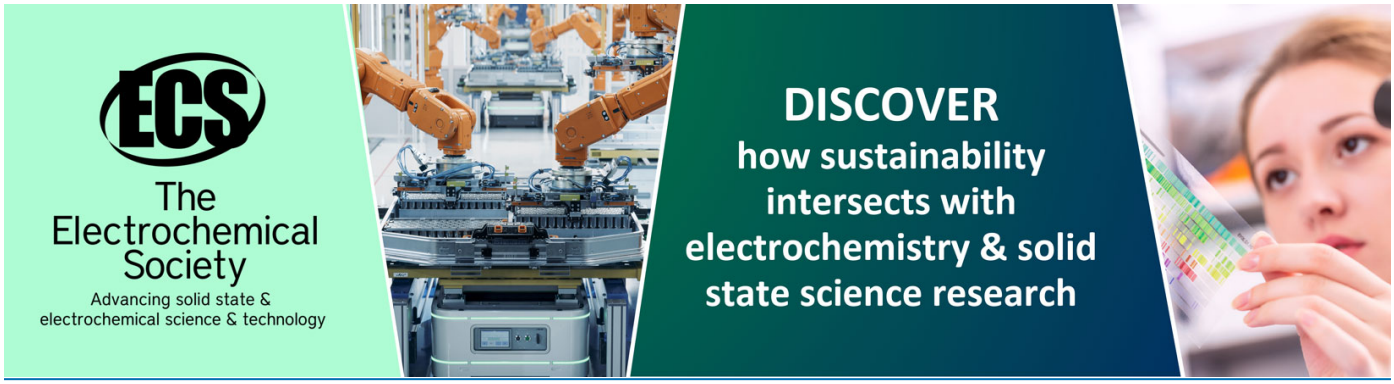
Study on mangrove canopy cover in Lembeh Island, North Sulawesi



IOP Conf. Series: Earth and Environmental Science **441** (2020) 012118 doi:10.1088/1755-1315/441/1/012118

Study on mangrove canopy cover in Lembeh Island, North Sulawesi

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Abstract. The purpose of this study is to monitor the cover of mangrove forests on Lembeh Island, North Sulawesi, to support various protections. The method used to determine mangrove health uses the value of Normalized Different Vegetation Index (NDVI). NDVI value of mangrove forest cover in 2016 and 2019 using Landsat image 8. Mangrove health in Lembeh Island Seen more in 2016 and 2019. Percentage of mangrove forest cover based on Minister of Environment Decree No. 201 of 2004 concerning standard criteria and guidelines for determining mangrove health. The rate obtained based on the dense category increased from 65% in 2016 to 67% in 2019, while mangrove in the group spares decreased from 13% percent in 2016 to 10% in 2019.

1. Introduction

Lembeh Island is one of the islands located in Bitung City, North Sulawesi Province, with an area of 5,040 hectares. Between Lembeh Island and Bitung City, the area is covered with the Lembeh Strait. The Lembeh Strait area has a high level of activities such as the ports building, industrial estates, warehousing, and resorts. The high activity will make the condition of the Lembeh Strait more easily polluted. Also, the activity in coastal can increase the risk of mangrove's growth in Lembeh Island.

Mangroves generally develop in locations that have a tidal influence relationship. Ecosystems in these intertidal areas play an essential role in connecting terrestrial and marine ecosystems [1, 2]. The function of this ecosystem is as a place to lay eggs and a place for enlargement for fish, chip, and others. Mangroves also have a service as a coastline stabilizer from erosion and act as a barrier to protect the coast from waves and strong winds [3, 4]. Also, mangroves play a role in climate change mitigation because of their ability to store carbon in their biomass and sediments [5, 6, 7].

Mangrove ecosystems are objects that can be analyzed using geographic information system technology (GIS) [8, 9, 10]. GIS is often used to monitor mangrove forests with a large area, shorter time, cheaper, and efficient [11]. The location of mangrove ecosystems in tidal areas provides characteristics when comparing other terrestrial vegetation objects [12, 13]. The impact of this recording is closely related to the spectral characteristics of the mangrove ecosystem. This ecosystem can facilitate separate transformations. In the detection of mangrove vegetation, changes in vegetation index are generally used.

This study aims to examine the condition of mangrove vegetation using GIS. The results of this study are expected to provide information about mangrove ecosystems on Lembeh Island based on GIS so

that reference materials can be used in the management of mangrove ecosystems managed on Lembeh Island.

