# Mangrove ecosystem conditions in Batu Bara district (case study in Lima Puluh Pesisir, Talawi and Tanjung Tiram sub-district)

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**Abstract.** The decline mangroves in the Districts of Lima Puluh Pesisir, Talawi, and Tanjung Tiram is caused by the lack of knowledge and understanding of the community about the importance of mangroves for life. This study aims to determine the condition of the mangrove ecosystem in the Batu Bara District. The data collection method was carried out by conducting a location survey to determine the sampling points used as research sites by using a quadratic transect. The results of the study was found 20 types of mangroves. Based on the results of satellite imagery in 2013, there are 3 districts with a total mangrove area of 1,323.5 ha. The highest important value index (INP) for trees at station 1, Lima Puluh Pesisir District, namely the *Avicennia marina* type of 17.77%, Important value index (INP) at station 2 Talawi District for the highest tree, namely the *Bruguiera cylindrical* type of 14.45% and The important value index (INP) at station 3 of Tanjung Tiram District for the highest tree was the *Avicennia marina* type of 20.51%.In 2013-2022 in the District of Lima Puluh Pesisir there has been a change in the area of mangroves, namely a reduction in area of 236.84 Ha.

## 1 Introduction

Indonesia is an archipelagic country that has mangrove ecosystems spread throughout the coast [1]. Mangroves function to maintain the sustainability of coastal ecosystems [2], because they are able to withstand coastal erosion, produce carbon [3], improve water quality, and provide habitat for coastal biota. The mangrove ecosystem is one of the typical tropical marine ecosystems that play an important role not only in terms of biology and ecology, but also physically because it helps maintain coastal resilience [4]. Biologically and ecologically, the mangrove ecosystem is an important habitat area for marine biota which spends part or all of its life phases in this area to grow and develop (*nursery ground*) [5]. Secsocially and

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economically, mangrove ecosystems also have an important role [6].

The mangrove ecosystem area is very vulnerable to changes in land use as human exploitation increases. Limited public knowledge about the functions and benefits of mangrove ecosystems, as well as management and utilization without regard to sustainability causes damage to the mangrove ecosystem itself [7]. According to [8], the magnitude of the benefits that exist in mangrove ecosystems makes them very vulnerable to over-exploitation and environmental degradation that is quite severe, resulting in a reduction in the area of the ecosystem every year. The reduced area of mangrove ecosystems is due to limited public knowledge of the functions and benefits of mangrove ecosystems, as well as management and utilization without regard to mangrove sustainability. This causes a lot of damaged mangrove land due to logging for the conversion of mangrove land into agricultural land or development. In addition, the largest decline in the area of mangrove ecosystem land was caused by the creation of pond businesses by the community [9].

Many studies related to mangrove ecosystems have been carried out such as ecosystem services, community structures, and mangrove monitoring using remote sensing [10];[11];[12];[13]. Currently monitoring changes in mangrove density can be known effectively through satellite imagery with remote sensing technology and Geographic Information Systems (GIS) [14];[15];[16]. The use of remote sensing provides an alternative and makes it easier for humans to determine the condition of mangroves in a time series [10].

Batu Bara Regency is one of the regencies in North Sumatra Province which has a large area of mangrove forest. Lima Puluh Pesisir, Talawi, and Tanjung Tiram sub-districts are sub-districts in Batu Bara Regency which have mangrove ecosystems that are used for daily life such as for firewood, building materials, and a place to find marine biota such as fish and crabs . In this case, the mangroves in these 3 sub-districts are experiencing biological pressures such as the loss of places to find food, spawning grounds, and places to play, which can threaten the life of marine biota. In addition, this can lead to abrasion around the coast. In 2001, Batu Bara District had 1,598.38 ha of mangrove forest [17]. However, according to the Coal Forest Service, there was a decrease (45.2%) of the mangrove forest area to 876.06 hectares in 2010 [18]. One of the factors causing the decline in the area of mangrove forests in Batu Bara Regency is the high beach abrasion. This is according to the statement of [19], that from the results of data processing it was concluded that most of the coast of Batu Bara Regency had undergone changes indicating the occurrence of abrasion with the degree of abrasion being evaluated.The decline in mangroves in the Districts of Lima Puluh Pesisir, Talawi, and Tanjung Tiram is caused by the lack of knowledge and understanding of the community about the importance of mangroves for life. This study aims to determine the condition of the mangrove ecosystem in Batu Bara District in the Districts of Lima Puluh Pesisir, Talawi, and Tanjung Tiram.

