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The impact of coastal degradation on mangrove ecosystem in North Karawang coastal area

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Abstract. Coastal degradation can be observed as destruction of mangrove area. The impact of mangrove destruction is evidenced by a significantly eroded area. Further impacts included lessened biodiversity, especially in the mangrove ecosystem. This study aimed to determine the impact of coastal damage to the mangrove ecosystem in Karawang coastal areas. The mangrove degradation was identified from changes in mangrove covered area by utilizing data from several Landsat TM satellite imagery and ground check equipped with GPS and Google Earth applications. Data from the inventory of mangrove area issued by the Perhutani of KPH Purwakarta 2017 were also used as supplement in determining the extent of destruction. From satellite imagery, the mangrove area in 2017 was 258 hectares. This area was only approximately 3% of the total area of mangrove protected areas assigned by the Regency Spatial Plan. Compared to the condition in 2009, the coastal destruction was significant. The worst mangrove degradation occurred in the sub-districts of Cibuaya, Tempuran, and Cilamaya Wetan. The coastal communities were aware of the problem. They understood that this problem was caused by coastal abrasion and land use change, wild catch, milkfish and shrimp aquaculture, salt ponds, rice farms, and tourism.

Keywords: coastal, ecosystem, mangrove

1. Introduction

The coastal area has levels of population density and intensity of high industrial development, so the coastal environment often gets a high human pressure [1, 2]. Meanwhile, in the coastal area, there is an important ecosystem of mangrove that plays a very important role for the balance of the environment.

The mangrove ecosystem is complex, dynamic, and unstable. It is said to be complex because the mangrove ecosystem, the waters, and the ground below it are all habitats for various animals and aquatic biotas. It is said to be dynamic because mangrove ecosystem can grow naturally, and unstable because they are easily damaged and difficult to recover [3].

Then mangrove vegetation is also a beach that can protect the coastal areas from tidal waves and tsunamis. In the case of the tsunami disaster, even the public know that if the mangrove vegetation in the coastal area are in a good condition and dense with trees that grew sturdy, it could perhaps save the region from the waves of the tsunami, and also the influence of abrasion and intrusion of seawater.

If the mangrove ecosystems are protected, in turn they could protect the spawning ground of fish and other marine lives.

Unfortunately, the mangrove ecosystem at this time has sustained a lot of damage. Even in the coastal area, mangroves have been chopped down, for timber or firewood. The mangrove area was converted into a riparian area, or developed into an office area or residential population. Spatial planning of coastal areas often has not been created, or if it had been made it could still be breached easily for the sake of commercialization. Mangrove ecosystems are damaged as a result, the coastal area destroyed. The damage to the coastline was due to two things: natural and anthropogenic damages [4].

Mangrove ecosystems in the regency of Karawang, especially in the north part of Karawang coastal areas, have also suffered damage, which has caused the loss of many things. The problems that occur in mangrove ecosystems in the coastal area of Karawang are the density of the human population and the increasing economic activities of aquaculture so that the conversion of mangrove ecosystem into cultivated lands becomes widespread.

There has been lot of research on the coastal areas and many studies on mangrove ecosystems. However, research on the impact of the damage to the coastal ecosystem of mangroves in Karawang has never been done, let alone research that utilizes satellite, which certainly fit is quite high.

2. Methods

This study aimed to determine the impact of coastal damage to the mangrove ecosystem, which was located in the northern part of the coastal area of Karawang Regency, West Java Province, Republic of Indonesia. The study was conducted in four months, starting from August to November 2017.

The data used in this research were primary and secondary data. The primary data collection method was direct observation by interviewing community's perceptions on the condition of mangrove ecosystem, interpretation of Landsat 8 satellite imagery in 2017, and GPS groundcheck data for the accuracy of interpreted data. Secondary data were obtained by literature study, including the data from annual report of related agencies.

Landsat 8 2017 image of the Karawang coastal area was analyzed and processed to find out the NDVI (Normalized Difference Vegetation Index) display with the help of arcGIS and Qgis applications to produce an existing map of the area of mangrove ecosystem in the northern part of the coastal area of Karawang Regency in 2017. The map was then tested by conducting a ground check and by using the Google Earth application to find out the real condition (ground truth), so that the results of the interpretation could be accounted for scientifically.

The data of mangrove area in 2017 resulting from this research were compared to secondary data of previous years from relevant agencies, to then be analyzed to determine the changes that occurred on the mangrove area.

