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Morphodynamics Model of Comaldelta In Coast Of North Central Java

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Abstract
North Coastal Region of Central Java many river deltas grow and develop relatively quickly.This study aims to analyze the morphodynamic model of the Delta region on the north coast of Central Java with remote multi-temporal remote sensing techniques in 1972, 1992, 2002 and 2017. This research is descriptive-explanatory, which is trying to find the widest possible data for example to study the dynamics of Delta, and trying to explain the relationship between the factors that influence it. In support of the study, Landsat satellite imagery, Bumi Bumi Indonesia Map, ER Mapper 7.0 software, GIS Arc, GPS, and other field equipment were used. The results showed that the development of Delta Comal tends to be shaped (cuspate) and narrowed. This narrowing is not due to abrasion factor but due to wave and current factors that distribute the sedimentary material of the river to the west side as well as to the east side of the Delta.

Keywords: Morphodynamics, Delta, Remote Sensing

1. Introduction

Delta is an encounter area of freshwater and salt water, the carrying nutrient promotes high ecological processes and water productivity, making deltas a vital role both in biodiversity and socio-economic roles due to the abundance of resources and as a place various other activities such as industry and transportation. According to Reineck and Singh (1975) is the mass of both subaerial and submerged sediments that are deposited on the body of water (sea or lake) primarily by river activity. In the dictionary of Oceanography (Setiyono, 1996) explained that the delta is a sediment derived from the land that formed in the mouth of the river bordering the sea or lake. Then Selby (1985) defines the delta as a nearly flat plain, located at the mouth of the river where sediment deposits accumulate. Wright (1978) defines the delta as an area of accumulation in the coastal region, both subaqueous and subaerial, the material derived from river deposits and secondary sediments from the sea formed by various agents, such as waves, currents or tides.

The long-lasting sedimentation forms the delta on the north coast of Java. The process of development of the delta region is quite dynamic, sometimes experiencing relatively rapid growth so that emerging land arises, but sometimes experience the abrasion process so that the coastline reverse backward towards the mainland.

Research related to delta morphodynamics has been done in many coastal areas of Indonesia. The methods used to determine changes in coastal dynamics also vary from field studies, such as Bird and Ongkosongo (1980), Sidarto (1997 on Sanjoto, 2012) or remote sensing methods such as Saptorini (2001), Dewayani (2005), and Subagio (2007).

The delta region, which is part of the coastal region, has also tended to face ecological pressures and received less serious attention to overcome the damage caused by both humans and nature. According to Kusumastanto (2007), delta damage occurs mainly due to sedimentation, pollution, declining habitat quality and biodiversity

North Coast of Central Java there are many river deltas with varying extents depending on the size of the river. Some of the relatively large and extensive river deltas are the Comal River Delta, the Bodri River Delta, and the Wulan River Delta. The three deltas have different shapes and varying morphological (morphodynamic) developments. The problem facing the delta area is a fairly high morphodynamic process. In some places increasingly expanding towards the sea (acres) as a result of a large sedimentation process, but in other places there are coastal areas experiencing the opposite problem of abrasion (Bird and Ongkosongo, 1980).

The morphodynamics delta needs to be monitored so that the geomorphic process that takes place there does not interfere with the social activities of the local economy to safeguard the interests of development sustainably. One effort to monitor the development of the Delta can be made by using remote sensing technology. Remote sensing technology has the advantage of ease in the spatial analysis because large areas can be covered in one scene only. Remote sensing technology can also be used to analyze the quality of the waters of the coastal delta

region.
Objects in the imagery of remote sensing also make it easier to think spatially to assist in the analysis of interconnectedness of space which in this case is the relationship between the upstream, the middle, downstream of the watershed with dynamic coastal processes that occur in the Delta region. Data and information on Delta and marine resources can be obtained by utilizing remote sensing technology. Another advantage of the use of remote sensing imagery (sensing) in this study is the acquisition of multi-temporal object information so that it can be reviewed and analyzed its development.
Research on Delta area management is significant because most of the economic growth centers in Java are located in the coastal area of North Beach. Therefore, the study of Delta Comal morphodynamics in North Coast of Central Java needs to be done.

