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MAPPING OF MANGROVE DISTRIBUTION IN PERCUT SEI TUAN SUB-DISTRICT DELI SERDANG REGENCY

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ABSTRACT: Mangroves are coastal ecosystems that are rich in diversity of flora and fauna. Mangroves have an important role in coastal areas in terms of ecology, biology, and economy. However, mangrove management has not balanced these three aspects and tends to be exploited for economic purposes. The purpose of this study was to map the distribution of mangroves, identify changes and zoning of mangroves in the Percut Sei Tuan subdistrict. The method used in this research is a survey method. Collecting data from Landsat Multitemporal images in 2017 and 2021 as well as field data through observation. Data analysis was performed using Envi and Arc GIS software. The results showed that the distribution of mangroves was found along the coast of Percut Sei Tuan District. The decline in mangrove ecosystems occurred in the period 2017 and 2021. Mangrove zoning in this area is in accordance with other mangrove zoning in Indonesia, which consists of open mangroves, transitional mangroves, brackish mangroves, and mangroves close to the mainland. The diversity of mangrove species in the form of true mangroves and associated mangroves was also found on the coast of Percut Sei Tuan District.

Keywords: Mapping, Zonation, Distribution, Mangrove

1. INTRODUCTION

Indonesia is an archipelagic country and ranks fourth as the country with the longest coastline in the world. The length of the coastline of Indonesia is around 95,181 km. The coastal zone and ocean zone are rich in biodiversity. This biodiversity is a source of strategic economy. The coast is a unique interaction/interface area between land and sea ecosystems, and contains the biological production and the role of the environment. The coastal area is a transitional ecosystem that is influenced by land and sea, which includes several ecosystems, one of which is the mangrove forest ecosystem. Mangrove areas are one of the most productive ecosystems on the earth [1], supplying a vast range of economic and ecological output and services, and contributing rich and diverse coastal and marine ecosystem [2] [3] [4].

Indonesia has the largest mangrove forest in the world, which is 3,489,140.68 Ha in 2015 ([5]. An area of 1,671,140.75 Ha is in good condition, the remaining 1,817,999.93 Ha is in damaged condition. The condition of mangrove forests is decreasing both in terms of quality and quantity. This is due to excessive and irresponsible use. It should be done for the preservation of mangroves through balanced management, for example, by replanting mangroves. Mangrove forest is the main ecosystem that supports important life in coastal and marine areas. Mangrove forests have a biological function as a provider of nutrients for aquatic biota, as a place for spawning and care (nursery ground) various kinds of biota [6]. The ecological function of mangrove forests is as a barrier to coastal abrasion, hurricane winds and tsunamis, waste absorbers, CO2 absorbers, and O2 producers which are relatively high compared to other forest types [7].

North Sumatra Province also has a coast overgrown with mangroves, including the East Coast Region. Based on data from the Sumatran Elephant Foundation [8], in 1989, the area of mangroves in North Sumatra was about 96,000 hectares in 2002 reduced to 63,000 hectares, in 2009 to 26,000 Ha. The shrinkage of the mangrove forest area is a concern for various groups. Prevention of increasing mangrove damage continues to be done by replanting mangroves in the area coast. This mangrove planting involves the government, NGOs, universities, and the surrounding community. This effort has started to succeed with increasing the area mangroves to 36,000 ha in 2014. In 2020, the mangrove forests in North Sumatra Province have reached 65,000 hectares [9].

Deli Serdang Regency is one of the districts that has a coastal area overgrown with mangroves. The mangrove forest area of Deli Serdang Regency is 14,389 Ha [9]. One of the districts that has a fairly extensive mangrove forest, namely, Percut Sei Tuan District. Percut mangrove forest is a registered area that is quite severe, namely, 2,872 ha out of a total area of 3,600 ha or 79.8% so that the remaining mangrove forest is quite good only 728 ha or 20.2% (Deli Serdang in figures, 2014). Mangrove damage continues to occur due to community activities and conversion of land use. Mangrove ecosystems have been decreased by socio-economic development [10]. This will disrupt the balance of the ecosystem because of the role of mangroves not only on the economic side but other important roles in the ecological and biology [11].

Technological developments can facilitate mangrove monitoring, for example, by utilizing remote sensing and Geographic Information Systems (GIS). Remote-sensing has been very useful to detect, identify, analyze, and investigate mangrove conditions, distribution and changes [12] [13]. The advances in remote sensing technology could provide new data resources for mapping mangrove forests [14] [15]. With this technology, the condition of mangroves can be analyzed in a wider area and with high accuracy. In addition, remote sensing can facilitate the collection of field data that is difficult to reach by direct observation [16] [17]. Remote sensing data can be in the form of aerial photographs and imagery. This data can be processed using GIS analysis for various purposes, including mapping related to mangrove zoning and distribution, identifying the characteristics and types of mangroves, and even the level of damage that occurs [18] [19] [20].

