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Spatial Analysis of Coastline Change by Remote Sensing in the North Coast of Karawang Regency

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Abstract. *The existence of the coast in the northern part of Karawang Regency is very worrying. Seawater that was far up to tens of meters from the side of the road, is now on the lip of the road, even some parts of the road are cut off due to abrasion of seawater. Some villages were affected by abrasion erosion. One of the effects of damage due to abrasion and sedimentation is the occurrence of shoreline changes. This change in coastline will affect people's lives and spatial planning for the development of the area. For this reason, this study aims to determine the extent and rate of shoreline changes that occurred on the coast of Karawang Regency in the periods of 1989, 1995, 2001, 2005, 2009, 2016, and 2018. The shoreline data was obtained from the extraction of Landsat 3 MSS, Landsat 5 TM, Landsat 7 ETM +, and Landsat 8 OLI-TIRS after the NDWI process was previously carried out. While the rate of change is calculated at 6 sample point locations scattered along the northern coast of Karawang Regency. The results showed that the largest area damaged by abrasion occurred in Sedari Village covering an area of 166.802 hectares, and the area formed by the largest sedimentation occurred in Muara Cilamaya Village at 276,318 hectares. Meanwhile, the fastest rate of shoreline change due to abrasion occurred in Sukajaya Village at 10 meters /year, while the slowest in Sedari Village at 3.77 meters / year. The fastest sedimentation process in Muara Cimalaya Village is 4.5 meters / year, while the late one in Tanjung Pakis Village is 3.09 meters / year.*

Keywords: *Abrasion, Accretion, Coastline Changes, Karawang*

1. Introduction

The beach is part of a dynamic coastal region, meaning that beach space (shape and location) changes rapidly in response to natural processes and human activities. Factors that influence the dynamic coastal environment include climate (temperature, rain), hydro-oceanography (waves, currents, tides), sediment supply (rivers, coastal erosion), changes in sea level (tectonics, global warming) and activities humans such as beach reclamation and sand mining (Solihuddin, 2006). The sea surface height is increasing gradually and will cover lowlands of the coastal region, icreasing frequency of flooding, abrasion/erosion, seawater intrusion and ecological changes in the coastal region (Loinenak et al., 2015).

The beach always adjusts the shape of its profile in such a way that it is able to reduce the incoming wave energy which is the adjustment of the shape is the natural dynamic response of the beach to the sea (Hidayat, 2012). Often the natural defense of the beach is not able to withstand the attack of sea activity (waves, currents, tides) so that the beach can be eroded, but the beach will be re-formed by the influence of normal waves (Hidayat, 2012). But sometimes the eroded beach does not return to its original shape because the beach-forming material is carried by the current to another place and does

not return to its original place (eroded beach) (Hidayat, 2012).

Coastline is one of the important component in determining the boundaries of a country's territory and regional autonomy. The authority of the provincial area in the sea area is as far as 12 miles from the coastline towards the open sea and or towards the waters of the islands in accordance with Article 1 of Law No. 22 of 1999. Therefore coastline information is needed given that the coastline is dynamic. Due to the dynamic nature of the shoreline, coastline monitoring is needed by periodically making maps of shoreline changes. Shoreline is defined as the line of contact between land and the water body, is one of the most important linear features on the earth's nature (Niya et al., 2013).

The existence of the coastline in the northern part of Karawang Regency is very worrying. Seawater that was far to tens of meters from the side of the road, is now on the edge of the road, even some parts of the road are cut off due to seawater abrasion. Some villages affected by seawater erosion (abrasion) include, Pusakajaya Utara Village, Cemara Jaya Village, Pisangan Village, Suka Jaya Village and Sungai Buntu Village. At this time there is abrasion and sedimentation that will damage nature, even can also damage community life. According to Halim et al. (2016), the beach is said to experience abrasion when the sediment transport that occurs to a point is greater than the amount of sediment transported out of that point. One of the impacts of damage caused by abrasion and sedimentation is the change in coastline that occurs in the area. This change in coastline will affect people's lives and spatial planning for the development of the area.