2. Research Method

The study will be conducted from March to October 2017. Research sites in the Delta River Comal. Administratively the research area is located in Pemalang District and Pekalongan Regency with administrative boundary is Comal River. To know the change of Delta coastline, the research material needed in the form of topography map scale 1: 25.000 the year 2000 and Landsat Imagery acquire year1992, year1997, year2002, year2007,. year2012, and. year2017. For data processing used software ER Mapper 7.0 and ArcGIS 13, while for field validation used GPS, binoculars. The first step is to make a geometric correction on remote sensing imagery used in this research is Landsat Path 120 Raw 65, acquisition results in year1987, 1992, 1997, 2002, 2007, 2012 and 2017. The first step in image processing activity is to make geometric correction firstly on 7 images used to equate the position of the coordinates of the same object in the image, so that when done overlay on the three images is not the same shift object. Of the 7 satellite imagery used in this study, the image of 2002 is a corrected image and will serve as the basis for making corrections on other images. In performing geometric corrections are taken 20 control points (GCP = Ground Control Points). Here is an example of image correction results in 1987 based on the image of 2002 that has been corrected. From the result of geometric correction, it can be known that the RMS (Root Mean Square) value is smallest 0.11 and 2.07. Analysis technique to know spatial change of Delta Comal shoreline is used overlay time series data technique with ER Mapper 7.0 software. The use of this method because the data processing is relatively simple and can involve all data at once, so that the shoreline changes between time can be observed interactively. From the view of the above data processing results it will be able to do further analysis related to changes in land cover and local ecosystems. Areas that have abrasion and sedimentation can be identified spatial distribution and intensity.

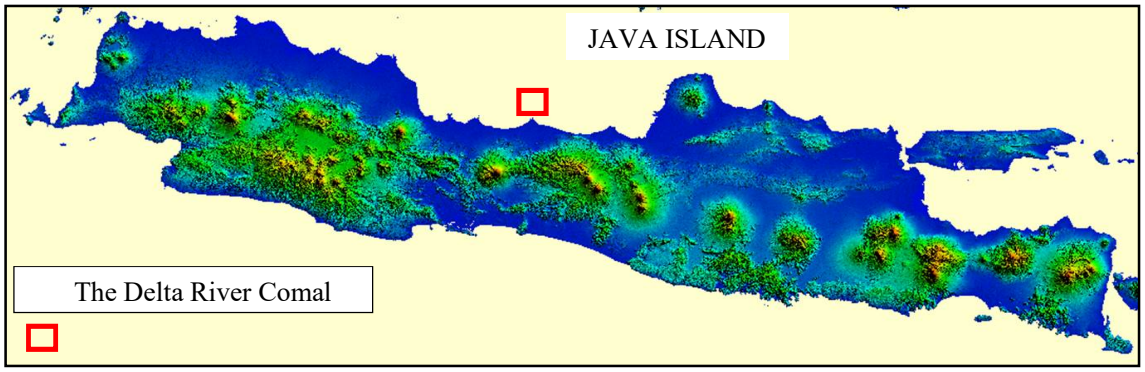

Figure 1. The location of study

3. Result and Discussion

1. Overview of Delta Comal

Delta Comal is located in the northern coastal area of Central Java composed entirely of contemporary sediments of sand beach, mudflats and mangroves. The shoreline is relatively straight-tapered (cuspate). This indicates that sea wave activity is quite responsible for the process of change and the formation of beaches, in addition to tidal factors and others.
The mapping of the Delta Comal coastline was done by Prijantono et al (2009) using the image of 1964, 1980, and 1988. Aeriel Photograph and field measurements along the coast of Tegal, Pemalang and Pekalongan

districts showing changes in the coastal line of Comal. The shoreline data from the Remote Sensing Image of the 1964 Aeriel Photography until 1988, it is clear that the shifting of the estuary develops eastward. From coastline data based on aerial photographs of 1964, the shape of the Comal estuary extends deeply into the sea and curves westward, so the sedimentary material transported by the Comal River is practically deposited west of the estuary.

The coastline of 1964 aerial photograph data of the Comal estuary area has one mouth of the estuary, and in 1988 it changed the estuary of the Comal river into three mouths of the estuary, each of which forms a delta to the north. The shape of the shoreline seems to be changing as the land more widely widens eastward, and nowadays the increase of land at the mouth of the river Comal has been utilized by the farmer's community as a pond business.

