Spatial Model of Canopy Density in Mangrove Forest of Percut Sei Tuan

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Abstract: Information about canopy density is needed in many ways, for example, in estimating forest degradation and forest quality. Utilization of vegetation index values on satellite imagery can be used to predict canopy density distribution. This study aims to predict canopy density distribution in mangrove forests. The methodology used is using regression analysis by connecting Normalized Difference Vegetation Index (NDVI) value with canopy density values in the field. The NDVI value is derived from Landsat 8 satellite images, while the canopy density percentage is obtained by using a camera. The spatial distribution of canopy density is obtained through spatial modeling using Geographic Information System (GIS). The results showed that the NDVI value of the linear regression model could be used to predict the density distribution of mangrove forest canopy with r square value of 59.0% and sig value <0.005.

1 INTRODUCTION

Land cover changes in mangrove forest into other land uses such as agriculture, mining, and settlement are the causes of deforestation in secondary mangrove forests in North Sumatra (Basyuni et al., 2018). in another hand, the existence of mangrove ecosystems, is very important for supporting survival in coastal zones (Duke et al., 2007). Therefore, efforts are needed for rehabilitating mangrove forests so that the mangrove forests fungction can optimally.

Information about canopy cover is needed in environmental rehabilitation planning activities (Azizia et al., 2008), including in the mangrove ecosystem. Canopy cover is defined as the proportion of forest floor covered by a tree canopy projected vertically (Jennings et al, 1999). Monitoring changes in canopy cover is needed as an initial effort to determine rehabilitation priority areas.

The utilization of vegetation indices on satellite images such as NDVI can be used to predict the spatial distribution of canopy density (Wachid et al., 2017). This study aims to predict the spatial distribution of mangrove forest canopy cover in Percut Sei Tuan.

2 MATERIALS AND METHOD

2.1 Studi Area

The data collection process was carried out on the mangrove forest landscape in Percut Sei Tuan Subdistrict, Deli Serdang Regency, North Sumatra Province. The geographical position of the mangrove forest landscape in Percut Sei Tuan is located at latitude 3.68º N - 3.77º N and at longitude 98.70º E - 98.83º E. The map of the research area can be seen in Figure 1.

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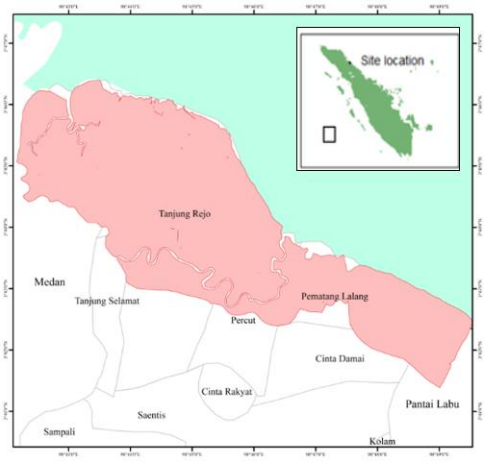

Figure 1: Site research location

2.2 Analysis of Vegetation Indices

NDVI is one of the most widely used vegetation indices in remote sensing including estimating canopy density. In this study NDVI values were obtained from Landsat satellite images 8 Path / Row 129/57 recording on July 1, 2016. The NDVI formula was calculated by equation (Rouse et al., 1973):

$$NDVI = \frac{(NIR-R)}{(NIR + R)} \quad (1)$$

where :
NIR : Digital value in Near Infrared bands
R : Digital value in the Red band

2.3 Analysis of Canopy Density

Measurement of canopy density in the reseach location is conducted through photographing canopy density from the bottom at the center point of a 30x30m sized plot. Furthermore, canopy density photos are processed using the canopy cover free android application to get the value of the canopy density percentage.

Estimation of canopy density distribution is done by regressing 30 plots of value data on canopy cover measurements in the field with NDVI values on landsat satellite images 8. The ordinary least square regression equation model used in this study is:

Linear: $Y = a + bx$ (2)

Exponential: $y = a \exp^{bx}$ (3)

tested, obtained information that the NDVI value can be used to predict canopy density (sig ANOVA

Information :
Y : canopy density (%)
x : NDVI
a, b : constanta

The classification of canopy density criteria in this study refers to Departemen Kehutanan (2005). Criteria for canopy density classification can be seen in table 1.