The technology that is often used in monitoring shoreline changes is to use remote sensing technology through satellite image recording (Halim et al., 2016). Coastal changes can be monitored using remote sensing satellite technology, on a multi-temporal basis. The image is analyzed to see changes in the coastline. By combining the results of multitemporal image analysis and expert knowledge, the process of shoreline change can be measured / observed in detail (Chand & Acharya, 2010). This study aims to analyse the coastline changes of Karawang Regency by using satellite imagery.

2. Methodology

The research conducted in Karawang regency beach located in the northern part of Karawang district which borders directly with the Java Sea. The location of sample points is spread over 6 points, namely in 6 sub-districts located along the Karawang coast, namely the districts of Cilamaya Wetan, Cilamaya Kulon, Cilebar, Cibuaya, Tirtajaya and Pakisjaya. This location is an area where the beach is damaged due to abrasion and accretion.

The data used in this study are coastlines in 1989, 1995, 2001, 2005, 2009, 2016, and 2018 which were extracted from satellite imagery of Landsat 3 MSS, Landsat 5 TM, Landsat 7 ETM +, and Landsat 8 OLI / TIRS. Satellite imageries were obtained from the website earthexplorer.usgs.gov. The processing of shoreline data from Landsat satellite imagery is assisted by the NDWI (*Normalized Difference Water Index*) method to clearly distinguish the boundary between land and sea (Alesheikh et al., 2007). NDWI is an index that shows a degree of wetness. The formula for NDWI can be seen in Figure 1 below.

$$NDWI = \frac{(\text{Green}-\text{NIR})}{(\text{Green}+\text{NIR})} \quad \ldots\ldots(1)$$

Where NIR is a near-infrared wave and Green is a green band wave. This formula is adjusted for each Landsat image used, because the wave spectrum can be different in each Landsat image. The values of NDWI greater than zero are assumed to represent water surfaces, while values less than, or equal, to zero are assumed to be non-water surfaces (McFeeters, 1996)

Then, shoreline digitization is carried out manually in each year recording different images, so that a total of seven coastlines is produced. After that, an overlay is carried out to see which areas and at what rate changes the coastline changes in the form of abrasion or accretion occur. To validate the results of data processing, a field survey was conducted to the location of abrasion and accretion sample points to see the condition of the coastline, and interviews with local residents.

3. Result and Discussion

From the digitization and overlay results of the seven coastlines, a total of six sample points were scattered along the north coast of Karawang Regency, namely in Muara Cilamaya Village, Sukajaya Village, Pusakajaya Utara Village, Sedari Village, Tambaksari Village, Desa Tanjungpakis. The extent of abrasion and accretion at each sample point location will be explained in the following discussion.

3.1 Muara Cilamaya Village

In this area a sedimentation process took place with a coastline change distance of 130.63 meters with a rate of change of 4.50 m / year, while the area of sediment formed was 276,318 ha. this can be caused by the large number of mangrove ecosystems in the area, resulting in significant accretion (Fig.1).