2. Comal Delta Morphodynamics

Over the next five years, **from 1987 to 1992**, Delta Comal underwent a complicated morphodynamic, both in the shape of its estuary and the extent and length of its coastline. From the Landsat image of 1988 shows that the two branches of the Comat Stream, which one leads to the northwest while the other leads to the north. Furthermore, in the 1992 Landsat image it shows that the estuary channel of the northwestern Comal River is not functioning, so the channel is fused all northwards. Consequently the development of the Delta Comal from 1987 to 1992 tended toward the north (figure 2).

This morphological change also affects the changes in the extent and length of the shore. Based on its extent, during 1987 to 1992 it expanded to 67.68 ha or an average of 13.53 ha per year with dominance in the Accretion process. Distribution process of Accretion include the area of Village Mojo and Village Limbangan, some other urban also have accretion process but the extent is not very significant if compared with the urban village of Mojo and Limbangan. The dominant area of the abrasion process is in the Kendaldoyong and Pesantren districts, to be more explicit about the distribution of regions experiencing abrasion and accretion process can see the map on (figure 4). About the length of the beach, over the course of 5 years, the coastline has grown shorter to 3.93 km or an average of 0.78 km per year. This coastline reduction is due to the Delta coast's morphological form being tortuous due to abrasion.

Figure 2. Images of the Comal River Delta in year 1987 (left) and 1992 (right)

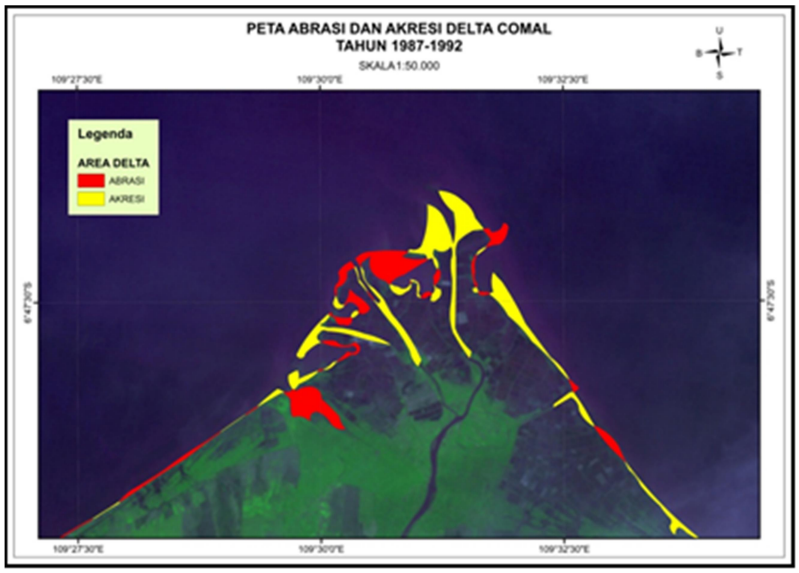

Figure 3. Map of Abrasion and Accretion Areas 1987 - 1992 The Comal River Delta

Later in the period **1992 to 1997** (for the next five years), Delta Comal's morphodynamics was quite complicated only at the mouth of the river, as a result of reduced material intake to the western and northwestern sides. This resulted in a rather high abrasion process in the area. On the contrary the river estuary to the north spills its sedimentary material to the north so that, as a whole, the shape of Delta Comal in 1997 is tapered. Changes in the shape of the estuary and the extent and length of the coastline also changed. From the Landsat image of 1992 shows that the origin of the northernmost Delta Comal was slightly convex, whereas the appearance in 1997 knew that the convex area actually had Abrasion so that it was concave (bay) (see figure 4).

By extent, during 1992 to 1997 it increased to 100.04 ha or an average of 20.00 ha per year with dominance in the Accretion process (same as previous period). The distribution of abrasion and accretion process is still the same as the previous period covering the urban areas of Mojo and Village Limbangan. The dominant area of the abrasion process is in Kendaldoyong and Pesantren districts, to be more explicit about the distribution of regions experiencing abrasion and accretion process can see the map in (figure 5). Then associated with the length of the beach, during the period of 5 years coastline also increased short reaching 8.31 km or an average of 1.66 km per year. The reduction of this coastline due to the Delta coast's morphological form becomes more winding due to abrasion.

