# ANALYSIS OF LAND COVER CHANGE IN THE MANGROVE FOREST IN AIR TELANG PROTECTED FOREST AREA, BANYUASIN REGENCY, INDONESIA

## (*Analisis Perubahan Tutupan Lahan di Hutan Mangrove di Kawasan Hutan Lindung Air Telang Kabupaten Banyuasin, Indonesia*)

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**ABSTRACT**

Mangrove has an ecological and climate control function, but mangrove forests continue to decrease so that they threaten wetland ecosystem. This study aims to determine the spatial change of mangrove forest land cover in the Air Telang Protected Forest (ATPF) Area of Banyuasin Regency. The materials used in this study are Landsat 8 image in 2013, 2015 and 2018. Identified by mangrove forests using normalized difference vegetation index . Analysis of changes in mangrove land using multitemporal data in 2013, 20 di15 and 2018. The accuracy of the classification of mangrove forest in the ATPF of Banyuasin Regency was accuracy overall certification on Landsat imagery 8  in 2013 of 93%, in 2015 of 93% and in 2018 of 94%. Mangrove forest in the air telang protection forest area of Banyuasin Regency has a trend of decreasing the extent of both the core zone and the utilization zone. Causes of Mangrove Areas loss are population, economic activity and natural factors. Changes in the extent of mangrove forest cover in the air telang protection forest area of Banyuasin Regency from 2013 to 2018 there was a decrease in the area of mangrove forests covering an area of 5,021 hectares.

**Keywords:** Air Telang Protected Forest Area, forests, land cover, landsat imagery, mangrove, spatial

***ABSTRAK***

*Mangrove memiliki fungsi ekologis dan pengendali iklim, tetapi hutan mangrove terus mengalami penurunan, sehingga mengancam ekosistem lahan basah. Penelitian ini bertujuan menganalisis perubahan spasial tutupan lahan hutan mangrove di Kawasan Hutan Lindung Telang Air Telang, Kabupaten Banyuasin. Data yang digunakan dalam penelitian ini adalah citra Landsat 8 tahun 2013, 2015 dan 2018. Identifikasi hutan mangrove dilakukan menggunakan Normalized Difference Vegetation Index . Analisis perubahan lahan mangrove menggunakan data multitemporal tahun 2013, 2015 dan 2018. Akurasi klasifikasi tutupan lahan hutan mangrove pada kawasan Hutan Lindung Air Telang Kabupaten Banyuasin adalah akurasi keseluruhan sertifikasi pada citra Landsat 8 tahun 2013 sebesar 93%, tahun 2015 sebesar 93% dan tahun 2018 sebesar 94%. Tutupan lahan hutan mangrove pada Kawasan Hutan Lindung Air Telang Kabupaten Banyuasin memiliki kecenderungan luasan yang semakin menurun baik pada zona inti maupun zona pemanfaatannya. Penyebab hilangnya mangrove adalah jumlah penduduk, aktivitas ekonomi dan faktor alam. Perubahan luasan tutupan hutan mangrove di Kawasan Hutan Lindung Air Telang Kabupaten Banyuasin dari tahun 2013 hingga 2018 terjadi penurunan luas hutan mangrove seluas 5.021 ha.*

***Kata Kunci*** *: Kawasan Hutan Lindung Air Telang, hutan, tutupan lahan, citra landsat, mangrove, spasial*

## INTRODUCTION

Mangrove is a tropical forest that grow in brackish areas, influenced by tides. Mangrove forest is the habitat for aquatic organisms as feeding ground, nursery ground, and spawning ground (Eduardo et al., 2015; Vaslet et al., 2012). Besides its ecological function, mangrove forest act as global climate control through carbon absorption (Kauffman et al., 2011; Ray et al., 2011; Seedre et al., 2014).

Given the important role of mangrove forests as one of the wetland ecosystems, the need for sustainable conservation. At the present time the mangrove forests have been reduced, the deforestation rate in Indonesia from 2000 to 2010 averaged 1.7%/year (Miettinen et al., 2011; Richards & Friess, 2015). Likewise, deforestation of mangrove forests in the Air Telang Protected Forest (ATPF) area of Banyuasin Regency.  The ATPF area of Banyuasin Regency was established in 1986 in accordance with Minister of Forestry Decree, Republic of Indonesia No. 410/Kpts-II/ 1986. The total area classified as protected forest at that time was 69,080.54 ha. The extent of protected forest areas continues to decrease in 2013 amounted to 12,660 ha (Setiawan, 2015).