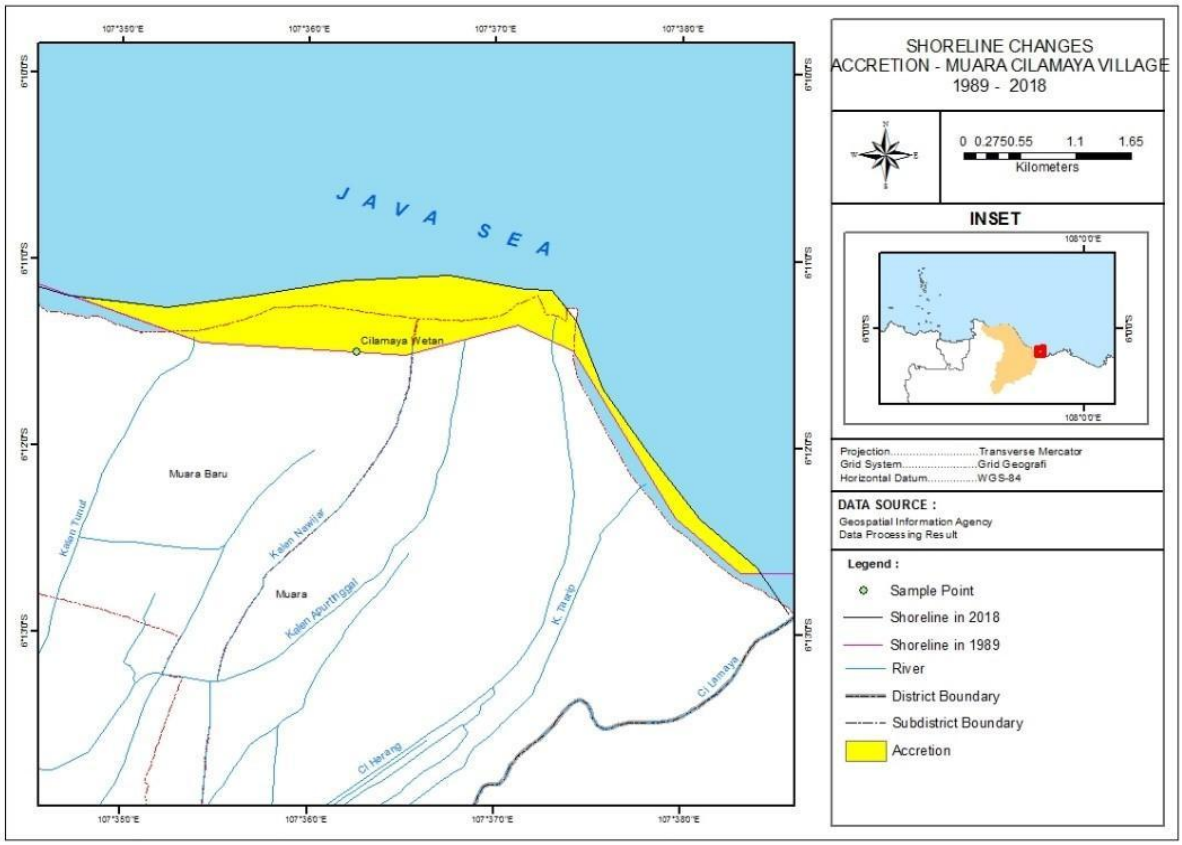

Figure 1. Changes in Shoreline in Cilamaya Village

3.2 Sukajaya Village

In this region an abrasion process has occurred with a coastline change distance of 290.13 meters with a change rate of 10.00 m / year while an abrasion area of 56,963 ha has occurred. (Fig. 2).

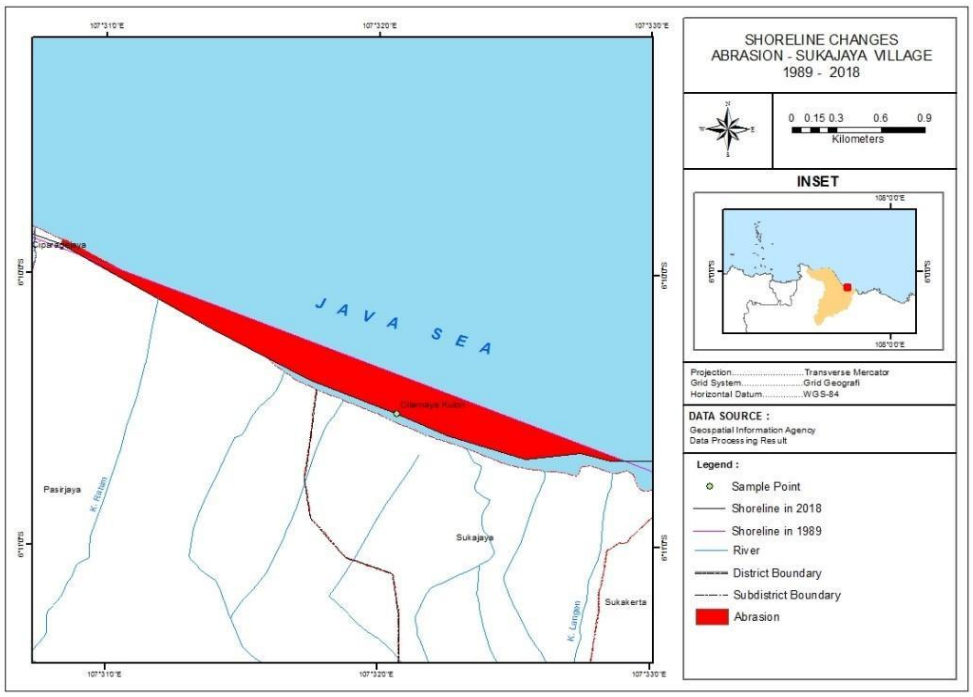

Figure 2. Changes in Shoreline in Sukajaya Village

3.3 Pusakajaya Utara Village

In this area there has been an abrasion process with a coastline change distance of 119.14 meters with a rate of change of 4.11 m / year while an area of abrasion that occurred amounted to 33,929 ha. (Fig. 3)