## 2 Materials and methods of research

### 2.1 Location and Venue

The research was conducted from June to August 2023 in the Batu Bara District, precisely in the Districts of Lima Puluh Pesisir, Talawi and Tanjung Tiram. Location determination was made based on satellite imagery in 2022 which can be seen in figure 1.

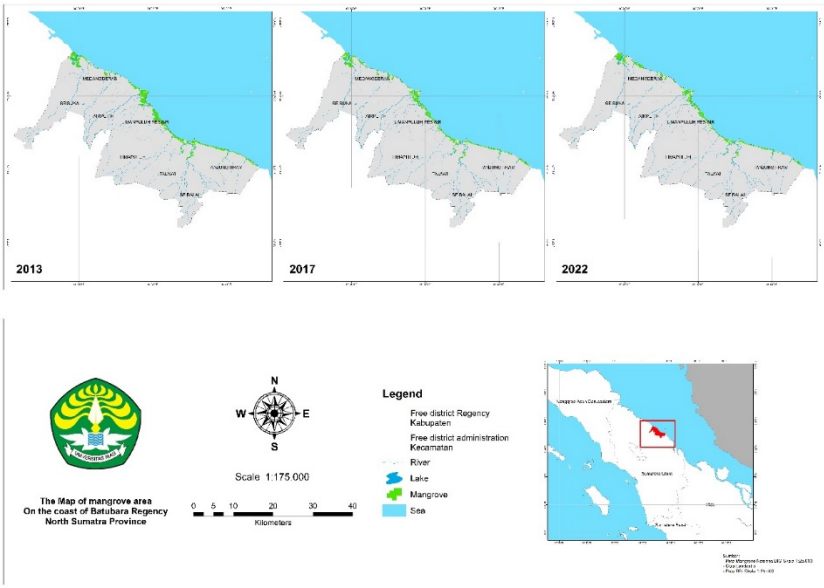


**Fig.1.** Research Locations

## 2.2 Tools and materials

The tools and materials were used by applying raffia rope, tape measure, stationery, camera, label paper, plastic bags, and a Guidebook for Mangrove in Indonesia [20]. The material used was alcohol and the object observed in this study was mangroves.

## 2.3 Method

This research was conducted using a survey method, namely by taking primary data at the research location and collecting secondary data. In this study the primary data collection was carried out in the field, namely by determining the type of mangrove based on the mangrove identification and measurement book.

## 2.4 Sampling Location Determination

Observation stations were determined by using the purposive sampling method, by selecting areas with the consideration that each station could represent the condition of the mangrove ecosystem.

## 2.5 Creation of Mangrove Transects

The technique is to stretch the rope from the reference point line (shore) in a direction perpendicular to the mainland (outermost mangrove forest) for 50 meters. Data were taken from 3 observation stations, at each station 3 plots were made by measuring 10x10 (m2), where plot 1 was located on the edge of the beach, plot 2 was in the middle of the mangrove, and plot 3 was in the outermost part of the mangrove forest.

