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Comparison Model of Vegetation Index and Mangrove Density Using Landsat 8 Satellite Imagery in Ujungpangkah

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ABSTRACT

Gresik Regency is a coastal area with a significant mangrove population, notably in the Ujungpangkah region. The Ujungpangkah mangrove forest is a designated ecotourism and conservation area. However, due to management and utilization practices by the local community, the mangrove ecosystem in Banyuurip Village, Ujungpangkah District, has experienced a decline. This study aims to determine the mangrove density in Banyuurip Village using vegetation index transformation methods (NDVI and DVI). Assessing the density of mangrove vegetation is crucial for the effective management of mangrove forests to ensure they fulfill their ecological functions. The research employs a quantitative method, utilizing Landsat 8 imagery data to measure mangrove density using the NDVI and DVI methods. The study results indicate that the NDVI canopy density classification is 86.67%, divided into three classes: dense (569.700 ha or 95.32%), medium (29.910 ha or 4.50%), and sparse (1.080 ha or 0.18%). Meanwhile, the FCD classification results are 73.33%, also divided into three classes: dense (583.740 ha or 97.67%), medium (13.410 ha or 2.24%), and sparse (0.540 ha or 0.09%). The NDVI method proved to be the most accurate for classifying canopy density based on the accuracy test data.

Keywords: *Mangrove; Landsat 8; NDVI; DVI*

INTRODUCTION

Mangrove forests are crucial ecosystems that support coastal life and help maintain the balance of biological cycles in their environment. For living organisms, mangrove ecosystems have both ecological and economic functions. Ecologically, mangroves serve as habitats, feeding grounds for marine life, and spawning areas. Economically, mangroves can be utilized as building materials, fishpond areas, and tourist attractions [1]. Mangroves also function as a barrier to prevent seawater intrusion [2]. Additionally, they help preserve natural sustainability, such as water quality and the area's natural biodiversity [3].

Indonesia's mangrove forest resources are extensive and distributed across various coastal regions. This natural wealth has the potential to be optimally managed and utilized to support national development and enhance the welfare of coastal communities while also preventing coastal erosion [4].

The importance of mangroves in coastal areas is widely recognized in Indonesia. However, the current management and utilization of mangroves are not based on comprehensive data about these resources, leading to significant degradation and even complete loss of many mangrove areas [5].

Mangrove forests can be identified using remote sensing technology. The geographical location of mangrove forests, situated in the transition zone between land and sea, produces distinctive recording effects compared to other terrestrial vegetation objects [6]. Thus, it is necessary to map mangrove forests to support monitoring, inventory, and conservation efforts at both local and national scales. At the local level, this can begin with Gresik Regency.

Gresik Regency is a coastal area with a significant mangrove population, particularly in the Ujungpangkah region. Within Ujungpangkah, mangroves are located in Banyuurip Village, Ujungpangkah District.

The Ujungpangkah mangrove forest is designated as an ecotourism and conservation area. However, due to the management and utilization practices by the local community, the mangrove ecosystem in Banyuurip Village, Ujungpangkah District, has experienced a decline [7].

Based on the previously described issues, the author undertakes research on predicting mangrove forest density in Ujungpangkah using Landsat 8 satellite imagery. This study aims to assess mangrove density in Banyuurip Village using vegetation index transformation methods (NDVI and DVI). The assessment of mangrove vegetation density is intended to support the management of mangrove forest areas to ensure they fulfill their appropriate functions and roles.

METHOD

The research method used in this study is quantitative research. Quantitative research involves the use of measurements, calculations, formulas, and numerical data certainty in planning, processes, hypothesis development, techniques, data analysis, and drawing conclusions [8]. The author employs the quantitative method to systematically and in detail calculate the model comparison of vegetation indices and predict mangrove density.

The imagery used in this study is Landsat 8, recorded on March 20, 2024. This imagery is utilized to predict mangrove density by comparing vegetation index transformations, specifically NDVI and DVI. Sampling points are determined using stratified random and proportional sampling methods, with photographs taken using a fisheye lens and processed using Gap Light Analyzer software.