This study focused on the objectives of mangrove zoning and mapping of mangrove distribution in Percut Sei Tuan District, Deli Serdang Regency. Thus, the potential of the mangrove ecosystem in this area can be explored more deeply for conservation and rehabilitation, regional development planning such as ecotourism and other uses in improving the economy of the surrounding community.

2. RESEARCH METHODS

The data in this study are primary data and secondary data. Primary data collected by image interpretation, survey, and field measurement. While the secondary data obtained from the documents of the Ministry of Environment and the Elephant Foundation Sumatra/Yagasu related to mangroves in the coastal area of Percut Sei Tuan Sub-district Deli Serdang Regency. Firstly, data collection is done by downloading Landsat images, multitemporal data from earth explorer, and data related to administrative boundaries, Percut Sei Tuan district, Deli Serdang Regency. Ground check location and the observation of mangrove vegetation was determined purposively on the administrative coast of Percut Sei Tuan District, Deli Serdang Regency. Observation was carried out to prove the actual conditions and collected other data that were not obtained through satellite imagery.

Tools and research materials include:
1. Landsat 8 OLI Citra image
2. RBI Map Scale 1:25,000
3. ArcGIS 10.8 . software
4. ENVI 5.1 . software
5. Global Positioning System (GPS)
6. Camera

Research Stages

1. Preparation Stage
   Identify the materials and tools needed in the research. This stage includes a review of the relevant literature and downloading the Landsat TM 8 region image of Percut Sei Tuan District.
2. Image Correction Stage
   Image corrections carried out include radiometric corrections and geometric corrections. A Radiometric correction was performed to eliminate the effect of the atmosphere due to clouds during recording. While geometric correction is done on the image so that the location matches the real position (reality) in the image Earth surface. Radiometric and atmospheric corrections were conducted to reduce errors and to enhance accuracy using ArcGIS [21].
3. Data Classification Stage

At this stage, it is carried out using the ENVI software in classifying the satellite imagery , namely, Landsat with RGB 564 composition, where the three bands have a spectrum visible and near-infrared and have wavelengths that are according to the needs of this study. Further analysis was carried out with GIS software. The output of this process is a map, namely, the distribution of mangroves in Percut Sei Tuan Sub-district. Overall, the data were analyzed at the stages of reduction, categorization, data presentation, and drawing conclusions. The stages of this research can be observed in Figure 1.

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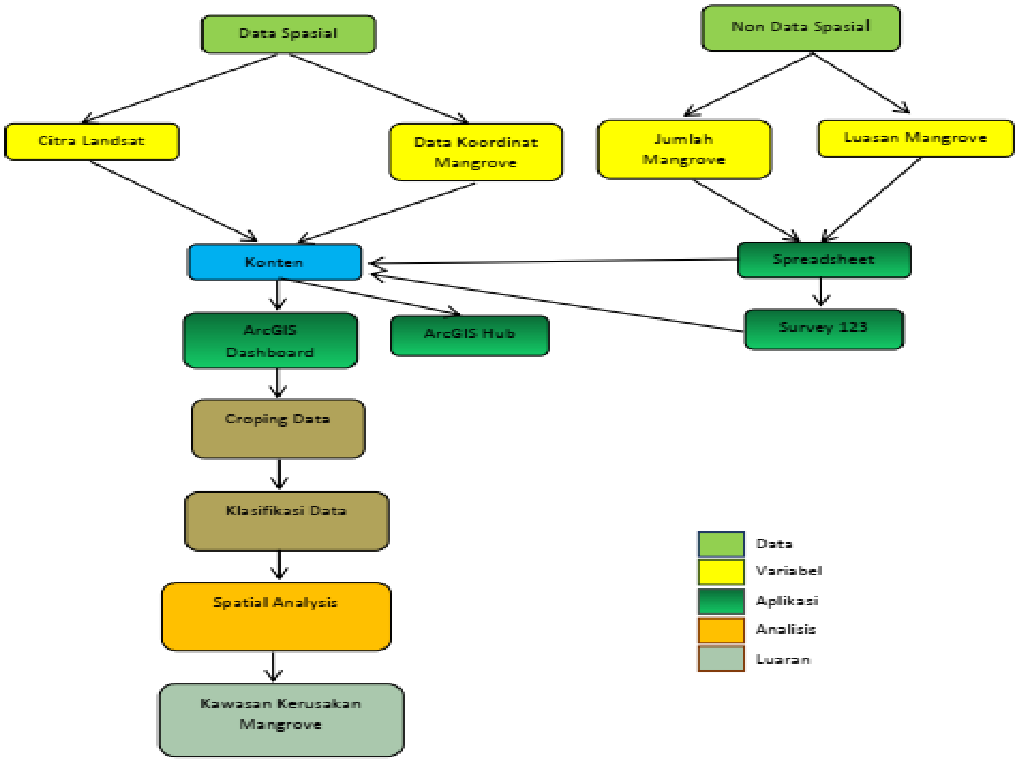