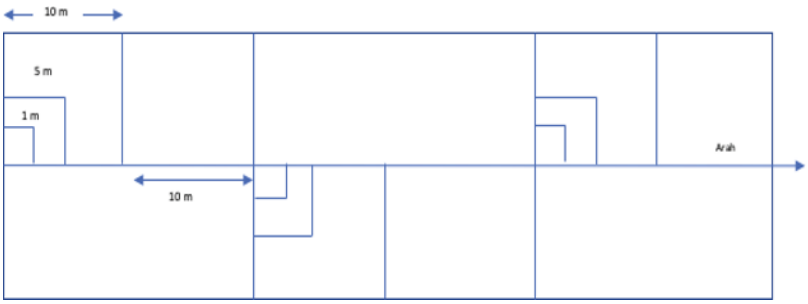


**Fig.2.**Observation transects Source: [21]

Observation of mangrove species was carried out by counting the number of all tree stands, saplings and seedlings at each station. The mangroves counted were those in a 10x10 (m2) plot. In order to identify the type of mangrove, observations of leaves, stems and flowers were carried out and then matched with the Guidebook for Mangrove in Indonesia [20].

## 3 Data analysis

Mangrove vegetation data analysis is carried out by calculating the structure of the mangrove community, which includes species density (K), Relative Density (KR), Species Frequency (Fi), Relative Frequency (FR), Dominance (D), Relative Dominance ( DR) and Important Value Index (INP) with the following formula.

$$\text{Density (K)}, = \frac{Number\ of\ individuals}{Example\ tile\ area}$$

$$\text{Relative Density (KR)}, = \frac{K\ a\ species}{K\ total\ of\ all\ species}\text{x}100\%$$

$$\text{Frequency (F)} = \frac{\sum sub\ plot\ found\ a\ species}{\sum all\ sample\ subplots}$$

$$\text{Relative Frequency (FR)}, = \frac{\text{F a species}}{F\ total\ of\ all\ species}\ x\ 100\%$$

$$\text{Dominance (D)} = \frac{area\ of\ the\ basal\ area\ species}{Luas\ petak\ contoharea\ of\ the\ sample\ plot}$$

$$\text{Relative Dominance ( DR)} = \frac{D\ a\ species}{D\ total\ of\ all\ species}\text{x}100\%$$

Important Value Index (INP) = KR + FR + DR

## 4 Results and Discussion

There are 20 types of mangroves found in 3 research locations, namely the District of Lima Puluh Pesisir, Talawi, and Tanjung Tiram. The types of mangroves found can be seen in table 1.

**Table 1.** Types of mangrove vegetation at the study site

| No. | Mangrove Type | family |
|---|---|---|
| 1. | *Acrostichum speciosum* | Pteridaceae |
| 2. | *Achantus ilicifolius L* | Acanthaceae |

| | | |
|---|---|---|
| 3. | *Aegiceras corniculatum* | Primulaceae |
| 4. | *Aegiceras floridum* | Primulaceae |
| 5. | *Avicennia lanata* | Avicenniaceae |
| 6. | *Avicennia marina* | Avicenniaceae |
| 7. | *Avicennia officinalis* | Avicenniaceae |
| 8. | *Bruguiera gymnorrhiza* | Rhizophoraceae |
| 9. | *Bruguiera cylindrica* | Rhizophoraceae |
| 10. | *Ceriops zippeliana* | Rhizophoraceae |
| 11. | *Ceriops tag* | Rhizophoraceae |
| 12. | *Excoecaria agallocha* | Euphorbiaceae |
| 13. | *Lumnitzera littorea* | Combretaceae |
| 14. | *Nypa fruticans* | Arecaceae |
| 15. | *Rhizophora apiculata* | Rhizophoraceae |
| 16. | *Rhizophora mucronata* | Rhizophoraceae |
| 17. | *Rhizophora stylosa* | Rhizophoraceae |
| 18. | *Scyphyphora hydrophyllacea* | Rubiaceae |
| 19. | *Sonneratia ovata* | Sonneratiaceae |
| 20. | *Xylocarpus moluccensis* | Meliaceae |