The ATPF area is located in the in Banyuasin Regency, South Sumatra Province. Since 2012 Banyuasin Regency area has been designated as a special economic zone in South Sumatra Province. As a special economic zone many of physical infrastructure will be built, such as ports, railroad stations, industries, offices, settlements, and education facility, that will promote economic activities. The economic concentration in the Banyuasin Regency will affect the extent and quality of mangrove forests in the area (Barbier & Cox, 2003; 2014; Siikamäki et al., 2012). Overlaping between protection of mangrove forests with special economic development makes it ambiguous in mangrove forest management (Walters et al., 2008).

## METHODS

### *Study area*

This study focused in ATPF area located in Banyuasin Regency, South Sumatra Province (**Figure 1**). Banyuasin Regency stretches on the east side of South Sumatra Province. The average temperature is 26.1-27.4$^0$C and the average relative humidity is 69.4-85.5% with an average rainfall of 2.723 mm/year. Banyuasin Regency has 80% of the flat topography of the land to tidal marsh and lowland swamp, while a 20% longer, wavy to undulating form of dry land with an altitude range 0-40 meters above sea level.
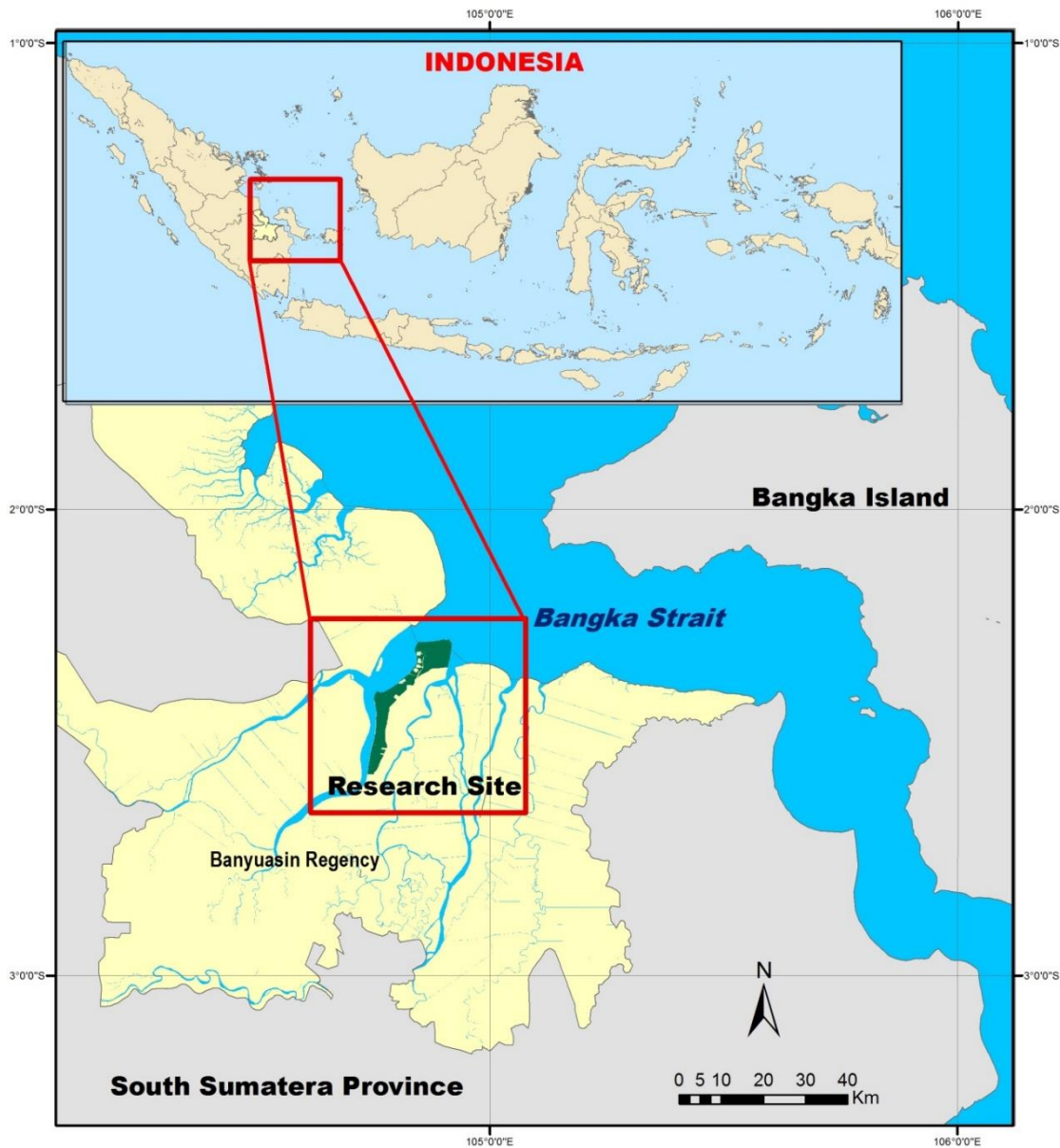


