Identification of Physical Characteristics and The Change of Mangrove Region in Coastal Southern Part of Padang City West Sumatra-Indonesia

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Abstract

The research about the identification of mangrove physical condition and the change of mangrove area has aims are knowing of mangrove physical condition and the change of mangrove area in the coastal region southern part of Padang city. The method used in this research is the field survey and multi-temporal satellite imagery analysis in 2001 and 2018 year. Based on the field survey at the date of August 18, 2017 generally the mangrove that found in research location i.e Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, and Nypa. The spatial distribution of the mangrove ecosystem is dependent on the ecological conditions of the area as reflected by the types of mangrove vegetation that grows and develops in the research location. A decrease in mangrove area that occurred between of 2001 to the 2017 years i.e in the coastal region of Bungus bay i.e 5.54 ha, where the decrease in mangrove area occurred because some mangrove plants were cut down and made the settlement land, while in the region of Sungai Pisang bay happen to increase in mangrove area i.e 36.12 ha, where the increase in mangrove area occurred because of the region obstructed by big waves of the sea (protected small the islands).

Keywords: Mangrove, Satellite Imagery, Coastal Southern, Padang City

Introduction

Mangrove is an ecosystem found in wet areas that are still affected by tidal sea water, ordinary mangrove vegetation can grow well in areas that still have a certain salinity. Commonly grown mangrove vegetation have their own pattern and zoning following the distribution of mud, sand, peat, waves, and tidal effects of seawater in an area so that mangrove vegetation grows and developers have their own propagation pattern that has its own characteristics that reflect physical characteristics of a region (Rochmady, 2015; Nicolás *et al*, 2017; Triyatno *el al*, 2018; Hermon *et al*, 2018; Hermon, 2019). Noor *et al* (2012); Gruetersa *et al* (2014); Hermon *et al* (2017); Proisy *et al* (2017) adds the mangrove vegetation has good adaptability to extreme environmental conditions such as high salinity, constantly inundated areas, strong tides, waves, and strong wind from of the sea. With such extreme environmental conditions, mangrove vegetation adapt to develop mechanisms that can remove salt from the leaf, and others develop breathing roots to obtain oxygen.

Mangrove ecosystem has a very important role for life in the coastal area. This mangrove plants a role in protecting coastal areas and maintaining the ecosystem of flora and fauna in the surrounding area, mangrove also serves to preserve biodiversity Castillo *et al*, 2017; Febriandi, 2017. In addition, mangrove also has economic potential that can be obtained from three main sources of forest products, fisheries, and ecotourism (Putra *et al*, 2018). Mangrove forests are often referred to as mangrove forests due to mangrove

vegetation or the types of Rhizophoraceae tribes that often dominate in the coastal region. The types of Rhizophoraceae tribes include Rhizopora mucronata, Rhizopora apiculata, and Rhizopora stylosa. Several other types are found i.e Bruguiera gymnorrhiza (Putra *et al*, 2015). Generally, the region of mangroves can be found throughout the Indonesian archipelago. The largest mangrove region is located in Papua island around 1,350,600 ha (38%), Kalimantan island 978,200 ha (28%), and Sumatera island 673,300 ha (19%) (Dwi, 2005; Noor *et al*, 2012; Triyatno *et al*, 2016).

The mangrove vegetation in Indonesia consists of 47 species of trees, 5 species of bushes, 9 species of herbs and grasses, 29 species of epiphytes, 2 species of parasites, and several species of algae and bryophyta (Noor *et al*, 2012; Putra *et al*, 2015). Dwi (2005); Kolinug *et al* (2014); Triyatno (2017) explains the mangrove forest formation consists of four main genera, i.e Avicennia, Sonneratia, Rhizophora, and Bruguiera. To identify mangrove vegetation can be done using satellite imagery of Landsat primarily to see changes of mangrove vegetation, mangrove vegetation changes can be analyzed using Normal Differential Vegetation Index (NDVI) on satellite imagery (Putra *et al*, 2015; Alatorre *et al*, 2016; Wilfrid *et al*, 2016; Jinyan *et al*, 2017). Where city that has mangrove vegetation in the administrative area of West Sumatera province in the Padang City.