2. Materials and methods

This research was conducted from June to August on Lembeh Island, Bitung City, North Sulawesi. Observations were made at 3 locations, namely the first location at coordinates 1 ° 27'9.23 "N125 ° 14'41.88" E in Pintu Kota urban village, the second location was at coordinates 1 ° 24'26.82 "N125 ° 10'53.17" E in Paudean urban village and the third location is at coordinates 1 ° 24'1.47 "N125 ° 11'14.69" E in Pasir Panjang urban village.

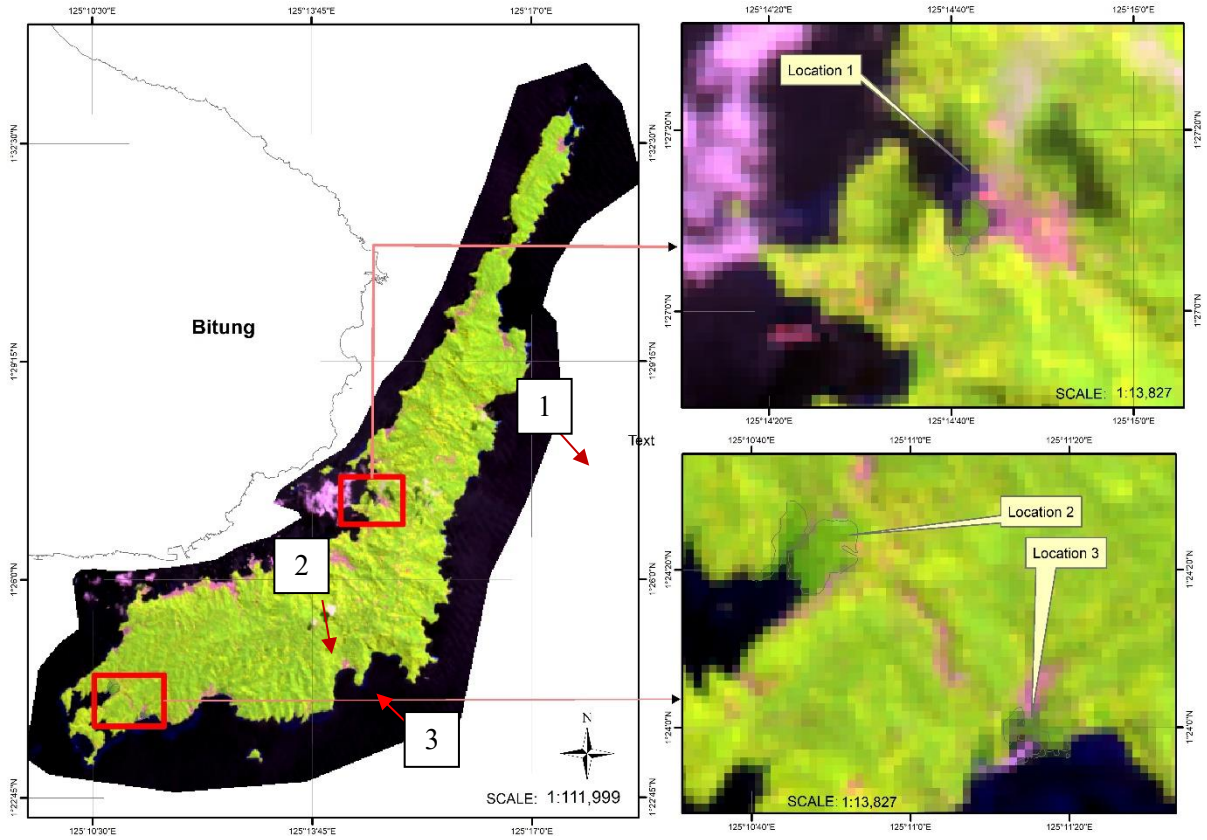

Figure 1. Map of the distribution of NDVI values in 2019; Location 1 (Pintu Kota Urban Village); Location 2 (Paudean Urban Village); Location 3 (Pasir Panjang Urban Village).

2.1. Data collection

The data obtained are primary and secondary. Primary data collection is carried out using a survey at the research location, while secondary data collection is done by taking data from Landsat 8 satellite imagery from its official website.

