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Mangrove Zonation Study In Carocok Mangrove Forest, West Sumatra: A Case Study Combining Field Data And UAV

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Abstract— Research on mangrove zoning studies using drones in the Carocok mangrove forest area has been carried out from March to June 2021 in the Carocok area, Koto XI Tarusan, Pesisir Selatan Regency. This study aims to analyze the zonation of the mangrove forest in the Carocok area using drones and field surveys. This research was carried out by taking pictures using a drone and making plots in the field at the tree and sapling level. Based on the results of research with field surveys, *Rhizophora apiculata* is a type of tree that dominates in this region were found to have a degree of dominance more than 90%. In this study, two mangrove zones were found, namely the front zone and the back zone. The front zone is always inundated by water while the back zone is flooded. It's only flooded at high tide. The results of this study indicated that the observation of mangrove zonation using drones is quite good for calculating the height of mangroves and describing the profile of mangroves on a wide scale, while the observation of mangrove zoning in field surveys is very good for calculating the number of individuals, stem diameters and classification of mangrove species, it is highly recommended by field surveys. For maximum results, higher studies are needed by combining drones with NDVI cameras.

Keywords— Mangrove, *Zonation, UAV, Field surveys, Carocok, West Sumatra*

I. Introduction

The mangrove ecosystem is a very unique ecosystem because it is a transition from land, salt water and fresh water. Mangrove ecosystem is one type of tropical rain forest that is found along the coastline of tropical waters and can grow in tidal areas (Kusmana et al, 2008; Giri et al, 2011). Physically, mangroves have a function to block waves, wind and control the rising of the boundary between the ground water level and sea level towards the mainland (intrusion) and protect the coastline to avoid erosion or abrasion. Ecologically, mangrove forests function to provide growth dynamics for coastal areas as spawning grounds, nursery grounds and feeding grounds for aquatic biota such as shrimp, fish and crabs. Economically, mangroves are one of the livelihoods of coastal residents and as a place of tourism.

Remote sensing technology that is currently being developed can be used as a new method for mapping and observing the environment and landscapes that can save time, reduce costs, and can be used for wide area coverage and work that is easier when compared to field surveys. One of the remote sensing technology is unmanned aircraft. Several studies that have been carried out using drones for mangrove vegetation include calculation of ground surface biomass, mapping of mangrove land cover dynamics, mapping of mangrove distribution, data acquisition of mangrove vegetation biophysical parameter surveys, monitoring of mangrove conditions in preventing seawater abrasion and so on.

Many biophysical surveys of mangrove vegetation using drones have been carried out, but not much has been done for mangrove zonation. Mangrove zonation is different in each area, different zoning in each area is influenced by various factors and is seen

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based on the characteristics of the waters that support the formation of zoning such as substrate, salinity and tides. The more complex the existing environmental conditions, the more diverse the differences in species composition that can be found (Djamaluddin, 2018).

Analysis using remote sensing methods provides many advantages including being able to reach mapping locations that are difficult to access, but on the other hand it is also necessary to check directly in the field to prove the results of the interpretation that has been carried out. In this study, an unmanned aircraft (drone) was tried as an alternative solution in seeing the zoning pattern in the mangrove survey. The study aims to analyze the zoning of carocok region mangrove forests using drones and field surveys.

II. Research Methodology

This research was conducted in the Carocok Mangrove forest area, Pesisir Selatan, West Sumatera. This study was conducted from March to June 2021 in the Carocok area, Koto XI Tarusan, Pesisir Selatan Regency, West Sumatera (Figure 1).