The procedures or stages carried out in this research begin with identifying the problem, which is the dynamic changes in the mangrove ecosystem in coastal areas that may disrupt the continuity of the mangrove ecosystem and diminish its primary benefits. Therefore, an analysis of mangrove ecosystem density is necessary. Following this, a literature review related to the research is conducted. Next, the study location is determined at the Mangrove Banyuurip Center, Ujungpangkah, Gresik. The research location can be seen in Figure 1.

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Figure 1. Research Location

RESULTS AND DISCUSSION

Radiometric Correction

Radiometric correction is performed to eliminate distortions in the imagery [9] Radiometric correction is performed to remove distortions in the imagery, resulting in sharper and clearer visuals using the ENVI application. The first step in radiometric correction involves converting Digital Number (DN) values to spectral radiance values. The calculation of spectral radiance values for each band is shown by the changes in maximum pixel values between the pre-conversion and post-conversion images. The pixel values from the conversion of digital numbers to reflectance for Band 5 and Band 6 are presented in Table 1.

Table 1. Pixel Values from Digital Number to Reflectance Conversion

Spectal Band	Pixel Values			
	Before		After	
	Min	Max	Min	Max
Band 5	-1127	19664	0	1
Band 6	-297	17423	0	1

To obtain the conversion results from digital numbers to radiance, bands 1 through 7 and the thermal band are used. For Landsat imagery, the thermal band utilized is Band 10. The pixel values from the conversion of digital numbers to radiance for each band from Band 1 to Band 7 are shown in Table 2.

Table 2. Pixel Values from Digital Number to Radiance Conversion for Bands 1 – 7

Spectal Band	Pixel Values			
	Before		After	
	Min	Max	Min	Max
Band 1	0	51.64	0	1
Band 2	0	56.44	0	1
Band 3	0	53.41	0	1
Band 4	0	48.18	0	1
Band 5	0	33.39	0	1
Band 6	0	8.34	0	1
Band 7	0	2.97	0	1

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Pixel values from Digital Number to Radiance conversion for Band 10 are shown in Table 3.

Table 3. Pixel Values from Digital Number to Radiance Conversion for Band 10

Spectal Band	**Pixel Values**			
	Before		**After**	
	Min	**Max**	**Min**	**Max**
Band 5	-1127	19664	0	1

Conversion of radiance values to brightness temperature is performed to transform the data from radiance (for thermal bands) to brightness temperature. The conversion of radiance values to brightness temperature is shown in Table 4.

Table 4. Conversion of Radiance Values to Brightness Temperature

Year	**Temperature Values (°K)**		
	Min	Max	Mean
2024	192.89	200.93	196.14

Conversion from Kelvin to Celsius is performed to change the unit from Kelvin to Celsius for the results of the radiance to brightness temperature conversion. The results of the Kelvin to Celsius conversion are shown in Table 5.

Table 5. Results of the Conversion from Kelvin to Celsius

Year	**Temperature Values (°C)**		
	Min	Max	Mean
2024	29.5	39.4	34.5

Results of Geometric Correction

Geometric correction aims to adjust pixel coordinates in the imagery to match Earth coordinates on a flat plane. The results of geometric checking for Landsat 8 include metadata with Ground Control Points (GCPs) and RMSE values. The geometric RMSE values from the Landsat 8 metadata are shown in Table 6.

Table 6: Geometric RMSE Values from Landsat 8 Metadata

Record Date	**GCP Point**	**RMS Values (m)**		
		X	Y	Z
20-03-24	411	4.323	5.538	7.025

Cropping Result

Cropping is performed on the area of study, which is the Banyuurip mangrove in Ujungpangkah, Gresik Regency. The result of the Landsat 8 cropping is shown in Figure 2.

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Figure 2: Result of Landsat 8 Cropping

NDVI and DVI analysis

After performing calculations using the QGIS application, the vegetation index values are obtained, where the vegetation index ranges from a minimum of -0.19 to a maximum of 1. The DVI values range from 92.1 to 6740.75. The results of the vegetation index calculations are shown in Table 7.

