



DETERMINATION OF COMMUNITY STRUCTURE AND INDEX MANGROVE HEALTH INDEX (MHI) IN DELI SERDANG DISTRICT, PROVINCE NORTH SUMATRA

Dea Synta Lusyanti¹, Yudi Antomi², Triyatno², Azhari Syarief²

¹Student of the D3 Remote Sensing Technology Study Program, Universitas Negeri Padang, ²Lecturer Study Program D3 Remote Sensing Technology, Universitas Negeri Padang
e-mail: deasyntalusyanti@gmail.com

ABSTRACT: This research aims to 1) Know the structure of the mangrove community in Deli Serdang Regency, 2) To find out the differences in the classification of the health level of the mangrove communities in Deli Serdang Regency using Sentinel 2A and Landsat 8OLI imagery in 2022. In determining the structure of the mangrove community carried out by making plot plots to measure trunk circumference and types of mangroves found in Deli Serdang Regency, while to find out differences in the classification of mangrove health levels it was done by comparing the vegetation density values in the field and the canopy density values based on the NDVI vegetation index from Sentinel 2A and Landsat 8OLI imagery. year 2022. The results of this study are, 1) The dominant mangrove species in Deli Serdang Regency are the *Avicennia marina*, *Avicennia alba* and *Excoecaria agallocha* types, with a low level of species diversity. 2) Sentinel 2A imagery is better to use than Landsat 8OLI imagery in determining the Mangrove Health Index (MHI).

Keywords: Mangrove, Mangrove community structure, Mangrove Health Index, Remote Sensing

1. INTRODUCTION

Deli Serdang is one of the regencies in North Sumatra which along the coast is used as a green belt overgrown with mangroves. The area of the mangrove forest in Deli Serdang Regency is 14.38 hectares (Buhanuddin, 2016) which are spread over Pantai Labu District, Precut Sei Tuan District, Hamparan Perak District, and Labuhan Deli District. Mangrove ecosystems that are scattered in various sub-districts continue to decline so that mangrove quality measurements need to be carried out to analyze the health level of mangrove ecosystems, because healthy mangrove forests can provide benefits according to their functions.

Physically, mangroves function as a place and source of life for several coastal creatures. Economically, mangroves can have direct and indirect impacts on the surrounding community. Malik *et al* (2015) the total economic valuation of mangrove conservation is higher than that of aquaculture activities. Coastal fisheries production is strongly influenced by mangrove ecosystems (Anneboina & Kumar, 2017). Therefore, the mangrove plant community is an important part of ecosystem health. The loss of mangroves will disrupt the mangrove ecological system which consists of biotic and abiotic components. Damaged mangrove ecosystems and their reduced area will provide lower ecosystem functions and services compared to healthy mangroves.

To prevent and mitigate damage to mangrove forests, it is necessary to map the distribution of mangrove health. This mapping is useful in managing and establishing policies on mangrove ecosystems in the region. To facilitate mapping, it can be done with the help of remote sensing technology such as satellite imagery, because it can provide information from an object on the earth's surface without us having to have direct contact with the object being studied, even for difficult areas. Based on these problems, the objectives of this research are 1) to find out the structure of the mangrove community in Deli Serdang Regency, 2) to find out differences in the classification of the health level of mangrove communities in Deli Serdang Regency using Sentinel 2A and Landsat 8OLI imagery in 2022.

2. METHODS

The form of this research is descriptive quantitative. The descriptive method is used to describe the analysis of data obtained from the interpretation of Sentinel 2A and Landsat 8OLI images, while the quantitative method is used to analyze community structure data and mangrove vegetation indexes to produce a mangrove health index in Deli Serdang Regency.

2.1. Research Location

Deli Serdang Regency is one of the regencies in North Sumatra Province which is located between 2°57 North Latitude and 3°16 South Latitude and 98°33- 99°27 East Longitude with an area of 2,497.72 km². The Deli Regency area is bordered by Langkat Regency to the north, Karo Regency and Simalungun Regency to the south, Serdang Begadai Regency to the east, and Karo Regency and Langkat Regency to the west. This research was conducted in the mangrove ecosystem area in Deli Serdang Regency, which is spread over several sub-districts, is Pantai Labu District, Percut Sei Tuan District, Labuhan Deli District and Hamparan Perak District.