The perception of coastal communities was descriptive. Factual description of the condition of mangroves and coastal environments from the perception of coastal communities was taken through direct field observations and interview methods and questionnaires.

3. Results and Discussions

Based on perceptions, the damage to the mangrove ecosystem in Karawang Regency was quite alarming. At several points of the research there were mangrove damages due to the impact of coastal abrasion and land use change. There were at least five components of the development of coastal and marine areas in Karawang Regency that served as the cause of the reduction in the area of mangrove ecosystem. This included capture fisheries, milkfish and shrimp aquaculture, salt ponds, rice farms, and tourism.

The results of this research show that satellite can be used to detect mangrove area in nine sub-districts in the northern part of Karawang coastal areas in 2017, as described in table 1. Also from secondary data from previous studies, the mangrove area in the year of 2009, 2012 and 2017 can be seen and compared in table 1.

Table 1. Primary and secondary data of mangrove area in nine sub-districts in the northern part of Karawang coastal areas.

No.	Sub-District	2009 (secondary data from local fisheries office, in hectares)	2012 (secondary data from local fisheries office, in hectares)	2017 (secondary data from Perhutani office, in hectares)	2017 (primary data from this research, in hectares)
1.	Pakisjaya	4.63	26.48	33.000	11.05
2.	Batujaya	6.73	-	321.700	4.61
3.	Tirtajaya	64.71	65.99	64.707	57.48
4.	Cibuaya	86.05	26.17	1,156.210	39.81
5.	Pedes	-	-	-	-
6.	Cilebar	12.64	13.75	-	80.18
7.	Tempuran	8.67	7.77	-	-
8.	Cilamaya Kulon	7.22	1.21	-	7.88
9.	Cilamaya Wetan	118.91	72.94	-	56.70
Total Area:		309.56	214.31	1,575.617	257.71

From the data resulting from the processing of satellite imagery, the mangrove area interpreted in 2017 was an area of 257.71 hectares, rounded up to 258 hectares. This area was only approximately 3% of the total area of mangrove protected areas in the Karawang Regency spatial planning pattern, locally referred to as RTRW (*Rencana Tata Ruang Wilayah*). Meanwhile, the data from the mangrove area land inventory issued by *Perhutani* (*Perusahaan Hutan Republik Indonesia*), which is the forestry company belonging to the government of Indonesia, located in Forestry Management Area or locally named *KPH* (*Kesatuan Pengelolaan Hutan*) of Purwakarta (including Karawang areas), in 2017 showed that the total area of mangroves in protected areas was only 1,576 hectares or around 18% of the 8,814.93 hectares of total protected area of *Perhutani KPH Purwakarta* located in Karawang Regency. The most severe was seen at Cemarajaya Beach, Cilebar Beach, Sungaibuntu Beach, Pasir Putih Beach, Tengkolak Beach, Tanjung Baru Beach, Muara Baru Beach, and Muara Lama Beach.

Mangrove is an important and rare ecosystem that is increasingly threatened [5, 6]. Loss and damage of mangrove ecosystems has led to a variety of negative impacts on the ecology, economy, and society [7]. The damage to the mangrove ecosystem affects the income of fishermen, which tend to decline, caused by a decrease in the volume and diversity of catches. An average of 56.32% of the types of fish that can be caught by fishermen are becoming rare (hard to come by) and 35.36% of which have even become lost (never again caught). Quantitatively, due to the damage of mangrove ecosystems the fishing income has declined to an average of Rp. 667,562 per month or just 33.89% of the income before the occurrence of the damage [8].

