

# Restoration of mangrove forest landscape in Babulu Laut village, sub district of Babulu, Penajam Paser Utara district

*by Marjenah Marjenah*

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## Restoration of mangrove forest landscape in Babulu Laut village, sub district of Babulu, Penajam Paser Utara district

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**Abstract.** The reforestation activities of mangrove forest carried out in various regions have not been well known as the success and influence of landscape in rehabilitation area. Utilization of existing land along the coastal Babulu Laut Village has reduced the area of mangrove forest from day to day. Due to the use of land by the community without considering the conservation aspect causes the loss of mangrove forest. This study aims to determine the final condition of the success rate of forest and land rehabilitation, land cover and the benefits of mangrove forest restoration for the surrounding people. The research method used is the preparation and orientation of research location, data input, codification, data processing, the field verification and analysis of data. The results of the execution of the inventory mangrove in 22 research location in the Babulu Laut Village, Babulu Subdistrict, Penajam Paser Utara District of 125 ha of plant a whole is kind of *Rhizophora sp*, where the intensity of sampling 2% with the growing plants of 65.92 % or 2,175 stem/ha then success rate of Mangrove Forest Rehabilitation at Babulu Laut Village Babulu Subdistrict is medium level (55-75%).

### 1. Introduction

Realizing the function of mangrove forests for the life of the community and the global ecosystem is requiring rehabilitation efforts of mangrove areas. The rehabilitation efforts are carried out to achieve the function, namely the function of mangrove forest as an economic zone and environmental function where mangrove forest is a buffer zone of life in the coastal area. Thus, the rehabilitation efforts are demonstrated in all mangrove forest areas, both in areas are controlled by the community (whole mangrove in the tambak area) or in areas are not controlled by the community (rehabilitation of pure mangrove) [1]

Research on landscape cover in the restoration of mangrove forest restoration area located in Babulu Laut Village within Babulu Subdistrict, the district of Penajam Paser Utara is one effort to restore the ecological carrying capacity of mangrove forest based on its function, with the rehabilitation of mangrove forest. With the hope of mangrove forest that formed can contribute to the ecological conservation of coastal areas in Babulu Laut Village within Babulu Subdistrict, the district of Penajam Paser Utara and also may provide benefits to the surrounding people.



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The above description indicates that the successful rehabilitation of mangrove forest did include the interference of the surrounding people. Therefore the researcher hopes this research can provide information to the government and the community in the coastal village of Babulu Laut in Babulu Subdistrict. It will be showing that the restoration of mangrove forest is very useful for the environment and resources nature so that the preservation of mangrove can be maintained.

Based on technical plan data of mangrove forest rehabilitation and beach seagrass, Babulu Laut Village in Babulu Subdistrict categorized as Priority I with minimum planting 3,300 stems/ha. Therefore, this study aims to determine the final condition of the success rate of forest and land rehabilitation in Babulu Laut Village, Babulu Subdistrict, to know the extent of land cover from the rehabilitation of forest and mangrove forest land in Babulu Laut Village, Babulu Subdistrict so that the achievement of mangrove forest landscape is sustainable.

## 2. Methods

This research was conducted in Babulu Laut Village, Babulu Subdistrict, Penajam Paser Utara District. Northside adjoining Labangka Village and Babulu Village of West Sea, South of Maresi Village in the south, Babulu Darat Village adjoining Babulu Darat Village and East of Makassar Strait Sea.

The research materials are East Kalimantan Province Administration Map, Peta Rupa Bumi (Topographic Map) scale 1: 50.000 Year 2013 Geospatial Information Agency, Map of Appointment of Forest and Fishery Area of East Kalimantan Province (attachment to Minister of Forestry Decree No. 718 / Menhut-II / 2014 dated August 29 2014), Map of Mangrove Forest Rehabilitation Block Area BPDAS Mahakam Berau Year 2013 Scale 1: 15.000 Babulu Subdistrict North Penajam Paser, Landsat Image Map 8 OLI (LC08\_L1TP\_117061\_20140724\_20170421\_01\_T1 coverage July 24, 2014 and LC08\_L1TP\_117061\_20160611\_20170324\_01\_T1 coverage June 11, 2016).

The tools needed to create and support the overlay process of the map are Computers, ArcGIS Software 10.5, printer, GPS Garmin Map Csx 60, phiband, Suunto brand compass, photo camera, stationery.

Research activities include: Preparation and orientation of research sites, data input, codefication, data processing, field verification and data analysis, as follows:

### 2.1. Preparation and Orientation of Research Sites

Activities undertaken in the preparation of the study is to explore the information areas related to the restoration of mangrove forest from 2014 to 2016 that have been completed. It will be used to identify and inventory research areas and data processing programs (image processing).

### 2.2. Input Data

Landsat 8 OLI image (path / row: 121/65) downloaded from the United States Geological Survey website via <http://earthexplorer.usgs.gov/> is LC08\_L1TP\_117061\_20140724\_20170421\_01\_T1 coverage July 24, 2014 and LC08\_L1TP\_117061\_20160611\_20170324\_01\_T1 coverage June 11, 2016 at research site Babulu Laut Village Babulu Subdistrict Penajam Paser Utara District.