Broadly speaking, the number of mangroves in the study area was 20 species consisting of 19 true mangrove species and 1 associated mangrove, *Achantus ilicifolius* L. Observations of mangroves were carried out in three sub-districts, namely Lima Puluh Pesisir, Talawi, and Tanjung Tiram. Mangrove ecosystem in Lima Puluh Pesisir Districts cattered around the coast with different density values from other sub-districts and have different substrate conditions at each station (Table 1). The condition of the substrate in the Lima Puluh Pesisir District at station 1 has a type of muddy substrate with the dominant mangrove species such as *Aviciena marina*, it was followed by *Bruguiera gymnorhiza*. Substrate conditions in Talawi District at station 2 have a sandy mud substrate type and it was dominated by *Avicennia lanata* and *Rhizophora mucronata* mangrove species. At station 3 the substrate conditions in Tanjung Tiram District had a hard mud substrate and it was dominated by types *Acrostichum speciosum*and Rhizophora apiculata.

**Table 2**. Substrate types for each observation station

| **sub-districts** | **Station** | **Parameter** | | |
|---|---|---|---|---|
| | | **Salinity** | **pH** | **substrate** |
| Lima Puluh Pesisir | 1 | 27 | 7 | Mud |
| Talawi | 2 | 25 | 6 | Sandy mud |
| Tanjung Tiram | 3 | 26 | 7 | Hard mud |

Judging from the type of substrate, mangroves have a substrate of mud, sandy mud and hard mud. This mud substrate comes from the process of sediment deposition, especially those adjacent to river mouths. Mangroves grow in places that receive little waves, currents will carry silt sediments, so that the mud will become a substrate for mangrove saplings that fall and will grow easily [22].

### 4.1 Mangrove densities in 2013

Based on the results of satellite image processing, it was found that the mangrove area in the Lima Puluh Pesisir District in 2013 was 552.47 ha. Mangrove class division was carried out to determine the level of density of mangroves in the District of Lima Puluh Pesisir with a low density of 1236.66 ha and the highest density of 38.33 ha.

Observations from satellite imagery in Talawi District have a mangrove area of 197.14

ha with a low density category of 1070 ha and a high density category of 36.66 ha. Talawi District has the least area of mangroves because the area was used as a residential and trading area, so that the coastal area was utilized by the community for settlement.

Tanjung Tiram District has a mangrove area of 573.91 ha, the category of low mangrove density is 2373.33 ha and the highest density is 143.33 ha. Tanjung Tiram District has extensive mangroves compared to other sub-districts, because the Tanjung Tiram area has a secondary mangrove ecosystem area. In addition, the mangrove ecosystem in this sub-district has not been widely used for settlements and ponds so that the area of mangroves is still relatively large.

### 4.2 Mangrove densities in 2017

Based on the results of satellite imagery in 2017, it can be seen that the total area of mangroves in the three sub-districts is 919.5 ha. Lima Puluh Pesisir District has a mangrove area of 336.64 ha with a low density mangrove category of 1,236.66 ha and a high density mangrove category of 20 ha. Talawi District has an area of 167.43 ha with a low density mangrove category of 636.66 ha and a high density mangrove category of 36.66 ha. Tanjung Tiram District has a mangrove area of 415.46 ha with a category of very low mangrove density of 291.66 ha and a category of high mangrove density of 40 ha.

Lima Puluh Pesisir Subdistrict has a higher density level than other Subdistricts, because Tanjung Tiram Subdistrict is dominated by traditional fishing communities, so the level of settlement development is still small. The low density in 2017 was found in Talawi District due to the use of the coastal area as a residential and trading area. The status of coastal land in Talawi District is owned by individuals with the validity of land documents at the sub-district level. Ownership of this land status can trigger damage to mangrove areas which has an impact on land conversion. Overall, there was a decrease in mangrove area for the 2013-2017 period of 403.9 ha. This means that there has been a decrease in the area of mangroves due to land conversion or opening of areas for other uses within a period of 4 years.