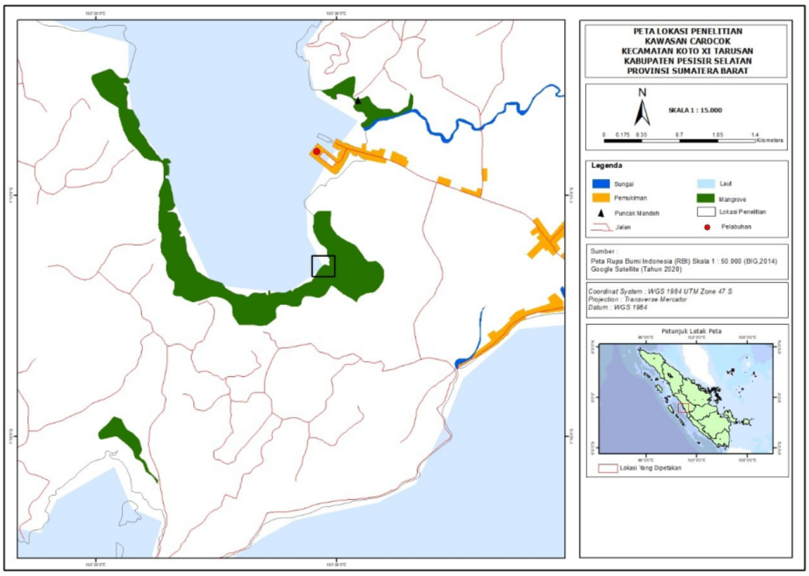


Figure 1. Map of Carocok Mangrove Forest, West Sumatera

This study uses the belt transect method, where the starting point is determined by purposive sampling, namely at locations that have diverse mangrove zonation. Lay the transect perpendicular to the shoreline until true non-mangrove species are found. Plot measuring 10 m x 10 m for tree level observations, Plot 5 m x 5 m for sapling level observations. Furthermore, in each plot the number of mangroves found was counted, tree dbh and sapling were measured using a dbh meter (1.3 m from ground level) and species were recorded. Species of unknown type were collected to be used as specimens.

Aerial photo processing

Processing of aerial photo data obtained using the Pix4D Mapper software trial version 4.5 (Pix4D, 2017). From the drones, DTM, DSM, and Orthomosaic data will be obtained. DTM and DSM data are processed in the RStudio application to obtain CHM (Canopy Height Model). CHM is a raster representation of the tree canopy which will later describe the mangrove profile and to get the estimated tree height value.

Data Analysis

Density

$$\text{Den} = \frac{\text{number of individuals of a species}}{\text{area of the whole plot}}$$

$$\text{RDen} = \frac{\text{Density a species}}{\text{Density all species}} \times 100\%$$

Information:

Den = Density

RDen = Relative Density

Frequency

$$\text{F} = \frac{\text{number of plot found for a species}}{\text{total all plots}}$$

$$\text{FR} = \frac{\text{frequency a species}}{\text{frequency all species}} \times 100\%$$

Information:

F = Frequency

FR = Relative Frequency

Dominance

$$\text{D} = \frac{\text{basal area}}{\text{total plot area}}$$

$$\text{DR} = \frac{\text{value of dominance of a species}}{\text{value of dominance of all species}} \times 100\%$$

Information:

D = Dominance

DR = Relative Dominance

Important Value Index (IVI)

Important Value Index (IVI) = RDen +RF + RDom

Diversity Index

To calculate the Diversity Index, the Shannon-Wiener equation is used with the equation:

$H' = -\Sigma\{(ni/N) \ln (ni/N)\}$

III. RESULT AND DISCUSSION

Field surveys

Based on the research that has been done, the results of taking field surveys is shown in Table 1. In this study, two mangrove zones were found, namely the front zone and the back zone. The front zone is always flooded by water while the back zone is only flooded at high tide. In the front zone no tree species were found, while in the back zone only a few individuals were found.

Rhizhopora apiculata is the dominant species in the study area. It is estimated that the age of mangroves at the time of the study was still at the sapling growth rate, this caused very few mangrove species for the tree level to be found.