### 2.3. Codefication

The first step is to make a link between the map with tabular data, then the process of giving the code for each object on the map. The code should be the same as the one on the tabular data. The next process is the projection of the position coordinate format. All digital maps are projected into a geographical or UTM projection, in order to have a universal coordinate system [2].

#### 2.4. Data Processing

Data processing includes the following process:

2.4.1. *Primary Data and Secondary Data.* Primary data is data collected through measurement or direct ground checking to research variable in research area. Meanwhile secondary data is data collected from related government institution, literature study, and interview result. Primary data includes classifying the land cover of mangrove forest rehabilitation activities in 2014 and 2016, overlaying between mangrove forest rehabilitation maps and landsat 8 OLI coverage maps of 2014 and 2016 downloaded year, composite band process combining bands in Citra Landsat with combination of 4, 3, 2 channels of natural color and vegetation analysis 6,5,4 with Red, Green, Blue (RGB) filter obtained by False Color Composite (FCC) to facilitate the separation of the appearance of natural vegetation, surface water, and open land.

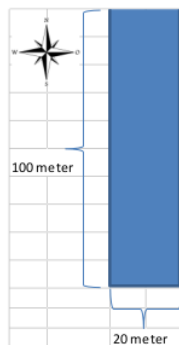
2.4.2. *Delineation of Object Research.* Delineation object research aims to explain the boundaries of coastal areas in Babulu Subdistrict to obtain information in the form of supporting data. Determination of delineation is to limit the results of land cover inventory and mangrove identification.

#### 2.5. Field Verification

Field verification parameters under study are as follows:

2.5.1. *Mangrove Forest Rehabilitation Plant.* Observation of mangrove forest rehabilitation plants growing. Observation aims to identify the physical condition of plants as the basis for the management of Forest and Land Rehabilitation (RHL) further and according to the design of activities. Plant observation includes: measurement of plant area; number and type of plants; and the calculation of healthy plant growth percentage. The measurement of cultivation area is carried out on the realization of cultivation areas shown in the total area planted in units of Ha and compared to the plan of plant area according to the design (Regulation of Directorate General of River Basin Management and Social Forestry Number : P.1 / V-SET / 2013).

2.5.2. *Making of Research Fields.* Conducted by sampling technique method Systematic Sampling with Random Start, the first measuring plot is made randomly and the next measuring plots are made systematically. Sampling intensity (IS) is adjusted to the field condition IS 2%, each plot represents 0,2 ha (20 meter x 100 meter), as shown in Figure 1 below.



**Figure 1.** Sample Field of Research

2.6. Analysis of Data

Some of the data analyzed are as follows:

2.6.1. Final Condition of Plant Success Rate. The result of mangrove forest inventory and percent of plant growth is calculated by comparing the number of plants present in a plot with the number of crops that should be present in the measuring plot, as the following formula :

$$T = \left( \frac{\sum hi}{\sum ni} \right) \times 100\% = \frac{(h1+h2+\dots+hn)}{(n1+n2+\dots+nm)} \times 100\% \quad (1)$$

1

(Regulation of Directorate General of River Basin Management and Social Forestry Number : P.1/V-SET/2013)

where: T = Percent (%) grows healthy plants

hi = Number of healthy plants contained in plot to i

ni = Number of plants that should be on plot to i.

Which results can be presented as Table 2.

2.6.2. Conversion Score In Percentage Form. The total score of RHL success evaluation is then converted into percentage form, and given the predicate according to the percentage value. How to convert a score into a percentage is by comparing the scored vector score with the maximum vector score that can be achieved, then multiplied by one hundred percent. Percentage of success rate has been obtained then given the predicate of success rate. The percentage class and predicate RHL success as presented in Table 1 below.

**Table 1.** Class of Percentage and Predicate of RHL Success

Number	Percentage of Class	Remarks
1	91 % - 100 %	Very good
2	76 % - 90 %	Good
3	55 % - 75 %	Moderate
4	< 55 %	Less

2.6.3. Land Cover Area. In this study used the Map of Rehabilitation of Mangrove Forest Activities in 2013 and Citra LC08\_L1TP\_117061\_20140724\_20170421\_01\_T1 coverage July 24, 2014 and LC08\_L1TP\_117061\_20160611\_20170324\_01\_T1 coverage June 11, 2016 with Band 4, 3, 2 that is natural color and vegetation analysis 6,5,4 with filter Red, Green, Blue (RGB) so that the appearance of closure and land use is clearly visible using unsupervised classification because the data obtained will be more accurate using field data. The calculation results of changes in mangrove forest cover can be presented as Table 3.

**3. Results and Discussion**

Research Sites in Babulu Laut Village in Babulu Subdistrict, the Penajam Paser Utara District, located at position between 116 ° 29 '46.572 "BT, -1 ° 33' 38.9592" LS and 116 ° 32 '54.42 "BT, -1 ° 29' 3.7644" LS, with the boundaries of the northern part of Labangka Village, south of Maruat Village, west of Sebakung Jaya Village and the Eastern Babulu Laut Strait of Makassar, as Figure 2.