**Figure 1.** Map of the research site.

### Material

The data used in this study are Landsat 8 imagery in 2013, 2015 and 2018. The tools are used to determine location using the Garmin 62 SC GPS (*Global Positioning System*), Roller Meters, Camera, Mangrove Guidebook, and software Quantum GIS.

### Data analysis

This study used Landsat imagery, which were obtained from USGS (ND), to identified mangrove forest land cover using *Normalized Difference Vegetation Index* (NDVI). So to ensure the results of identification carried out sampling as a check identification accuracy.

Mangrove sampling is done using the spot check method. At each station, the transect is pulled perpendicular from the direction of the sea to the land along 50 m for 3 lines with a distance between the tracks 20-500 m. At each transect, tree vegetation data is sampled in 10 x 10 m transects, for puppies on 5 x 5 m transects, and seedlings on the 1 x 1 m transect diagonally 3 times.

Analysis of changes in mangrove coverage using multitemporal data in 2013 and 2015, and 2018. Area and change using overlay analysis with the **Formula (1)**.

$$\Delta L = \frac{LT_2 - LT_1}{\Delta t} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(1)$$

where: ΔL is the rate of change of the area, $Lt_1$ is the area in early observation year (ha) and $Lt_2$ is the area in the furthermore observation year (ha). Δt is the difference between the early observation period (year) and final observation period (year).

### RESULTS AND DISCUSSION

The accuracy assessment of mangrove forest land cover classification in the ATPF area resulted overall accuracy of 93% for 2013 Landsat 8 image, 93% for 2015 image and 94% for 2018 image. Based on the accuracy value, the accuracy was quite good because it meets the requirements set by the USGS which states the accuracy of the interpretation is around 90% (USGS, 2019; Kirui et al., 2013). So that the results of the Landsat Imagery 8 classification in the ATPF area of Banyuasin Regency can be used to assess the mangrove forest land cover.

**Figure 2** shows mangrove forest land cover in the ATPF area. Forest area in 2013 amounted to 12,660 ha divided into two zones, namely the core zone as forest which is not converted, while the utilization zone can be utilized but not corrupt the forest. The area of mangrove forest core zone about 7,836 ha and utilization zone about 5,025 ha. From 2013 to 2018 there was loss of mangrove forest cover (Basyuni et al., 2018; Daulat et al., 2018; Hermon et al., 2018). The loss of the extent of mangrove forest cover in the 2013-2015 period was 1,240 ha or 9.8% and in the 2015-2018 period was 5,021 ha or 39.7%. Trending trends in the loss of mangrove forest cover in each zone are different. In the core zone in the period of 2013-2015 there was a loss of mangrove forest cover area of 263 hectares or 3.5%, and in the period of 2015-2018 there was a loss of mangrove forest cover in an area of 577 ha or 7.6%. In the utilization zone there was a loss of extensive mangrove forest cover, in the period of 2013-2015 the area of mangrove forest cover was 977 ha or 19.4% and in the 2015-2018 period was very wide, which was 4,444 ha or 88.4%.