Table 7. Results of Vegetation Index Calculations

Results of Data Processing	Pixel Values	
	Min	**Max**
NDVI	-0.19	1
DVI	92.1	6740.75

After obtaining the minimum and maximum vegetation values for the Banyuurip mangroves in Ujungpangkah, the next step is to classify the vegetation based on the desired class intervals. The class intervals for NDVI and DVI vegetation are shown in Table 8.

Table 8. Results of Vegetation Index Calculations

Vegetation Classes	NDVI		DVI	
	Pixel Values		Pixel Values	
	Min	Max	Min	Max
Rarely	-0.19	10.28	92.1	765.1
Medium	0.28	0.74	765.1	2440.5
Tight	0.74	1	2440.5	6475.75

Analysis of Classified NDVI and DVI Image Areas

To obtain the area for each class, Export Color Slices to Shapefile is performed for each class, which automatically calculates the vegetation area for each class.

The percentage of density for each class is calculated using the following formula:

$$Xn \quad = \frac{Li}{N}\, x\ 100\% \qquad (1)$$

Whereas:

N : Total area of class
Li : Area of Class i
Xn : Percentage of Vegetation Index Class Density

The calculation of the percentage area for NDVI classes is shown in Table 9.

Table 9. Percentage Area Calculation for NDVI Classes

Density Level	**Area (ha)**	**Percentage (%)**
Dense	569.7	95.32
Moderate	26.91	4.50
Sparse	1.08	0.18
Total	597.69	100

The calculation of the percentage area for DVI classes is shown in Table 10.

Table 10. Percentage Area Calculation for NDVI Classes

Density Level	**Area (ha)**	**Percentage (%)**
Dense	583.74	97.67
Moderate	13.41	2.24
Sparse	1.08	0.09
Total	597.69	100

This analysis is conducted to determine the differences in vegetation density based on two different algorithmic methods. The comparison of the area for each class between the two vegetation index methods is shown in Table 11.

Table 11.Comparison of Area for Each Class from Two Vegetation Index Methods

Density Level	**NDVI Total Area (ha)**	**DVI Total Area (ha)**
Dense	569.7	583.74
Moderate	26.91	13.41
Sparse	1.08	1.08
Total	597.69	597.69

The comparison of the percentage for each class between the two vegetation index methods is shown in Table 12.

Table 12. Comparison of Percentage Area for Each Class from Two Vegetation Index Methods

Density Level	**NDVI Total Area (%)**	**DVI Total Area (%)**
Dense	95.32	97.67
Moderate	4.50	2.24
Sparse	0.18	0.09
Total	100	100

The comparison table of vegetation density levels above shows that the vegetation density in the Banyuurip mangroves, Ujungpangkah, exhibits a variety of types ranging from dense to moderate classes.

The results of the data interpretation and analysis indicate that the vegetation density in the Banyuurip mangroves, Ujungpangkah, shows the largest classification in the dense vegetation category, covering an area of 583,740 ha (97.67%). Moderate vegetation covers 26,910 ha (4.50%), and sparse vegetation covers 1,080 ha (0.18%).

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Canopy Density Accuracy Assessment

The canopy refers to the entire part of the plant, especially trees, shrubs, or lianas, that is above the ground and attached to the main trunk. Measurement of the canopy is used to detect the health of a plant and the efficiency of its photosynthesis.[10]

Accuracy calculation can be performed using various methods. One of the methods used in this study for accuracy testing is the confusion matrix. Essentially, a confusion matrix involves organizing the classification results and field observations into a comparative percentage table.

The sample taken for NDVI classification results consists of 30 points, which are then compared with field data from the same points. The accuracy percentage of the NDVI classification results verified with field data is shown in Table 13.

Table 13. Accuracy Assessment of NDVI Classification Results

Class	Dense	Moderate	Sparse	Total
Dense	9	1	0	10
Moderate	1	9	0	10
Sparse	0	2	8	10
Total	10	12	8	30

From the data in the confusion matrix table above, the accuracy calculation is as follows:

$$Overall\ Accuracy = \frac{Number\ of\ diagonal\ elements}{Number\ of\ sample\ points}\ x\ 100\% \quad (2)$$

$$\text{Overall Accuracy} = \frac{26}{30} \text{ x } 100\%$$

$$= 86.67\ \%$$

Therefore, from the 30 sample points, the average overall accuracy of the classification results is 86.67%, which meets the minimum requirement of ≥ 70%.