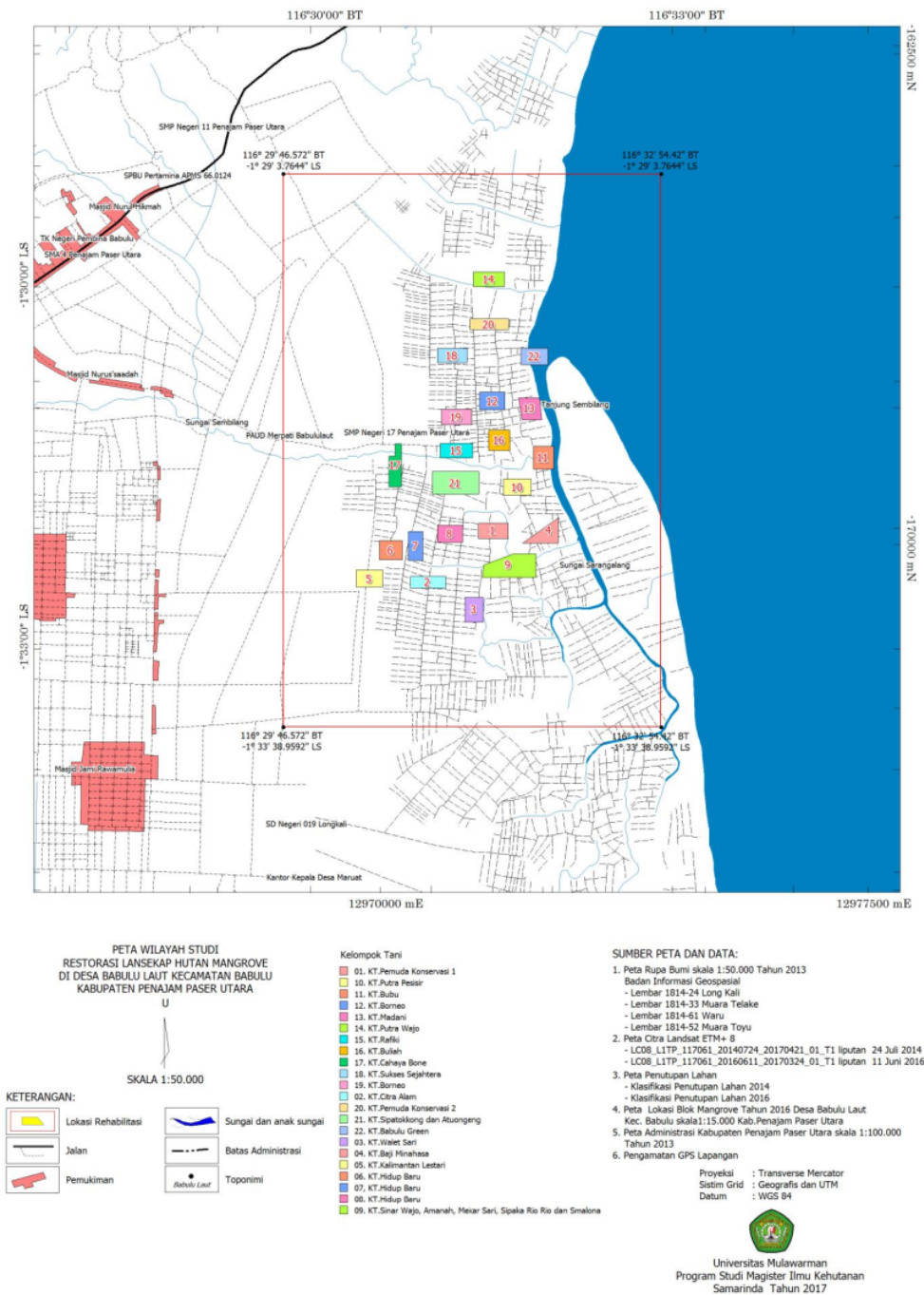


Figure 2. Study Area Map

Rehabilitation planting of mangrove forest implemented by Mahakam Berau Protected Forest Watershed Management Center in 2013 by involving community and farmer group, list of farmer group name and area of research location is as follows:

**Table 2.** List of Farmers Group and Area of Research

Locations	Names of Farmer's Group	Wide (Ha)
1	Pemuda Konservasi 1	10.78
2	Citra Alam	10.47
3	Walet Sari	10.69
4	Baji Minasa	10.29
5	Kalimantan Lestari	10.58
6	Hidup Baru	10.33
7	Hidup Baru	10.25
8	Hidup Baru	10.31
9	Sinar Wajo, Amanah, Mekar Sari, Sipaka Rio Rio, and SMA Lona	25.19
10	Putra Pesisir	10.46
11	Bubu	10.39
12	Bomeo	10.47
13	Madani	10.86
14	Putra Wajo	10.24
15	Rafiki	10.88
16	Buliah	10.06
17	Cahaya Bone	10.77
18	Sukses Sejahtera	10.25
19	Bomeo	10.93
20	Pemuda Konservasi 2	10.17
21	Sipatokkong and Atuongeng	25.45
22	Babulu Green	10.34
<b>Total</b>		<b>260.16</b>

### 3.1. Plant Assessment of Mangrove Forest

The result plant assessment of Mangrove at 22 locations of research in Babulu Laut Village Babulu Subdistrict of Penajam Paser Utara District with area of 5,2 Ha with total plant species is type of *Rhizophora sp* end stand at each location with 2% Sampling Intensity, with plant growth percentage 65.92%.