Furthermore, by using the NDVI, the level of mangrove forest density in the ATPF area of Banyuasin Regency overall in 2013 the dominance density level of the medium vegetation density category (**Figure 3** and **Table 1**). The medium vegetation density category about 1,1521 ha, followed by the sparse vegetation density category about 723 ha, and the dense vegetation density category only 410 ha.
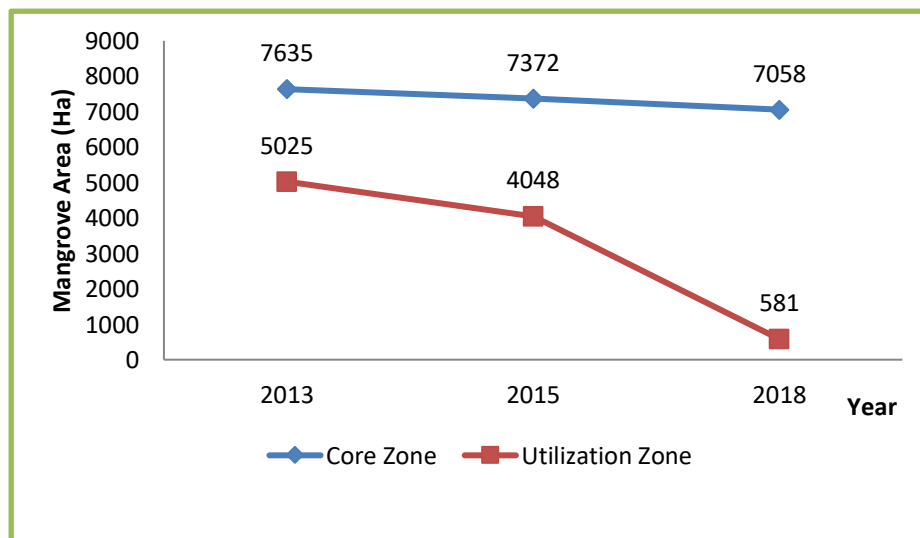


**Figure 2.** Mangrove area changes in ATPF area of Banyuasin Regency in 2013, 2015 and 2018.
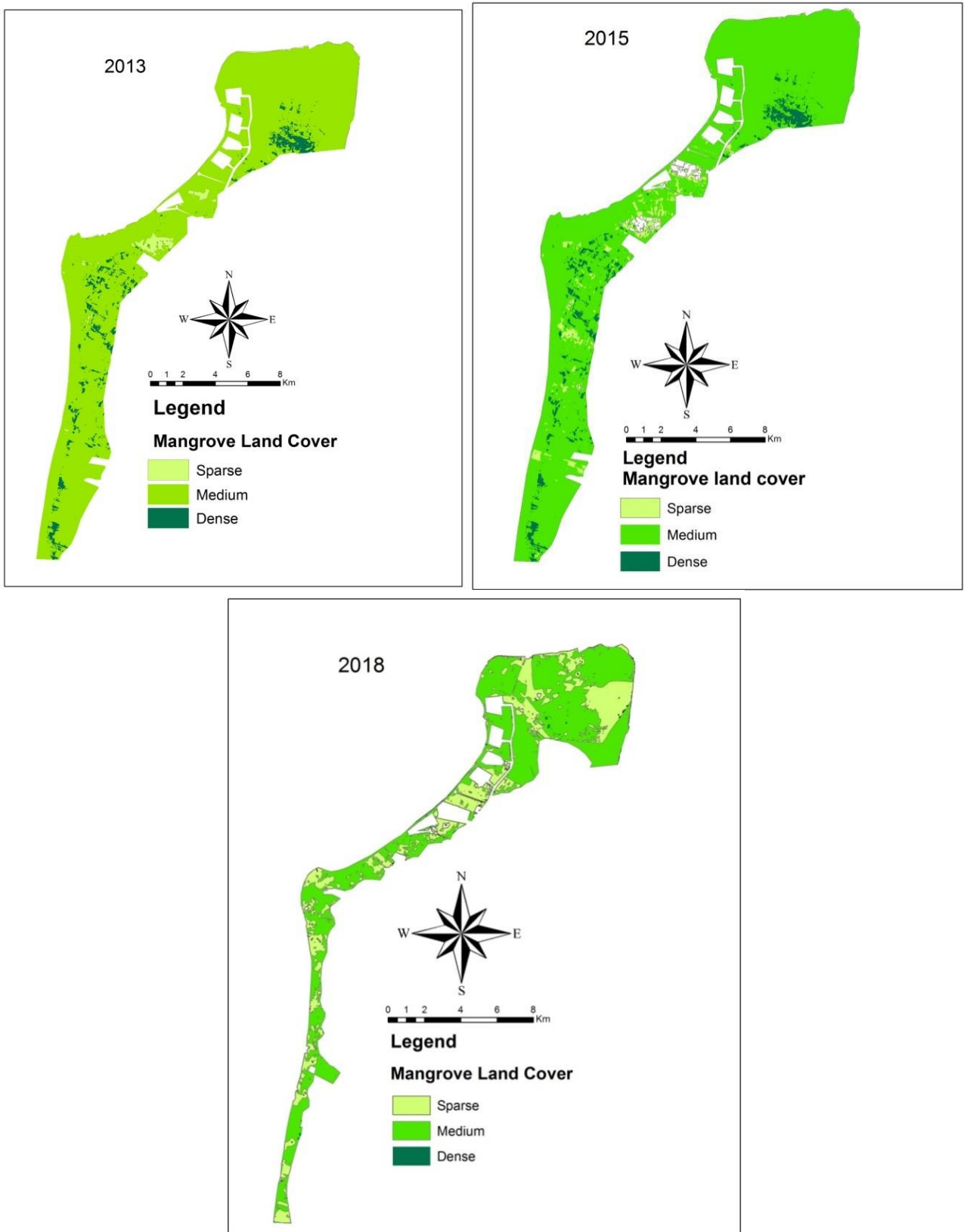
**Figure 3**. The mangrove forest density in the ATPF area, Banyuasin Regency, South Sumatra in 2013, 2015, and 2018.