The sample taken for DVI classification results consists of 30 points, the same as for NDVI, which are then compared with field data from the same positions. The accuracy percentage of the DVI classification results verified with field data is shown in Table 14.

Table 13. Accuracy Assessment of DVI Classification Results

Class	Dense	Moderate	Sparse	Total
Dense	9	1	0	10
Moderate	2	8	0	10
Sparse	1	4	5	10
Total	12	13	5	30

From the data in the confusion matrix table above, the accuracy calculation is as follows:

$$\text{Overall Accucacy} = \frac{22}{30} \text{ x } 100\%$$

$$= 73.33\ \%$$

Therefore, from the 30 sample points, the average overall accuracy of the classification results is 73.33%, which meets the minimum requirement of ≥ 70%.

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Map layout creation

Cartography is the art and science of map-making. The cartographic process in QGIS includes displaying or arranging the map, setting the map projection system, configuring the map layout page, adding map titles, and including legends. The result of the NDVI vegetation density map is shown in Figure 3.

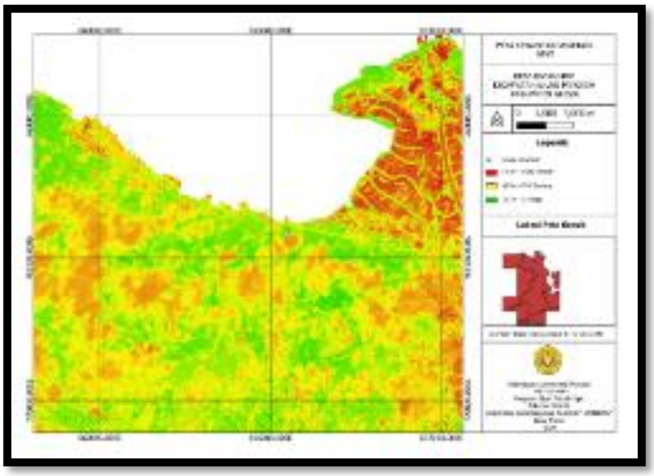

Figure 3. NDVI Vegetation Density Map

The NDVI vegetation density map is shown in Figure 4.

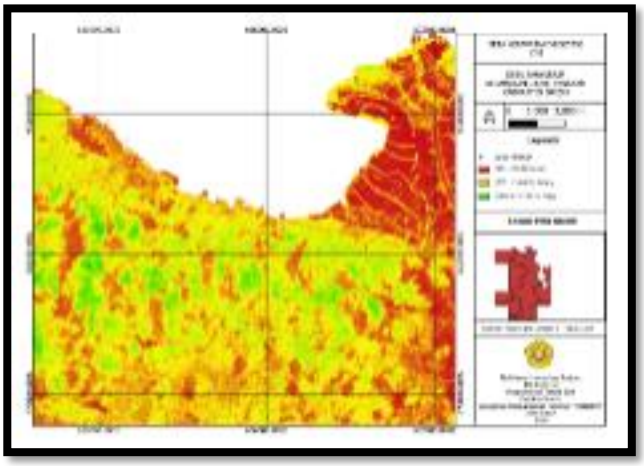

Figure 4: NDVI Vegetation Density Map

CONCLUSION

From the research conducted using two classification methods to predict and identify mangrove vegetation density with Landsat 8 satellite data, several conclusions can be drawn. The vegetation density derived from the Landsat 8 satellite imagery processing includes three classes of vegetation density: dense, moderate, and sparse, each with different area measurements. Based on NDVI, dense vegetation covers 569,700 ha (95.32%), moderate vegetation covers 29,910 ha (4.50%), and sparse vegetation covers 1,080 ha (0.18%). Based on DVI, dense vegetation covers 583,740 ha (97.67%), moderate vegetation covers 13,410 ha (2.24%), and sparse vegetation covers 540 ha (0.09%).