The existence of mangrove vegetation in the coastal region of Padang City is mostly found in the coastal southern part, this is caused by the characteristics of different areas between the north and south of Padang City. Generally, the northern part of Padang City has the material of the region in the form of sand that mostly comes from the upper land, while in the southern part of Padang City has the material of the region composed of sand, coral reefs and mud. Along with the increasing number of total population and the need for land increased cause it to occur land conversion, such as agricultural land into settlements and mangrove forests into settlements, therefore need to be analyzed changes in mangrove area and mangrove plant physical characteristics. This research aims to analyze the mangrove types (physical characteristics) and analyze the changes in mangrove area in the southern part of Padang City.

Method

The method used to analyze the change of mangrove area in the coastal region of southern part Padang City i.e in 2 bay regions (Bungus and Sungai Pisang) were done by analyzing Landsat TM imagery 2001 and Landsat OLI 2017. While to analyze the characteristic of the region, determined based on mangrove types analyzed based on reflection value of satellite imagery Landsat Darmadi *et al* (2016); Alatorre *et al* (2016); Wilfrid *et al* (2016); Nicolás *et al* (2017), and to identify the condition of mangrove vegetation carried out with the combination method between the path method and the line method (square plot) that placed perpendicular to the coastline to land with a width of 10 m and length depending on field conditions (the distance of the mangrove vegetation on the beach with the mangrove border with land behind the mangrove vegetation) (Hermon, 2016). The analytical techniques used to distinguish mangrove vegetation from other land uses (forests vegetation) i.e with Normal Differential Vegetation Index (NDVI) methods. This NDVI analysis technique is well used to analyze the characteristics of forest structures (Alatorre *et al*, 2016; Wilfrid *et al* (2016); Jinyan *et al*, 2017). NDVI values in satellite imagery can be formulated as follows:

$$NDVI = \frac{IR - R}{IR + R}$$

NDVI = normal differential vegetation Indexs
IR   = infrared spectral band
R   = red spectral band.

Result and Discussion

Type of Mangrove

The mangrove types found in the research location are Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, and Nypa. Distribution of mangrove type shows differences in physical

characteristics or ecological conditions the place of mangroves grows and develop. For more details can be seen in Table 1 follows:

Table 1. Types of Mangroves and Physical Characteristics

Mangrove Types	Physical characteristics		Physical Characteristics (Ecological Condition)
	Leaf appearance	Flower	
Rhizophora apiculata	Dark green skin with light green on the middle and redness at the bottom. The leaf strap is 17-35 mm long and the colour is reddish. Unit & Layout: simple & opposite. Shape: the ellipse narrows. Edge: tapering. Size: 7-19 x 3.5-8 cm.	Flower: Bisexual, yellowish flower head located on the handle <14 mm. Crown leaves: yellow-white, no hair, length of 9 -11 mm. Fruit: Roughly rounded fruit elongated to pear-like, brown, length of 2 - 3.5 cm.	Grows on muddy soil, smooth, deep and inundated during normal tide. Dislikes harder substrates mixed with sand. The level of dominance can reach 90% of the vegetation growing in a location. Loves tidal waters that have a strong permanent influence of freshwater input.
Rhizophora mucronata	Leaf is skinned. The leaf handle is green, 2.5 - 5.5 cm long. Pinak leaf is located at the base of the leaf handles measuring 5.5 - 8.5 cm. Unit & Layout: simple & opposite. Shape: the ellipse extends until the round is elongated. Edge: tapering. Size: 11-23 x 5-13 cm.	The flower-head handle is like a cigarette, bisexual, each attached on individual handles that are length of 2.5 - 5 cm. Fruit: Oval/long to egg-shaped fruit measuring 5-7 cm, colored green, often rough at the base, single seed.	It grows in the same area as R.apiculata but is more tolerant of harder substrates and sand. Generally grown in clusters, near or at the tidal creek and at the mouth of the river, rarely grows in areas far from tidal water. Optimal growth occurs in deep flooded areas, as well as on soils rich in humus.
Sonneratia alba	Leaf are skinned, have a gland that does not develop at the base of the leaf handles. The long leaf handle is 6-15 mm. Unit & Layout: simple & opposite. Shape: ovoid reversed. Edge: round. Size: 5-12,5 x 3-9 cm.	Bisexual; blunt flower handle 1cm long. Petals: 6-8; skinned, outer green, in redness. Like the bell, the length is 2-2.5 cm. Fruit: Like the ball, the ends are stemmed and the bottom is wrapped in flower petals. Fruit contains many seeds (150-200 seeds) size, fruit, diameter 3.5-4.5 cm	Pioneer type, intolerant of fresh water in long periods. Likes the soil mixed with mud and sand, sometimes on rocks and corals. Often found in coastal locations that are sheltered from the wave, also in the estuary and around offshore islands. On the shore lined coastline they are vegetatively spread. Fruit floats because of a network containing water in the seeds. The root of the breath is not present in trees growing on hard substrates.
Nypa	Like the arrangement of coconut leaf. Length of bunch/leaf handlebar 4 - 9 m. There are 100-120 leaves on each leaf bunch, glossy green on the upper surface and powdered at the bottom. Shape: lanceolate. Edge: tapering. Size: 60-130 x 5-8 cm.	Bunches of bisexual flowers grow from near the top of the stem on the handle as long as 1-2 m. The female flowers form a circular head 25-30 cm in diameter. Bright yellow male flowers, located under the head of the flower. Fruit is round, brown, stiff and fibrous. Size head fruit diameter up to 45 cm. Seed diameter of 4-5 cm.	It grows on a smooth substrate, at the top edge of the waterway. Requires high annual freshwater input. It is rare outside the coastal zone. Usually grows on a grouped stand. It has a strong, dense root system that is better adapted to changes in water input, compared to most other mangrove species. Sticky pollen and pollination seem to be aided by the Drosophila fly.

Source: Noor *et al*, (2012) and the results of data analysis (2017).

Based on Table 1 above can be seen the distribution of mangrove plants depending on the physical condition or ecological conditions of an area. Generally, mangroves Rhizophora apiculata type can grow and develop well in areas that have a subtle material in the form of mud and flooded during normal tide. Mangrove Rhizophora apiculata type are found in coves, especially in Pandan cove, Kaluang cove, Kabuang cove in the coastal region of Bungus bay, and Sungai Pisang cove and Siboko cove in the coastal region of Sungai Pisang bay. Based on the research Putra *et al*, (2015); Putra (2017); Hermon *et al* (2018) in the coastal region of Bungus bay and Sungai Pisang bay, this plant is generally grown on the front of the coves area because this area has the material of the forming of fine mud and always inundated by sea water during tidal water.

The mangrove type of Rhizophora mucronata grows and develop around tidal areas and usually grow along with Rhizophora apiculata mangroves but are usually more tolerant of areas with sandy substrates. Mangrove type of Rhizophora mucronata in the coastal region of southern part Padang city grows and develop on the back of Rhizophora apiculata mangrove type which generally has the sandy material and still gets the effect of sea tides. The mangrove type of Sonneratia alba generally on the back of Rhizophora mucronata with environmental conditions that has a muddy and sandy soil. Based on research [24] mangrove type Sonneratia alba is generally not formed the root of the breath in an environment that has a hard and rough material, while in the environment that has mud materials and a little sandy mangrove species will

have a root breath, especially if growing and developing in an environment that is always inundated. Nypa is a type of mangrove plant that grows and develops around the environment that has a lot of fresh water, especially around the river (Okpiliya *et al*, 2013). In the coastal region of southern part Padang City, Nypa plant is grown not so much this is because this plant requires a lot of fresh water so spread just around the area that has a river. This plant is spread in the area of the Bungus river, Timbalun river, and Sungai Pisang river.

The change of mangrove cover

The change in a mangrove area generally occurs naturally or as a result of human activities that make changes around the mangrove vegetation. To analyze the change of mangrove area is done by interpretation of Landsat imagery of TM 2001 and OLI 2017. Satellite imagery interpretation result showed that in 2001 mangrove vegetation was only found in the middle part of the coastal region of Bungus bay especially around Kabung cove, Kaluang cove, and Pandan cove. For more details can be seen in Table 2 follows:

Table 2. Mangrove Cover Area in 2001.