Tabel 1. Relative density, relative frequency, relative dominance and index of importance of Tree in Carocok area

No	Spesies	Number of individuals	RDen (%)	RF (%)	RDo (%)	IVI (%)
1	*Rhizophora apiculata*	9	90	75	92	257
2	*Ceriops tagal*	1	10	25	8	43
	Total	10	100%	100%	100%	300%

Tabel 2. Relative density, relative frequency, relative dominance and index of importance of Sapling in Carocok area

No	Spesies	Number of individuals	RDen (%)	RF (%)	RDom (%)	IVI (%)
1	*Rhizophora apiculata*	145	82	67	84	233
2	*Ceriops tagal*	31	18	33	16	67
	Total	176	100%	100%	100%	300%

Rhizophora apiculata was the species found in each plot and had the most individuals with the highest important value index. This is in accordance with the research conducted by Izil (2015) in the Carocok Tarusan area, for the sapling category, *R. apiculata* and *C. tagal* had the highest significant value index.

Arief (2003), stated that the genus *Rhizophora* generally grows in areas with soft substrates and has a wide distribution. Substrate, waves and currents also have a direct effect on the distribution of Rhizophora species, for example, Rhizophora fruit or seedlings are carried by waves and currents easily stick to a suitable substrate and eventually grow. Bengen (2002), added that the typical life cycle of Rhizophora with seeds that can germinate when they are still on the parent plant is very supportive of the wide distribution process of this species in the mangrove ecosystem. The level of dominance of this species can reach 90% of the vegetation that grows in a location.

The diversity of mangrove species in the study area based on the Shannon-Wienner (H') diversity index law is in the low category where H' is only 0.46 at the sapling growth rate because it is only dominated by *Rhizopora apiculata* and *Ceriops tagal* species while for trees it is only 0.32. A community has a low value of species diversity, if the community is composed of a few species and there is a dominant species (Indriyanto, 2006). Although the diversity index at the study site is very low, the number of individuals in the research location is quite high. Based on the results of the field survey, the number of individuals found were 186 individuals, 176 individuals were sampled and 10 individuals were trees. Naturally, the diversity of mangrove forest species is lower when compared to tropical forests. However, mangrove forests have structures and functions that are able to survive in extreme environments in the tidal zone (Duke et al., 1998).

Drone Surveys

Based on the research that has been done, the results of taking drone photos are as shown below:

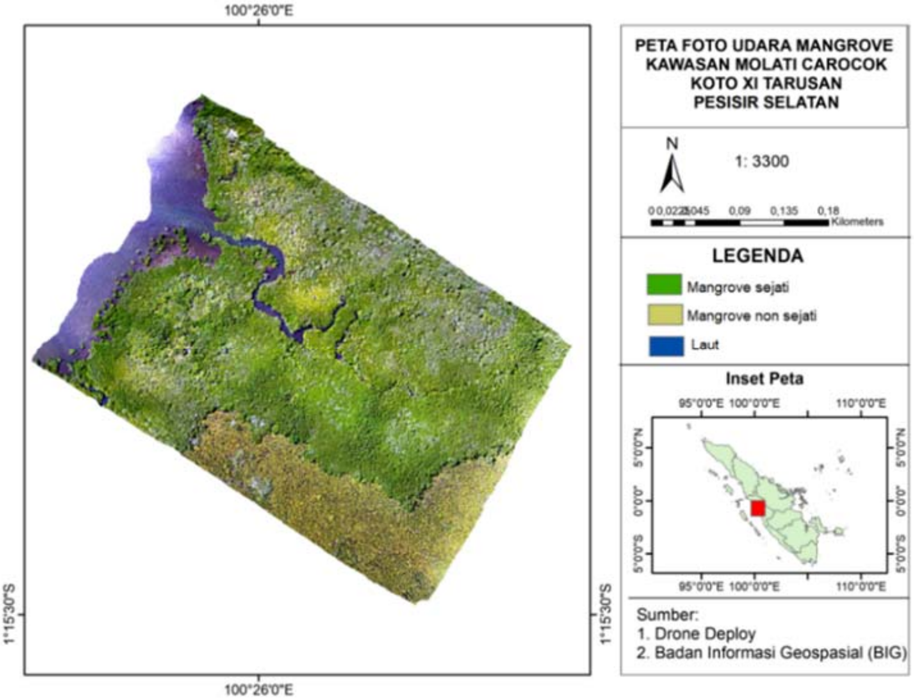
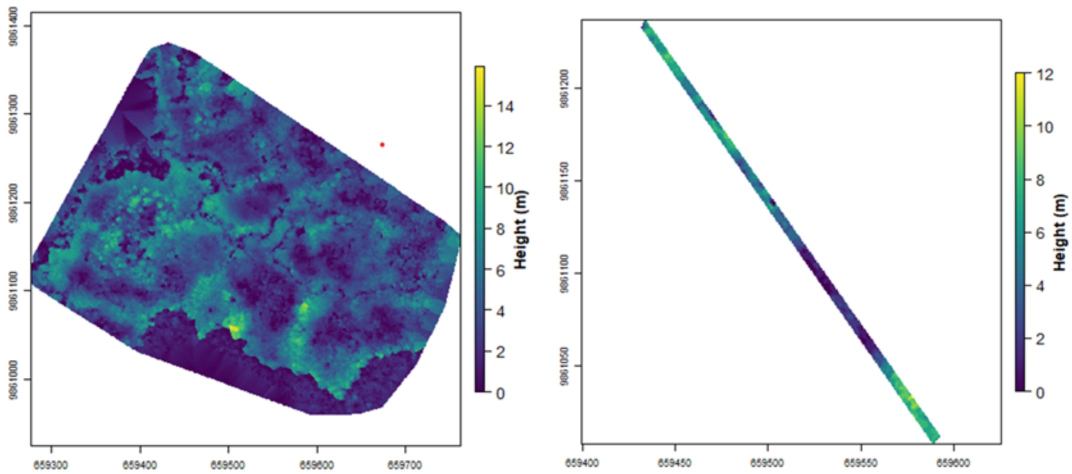


Figure 2. aerial photo map using drone



a.Canopy Height Model survey drone

b. Canopy Height Model field survey

Figure 3. CHM data display form

Tabel 3. Tree canopy height (a) drone coverage area, (b) research plot area.

Parameters	Value
Number of individuals	1923
H max	15,81
H mean	5,75
H min	2
H median	5,43

(a)

Parameters	Value
Number of individuals	69
H max	10,89
H mean	5,9
H min	2
H median	6

(b)

According to Lizuka et al., (2018) the difference in the number of individuals on drones with manual calculations can be caused because drones have limitations in detecting lower trees or non-canopy trees and trees covered by a higher canopy are not counted by drones. This is also supported by Wijaya (2018) that the gap between the canopy which is used as a sign of different individual trees is not visible, so the estimation of the number of trees using drone surveys tends to be overestimated because it is not necessarily one tree that has one canopy.

In the field survey, tree height measurements were not carried out because it was not possible to measure height in very dense vegetation. However, based on the research conducted by Harapan et al., (2021), the results of measuring the height of the field survey trees with drone measurements are not too different so that in this study, height measurements no longer need to be carried out by field surveys.

Based on the latest research, the identification of mangrove species using drones can only be done up to the genus level. *Rhizophora* sp is characterized by a green color with a relatively dark hue, this is influenced by the small or thick leaf base area (Wijaya, 2018). In research that has been carried out with field surveys, there are two species found, namely *Rhizophora apiculata* and Ceriops tagal. However, the drone image shows the difference between the two species. The current quality of drone cameras cannot identify mangrove species to the species level. To identify species using drones, higher study is needed, namely by combining drones with NDVI (Normalized Difference Vegetation Index) cameras.

IV. Conclusion

Observation of mangrove zoning using drones is quite good for calculating the height of mangroves and describing the profile of mangroves on a wide scale, while observations of mangrove zonation in field surveys are very good for calculating the number of individuals, trunk diameters and classification of mangrove species, it is highly recommended by field surveys.

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