From the accuracy testing of the two canopy density classification methods, NDVI achieved an accuracy of 86.67%, while DVI achieved an accuracy of 73.33%. Based on the accuracy test data, the NDVI method is the most accurate and closest to the true classification of canopy density.

REFERENCE

[1] B. M. Sukojo And Y. N. Arindi, "Analisa Perubahan Kerapatan Mangrove Berdasarkan Nilai Normalized Difference Vegetation Index Menggunakan Citra Landsat 8 (Studi Kasus : Pesisir Utara Surabaya) Pembangunan Wilayah Pesisir Menyebabkan Perubahan Fungsi Lahan Menjadi Kawasan Pemukiman , I," Vol. 8, Pp. 1–5, 2018.

[2] S. Irawan And A. O. Malau, "Analisis Persebaran Mangrove Di Pulau Batam Menggunakan Teknologi Penginderaan Jauh," *J. Integr.*, Vol. 8, No. 2, Pp. 80–87, 2016 .

[3] H. Ariadi, M. Fadjar, M. Mahmudi, And Supriatna, "The Relationships Between Water Quality Parameters And The Growth Rate Of White Shrimp (Litopenaeus Vannamei) In Intensive Ponds," *Aacl Bioflux*, Vol. 12, No. 6, Pp. 2103–2116, 2019.

[4] S. S. A. Syukri, Muhammad Rijal, "Identifikasi Kerapatan Tutupan Mangrove Pulau Gusung Menggunakan Citra Landsat 8," *J. Sains Inf. Geogr. [Jsig]*, Vol. I, No. November, Pp. 40–43, 2018, Doi: 10.31314/J.

[5] S. Irawan And J. Sirait, "Perubahan Kerapatan Vegetasi Menggunakan Citra Landsat 8 Di Kota Batam Berbasis Web," *J. Kelaut. Indones. J. Mar. Sci. Technol.*, Vol. 10, No. 2, P. 174, 2018, Doi: 10.21107/Jk.V10i2.2685.

[6] K. K. Ahmad, K. A. Putri, A. D. Wilujeung, D. A. Lestari, And W. A. Arifin, "Status Sebaran Dan Kerapatan Kanopi Mangrove Di Pulau Tobea Besar Sulawesi Tenggara Menggunakan Data Satelit Landsat 8," *Pena Akuatika J. Ilm. Perikan. Dan Kelaut.*, Vol. 20, No. 2, 2021, Doi: 10.31941/Penaakuatika.V20i2.1363.

[7] Izzatinnisa And U. Dan A. M. Utami, "Keanekaragaman Burung Di Kawasan Hutan Mangrove Banyuurip Kecamatan Ujungpangkah Kabupaten Gresik," *J. Ris. Biol. Dan Apl.*, Vol. 2, No. 50, Pp. 18–25, 2020.

[8] M. Waruwu, "Pendekatan Penelitian Pendidikan: Metode Penelitian Kualitatif, Metode Penelitian Kuantitatif Dan Metode Penelitian Kombinasi (Mixed Method)," *J. Pendidik. Tambusai* , Vol. 7, No. 1, Pp. 2896–2910, 2023.

[9] D. Kosasih, I. Nasihin, And E. R. Zulkarnain, "Deteksi Kerapatan Vegetasi Dan Suhu Permukaan Tanah Menggunakan Citra Landsat 8 (Studi Kasus : Stasiun Penelitian Pasir Batang Taman Nasional Gunung Ciremai," *Konserv. Untuk Kesejaht. Masy.*, Vol. 1, Pp. 162–173, 2019.

[10] A. Sukmono, A. S. Pratama, And L. Sabri, "Analisa Perubahan Kerapatan Vegetasi Pada Das Blorong Menggunakan Metode Forest Canopy Density (Fcd) Dari Citra Landsat 8," *Elipsoida J. Geod. Dan Geomatika*, Vol. 3, No. 01, Pp. 92–97, 2020, Doi: 10.14710/Elipsoida.2020.8051.