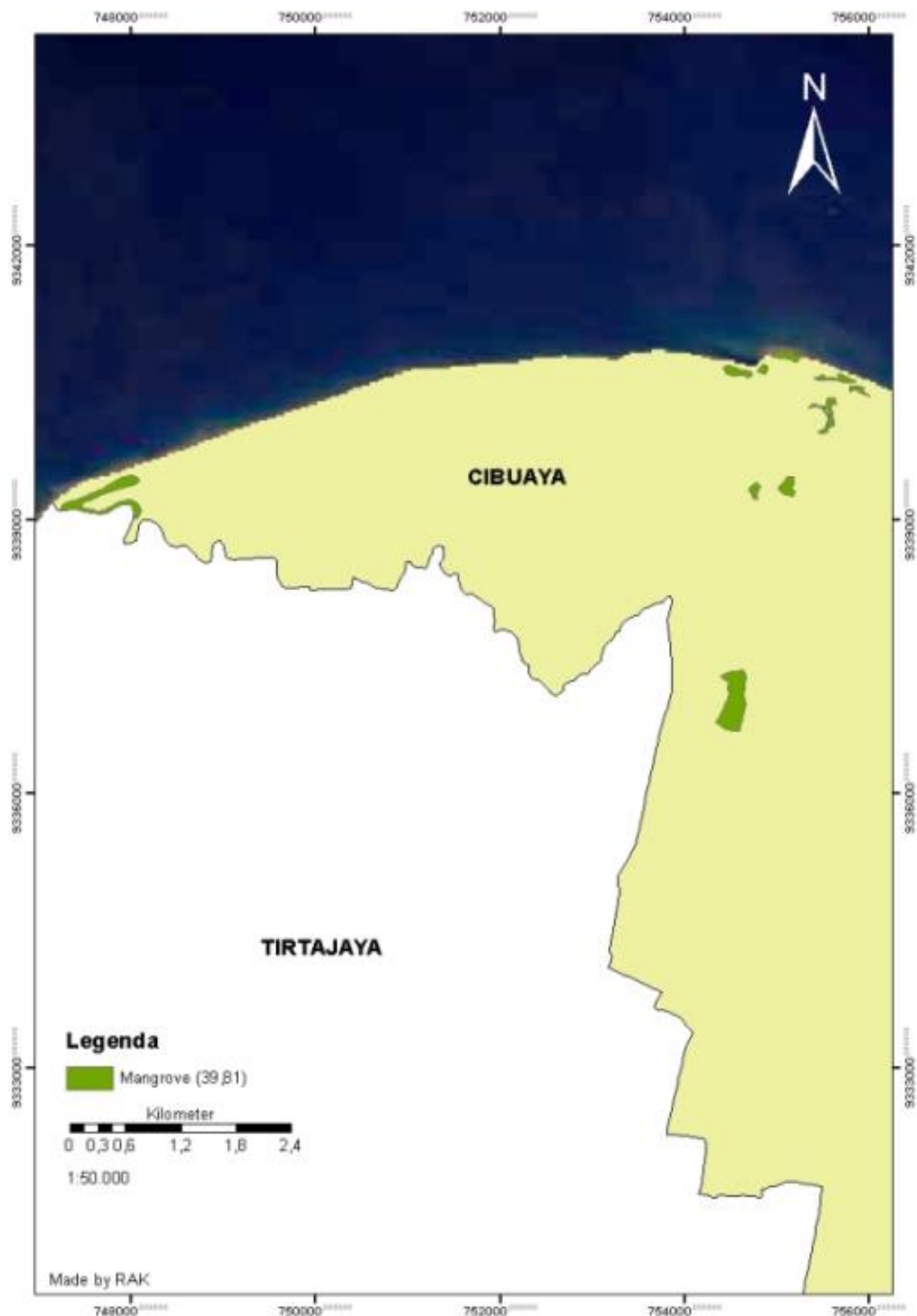


Figure 1. Map of mangrove ecosystem in Cibuaya sub-district in 2017 (green colour is the existing mangrove area).