**Table 1.** The mangrove forest density in core zone and utilitization zone.

| No | Mangrove forest density | Core Zone (ha) | | | | Utilitization Zone (ha) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2015 | 2018 | Size | 2013 | 2015 | 2018 | Size |
| 1 | Dense | 108 | 106 | 9 | dec | 615 | 610 | 3 | dec |
| 2 | Medium | 7,427 | 7,103 | 4,809 | dec | 4,100 | 3,048 | 420 | dec |
| 3 | Sparse | 100 | 163 | 2240 | inc | 310 | 390 | 158 | dec |

Note: dec = decrease, inc = increase

Since the period of 2013-2018 mangrove forest vegetation density occurred dynamics of land cover change (Yuvaraj et al., 2014; Khakhim et al., 2018). At the core zone there was a decrease in the area of mangrove forests occurring in areas with a density of 99 ha and medium densities of 2,618 ha, while a significant increase occurred in the level of vegetation density which was rarely 2,140 ha. Unlike the case with the utilization zone at all levels of vegetation density occurs all the decrease in area. The highest decrease is at the level of medium vegetation density with an area of 3,680 ha and the lowest is at the sparse vegetation density category with an area of 152 ha. From these data indicate that damage to the utilization zone has been severe so that it penetrated the core zone.

The spatial dynamics of the density of mangrove forests in the air telang protected forest area, the density of mangrove forests in the core zone, there is no improvement in density. Which rarely does not become medium, nor becomes solid. Likewise, mangroves with medium density do not become dense. In the utilization zone as well as in the core there is no improvement. Mangrove forests have changed land use into ponds, rice fields, and coconut plantations.

The condition of ponds in the ATPF area continues to increase both in area and production, in 2018 the production of pond fish was 8,863.96 tons. In addition to the changing ponds of mangrove forests into rice fields, in 2018 the area of rice fields was 14,780,20 ha with a production of 75,146.40 tons. Rice fields planting rice is the community's first activity when clearing forest land. This activity is still ongoing until now with the conditions of tidal rice fields, lebak swamps and rain-fed rice fields. The air telang protected forest area has also been converted into coconut plantations (**Figure 4**). In 2018 coconut plantations covered an area of 9,177 ha with a production of 9,900 tons (BPS, 2019).