**Table 3.** Percentage of Plant Growth

Site	Area (ha)	Area IS 2% (ha)	Trees (stem)	$\Sigma$ Average (stem/ha)	Percentage of Growth (%)
1	10.78	0.22	662	3,071	93.05
2	10.47	0.21	554	2,646	80.17
3	10.69	0.21	351	1,642	49.75
4	10.29	0.21	504	2,449	74.21
5	10.58	0.21	428	2,023	61.29
6	10.33	0.21	320	1,549	46.94
7	10.25	0.21	376	1,834	55.58
8	10.31	0.21	414	2,008	60.84
9	25.19	0.50	1537	3,051	92.45
10	10.46	0.21	372	1,778	53.88
11	10.39	0.21	300	1,444	43.75
12	10.47	0.21	388	1,853	56.15
13	10.86	0.22	576	2,652	80.36
14	10.24	0.20	516	2,520	76.35
15	10.88	0.22	502	2,307	69.91
16	10.06	0.20	394	1,958	59.34
17	10.77	0.22	545	2,530	76.67



Site	Area (ha)	Area IS 2% (ha)	Trees (stem)	$\Sigma$ Average (stem/ha)	Percentage of Growth (%)
18	10.25	0.21	470	2,293	69.48
19	10.93	0.22	488	2,232	67.65
20	10.17	0.20	454	2,232	67.64
21	25.45	0.51	967	1,900	57.57
22	10.34	0.21	398	1,925	58.32
<b>Average</b>					<b>65.97</b>

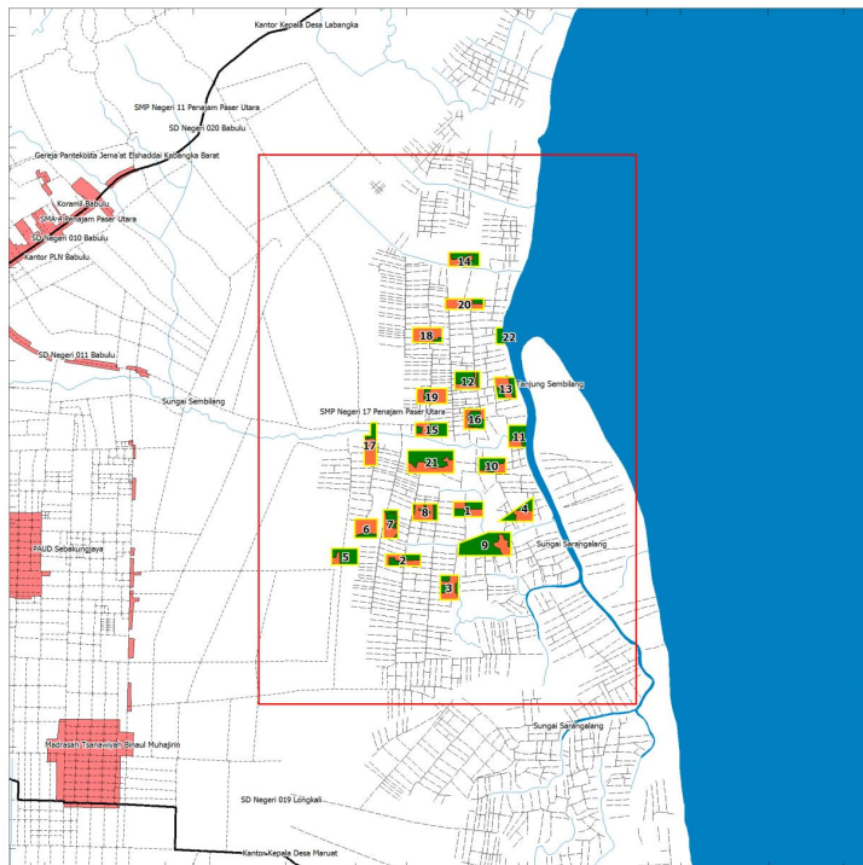
As comparative data of plant assessment conducted by BPDASHL Mahakam Berau, on Assessment of Mangrove Forest Rehabilitation (P-0) of 125 Ha in 2013 of 76.97%, and Evaluation of RHL Activities (P-1) covering 100 Ha in 2014 of 66.37% and research results Year 2016 amounted to 65.92%, then based on the criteria set by the Director General for Management of Watershed and Social Forestry Number: P.1 / V-SET / 2013, the success rate of Mangrove Forest Rehabilitation in Babulu Laut Village Babulu Sub-district North Penajam Paser District is moderate (55-75 %) and declared successful.