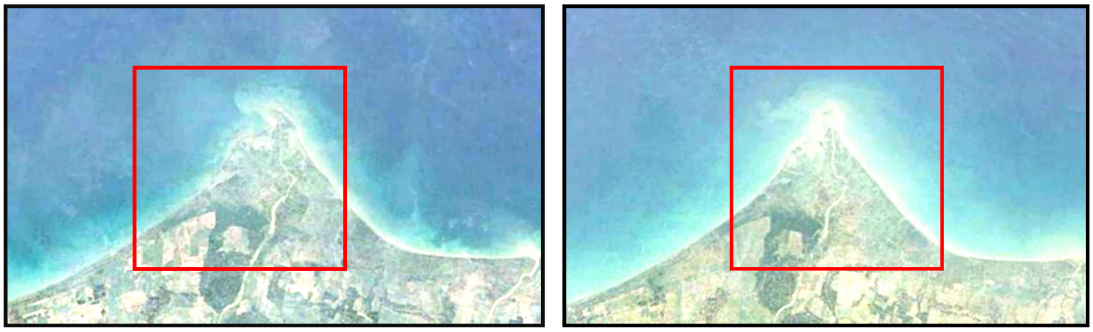

Figure 4. Images of the Comal River Delta in yaer 1992 (left) and 1997 (right)

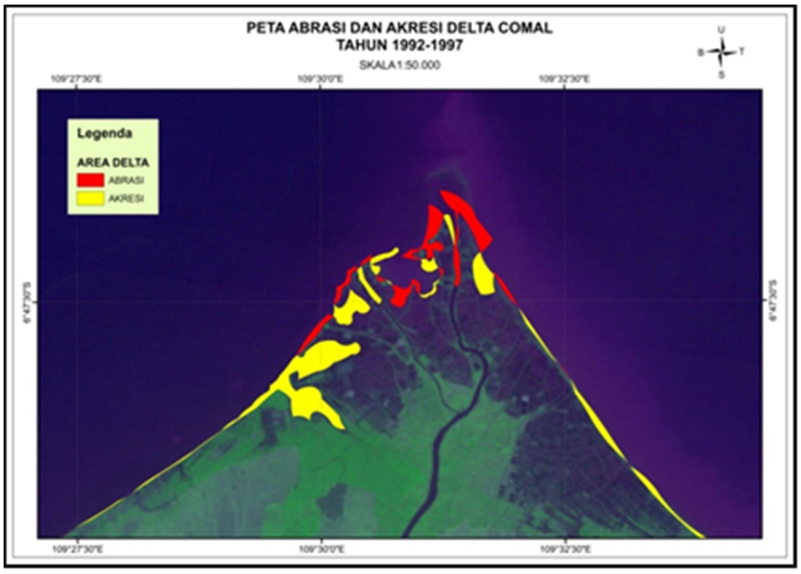

Figure 5. Map of Abrasion and Accretion Areas 1992 - 1997 The Comal River Delta

Subsequently, from **1997 to 2002** (over the next five years), the complex morphology of Delta Comal was still at the mouth of the river. The western and northwestern channels of the Comal River, which were not functioning at first, in 2002 the image seems to be functioning again. As a result material intake to the western and northwestern sides of the Delta began to fill the gaps of sedimentary material in the area. However, to cover the location of abrasion in the area still requires time, this is because some of the sediment material is also carried alongshore current (longshore current). From Landsat's image in 2002 also seen the flow of the river estuary to the north still shed its sedimentary material to the north, so the overall shape of Delta Comal in 2002 tapered. From the 1997 Landsat image shows that the area undergoes an abrasion so that the concave (bay) looks the same in 2002 (see figure 6).

By extent, during 1997 to 2002 it narrowed to 81.22 ha or an average of 16.24 ha per year with dominance in the Abrasion process. The distribution of the Abrasion process includes the areas of Pesantren, Mojo and Limbangan Village, as seen in (Figure 8), namely the map of the distribution of abrasion and accretion areas. Then associated with the length of the beach, for the period of 5 years coastline also increased in length reaches 1.32 km or an average of 0.26 Km per year. This coastline increase due to the Delta coast's morphological form becomes more winding due to abrasion.