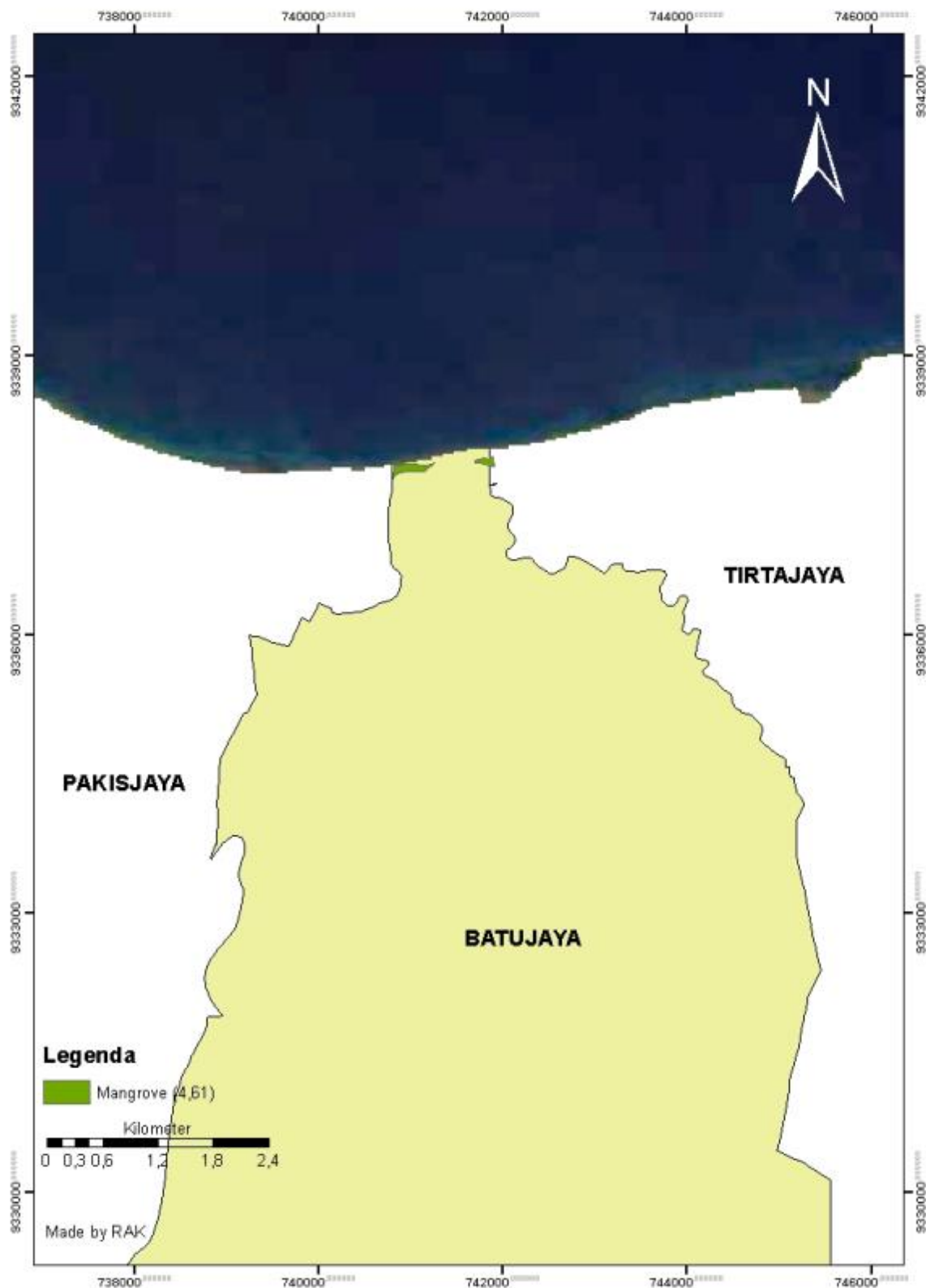


Figure 2. Map of mangrove ecosystem in Pakisjaya, Batujaya, and Tirtajaya sub-districts in 2017 (green colour is the existing mangrove area).