2.2. Data analysis technique

Determining the density of the canopy is used as the normalized difference vegetation index (NDVI) analysis technique. This analysis technique uses data from Landsat image 8. In determining canopy density with NDVI, a formula is required to compile a band in Landsat image 8. NDVI is the header density; NIR is band five, and Red is band four from Landsat image. The formula is:

$$NDVI = \frac{(\mathrm{NIR} - \mathrm{red})}{(\mathrm{NIR} + \mathrm{red})}$$

2.3. Image processing techniques

The Image processing techniques carried out in several steps before the density of mangroves can be determined at the study site, namely as follows:

2.3.1. Image correction

Before using Landsat 8 images, image correction needs to be done. Corrections made are in the form of radiometric and geometric corrections. Radiometry correction aims to correct pixel values that are not appropriate due to the reflection or emission of the object. Radiometric correction is a step to correct errors in image positioning to match the study location.

2.3.2. Image cutting

Image cropping is done so that images that were previously too broad to be scaled according to the study location to facilitate image data processing.

2.3.3. Composite band image

The composite band of the Landsat 8 image used is band four and band five. Both of these bands are used because they can determine the value of NDVI, as in the formula described earlier. Classification of NDVI results is divided into three classes: spares, moderate, and dense. The NDVI classification is shown in Table 1.

Table 1. NDVI Classifications

NDVI Value	Density Level
$0{,}43 \leq NDVI \geq 1{,}00$	Spares
$0{,}33 \leq NDVI \geq 0{,}42$	Moderate
$-1{,}00 \leq NDVI \geq 0{,}32$	Dense

3. Results and discussion

The area of mangrove vegetation in North Sulawesi Province, according to BPDAS Tondano, released in 2011 reaches 11,546 ha with a coastline of 1,837 km. From the calculation of satellite imagery and field validation, the area of mangrove forests on the island of Lembeh is 10.37 hectares, with a coastline length of 96.9 km. The extent of mangrove forests on the island of Lembeh This means that only about 0.1% of the total area of mangrove forests in North Sulawesi.

Calculate NDVI values using Landsat 8 imagery, get the same range of results in the three study sites with the lowest amount of -0.15 and the highest value of 0.62. The NDVI range is divided into three classes of mangrove cover with sparse, moderate, and dense criteria [14]. The map of the distribution of mangrove NDVI values in Lembeh Island in 2016 can be seen in Figure 2, while in 2019 can be seen in Figure 2.