Table 1: Criteria for canopy density classification

No	Criteria	Score
1	Low canopy density	< 50 %
2	Medium canopy density	50 – 69 %
3	High canopy density	> 70 %

3 RESULT AND DISCUSSION

3.1 Distribution of NDVI

Based on NDVI analysis using landsat 8 satellite imagery in 2016, mangrove forest cover has a minimum NDVI value range of -0.259 and a maximum NDVI value of 0.529 (Figure 2). The greater the NDVI value indicates the closure of vegetation cover, on the contrary the smaller the NDVI value shows that vegetation cover is increasingly rare (Sulistiyono et al., 2018).

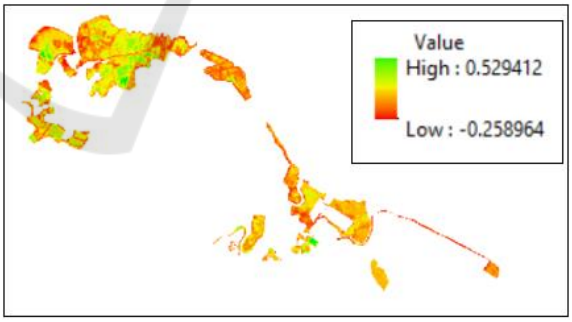

Figure 2: Spatial distribution of NDVI in mangrove forest in Percut Sei Tuan

3.2 Model Prediction of Canopy Density

The results of statistical tests that describe the relationship between canopy density and NDVI can be seen in table 1. The ANOVA (analysis of variance) test results on the two regression models
<0.05). Based on the determination coefficient value (R square), the best canopy density estimator model

is a linear model with an R square value of 59%. The results of this study are relatively similar when compared with the results of the Wachid et al (2017) study which produced an r square value of 59.89% in mangrove vegetation in Teluk Jor.

Table 1: Result of statistical models using OLS regression

Model	Regression	Sig ANOVA	R square	R
Linear	y = - 0.457 + 13.862 NDVI	0.000	0.590	0.768
Exponential	$y = 50.881\ e^{11.983\ NDVI}$	0.000	0.451	0.671

Based on the selected linear regression model, the area and percentage of canopy density in each class can be seen in table 2. The low canopy density class is 606.80 ha (57.8%), while the high canopy density class is only 2.25 ha (0.21%). This indicates that the landscape of the mangrove forest in Percut Sei Tuan is dominated by vegetation with a low canopy density. This can also be an indication that the level of disturbance to the mangrove vegetation in Percut Sei Tuan is quite high.

Table 2: Class canopy density in mangrove forest Percut Sei Tuan

Class of canopy density	Area (ha)	Percentage (%)
Low canopy density	606.80	57.80
Medium canopy density	440.86	41.99
High canopy density	2.25	0.21
Total	1,049.91	100.00

The spatial distribution of canopy density in the mangrove forest landscape of Percut Sei Tuan can be seen in Figure 3. The distribution of the class of low density canopy (pink color) is distributed along the outer land line dominated by *Avicennia sp*. Low density canopy classes are also widely seen in former pond areas.

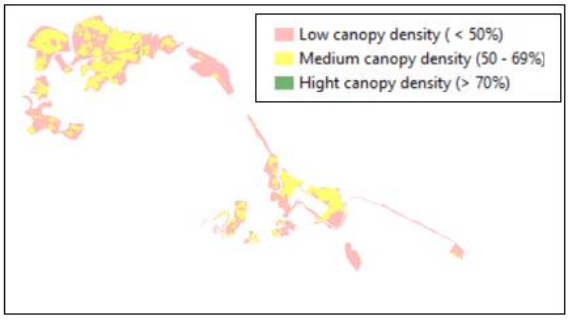

Figure 3: Spatial distribution of canopy density class in mangrove forest in Percut Sei Tuan

4 CONCLUSIONS

The result showed that NDVI approaches can estimate the forest canopy cover with r square value 59.0 %. Low canopy density (57.8%) is majority canopy density in mangrove forest of Percut Sei Tuan.

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