### 3.2. Classification of Land cover

The land cover classification of 2014 and 2016 underwent a land cover change with a 206,96 ha classified land cover by 2016, and an open field classification of 57,17 Ha, as Table 4 and Figure 3 and 4.

**Table 4.** Land Cover Year 2014 and Year 2016

Site	Area	Year of 2014		Year of 2016	
		Land Cover	Open Field	Land Cover	Open Field
1	10.78	5.19	5.58	9.5	1.27
2	10.47	4.65	5.82	8.94	1.53
3	10.69	3.66	7.02	7.33	3.35
4	10.29	5.62	4.67	9.36	0.93
5	10.58	8.68	1.89	9.08	1.5
6	10.33	2.52	7.8	9.02	1.3
7	10.25	4.63	5.62	7.97	2.29
8	10.31	3.31	7.00	8.09	2.23
9	25.19	20.37	4.82	16.75	8.45
10	10.46	6.00	4.46	8.24	2.21
11	10.39	7.05	3.35	7.42	2.97
12	10.47	7.03	3.44	9.74	0.72
13	10.86	4.92	5.93	8.24	2.61
14	10.24	6.06	4.17	9.37	0.87
15	10.88	6.78	4.11	9.26	1.63
16	10.06	5.71	4.35	6.12	3.94
17	10.77	2.87	7.9	9.57	1.19
18	10.25	1.02	9.23	7.22	3.03
19	10.93	1.17	9.76	9.71	1.22
20	10.17	1.31	8.86	5.53	4.64
21	25.45	15.25	10.2	23.57	1.88
22	10.34	4.18	6.16	2.93	7.41
<b>Total</b>	<b>260.16</b>	<b>127.98</b>	<b>132.14</b>	<b>202.96</b>	<b>57.17</b>



**PETA  
 PENUTUPAN LAHAN TAHUN 2014  
 RESTORASI LANSEKAP HUTAN MANGROVE  
 DI DESA BABULU LAUT KECAMATAN BABULU  
 KABUPATEN PENAJAM PASER UTARA**

**SUMBER PETA DAN DATA:**

1. Peta Rupa Bumi skala 1:50.000 Tahun 2013  
 Badan Informasi Geospasial  
 - Lembar 1814-24 Long Kall  
 - Lembar 1814-33 Muara Telake  
 - Lembar 1814-61 Waru  
 - Lembar 1814-52 Muara Toyu
2. Peta Citra Landsat ETM+ 8  
 - LC08\_L1TP\_117061\_20140724\_20170421\_01\_T1 liputan 24 Juli 2014  
 - LC08\_L1TP\_117061\_20160611\_20170324\_01\_T1 liputan 11 Juni 2016
3. Peta Penutupan Lahan  
 - Klasifikasi Penutupan Lahan 2014  
 - Klasifikasi Penutupan Lahan 2016
4. Peta Lokasi Blok Mangrove Tahun 2016 Desa Babulu Laut  
 Kec. Babulu skala 1:15.000 Kab. Penajam Paser Utara
5. Peta Administrasi Kabupaten Penajam Paser Utara skala 1:100.000  
 Tahun 2013
6. Pengamatan GPS Lapangan

Proyeksi : Transverse Mercator  
 Sistem Grid : Geografis dan UTM  
 Datum : WGS 84