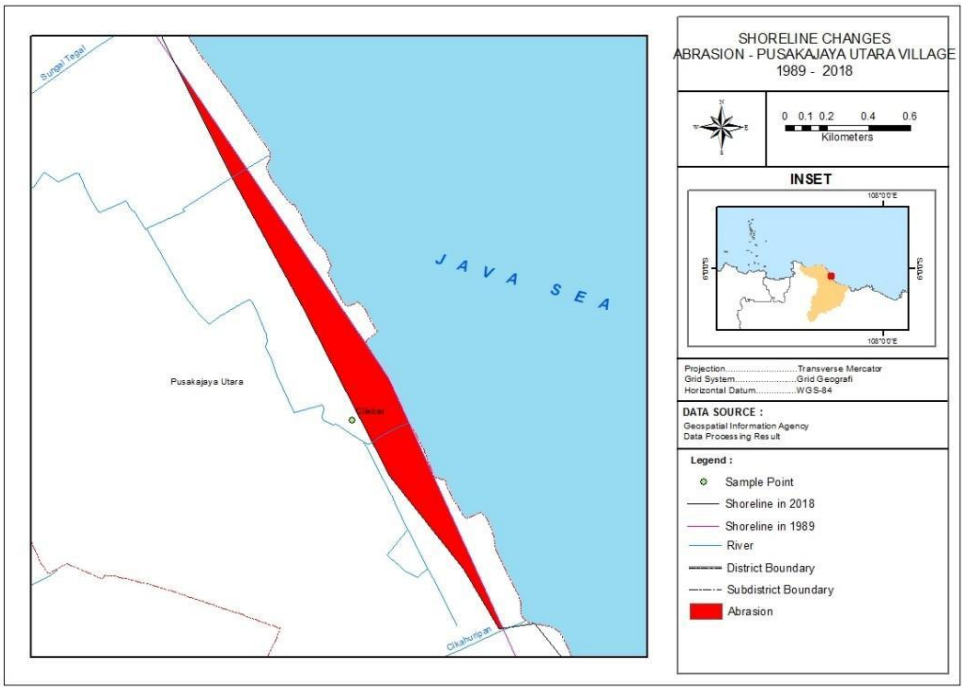

Figure 3. Changes in Shoreline in Pusakajaya Village

3.4 Sedari Village

In this region an abrasion process has occurred with a distance of 109.3 meters shoreline change with a change rate of 3.77 m / year while abrasion area that occurs is 166,802 ha. the existence of shoreline currents and waves along the north coast of the Karawang regency can be one of the reasons this region is the worst affected area due to the direction of the beach. (Fig. 4)