### 4.3 Density of mangroves in 2022

Based on the results of processed satellite imagery in 2022, the total areamangroves in three districts is 811.7 ha. Lima Puluh Pesisir District has a mangrove area of 315.63 ha. The low density mangrove category is 845 ha and the high density mangrove category is 26.66 ha. Talawi District has a mangrove area of 116.71 ha. The low density mangrove category covers 470 ha and the high density mangrove category covers 16.66 ha. Tanjung Tiram District has a mangrove area of 379.36 ha with a low density mangrove category of 403.33 ha and a high density mangrove category of 46.66 ha.

The density of mangroves in 2022 has decreased in all districts. Utilization activities for settlements and ponds are things that occur in the conversion of mangrove land so that it can have an impact on the surrounding ecosystem without balancing it with the environment [23]. Besides that mangrove forest ecosystem is an important habitat for marine organisms [24].

### 4.4 Significant Value Index

The highest important value index (INP) for trees at station 1 of the Lima Puluh Pesisir District was the *Avicennia marina* type of 17.77%. The highest IVI for saplings was the type of *Rhizophora apiculata* at 15.32%. The IVI for the highest seedling, Nypa fruticans, was 15.38%. The relative density (KR) value for the highest tree is *Nypa fruticans*, which is 6.70%. The highest KR sapling value was for *Rhizophora apiculata* at 7.41%, while the highest for seedlings was for *Nypa fruticans* with a value of 8.22%. The relative frequency

(FR) value for the highest trees of *Ceriops tagal* and *Scyphyphora hydrophyllacea* was 6.12%. The FR value of the highest sapling of *Xylocarpus moluccensis* was 6.42%. The highest seedling FR value was for *Rhizophora mucronata* at 5.73%. The highest relative dominance (DR) value for *Nypa fruticans* was 6.21%.

The importance value index at station 2 of Talawi District for the highest tree, namely the *Bruguiera cylindrical* type, was 14.45%. The highest sapling IVI of *Avicennia officinalis* was 12.21%. The IVI of the seedlings for *Acrostichum speciosum* was 14.11%. The highest relative density (KR) value of a *Bruguiera cylindrical* tree was 5.51%. The highest KR value for saplings of the *Avicennia officinalis* type was 4.85%, while the seedlings, namely *Acrostichum speciosum*, were 7.65%. The relative frequency (FR) value for trees, namely *Rhizophora mucronata*, was 6.12%, while the FR value for the highest sapling was the type *Avicennia lanata*, which was 5.71%. The seed FR value of *Nypa fruticans* was 5.73%. The highest relative dominance (DR) value for *Avicennia marina* was 6.33%. The highest DR value for *Bruguiera cylindrical* saplings was 4.

The important value index (INP) at station 3 of Tanjung Tiram District for the highest tree was the *Avicennia marina* type of 20.51%. INP for the highest sapling type *Avicennia marina* of 16.57%. The highest INP of *Acrostichum speciosum* seedlings was 22.35%. The highest relative density (KR) value of *Acrostichum speciosum* is 12.167%. The highest KR value of *Bruguiera cylindrical* is 10.86%. The KR value of *Acrostichum speciosum* seedlings was 15.58%. The highest relative frequency (FR) value of *Acrostichum speciosum* is 6.12%. The FR value of the highest sapling of *Rhizophora apiculata* was 5%. The highest Fr in *Bruguiera cylindrical* seedlings was 5.09%. The highest relative dominance (DR) value for *Avicennia marina* was 3.92%. The highest DR value was in *Bruguiera cylindrical* saplings of 3.58% and the highest DR value in *Rhizophora apiculata* seedlings of 3.43%.