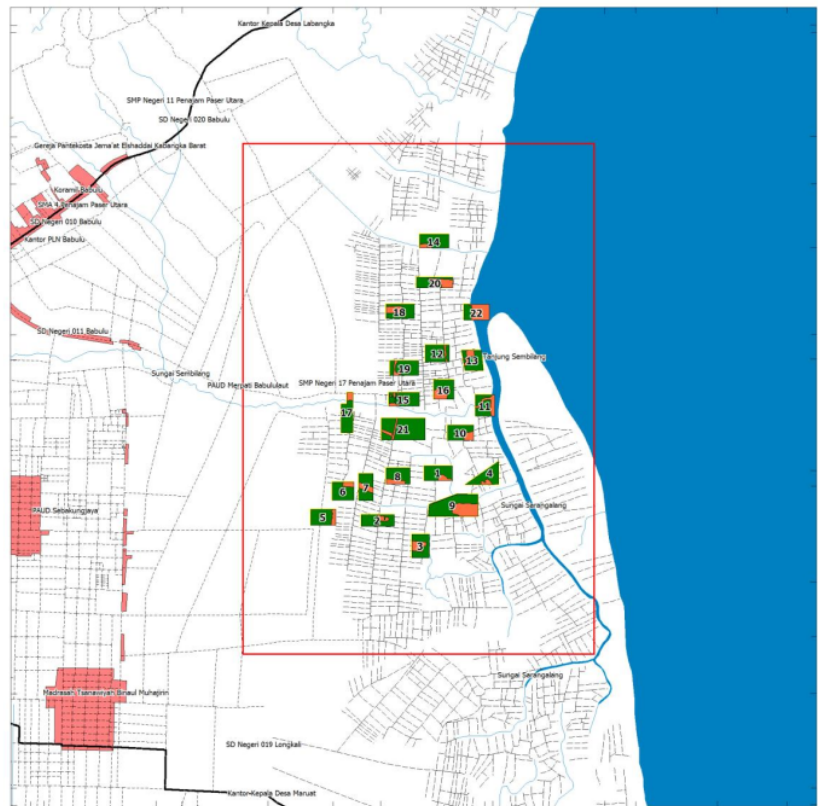


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**KETERANGAN:**

- |  |                        |  |                |
|--|------------------------|--|----------------|
|  | Lokasi Rehabilitasi    |  | Lahan Terbuka  |
|  | Jalan                  |  | Lahan Tertutup |
|  | Pemukiman              |  |                |
|  | Sungai dan anak sungai |  |                |
|  | Batas Administrasi     |  |                |
|  | Toponimi               |  |                |

**Figure 3.** Map of Land Cover Classification Year 2014



PETA  
 PENUTUPAN LAHAN TAHUN 2016  
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Proyeksi : Transverse Mercator  
 Sitem Grid : Geografis dan UTM  
 Datum : WGS 84

KETERANGAN:

- |  |                        |  |                |
|--|------------------------|--|----------------|
|  | Lokasi Rehabilitasi    |  | Lahan Terbuka  |
|  | Jalan                  |  | Lahan Tertutup |
|  | Pemukiman              |  |                |
|  | Sungai dan anak sungai |  |                |
|  | Batas Administrasi     |  |                |
|  | Toponimi               |  |                |

Figure 4. Map of Land Cover Classification Year 2016

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From the land cover classification results in 2014 and 2016, the additional land cover area of 74,98 ha and reduction of land cover area of 74,97 ha. Thus there is a change of land cover from 2014 to 2016.

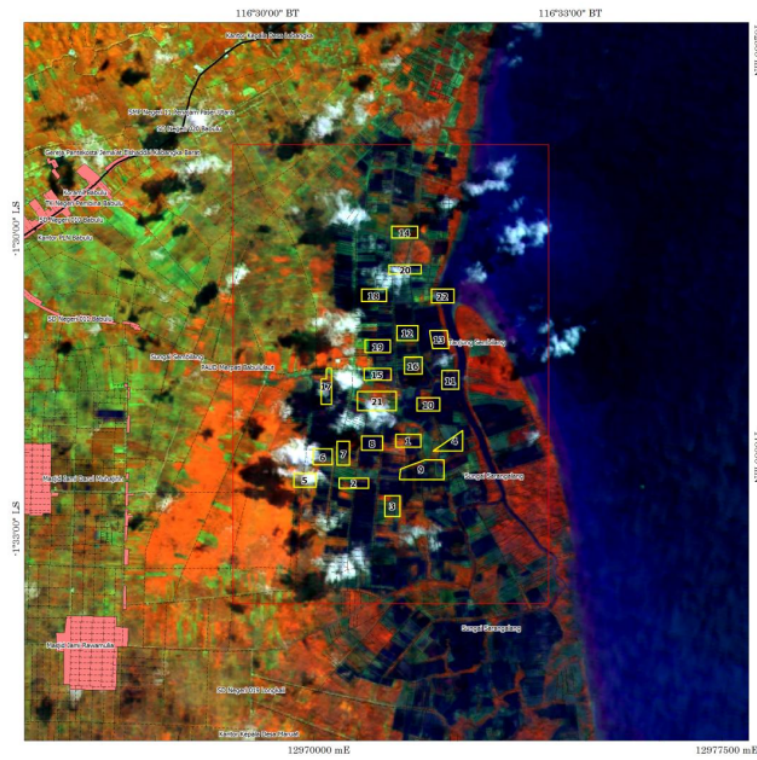
### 3.3. Land cover change

The overlay results of 22 (twenty two) mangrove forest rehabilitation locations and the land cover classification results of 2014 and 2016 and Landsat ETM + 8 B654 in 2014 and 2016 obtained the result of land cover change in the research location obtained result of changes in land cover area of 56.74% , as Table 5 and Figures 5, 6 below:

**Table 5.** Open Coverage Changes in 2014 and 2016

Site	Area	Open Field (Ha)		Percentage of Changes Land Cover (%)
		2014	2016	
1	10.78	5.58	1.27	77.24
2	10.47	5.82	1.53	73.71
3	10.69	7.02	3.35	52.28
4	10.29	4.67	0.93	80.09
5	10.58	1.89	1.5	20.63
6	10.33	7.80	1.3	83.33
7	10.25	5.62	2.29	59.25
8	10.31	7.00	2.23	68.14
9	25.19	4.82	8.45	-75.31
10	10.46	4.46	2.21	50.45
11	10.39	3.35	2.97	11.34
12	10.47	3.44	0.72	79.07
13	10.86	5.93	2.61	55.99
14	10.24	4.17	0.87	79.14
15	10.88	4.11	1.63	60.34
16	10.06	4.35	3.94	9.43
17	10.77	7.90	1.19	84.94
18	10.25	9.23	3.03	67.17
19	10.93	9.76	1.22	87.50
20	10.17	8.86	4.64	47.63
21	25.45	10.20	1.88	81.57
22	10.34	6.16	7.41	-20.29
<b>Total</b>	<b>260.16</b>	<b>132.14</b>	<b>57.17</b>	<b>56.74</b>