No.	Lands cover	Sub-districts	ha
1			13.68
2	Mangrove vegetation	Bungus Teluk Kabung	12.24
3			30.60
	Total		**56.52**

Source: Analysis of Landsat TM 2001 satellite imagery.

Based on Table 2 above it can be seen that mangrove vegetation in the 2001 year is only found around pandan cove, kaluang cove, and kabung cove area located in Bungus Teluk Kabung sub-district. This mangrove vegetation is spread only in three places scattered around the bay region with an area larges of 56.52 ha. This indicates that mangrove vegetation can live well in areas that have the material in the form of mud and sand. Generally mud material comes from the upper land that is carried by a river that empties into the estuary area. For more details can be seen in Figure 1 follows:
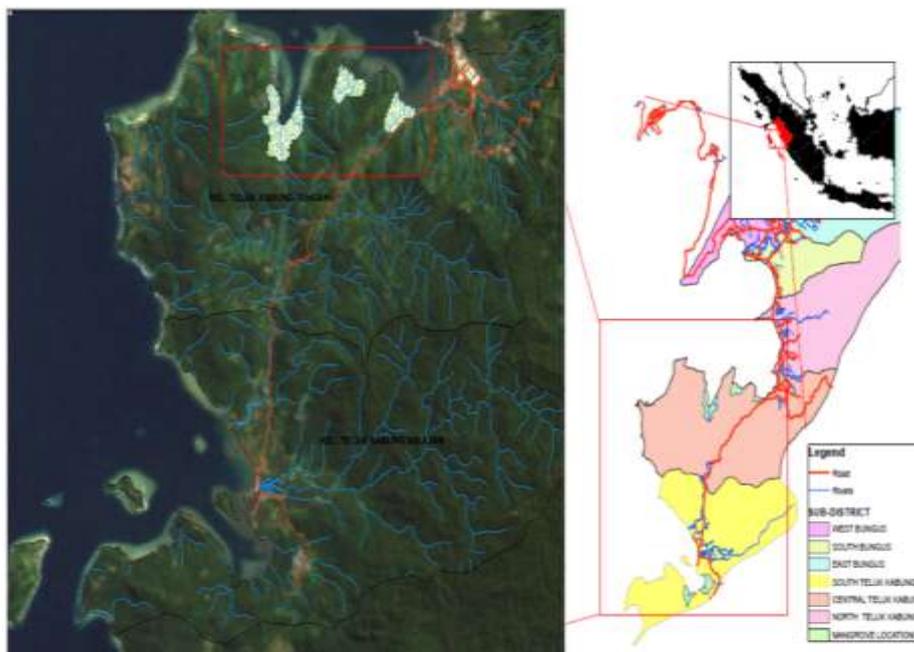

Figure 1. Map of Spatial Distribution of Mangrove Vegetation in The Coastal Region of Bungus bay in 2007

Based on Figure 1 above can be seen that the mangrove vegetation is only scattered on the bay that has a river that empties into the bay. This small river has a role to transport sediment from the upperlands, especially the material that has a fine size that is in the form of mud and sand. Sand contained in this area can be divided into two parts, i.e sand that comes from land and sand that formed as a result of coral reef debris. The types of mangroves that grow and develop in this area are Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, and Nypa. The area of mangrove cover in 2017 has increased especially in the Sungai Pisang bay. Increased the mangrove cover area is caused by the local government program to do the conservation or reclamation of the beach, especially using mangrove vegetation. For more detail changes in mangrove cover area in 2017 of year can be seen in Table 3 follows:

Table 4. Mangrove Cover Area in 2017

No.	Land cover	Sub-districts	Sub-districts	Ha
1				12.87
2			The coastal region of Bungus bay	5.27
3				32.85
			Total	50.99
4	Mangrove vegetation	Bungus Teluk Kabung		3.24
5				0.54
6			The coastal regon of Sungai Pisang bay	1.04
7				17.12
8				14.18
			Total	36.12
		Total of Area		87.10

Source: Analysis of Landsat OLI 2017 satellite imagery.