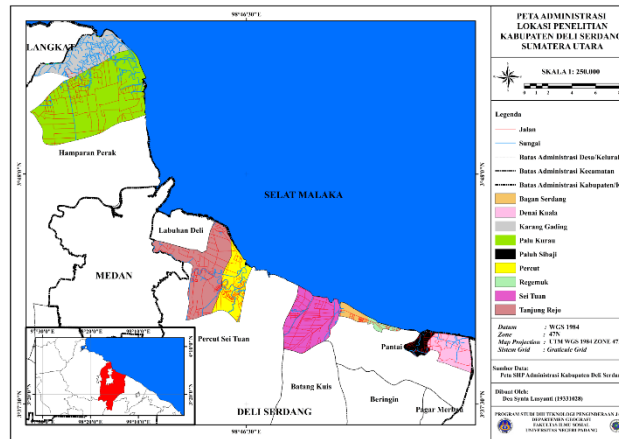


Figure 1. Administrative Map of Research Locations

2.2. Data Analysis Techniques

2.2.1. Collection Of Data

- a) Secondary Data, secondary data is data not directly obtained by researchers, usually coming from an institution in the form of archives or documents. Secondary data from this study are in the form of satellite images of Sentinel 2A and Landsat 8OLI in 2022 with the study area of Deli Serdang Regency. Sentinel 2A imagery is used to determine mangrove and non-mangrove areas in the study area and to calculate the vegetation index value of mangrove plants, while Landsat 8OLI imagery is used as comparative data in determining the vegetation index value with the vegetation index from Sentinel 2A imagery, which will then be processed to obtain the health index of mangroves in Deli Serdang Regency, North Sumatra.
- b) Primary Data, primary data is data collected directly by researchers. The primary data in this study were stem circumference measurements to obtain the structure of the mangrove forest community in Deli Serdang Regency.

2.2.2. Data Processing

- a) Satellite Image Pre-processing, at this stage satellite image pre-processing is carried out in the form of a combination of image bands and image cropping. Band combinations are performed to match the band channels required in satellite image data analysis. In this study a combination of band 8A (NIR), band 12 (SWIR), and band 4 (Red) was used, this combination was used because it uses Short wavelength and Near-infrared which can show vegetation in various shades of green, making it suitable for viewing vegetation areas mangrove and non-mangrove, then the combined images are cut based on the research study area to facilitate the processing of satellite imagery.
- b) Satellite Image Processing, at this stage the first thing to do is image classification, this classification is done to group the same objects or pixels in satellite imagery. The classification used in this study is supervised classification with the maximum likelihood method, this method assumes the same spectral distribution into the sample areas (training



area), and from the results of this classification, mangrove and non-mangrove areas are obtained. In the research area, then satellite image processing is carried out in the form of mangrove health index processing using the Normalized Difference Vegetation Index (NDVI) method, this index is used because it uses light waves and NIR on satellite images so that it can show differences in the reflectance value of the electromagnetic spectrum by tree canopy cover. High or low NDVI values can be used as a basis for determining the health level of mangroves in the study area. To determine the NDVI value, the following equation is used.

Sentinel 2A:

$$NDVI = \frac{\text{band } 8A - \text{band } 4}{\text{band } 8A + \text{band } 4}$$

Landsat 8OLI:

$$NDVI = \frac{\text{band } 5 - \text{band } 4}{\text{band } 5 + \text{band } 4}$$

2.2.3. Data Analysis

a) Mangrove Community Structure

Determination of the mangrove community structure is calculated based on the value of the important index (NIP). NIP is determined based on the values of relative density, relative frequency, and relative dominance. The importance index value of a species ranges from 0% to 300%. The importance value index provides an overview of the influence or role of a mangrove plant species.

b) Mangrove Health Index

Mangrove health analysis was determined based on the vegetation index (cone density) on Sentinel 2A and Landsat 8OLI images, which were then carried out by linear regression analysis to compare the crown density values on satellite images with field density. The health classification is divided into three which consist of bad, medium and good classes.

2.2.4. Accuracy Test

To determine the level of accuracy or reliability of the data from this study, an accuracy test was carried out with samples from the results of field activities. The method used is the error matrix (Confusion Matrix), where the calculation of accuracy is done by calculating the Producer's Accuracy, User's Accuracy, Overall Accuracy and Kappa Coefficient. Producer's Accuracy is the accuracy seen from the map produced, while User's Accuracy is the accuracy seen from the situation in the field/original, and Overall Accuracy is the accuracy of the whole.

3. RESULTS AND DISCUSSION

Determination of the mangrove health index in mangrove areas can be carried out using community structure parameters and remote sensing. This study aims to determine the community structure and health index of mangroves in Deli Serdang Regency using Sentinel 2A imagery and Landsat 8OLI imagery.