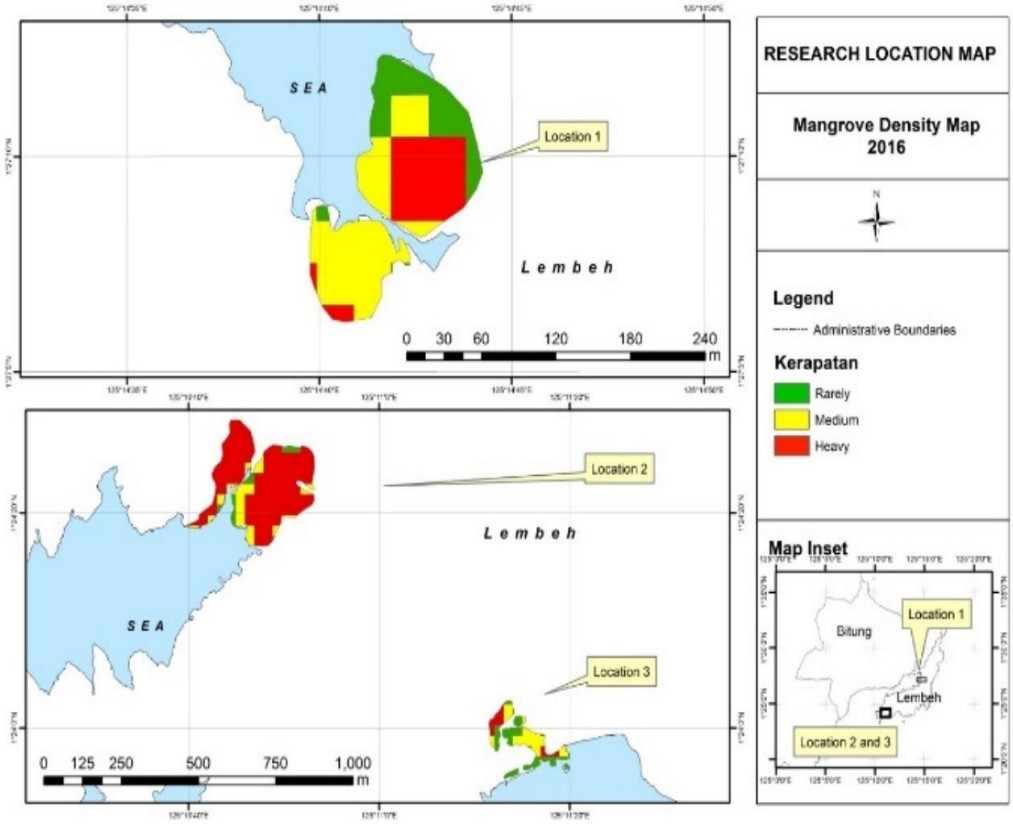

Figure 2. Map of the distribution of NDVI values in 2016.

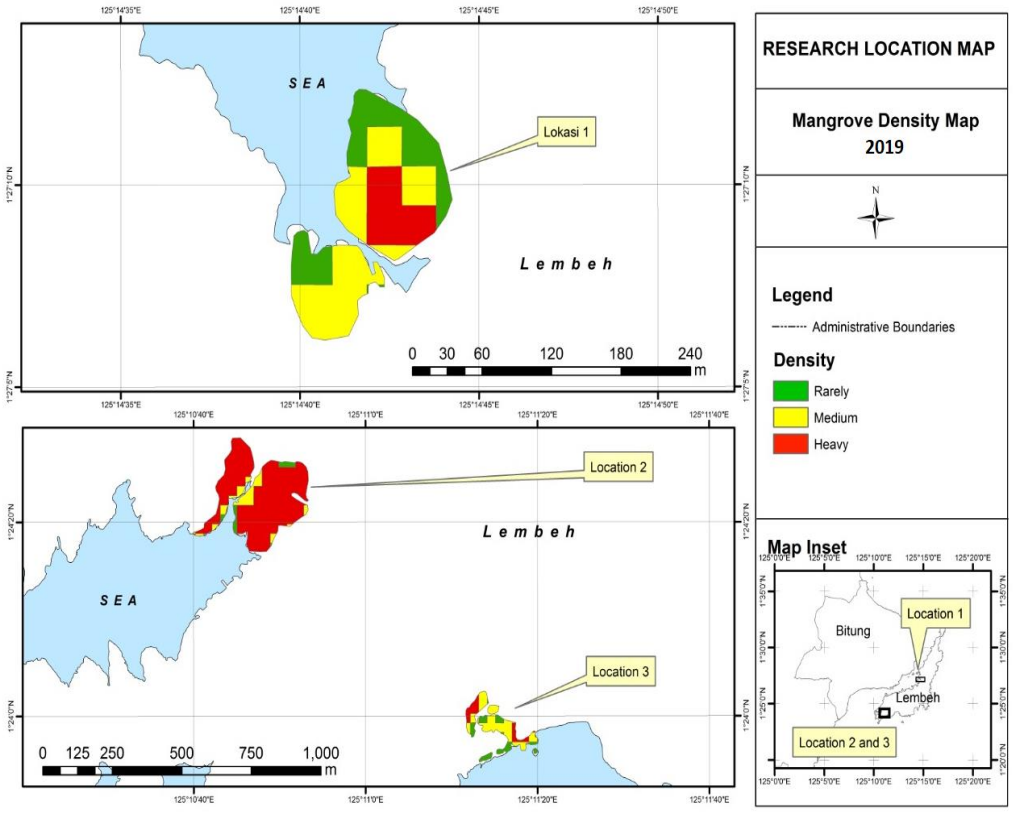

Figure 3. Map of the distribution of NDVI values in 2019.

NDVI classification results obtained mangrove areas in Lembeh island with very dense conditions in 2016 with an area of 65%, up to 67%. Mangrove conditions in the Spares category in 2016 with an area of 13% increase in 2019 to 10%. While mangrove conditions in the moderate category did not change both in 2016 and 2019 with an area of 22%, the percentage of mangrove island cover in 2016 and 2019 can be seen in Figure 4.