**Figure 4.** The condition of the plantations in the ATPF area.

Changes in mangrove cover in the air telang protected forest area Banyuasin Regency differ tended to in the utilitization zone of greater cover loss due to the use of the forest zone other than forests can be utilized. With the increase in the number of inhabitants in the air telang protected forest areas, the conversion of forests to non-forests has increased (Abuodha & Kairo, 2001; Martinuzzi et al., 2009). Air telang protected forest area is administratively in the Banyuasin II sub-district of Banyuasin Regency with a population of 2018 totaling 32,030 with an annual population growth rate of 1.56% (BPS, 2019). The population increases every year causing the demand for land to increase. So that the conversion of protected forest land into settlements, ponds, rice fields, plantations (Yumna & Halid, 2015)

Economic activities also affect changes in mangrove forest land cover (Cornejo et al., 2005). The establishment of special economic zones increases the conversion of land in protected forests to roads, ports, railway stations, industry. Currently, Tanjung Api Api ferry and container ports have been built, access roads to get there, and several industries. The establishment of special economic zones makes ambiguous management of protected areas in the air telang protection forest area of Banyuasin Regency.

Economic activities also affect land cover changes in mangrove forests (Cornejo et al., 2005). The establishment of special economic zones increases the conversion of land in protected forests into roads, ports, railway stations, and industries. The determination of the ATPF area in Banyuasin Regency is based on SK.822/Menhut-II/2013 concerning the Determination of Forestry Areas in the Province of South Sumatra. Meanwhile, the determination of the Tanjung Api Api Special Economic Zone is based on Government Regulation no. 51/2014 regarding the Tanjung Api Api SEZ. Tanjung Api Api is part of a protected forest in the Special Economic Zone. Currently, the Tanjung Api Api ferry and container port has been built, road access to get there, and several industries. The determination of special economic zones makes the management of protected areas ambiguous in the ATPF area, Banyuasin Regency.

The change in the thickness of the mangrove forest in the ATPF area since it was designated as a special economic zone is very significant. In the core zone, there was a decrease in thick area of 99 ha or 91% from the previous area, and in the medium thickness forest there was a decrease in area of 2618 ha or 35% from the previous area. In the utilization zone, the changes in the thickness of the mangrove forest are more severe. a decrease in thick forest area of 612 ha or 99% of the previous area, and a decrease in medium thickness forest area of 3680 ha or 89% of the previous area.

Changes in mangrove cover area vary in each period. The biggest loss of mangrove forest in the 2015-2018 periode was caused by forest fires. A World Bank report in the period of July-October 2015 that the province of South Sumatra experienced forest fires, causing a loss of 292,000 ha of forest area (World Bank, 2016). One of the areas that caught fire in South Sumatra was the ATPF area , Banyuasin Regency. The 2015 El Nino incident was associated with a significant increase in forest and land fires compared to previous years, especially in the South Sumatra region (Yananto & Dewi, 2016).

The 2015 forest fires destroyed land and forests in South Sumatra Province with an area of 0,984.98 ha (Utomo et al., 2022; Yuningsih et al., 2018). Land and forest fires in South Sumatra Province occur in August, September, and October, these months are usually the dry season (Pandjaitan & Panjaitan, 2015). The most pronounced impact of land and forest fires is the occurrence of smog (Cahyono et al., 2015). The smog even causes schools to close (Astika et al., 2022), interferes with health, and transports both air, sea and land (Mala et al., 2017). Forest and land fires ecologically damage biodiversity, loss of flora and fauna (Saharjo & Wasis, 2019; Wasis et al., 2019).

Deforestation that occurs in mangrove forests in general, apart from humans, economic activities, damage to mangrove forests can also be caused by nature (Rivera-Monroy et al., 2017; Gorman, 2018). One of the natural factors of changes in mangrove forest cover is forest fires. It is necessary to anticipate both natural and human factors to prevent more massive mangrove forest destruction, so that the mangrove forest ecosystem remains sustainable.

## CONCLUSIONS

From 2013 to 2018, the extent of mangrove forest cover in the ATPF area decrease by 5,021 ha. The decreasing mangrove forest coverage occurs in both core zone and utilization zones. The causes of mangrove areas loss are population, economic activity and natural factors. Although the core zone occurs, it is better than the activation zone, it needs to be done immediately so that the Mangrove Forest can be minimized as early as. The preservation of mangrove forests will have an impact on improving its function and role as a coastal ecosystem in the tropics.

## ACKNOWLEDGMENTS

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