Determination of the mangrove area was carried out by classifying Sentinel 2A satellite imagery for the recording year 2022. Based on the results of the classification of land cover classes in the study area, namely mangroves, oil palm plantations, ponds, open land, built-up land, rice fields and bodies of water. Each land class is then validated with field data based on producer's accuracy, user's accuracy, overall accuracy and kappa accuracy tests. The result for overall accuracy is 89% and for kappa accuracy is 87%, this means that the land classification that has been carried out is good and can be continued to the next stage, namely to determine community structure and mangrove health index.

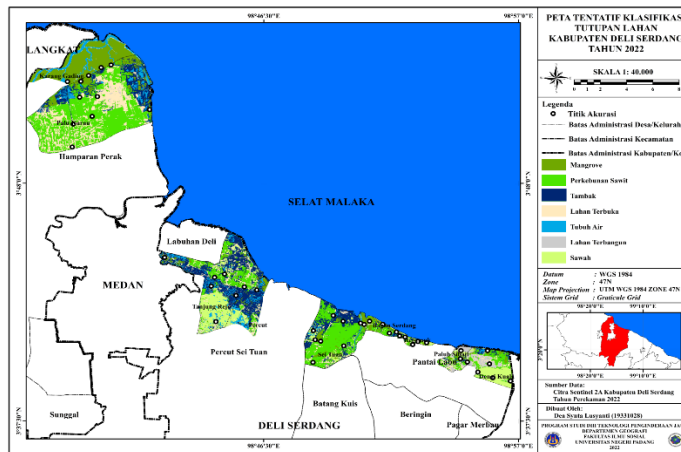


Figure 2. Land cover map Mangrove Community Structure

3.1 Mangrove Community Structure

The structure of the mangrove community was determined based on the importance index value of the type and number of mangrove stands present at each research plot point. Based on the results of the analysis of the importance value index calculated based on the diameter of the tree at breast height, the tree level of *Avicennia marina* (api-api putih) is the dominant mangrove species in the six study villages, namely Denai Kuala Village, Sei Tuan Village, Rugemuk Village, Bagan Serdang Village, Percut Village and Tanjung Rejo Village. Palu Sibaji Village is dominated by the type *Excoecaria agallocha* (blind-blind), and Paluh Kurau Village is dominated by the mangrove species *Avicennia alba* (black fire).