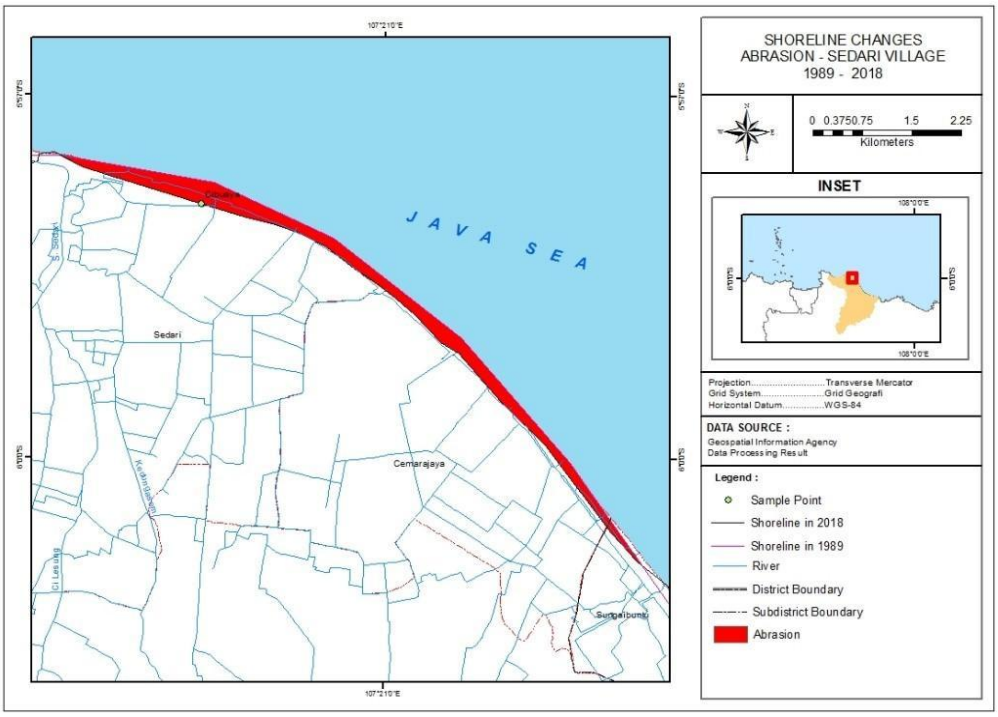

Figure 4. Changes in Shoreline in Sendari Village

3.5 Tambaksari Village

In this area there has been an abrasion process with a change in coastline distance of 273.87 meters with a rate of change of 9.44 m / year while the abrasion area of 60.126 ha. (Fig. 5)

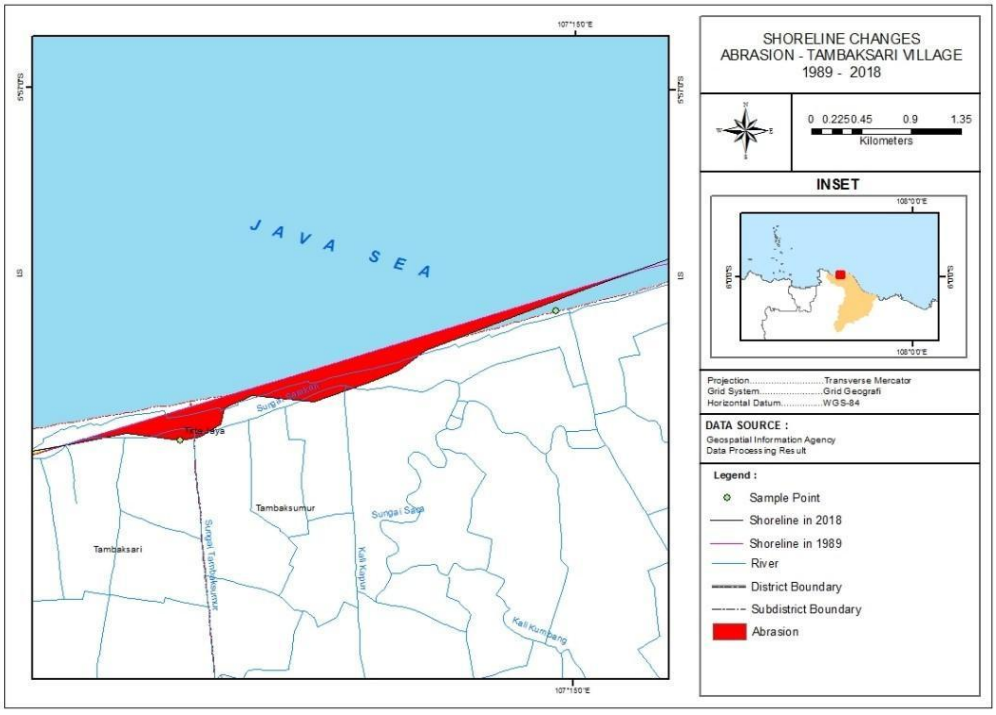

Figure 5. Changes in Shoreline in Tambaksari Village

3.6 Tanjungpakis Village

In this area a sedimentation process took place with a distance of coastline change of 89.72 meters with a rate of change of 3.09 m / year while the area of sediment formed was 101.463 ha. accretion can occur due to the supply of sediment brought from the river and deposited at the site of the accretion (Fig. 6)