Figure 1. Stages of The Research

3. RESULT AND DISCUSSION

3.1 Mapping of Mangrove Distribution in Percut Sei Tuan District

Mapping of mangroves in Percut Sei Tuan District was carried out using remote sensing, specifically multitemporal Landsat images in 2017 and 2021. A series of processes was carried out to identify mangrove areas and their changes over a set period of time. The data obtained from the interpretation of this satellite image is quite effective. Remote sensing is a big data source simplifying field surveys by circumventing the baneful method and decreasing the time and cost for field surveys [22] [23].

Based on image analysis in both years, the mangrove area and its changes were obtained. Mangrove area decreased from 1121 ha to 1079 ha or decreased by around 42 ha over a period of 4 years. This change in the mangrove area is due to the activities of the surrounding population, especially aquaculture. Aquaculture is the main source of livelihood for the community in this village. Types of fish that are cultivated include tilapia, mujair, catfish, and other types of fish. , without destroying mangroves, fisheries can still be managed on mangrove land wisely. Mangroves are a nursery grounds for various type of fishes, shrimps, and crabs [24]. Mangrove area decreased because of pressure from human activities, such as over-harvesting, aquaculture and coastal development [6]. Regulations, rules and policies, the management and protection of mangrove resources are still weak and lacking linkage among sectors [4].

The decline in mangrove area is also due to the change of mangrove land into residential land and infrastructure development. Not only that, mangroves are also a commodity that is used by the community. Mangrove trunks are used as building materials, making charcoal and firewood. While the fruit is used as medicine and food. This is also in line with the research findings of [25] that the use of mangroves as wood for housing, fruit parts for food, and herbal medicine is also found in Sei Nagalawan Village, Perbaungan District, Serdang Bedagai Regency.

A map of the distribution of mangroves in Percut Sei Tuan District can be seen in Figure 2 and Figure 3. Based on Figure 2 and Figure 3, it can be seen that visually there is new land overgrown with mangroves, especially in the estuary area. This means that this land is overgrown with young mangroves or land that has been replanted by community groups who care for mangroves. Meanwhile, the damage to mangroves on private land is permanent and has shifted to other uses such as ponds. Although mangrove forests were growing up, overall, mangrove area was reduced because large exsiccate in other areas [26]. Society awareness and involvement

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must be increased to ensure the sustainability of mangroves. Allocation of mangrove forests to local communities should be considered to serve as incentives, to supervise and to preserve mangrove ecosystems at several levels is one of the best approaches [27] [28]. Factors affecting the effectiveness of community-based mangrove management, including leadership, change of occupational experience and capacity to control of local residences, NGO support, and enhancing government involvement and recognition, should be taken seriously in the management process [29].