Table 5 shows that location 9 under the coordination of Sinar Wajo Farmer Group, Amanah, Mekar Sari, Sipaka Rio Rio & Sma Lona experienced a change in land cover reduction by 75.31%. After observation in the field this is because the distance of location 9 too close to the beach so that the mangrove easily flooded water and low success rate of planting. And plot 22 under the coordination of Sipatokkong & Atuongeng Farmer Group experienced a change in land cover reduction by 20.29%, this is due to the lack of seriousness of the farmer group in maintaining the mangrove plants that have been planted.



PETA  
 CITRA LANDSAT ETM+8 B654 COMPOSITE  
 LC08\_L1TP\_117061\_20140724, liputan 24 Juli 2014  
 RESTORASI LANSEKAP HUTAN MANGROVE  
 DI DESA BABULU LAUT KECAMATAN BABULU  
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5. Peta Administrasi Kabupaten Penajam Paser Utara skala 1:100.000  
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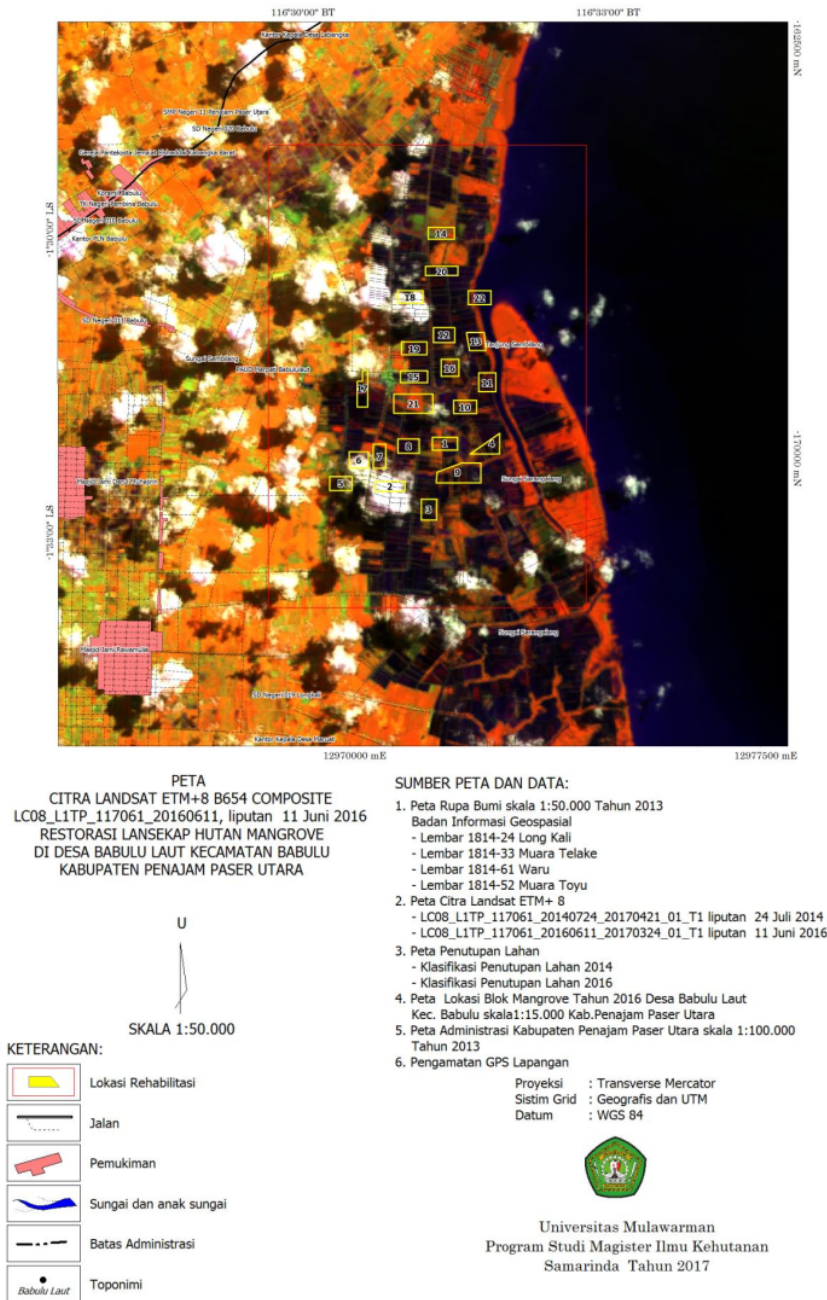
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KETERANGAN:

