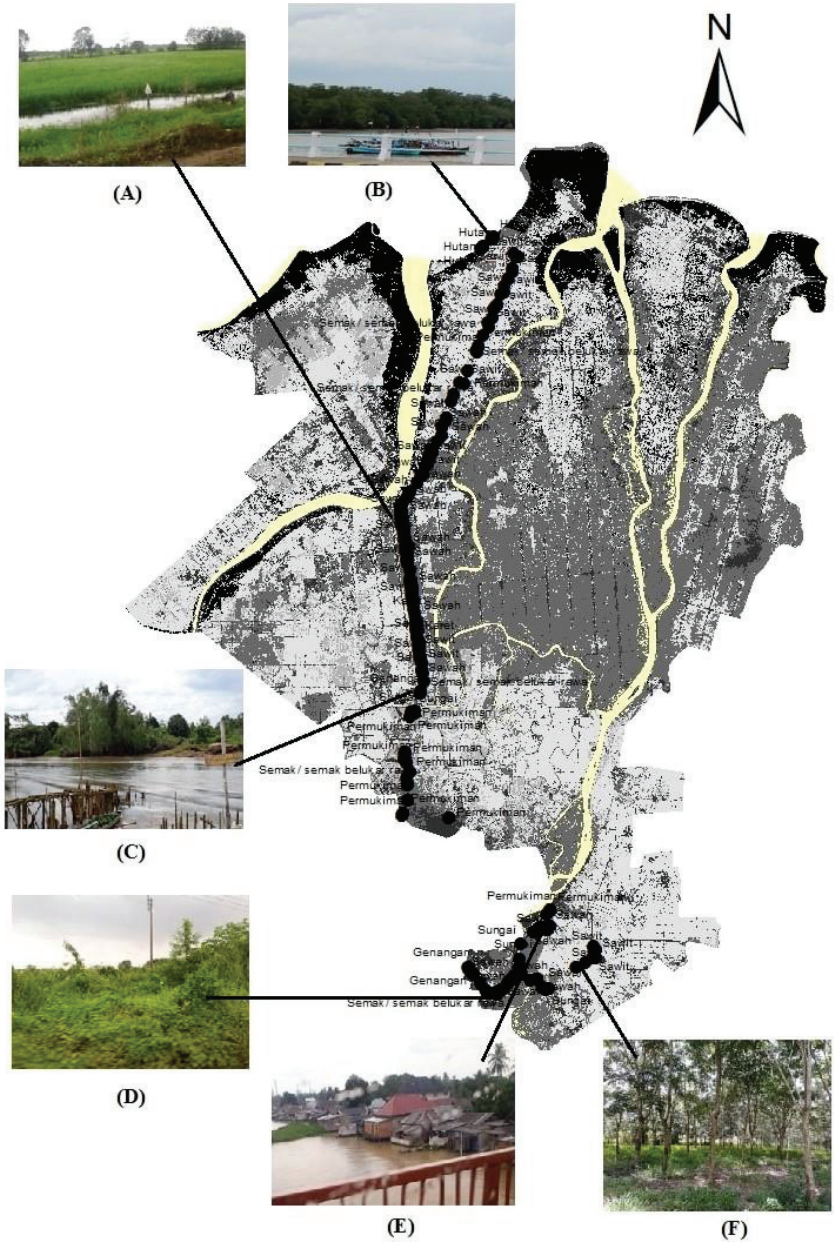

FIGURE 6. Cross Cek Result of Landuse Classification (A) Rice Field in Sub Distric of Tanjung Lago; (B) Mangrove on TAA Port; (C) Water Body on Gasing; (D) Shurbs in Sub Distric Rambutan; (E) Settlement in Sub Distric Banyuasin I; (F) Plantation on Sungai Dua

Confusion matrix indicates that the producer's accuracy is an error that occurs when certain categories that actually exist in the field but are omitted. The lowest percentage of producer accuracy was 71% in the plantation classification since in some locations classified as plantations, however, the reality of the field was a shrubs/shrub swamps, the cause was there are some located on the plantation that was not be used to the location becomes shrubs. The highest percentage of producer accuracy was rice field / PLK mixture of shrubs namely equal to 89%.

User accuracy is defined the land use category however actually is not available in the field. The smallest percentage of user accuracy was 70 % in the water body classification since some puddles and rivers were not visible in the image due to the wide of the small water body so that it was covered with other land use

classifications. The highest percentage of user accuracy was 90 % in the settlements and shrubs/ shrub swamps classification.

The percentage of overall accuracy was 80%, indicating that the results of land use classification could be used in making land use thematic maps.

Discussion

Some of the considerations in determining the trace of road in swamp area based on the results of land use classification were : (1) land use in District of Banyuasin is dominated by plantation and rice field, this must be a consideration in designing class of road that is able to serve the vehicle which transports plantation and agricultural products; (2) the location of settlements are mostly located in the watershed areas so that people still choose the water transportation facilities in carrying out the activities, so it needs to be taken into consideration whether people need road infrastructure in the future.

CONCLUSION

The land cover classification result based on vegetation density with NDVI method, the range of reflectance values was 0.5120 – 0.3706 for the high-density vegetation; 0.3706 – 0.6149 for the moderate density vegetation and 0.6149 – 0.8677 for low-density vegetation areas. Whereas the overall accuracy percentage of land use classification was 80 %.

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