### 4.5 Mangrove Area Change

Based on the research results that have been observed in three sub-districts, namely Lima Puluh Pesisir, Talawi, and Tanjung Tiram, regarding changes in mangrove areas. In 2013-2022 in the District of Lima Puluh Pesisir there has been a change in the area of mangroves, namely a reduction in area of 236.84 Ha. In 2013-2017 there was a reduction in the area of mangroves by 215.83 Ha and in 2017-2022 there was a reduction in the area of 21.01 Ha. The mangrove area in Talawi District in 2013-2017 has decreased by 29.71 Ha and in 2017-2022 it has decreased by 50.72 Ha. In 2013-2022 there has been a change in the area of mangroves, namely a reduction in the area of 80.43 Ha. In 2013-2022 in Tanjung Tiram District there has been a change in the area of mangroves, namely a reduction in area of 194.55 Ha.

**Table 3.** Mangrove Areas in Three Districts, namely Lima Puluh Pesisir District, Talawi District, and Tanjung Tiram District

| sub-districts | Mangrove Area (Ha) | | | Mangrove Area Change (Ha) | | |
|---|---|---|---|---|---|---|
| | 2013 | 2017 | 2022 | 2013 - 2017 | 2017 - 2022 | 2013 - 2022 |
| Lima Puluh Pesisir | 552.47 | 336,64 | 315.63 | (-) 215.83 | (-) 21.01 | (-) 236.84 |
| Talawi | 197,14 | 167,43 | 116.71 | (-) 29.71 | (-) 50.72 | (-) 80.43 |
| Tanjung Tiram | 573.91 | 415,46 | 379,36 | (-) 158.45 | (-) 36.1 | (-) 194.55 |

Mangrove ecosystems are vulnerable to degradation caused by natural conditions or human activities, such as land conversion, excessive logging, pollution, availability of fresh water, flooding, and cyclonic storms [25]. The condition of the mangrove ecosystem in three sub-districts, namely Lima Puluh Pesisir, Talawi and Tanjung Tiram sub-districts, was

damaged due to the large number of mangrove trees being cut and the conversion of mangrove areas into settlements and ponds due to a lack of public knowledge of the types, functions and benefits of mangrove forests. [26] added that damage to mangrove ecosystems in Indonesia is more often caused by limited public understanding of the benefits of mangrove ecosystems in these tidal areas.

## 5 Conclusion

There are 20 types of mangroves found in 3 research locations, namely the District of Lima Puluh Pesisir, Talawi, and Tanjung Tiram. Mangrove species found during observation at all stations viz*Acrostichum speciosum, Achantus ilicifolius L, Aegiceras corniculatum, Aegiceras floridum, Avicennia lanata, Avicennia marina, Avicennia officinalis, Bruguiera gymnorrhiza, Bruguiera cylindrical, Ceriops zippeliana, Ceriops tagal, Excoecaria agallocha, Lumnitzera littorea, Nypa fruticans, Rhizophora apiculata, R hizophora mucronata, Rhizophora stylosa, Scyphyphora hydrophyllacea, Sonneratia ovata,*and *Xylocarpus moluccensis*. Observations from satellite imagery in 2013 for Three Districts have a total mangrove area of 1,323.5 ha, in 2017 the total area of mangroves in the three Districts is 919.5 ha, and the total area of mangroves in 2022 is 811.7 ha . The highest important value index (INP) for trees at station 1 of Lima Puluh Pesisir District was the *Avicennia marina* type of 17.77%, the important value index at station 2 of Talawi District for the highest tree was the *Bruguiera cylindrical* type of 14.45% and the important value index (INP) at station 3 of Tanjung Tiram District for the highest tree of the *Avicennia marina* type of 20.51%. In 2013-2022 in the District of Lima Puluh Pesisir there has been a change in the area of mangroves, namely a reduction in area of 236.84 Ha. In 2013-2022 there has been a change in mangrove area, namely a reduction in area of 80.43 Ha and in 2013-2022 in Tanjung Tiram District there has been a change in mangrove area, namely a reduction in area of 194.55 Ha.