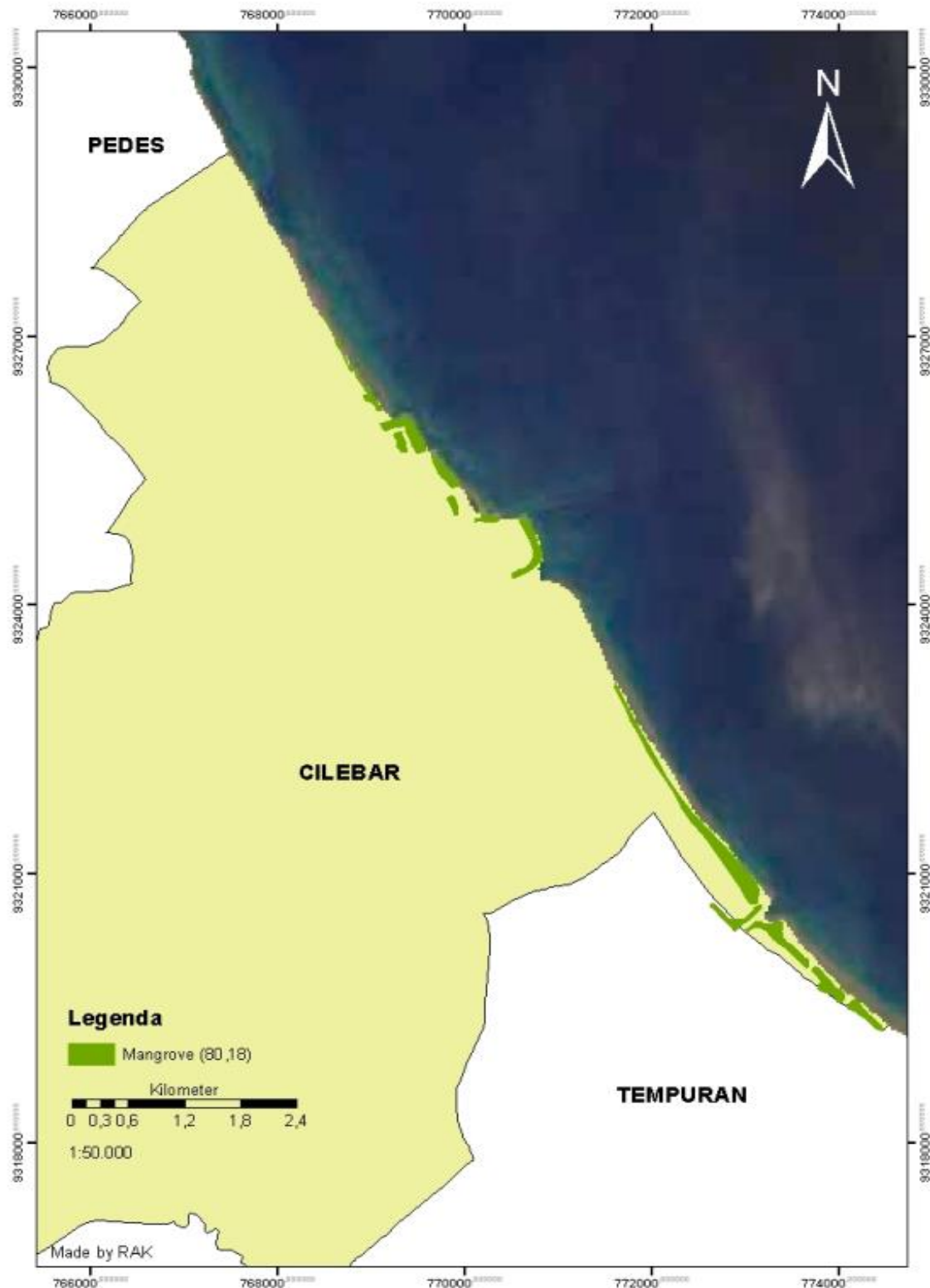


Figure 3. Map of mangrove ecosystem in Cilebar sub-district in 2017 (green colour is the existing mangrove area).



Figure 4. Map of mangrove ecosystem in Cilamaya Kulon and Cilamaya Wetan sub-districts in 2017 (green colour is the existing mangrove area).