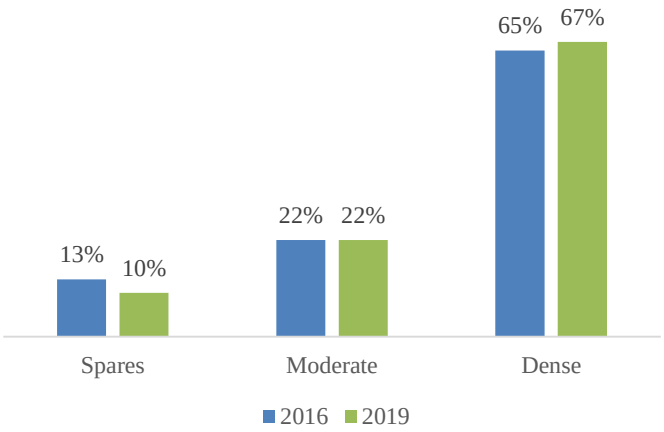

Figure 4. The Percentage of mangrove cover in 2016 and 2019.

Figure 4 shows an increase in the quality of mangrove cover, especially dense cover in 2016 by 65% to 67% in 2019. Mangroves in the moderate cover category did not experience significant changes between 2016 and 2019, which was 22%. Mangrove forests in the category spares decreased from 13% in 2016 to 10% in 2019. From field observations, mangrove forests on Lembeh Island have been preserved by local community groups. This conservation activity has also been supported by non-governmental organizations, academics, and government. The results of observations at three mangrove locations on Lembe Island, namely location 1, location 2, and location 3, are shown in Figure 5.

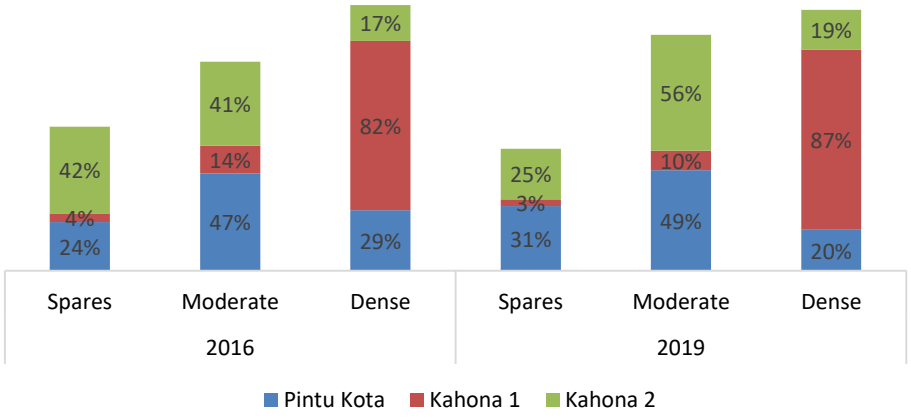

Figure 5. Percentage change of the mangrove island cover per location in observations in 2016 and 2019

From Figure 3, we can compare the percentage of mangrove cover conditions at each location on Lembeh Island. In 2016 the condition of mangrove forests with the dense category on location 2 and location 3 in 2019. While location 1 experienced a decline from 29% in 2016 to 20% in 2019.

When compared to the condition of mangroves in the spares category at three locations, it showed that location 2 and location 3 have decreased in percentage. Percentage decrease explained locations 2 and 3 had improved mangrove cover quality. Whereas at location 1 there was an increase in mangrove cover from 24% in 2016 to 31% in 2019. The increase in this percentage showed that the condition of location 1 (Pintu Kota urban village), decreased mangrove cover.

Validation at the research location was known that the three locations had been carried out conservation activities by community groups. Geographically, the location of mangroves in location 1 (Pintu Kota urban village) was safest from currents and waves because of its position in the Lembeh Strait. However, due to the high pressure and human activity, causing a more significant impact of activities, when compared to location 2 and location 3. Information from the community that is in location 1, in 2016, there was a disposal of palm oil waste near the location 1 mangrove by a palm oil transporting ship that stopped at the port of Bitung. Mangroves are one of the high-speed impacts if the waters are polluted [15].

Location 2 has the highest percentage of mangrove cover with the dense category. Geographically, location 2 is in the bay and is very protected from currents and waves. Mangroves were found in coastal areas that protected from the waves [4]. Waves and currents can change the structure and function of mangrove ecosystems [16]. Also, human activities in this location are relatively few compared to other locations.

4. Conclusion

Based on the results of image observations, it can be concluded that changes in the density of mangrove vegetation from 2016 to 2019 can occur due to an increase in the number of mangrove populations. It also happens because the mangrove canopy is getting dense

5. References

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Acknowledgements

We would like to thank Hernie Onibala, who helped us in the field. We are also grateful for the support of the 2019 Sam Ratulangi University DIPA research funding.