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## References

1 Sutikno MAF, Julpa IS, Rahmadani ANL., Pamungkas UR., Fariz TR., and Amalia AV, "Estimation of mangrove canopy cover with hemispherical photography method in tambakrejo village, semarang city," pp. 641–648,(2023).
2 Sunaryo S, Ambariyanto A, Sugianto DN, Helmi M. Kaimuddin AH, and Indarjo A., "Risk analysis of coastal disaster of semarang city, Indonesia," pp. 1–5,(2018)
3 Handayani S., Adrianto L., Bengen DG, Nurjaya IW, and Wardiatno Y., *J. Agriculture Science. Indonesia.*, **25**, 4, pp. 574–583, (2020)
4 Permana R. and Andhikawati A., *J. Community Serv.*, **4**, 1, pp. 11–16, (2023)
5 Julaikha S. and Sumiyati L. *j. biol. trop.*,**17**, 1, pp. 23–32, (2017)
6 Kurniawati ND., and Pangaribowo EH., *J. Bumi Indonesia.*, **6**, 2, pp. 1–12, (2017)
7 Mendrofa S., Kurnia R., and Pratiwi NTM, j. science and technology. trop., **9**, no. 2, pp. 499–506, (2017)
8 Kalitouw WD, "Economic valuation of mangrove forests in tiwoho village, wori district, north Minahasa regency,"(2015)

9 Hidayah N., and Muzayanah, "Study of decreasing mangrove land area in ujungpangkah district, Gresik Regency,"*Swara Bhumi*, **5**, 61, pp. 162–169, (2018)
10 Febrianto S., Syafina HA, Latifah N., and Muskananfola MR., *J. Marine. Trop.*, **25**, 3, pp. 369–377, (2022)
11 Handayani S., Adrianto L., Bengen DG., Nurjaya IW., and Wardiatno Y., *J. Agriculture Science. Indonesia.*, **25**, 4, pp. 574–583, (2020)
12 Latifah N., Febrianto S., Endrawati H., and Zainuri M., *J. Marine. Trop.*, **21**, 2, pp. 97–102, (2018)
13 Safitri F., Suryanti S., and Febrianto S., *Geomatics*, **25**, 1, pp. 37–46, (2019)
14 Dharma F., Aulia A., Shubhan F., Ridwana R., and Somantri L., *J Educator. geogr. Undiksha*, **10,** 2, pp. 155–165, (2022)
15 Purwanto A., *education*, **13**, 1, pp. 27–36, (2015)
16 Rafsenja U., Muh L., Jaya G., and Rahim S., *j. geogr. app. and technol.*, **4**, 1, pp. 63–70, (2020)
17 Lubis DP, Pinem M., and Simanjuntak MAN, *j. geogr.*, **9**, 1, pp. 21–31, (2017)
18 Sitompul OS, Yunasfi, and Rangkuti AM, "The ecological condition of mangrove in bali beach, mesjid lama village, talawi sub district, batu bara district, north Sumatra Province,"(2014).
19 Rumondang, Feliatra F., Warningsih T., and Yoswati D., "Detection of coastline changing by using remote sensing imagery (case study in Talawi District, Tanjung Tiram District, Lima Puluh PesisirDistricts of Batu Bara Regency)," IOP Conf. Ser. Earth Environment. Sci., pp. 1–10, (2022)
20 Noor YR, Khazali M., and Suryadiputra INN,Mangrove management guide in indonesia. (2012).
21 Rusdi R., Setyobudiandi I., and Damar A., *J. Science and Technology. To the sea. Trop.*, **12**, 1, pp. 119–133, (2020)
22 Kamal E. and Haris N., *Marine Science.*, 19, 2, pp. 113–120, (2014).
23 Aulia B., *Sumatra J. Disaster, Geogr. geogr. educ.*, **1**, 1, p. 57, (2017)
24 Karimah, *J. Biol. Trop.*, **17**, 2, pp. 51–58, (2017).
25 Giriet al C., J. Environ. Manage., **148**, pp. 1–11, (2015)
26 Lasibani SM., and Kamal E, *j. mangroves and coastal x*, **10**, 1, pp. 33–38, (2010).