- Lokasi Rehabilitasi
- Jalan
- Pemukiman
- Sungai dan anak sungai
- Batas Administrasi
- Toponimi

SKALA 1:50.000

Figure 5. Map of Citra Landsat ETM+8 B654 Composite Year 2014



**Figure 6.** Map of Citra Landsat ETM+8 B654 Composite Year 2016

### 3.4. Changes in Mangrove Forest Landscape

The landscape change in mangrove forest cover from 2014 open land area of 132,14 ha to an area of 57,17 ha in 2016 with a percentage of 56.74% as shown in Figure 7 below :

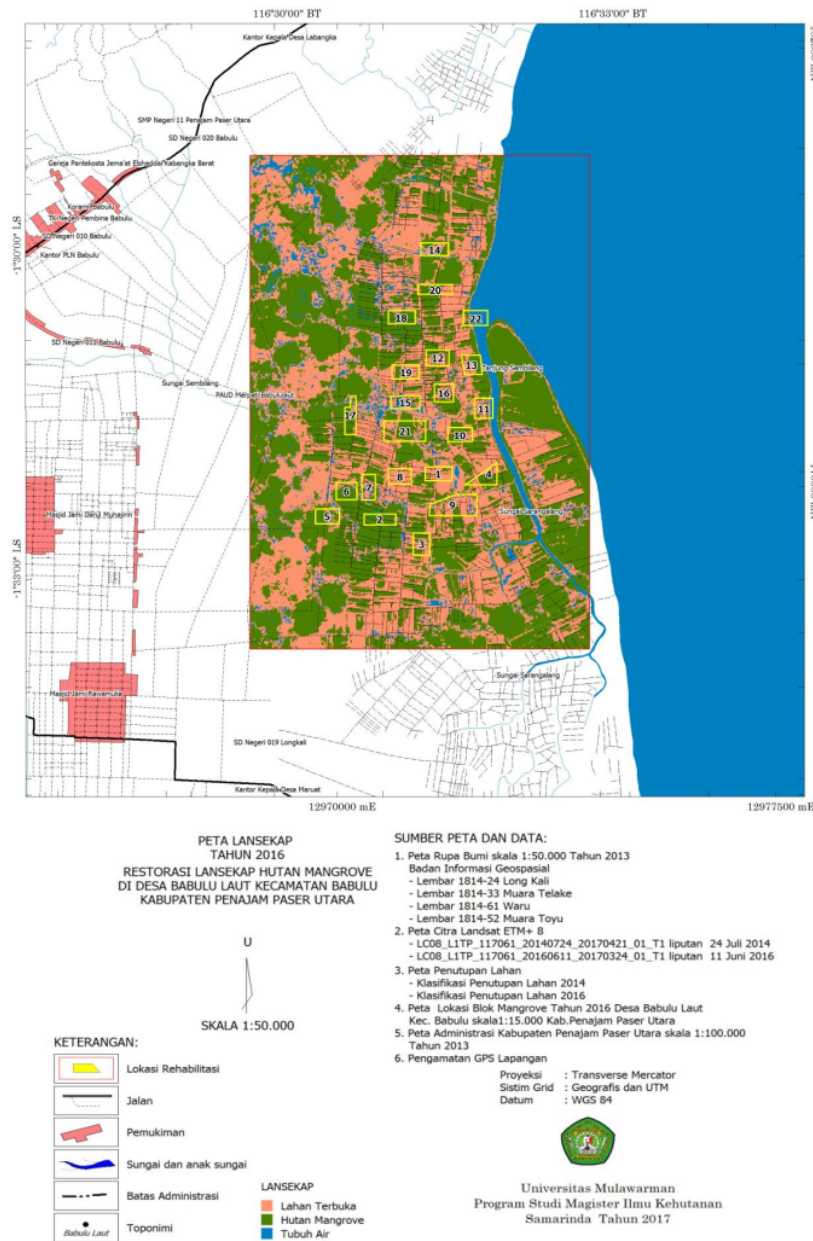


Figure 7. Mangrove Forest Landscape Map 2016

The type of plant that becomes the dominant structural element in the landscape is the type of tree. Trees in the landscape have an important functional and aesthetic role. Aesthetically, trees can function as a complement, unifying, enforcing, marking and framing the environment [3].

In his research [4] stated that the economic value of the mangrove area emerging as a result of its ecological role and its harvest products is often ignored so that the area is widely converted into agricultural areas, fishponds, salt ponds, forestry, and infrastructure [4]. So with the restoration of mangrove forest landscape in Babulu Laut Village Babulu Subdistrict North Penajam Paser Regency, can create a fertile ecosystem and become habitat for some kind of biota of economic value, of course public welfare can be guaranteed.

Forest landscape restoration approaches can therefore play a positive role in the conservation and sustainable management of this globally important forest type. In addition, our research suggests that forest restoration can be cost-effective, at least in some situations, in that the increase in benefits provided to people can outweigh the costs incurred. This is consistent with recent reviews highlighting the ecological feasibility restoration [5] and its potential benefits for both biodiversity and provision of ecosystem services [6].

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