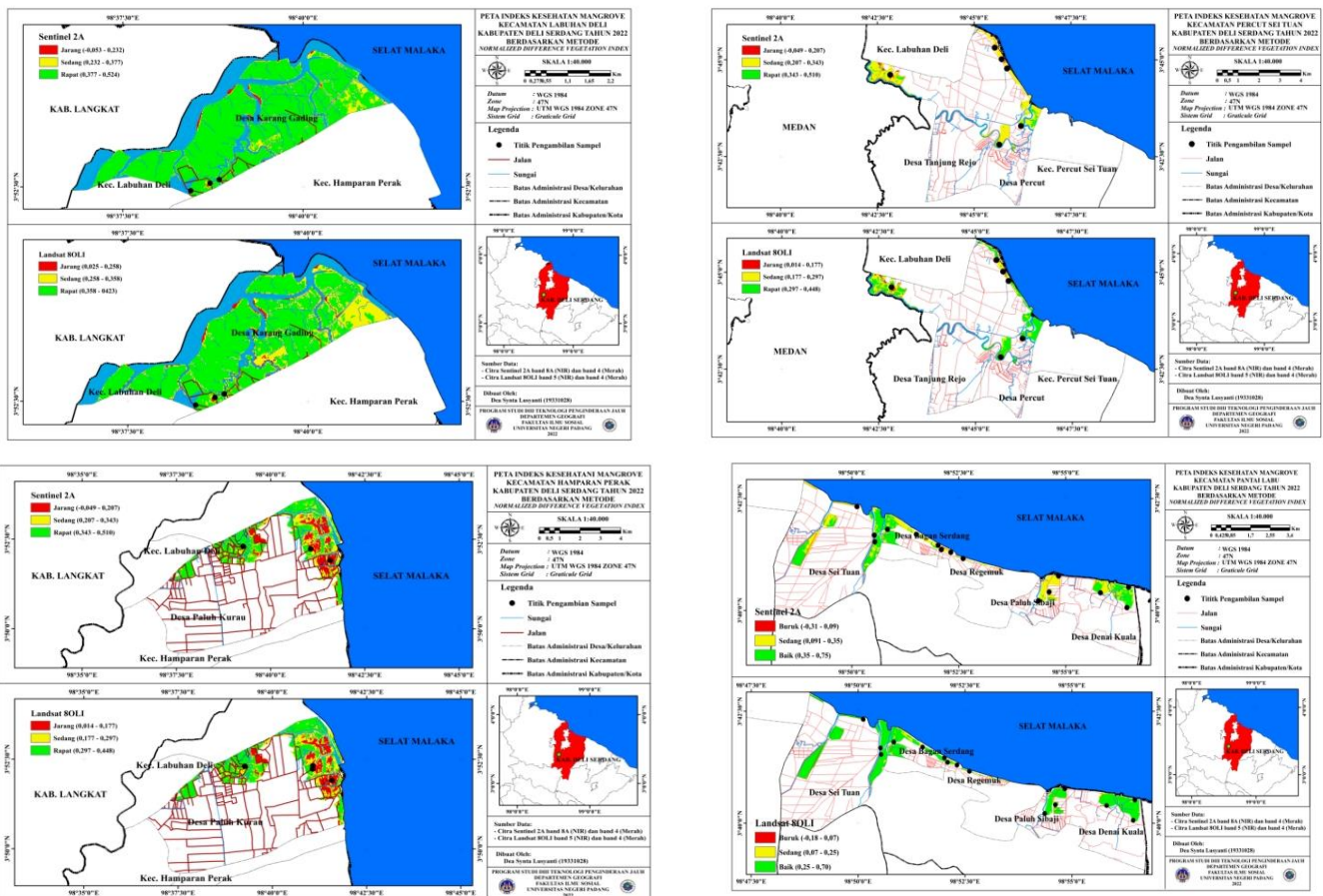


Figure 4. Mangrove Vegetation Index Map in Deli Serdang Regency



At the sapling level, *Avicennia marina* dominated in Bagan Serdang Village, Rugemuk Village, Sei Tuan Village, Percut Village and Tanjung Rejo Village, while *Avicennia alba* dominated in Denai Kuala Village. In Paluh Sibaji Village it is dominated by *Xylocarpus Granatum* and in Krang Gading Village it is dominated by *Bruguiera sexangula*. At the seedling level in Rugemu Village, Bagan Serdang and Perut Village, *Avicennia marina* was dominated. Desa Denai Kuala by *Achantus ilicifolius*. Paluh Kurau Village *Avicennia alba* and Paluh Sibaji Village, Sei Tuan Village, Tanjung Rejo Village, Karang Gading Village are dominated by *Avicennia marina*.

The type of mangrove in Bagan Serdang Village that had the highest INP was *Avicennia marina* with INP at a sapling level of 136.17% and a tree level of 117.41%. In Rugemuk Village, the highest type of mangrove was *Avicennia marina*, with an INP at a sapling level of 152.11% and at a tree level an INP of 122.31%. Percut Village, the type of mangrove that has the highest INP is *Nypa Fruticans* at the seedling level with an INP of 111.11%, the level of *Avicennia marina* saplings with an INP of 147.8% and at the tree level with an INP of 146.8% for *Excoecaria agallocha*.

In Paluh Kurau Village, the type of mangrove that had the highest INP for the sapling level was *Avicennia marina* with an INP of 51.67%, and at the tree level an INP of 153.44%. In Denai Kuala Village, the type of mangrove with the highest INP value was *Avicennia marina* with an INP of 63.55%, sapling level of 220.43% for *Acanthus illicifolius* and for trees with an INP of 107.63% for *Avicennia marina*.

The mangrove village of Paluh Sibaji with the highest INP was *Xylocarpus granatum* with an INP of 111.07% at the sapling level and at the tree level in the *Avicennia marina* tree with an INP of 94.98%. in Sei Tuan Village, the mangrove vegetation with the highest INP was *Avicennia marina* with an INP of 200%, 102.17% at the sapling level and 105.94% at the tree level.

In Tanjung Rejo Village, the mangrove species with the highest INP was *Bruguiera cylindrica* with an INP of 98.91% at the sapling level, and at the tree level with an INP of 142.54% for the *Excoecaria agallocha*. in Karang Gading Village the type of mangrove with the highest INP was *Ryzophora apicullata* at the sapling level with an INP of 242.7% and at the tree level of 198.32% for the type *bruguiera cylindria*.

Based on the results of the calculation of the diversity index (H'), in all research plots it was found that at the seedling level it ranged from 0 - 0.79. At the sapling level it ranged from 0-0.66 and at the tree level it ranged from 0-0.111. This shows that the diversity of mangrove species found in the study area both for the seedling, sapling and tree levels is still low, because according to the diversity level class of Shannon Wiener if the diversity value in a plot is <1 then it means the diversity level is low, if $1 < H' < 3$ the level of diversity is moderate and if $H' > 3$ then the level of diversity of the vegetation is high.