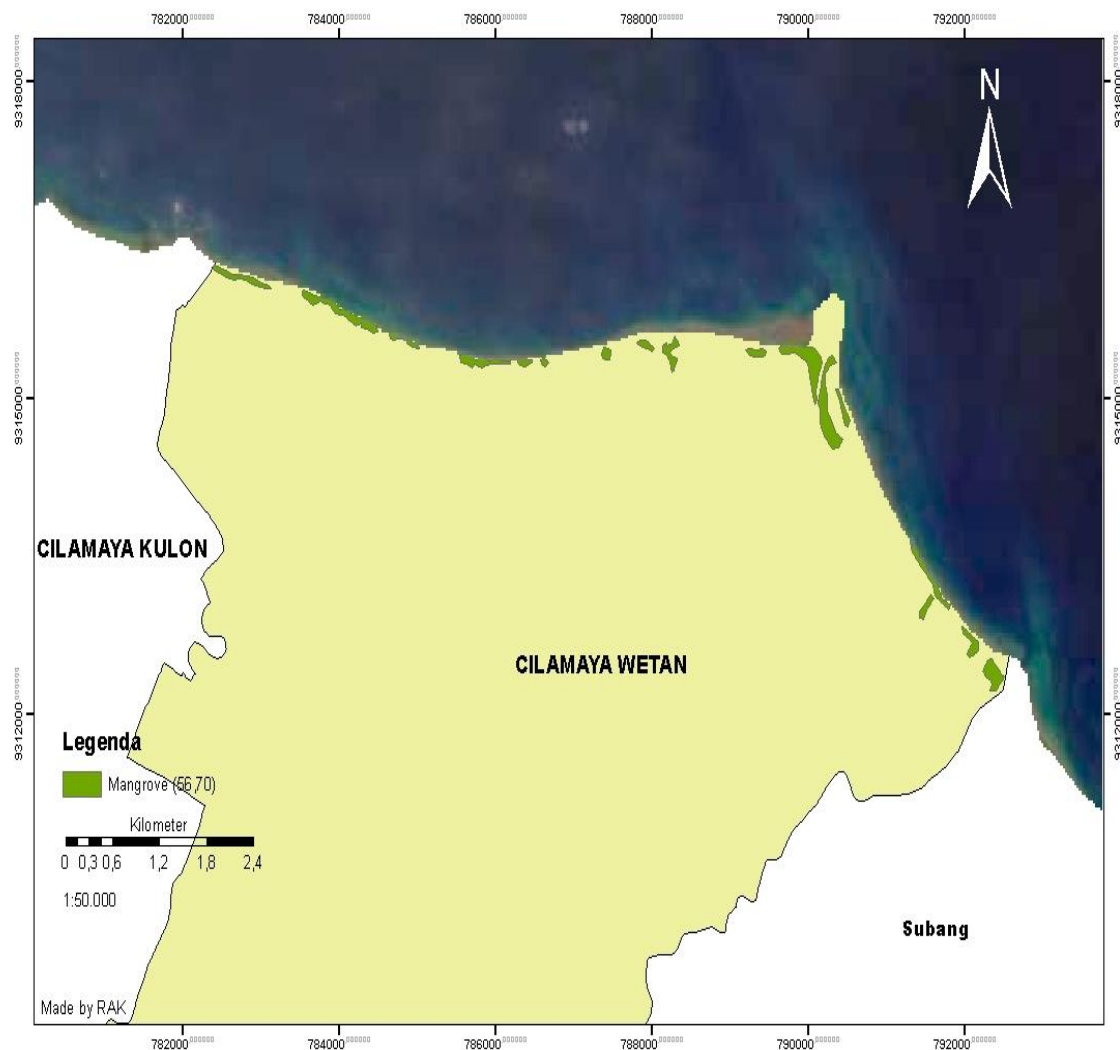


Figure 5. Map of mangrove ecosystem in Cilamaya Wetan and Cilamaya Kulon sub-districts in 2017 (green colour is the existing mangrove area).

The impact of the coastal damage to mangrove ecosystems in the northern part of Karawang coastal areas is currently very worrying at some points where mangrove damages have occurred due to the impact of coastal abrasion, which has caused settlements, plantations, and highways to be eroded by abrasion. In addition to abrasion, the damage to mangrove ecosystems in Karawang Regency was caused by the conversion of land to community residential areas, vacant land, community-owned ponds, grooves, and *Pertamina* (oil company) drill wells.

Ecological problems that arise from the utilization of mangrove ecosystem area for which no aspect preserved include changes in ecosystems, loss of biodiversity, and the pollution of the lowest waters in the surroundings [9]. Please note that mangroves in ecosystems play a role as a filter against pollutant materials in the form of household wastes, oil spills, as well as industrial waste [10]. The ecological changes in the region caused by various forms of utilization of coastal resources tend to be exploitative [11, 12]. Ecological change in shape can be seen from the damage to the mangroves and coral reefs.

The maps of the recent existing mangrove area based on the data from satellite are shown in figure 1-5. The green color in the map is the existing mangrove area (2017) in nine sub-districts in the northern part of the Karawang coastal area totaling 258 hectares.

The data show that the area of mangrove ecosystem has been significantly reduced since 2009. The greatest loss of mangrove area occurred in the sub-districts of Cibuaya, Tempuran, and Cilamaya Wetan, where visible environmental damages were observed.

4. Conclusions

The impact of coastal area damage on the mangrove ecosystem in the northern part of Karawang coastal area is currently quite alarming. There has been mangrove damage due to the impact of coastal abrasion and land use change, such as conversion to community residential areas, vacant land, community-owned ponds, grooves, and *Pertamina* (oil company) drill wells. The five components causing the reduction in the area of mangrove ecosystem in Karawang include capture fisheries, milkfish and shrimp aquaculture, salt ponds, rice farms, and tourism.

The damage of mangrove ecosystems in Karawang regency has significantly occurred since 2009 and has caused the total area of mangrove ecosystem to be reduced, leaving only 258 hectares in 2017. The greatest loss of mangrove area occurred in the sub-districts of Cibuaya, Tempuran, and Cilamaya Wetan, where visible environmental damages were observed.

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