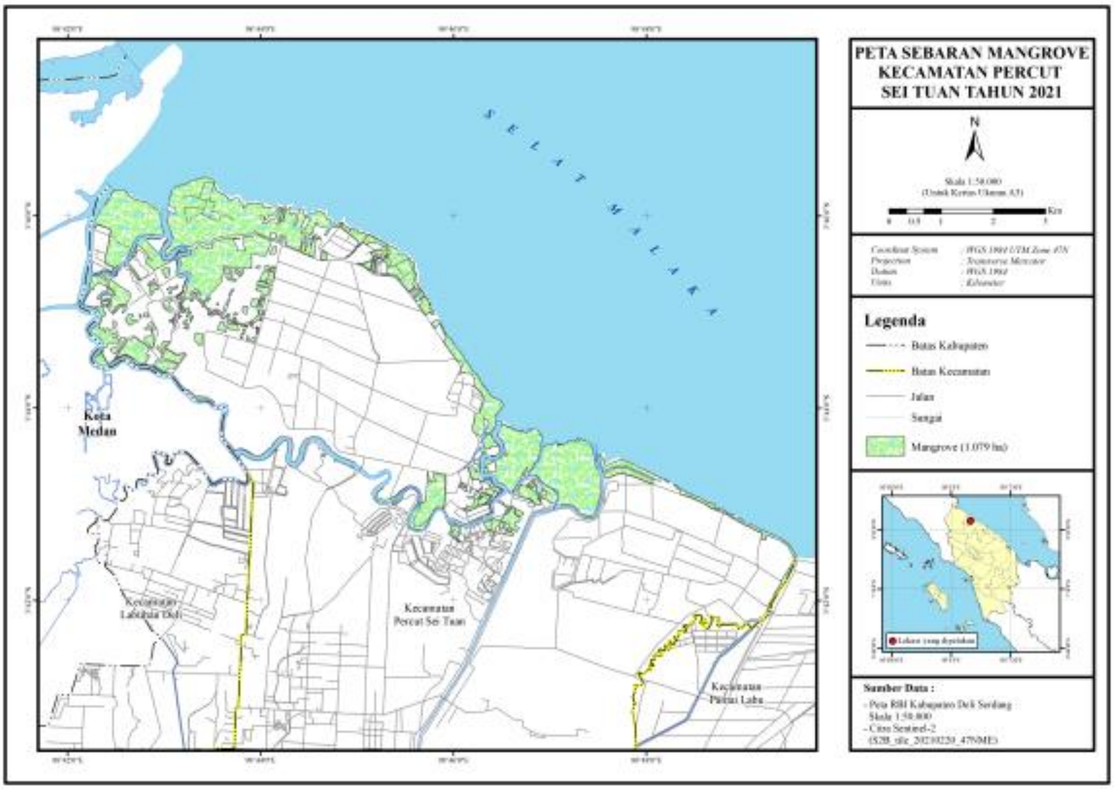

Figure 2. Distribution of Mangrove in Percut Sei Tuan District in 2021

Figure 3. Distribution of Mangrove in Percut Sei Tuan District in 2017

3.2 Zoning of Mangrove in Percut Sei Tuan District

Mangrove zoning in Percut Sei Tuan District is in accordance with the zoning commonly found in other mangrove ecosystems in Indonesia. In areas very close to the sea, Avicennia sp. Characteristics of this habitat are always hit by waves, high salinity and sandy substrate, and muddy soil. This zoning is also known as the open mangrove zone/pioneer zone. Avicennia sp is usually associated with Sonneratia Sp, which has very strong roots so it can survive the waves. The next zone in the area behind the Avicennia sp zone is the Rhizopora zone. The characteristics of this zone are soft muddy sediments with lower salinity. Plant roots remain submerged in this zone. Rhizopora sp is associated with Bruguiera sp and Heritiera sp. The middle zone is also known as the Bruguiera zone. The muddy substrate is rather hard, the roots are only submerged at high tide twice a month. The brackish zone is usually found in Nypah. This zone is a boundary between land and sea which is usually found in the river channel / along the estuary. In this zone the salinity is very low with hard soil [25].

The types of vegetation found in the ecosystem area. Mangrove forests in Percut Sei Tuan District consist of two categories, namely, true mangroves and associated mangroves. True mangroves are species of mangroves that grow in tidal areas with muddy substrate, salty with high salinity. This species is found from the seafront reaching the mainland. Associated mangroves are plant species that are able to adapt to salinity or known as companion mangroves. Diversity of mangroves found in Percut Sei Tuan District includes the following:

1. Avicennia Alba

This true mangrove is a pioneer or close to the sea. Height can reach 20 meters with dark gray or black. The leaves and fruit are elliptical with tapered ends. Avicennia Alba can be seen in Fig. 4 below.

2. Avicennia Marina

This mangrove species is also a pioneer that can live on substrates with high salinity. The height can reach 30 meters. Colored leaves shiny green on top and pale on the bottom, fruit green color.

3. Avicennia officinalis

This species is an Avicenniaceae family that grows along the tidal-affected borders of rivers and swamps. The height reaches 12 meters with a hanging root of the breath. Stem reddish brown with elliptical leaves. It has brownish yellow fruit and is flattened.

Fig. 4 Avicennia Alba, Avicennia Marina and Avicennia officinalis

4. Acanthus Ebracteatus

This family Acanthaceae, grows on the back mangroves with a size of up to 2 meters. Leaf edges serrated or slightly flat, and gradually narrowed to the base. Colored flowers crown light blue to mauve, sometimes slightly white. Fruits like star fruit, when young, shiny green, 2.5-3 cm long.