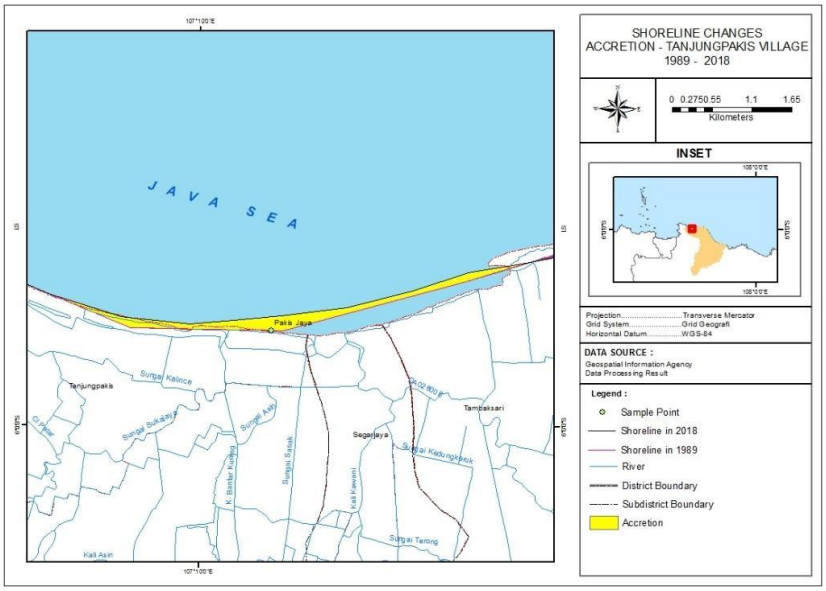

Figure 6. Changes in Shoreline in Tanjungpakis Village

Based on the previous explanation it can be seen that along the coast of Karawang regency there has been a change in the coastline caused by abrasion and sedimentation processes. From 6 locations observed, the abrasion process was more common than sedimentation. From observations of Landsat imagery for 29 years (1989-2018) change of distance, speed and abrasion and sedimentation vary widely throughout the year.

Changes within a large coastline is in the village Sukajaya namely along the 290.13 m. The speed of shoreline change is also different, the fastest change in coastline location occurs in the village of Sukajaya at 10.00 m / year. For the large area of abrasion and sedimentation that occurred, the largest area of abrasion is located in Sedari village which is 166,802 ha while the largest area of sedimentation occurred in Muara Cilamaya village of 276,318 ha. Furthermore, the magnitude of the distance and speed of coastline changes and the area that occurs can be seen in the table below.

Table 1. Speed and Area of Coastal Change at each location

No	Village	Subdistrict	Type of Shoreline Changes	Change Distance (m)	Change Speed (m/yr)	Wide (Ha)
1	Muara Cilamaya Village	Cilamaya Wetan	Sedimentation	130.63	4.5	276.318
2	Sukajaya Village	Cilamaya Kulon	Abrasion	-290.13	-10	56.963
	Pusakajaya Utara Village	Cilebar	Abrasion	-119.14	-4.11	33.929
4	Sedari Village	Cibuaya	Abrasion	-109.3	-3.77	166.802
5	Tambaksari Village	Tirtajaya	Abrasion	-273.87	-9.44	60.126
6	Tanjung Pakis Village	Pakisjaya	Sedimentation	89.72	3.09	101.463

Note: the '-' sign is an abrasion process, '+' is an sedimentation proces

4. Conclusion

The shoreline changes occurred due to abrasion and sedimentation (accretion). Based on the 6 village locations observed and analysed using satellite imagery data, 4 villages experienced more abrasion, while 2 villages experienced sedimentation. Abrasion occurs most severely in the characteristics of the coast in which the direction in front of it supports for the occurrence of shoreline along the coastline. This region is located in the central part of Karawang district. Abrasion can also be caused by waves and tides. while for accretion, it occurs in areas with many river mouths, compounded by the massive mangrove ecosystems contained in the region. Natural mitigation efforts are carried out by planting coastal plants such as mangroves, shrimp fir or building structures that hold currents and waves such as breakwater, groynes, jetties and others.

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