Based on Table 3 above can be seen mangrove cover area changes that mostly increased in the Sungai Pisang bay. The area mangrove cover in the Sungai Pisang bay of 36.12 ha, most of which are spread around the estuary. Generally, estuaries carry material of sand and mud from upper lands that rich in minerals that are needed by plants. In 2017 of year, the area covered by mangrove vegetation in Bungus Teluk Kabung sub-districts experienced a reduction of 6.97 ha, this is due to the change of mangrove cover area into a settlement land and the construction of a power plant in the Sirih bay.
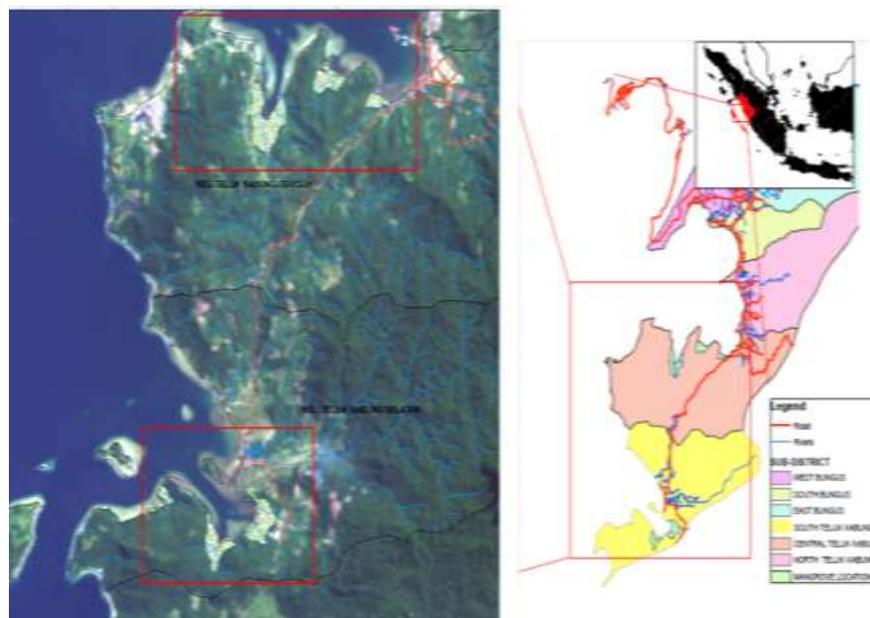

Figure 2. Map of Spatial Distribution of Mangrove Vegetation in The Coastal Southern Part in 2017

Based on Table 2 and 3, and Figure 1 and 2 above it can be seen that from 2001 to 2017 of the year in the region of Bungus Teluk Kabung sub-district, the mangrove cover area decreased by 5.54 ha or 9.79 % from in 2001. In the southern part of Bungus Teluk Kabung sub-districts experienced an increase of mangrove land cover of 36.12 ha that is around in the Sungai Pisang bay. The types of mangroves found in this area are Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, and Nypa. The spread of this mangrove types shows different ecological characteristics or ecological environment will affect the growth and development of these mangrove types.

Conclusion

Based on the results of the interpretation of satellite imagery Landsat that has been done on the coastal southern part of Bungus Teluk Kabung sub-district, the mangrove types found in this area in the form of Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, and Nypa. The distribution spatial of mangrove type depends on the ecological environment of a region. The changes in the mangrove cover area that occurred in 2001 until the year 2017 showed the dynamics of a very important change in the coastal region of Bungus bay, where the mangrove cover area has decreased by 5.54 ha, while of change in the coastal region of Sungai Pisang bay has increased by 36.12 ha. Based on the results of previous findings, suggestions that can be done to protect mangrove vegetation from extinction can be done as follows; 1) Conducting a deep study of mangrove vegetation and physical characteristics that are indispensable for the growth of mangrove vegetation; 2) Providing counseling to the community so as not to damage the existing mangrove forest; and 3) Issuing local regulations especially for the protection of mangrove vegetation from damage.

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