5. Bruguiera

This mangrove belongs to the Rhizoporaceace family, which consists of white hornbill (Bruguiera cylindrica) and red hornbill (Bruguiera gymnorrhiza). The white horn grows behind the Avicennia zone, the border river with clay substrate. The red tanjang is found in a slightly dry with low salinity.

6. *Ceriops Tagal*

These mangroves grow on the edge of mangrove forests with clay substrates and mud. Found in flooded tidal zones. Leaf shaped shiny ellipses and rounded edges; small slender and nodule.

7. Nypa Fruticans

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This mangrove from the palmae family, similar to palms with a height reaching 10 meters. Grows on the border of a river where there is a water supply tasteless with a smooth substrate.

8. Rhizopora Stylose

Mangrove species from the Rhizopraceae family that grow in high tide areas receded into mud, sand, and rock substrate. Elliptical shaped leaves tapered at the ends. On the underside of the leaves there are regular black spots.

Fig. 5 Acanthus Ebracteatus, Bruguiera, *Ceriops Tagal,* Nypa Fruticans, and Rhizopora Stylose

Associated mangrove species found on the coast of Percut Sei Tuan District:

a. Hibiscus Tiliaceus

Mangrove associations of the Malvaceae family was found around the coast and ponds. Heart-like leaves and yellow bell-shaped flowers and orange.

b. Melastoma Malabathricum

Associated mangroves from the family Melastomataceae in the form of shrubs with leaves rather wide, purple and pink flowers and capsule-shaped fruit.

c. Morinda Citrifolia

This association between mangrove of the Rubiaceae family can also be cultivated for herbal plants.

d. Pluchea Indica

The Asteraceae family includes shrubs that grow wild in the back of the forest mangroves. The bright green leaves are jagged, have a strong aroma, and are often processed into vegetables.

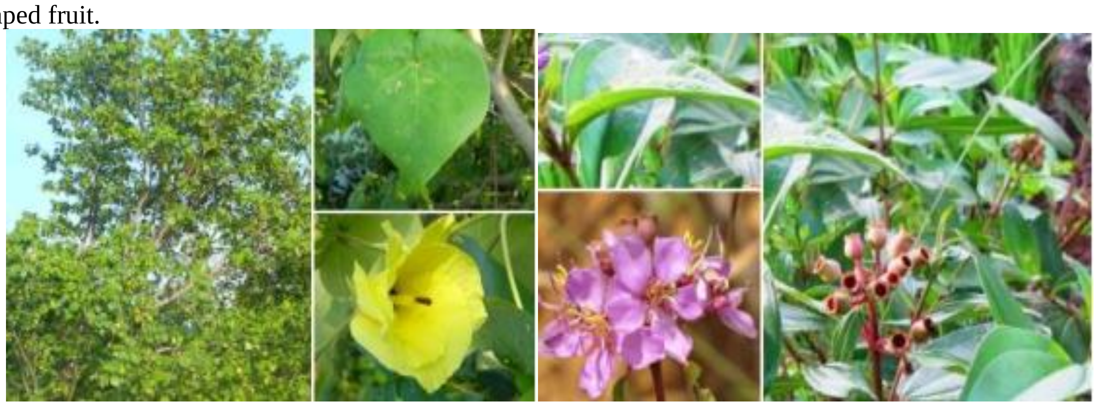

Fig. 6 Hibiscus Tiliaceus, Melastoma Malabathricum, Morinda Citrifolia and Pluchea Indica

4. CONCLUSION

This research employed multi-temporal Landsat images in 2017 and 2021 in Percut Sei Tuan District. Supervised classification method was conducted to investigate the distribution of mangroves and changes in 2017 and 2021 periods. The results indicated that during the two periods, the mangrove area was decreased in Percut Sei Tuan District. However, mangrove restoration and replanting initiated by local residences and local authorities has been successful to increase the mangrove area in several places. Mangrove zoning in Percut Sei Tuan District is in accordance with the zoning commonly found in other mangrove ecosystems which has abundant diversity. The main mangroves species in Percut Sei Tuan District were *Avicennia Alba, Avicennia Marina and Avicennia officinalis, Acanthus Ebracteatus, Bruguiera, Ceriops Tagal, Nypa Fruticans, and Rhizopora Stylose.* While the mangrove association in this area were *Hibiscus Tiliaceus, Melastoma Malabathricum, Morinda Citrifolia and Pluchea Indica.*

5. ACKNOWLEDGEMENTS

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