3.2 Mangrove Health Index

The mangrove health index is determined based on the vegetation density value on satellite imagery which is then compared with the density value per plot in the study area. Figures 8 and 9 show the relationship between plot type density values in the field and Sentinel 2A and Landsat 8OLI images. The coefficient of determination (R^2) in Sentinel 2A imagery with a field density of 0.83 or a correlation value (R) of 0.91%, while the coefficient of determination (R^2) in Landsat 8OLI imagery with a field density of 0.76 or the correlation value (R) of 0.87. So that it can be said that the NDVI values in Sentinel 2A and Landsat 8OLI images have a stronger correlation with field density values, namely NDVI in Sentinel 2A images.

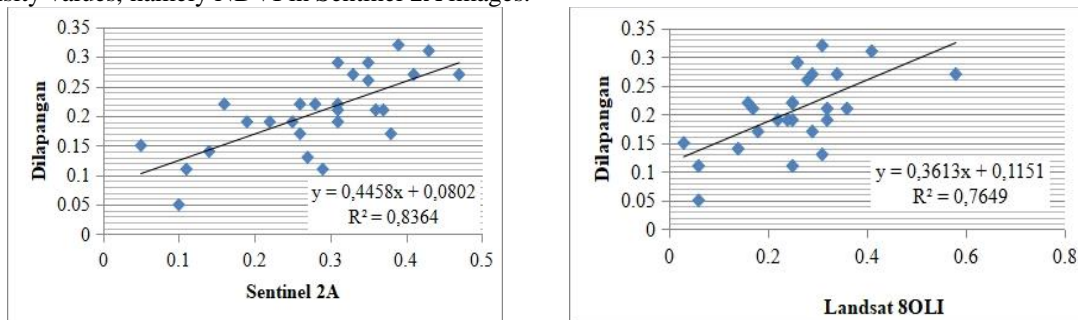


Figure 5. Linear Regression Graph between Image NDVI Values and Density in the Field



The difference in the correlation results between the two images used is influenced by the resolution of the image, where the resolution of the Sentinel 2A image is 10 m while that of the Landsat image is 30 m. It can be concluded that Sentinel 2A imagery is more detailed in recording objects on the earth's surface than Landsat 8OLI imagery. Based on the NDVI analysis carried out using Sentinel2 and Landsat 8OLI imagery, the mangroves in the research area categorized the mangrove health levels into 3 classes, namely bad, medium and good. The mangrove health index on Sentinel 2A imagery at the bad level ranges from -0.316 to 0.091, the moderate class ranges from 0.091 to 0.356 and the good class ranges from 0.356 to 0.756. On Landsat 8OLI imagery, the bad level ranges from -0.306 to 0.096, the moderate level ranges from 0.096 to 0.277, while the bad level ranges from 0.277 to 0.874.

Subdistricts with a dominant poor health level were found in Percut Subdistrict and Hampan Perak Subdistrict which were caused by the conversion of mangrove land into ponds and oil palm plantations, while mangroves with a good level of health were found in Labuhan Deli Subdistrict where the mangrove ecosystem in these subdistricts was still natural, but at the northern part of this sub-district has started to enter into the moderate health level because the mangroves have started to die and the community has changed the function of mangrove land into ponds.

4. CONCLUSION

Based on the results and discussion above, the conclusions in this study are:

- 4.1 The dominant mangrove species on the coast of Deli Serdang Regency are *Avicennia marina*, *Avicennia alba* and *Excoecaria agallocha*. Denai Kuala Village, Sei Tuan Village, Rugemuk Village, Bagan Serdang Village, Percut Village and Tanjung Rejo Village are dominated by *Avicennia marina* (white fire) mangroves, Paluh Sibaji Village by *Excoecaria agallocha* (blind), and Paluh Kurau Village dominated by *Avicennia alba* (black fire) mangroves, and the diversity of mangrove species in Deli Serdang Regency is currently relatively low.
- 4.2 Sentinel 2A imagery is better to use than Landsat 8OLI imagery in determining the mangrove health index, due to the difference in resolution of the two images. The level of mangrove health is classified into three classes, namely bad, medium and good. At the bad level, the value range based on Sentinel 2A imagery is -0.316 to 0.091, while on Landsat 8OLI imagery it ranges from -0.306 to 0.096. Moderate level on Sentinel 2A imagery ranges from 0.091 to 0.356 while on Landsat 8OLI imagery it ranges from 0.096 to 0.277, and at a good level on Sentinel 2A imagery it ranges from 0.356 to 0.756 while on Landsat 8OLI imagery it ranges from 0.277 to 0.874. The low health level of mangroves is caused by strong ocean currents so that mangrove roots are eroded and some even fall, besides that land conversion also occurs so that the mangrove community decreases.

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