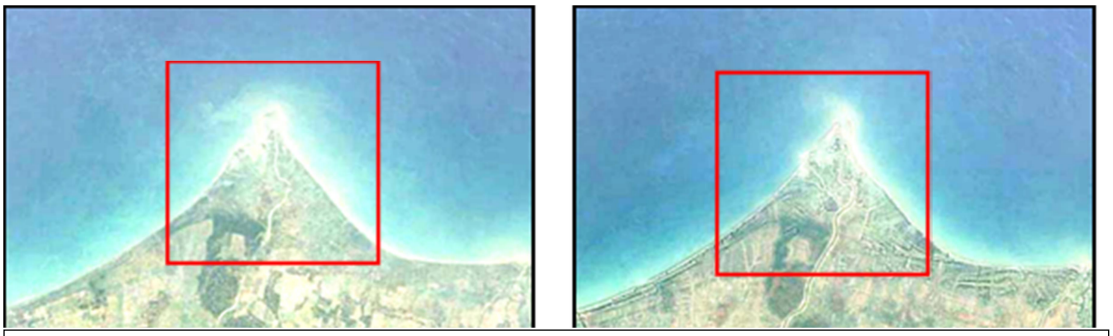

Figure 6. Picture of the Comal River Delta in year 1997 (left) and 2002 (right)

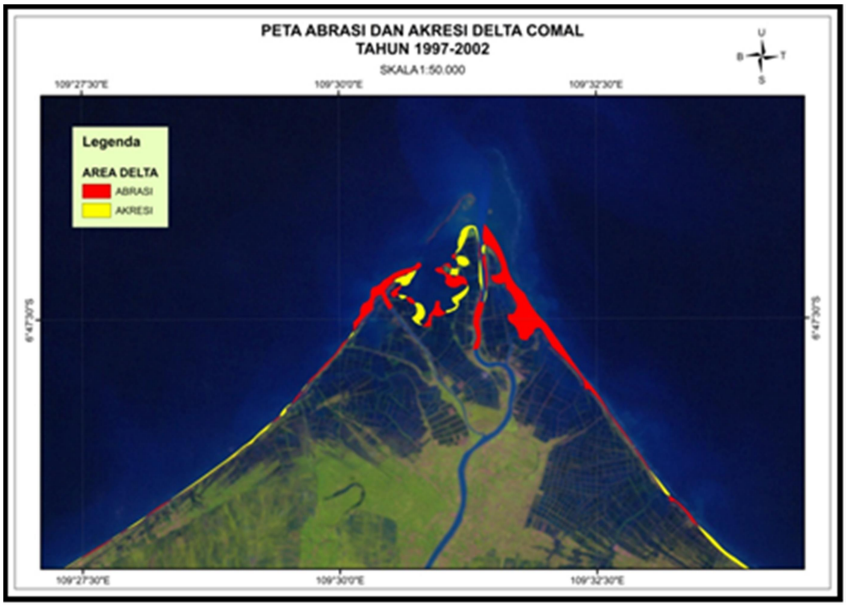

Figure 7. Map of Abrasion and Accretion Areas 1997 - 2002 River Delta Comal

From **2002 to 2007** (for five years), Delta Comal's morphodynamics was relatively stable. No significant changes. The Channel of the Comal River to the west and northwest still seems to function. Nevertheless, to restore the previously abbreviated land still requires time, so the end of the northwestern delta is still a concave/bay. This proves that the sediment material from the flow of the river to the northwest is carried along longshore currents to the southwest, while the sediment carried by the flow of the river Comal to the north much distributed to the east-southeast. For the material deposited in the mouth of the Comal estuary is relatively small (see figure 8).

Based on the extent, during 2002 to 2007 experienced a considerable expansion of 80.49 ha or an average of 16.09 ha per year with dominance in the process of Accretion. The distribution of the accretion process is dominated in Mojo urban area to more clearly understand the distribution of abrasion and accretion areas can see (figure 10) below. Related to the length of the beach, during the period of 5 years coast line also increased in length reaches 0.62 km or an average of 0.12 km per year. This coastline increase is due to the Delta coast's morphological form becoming more winding due to accretion or abrasion in the area.

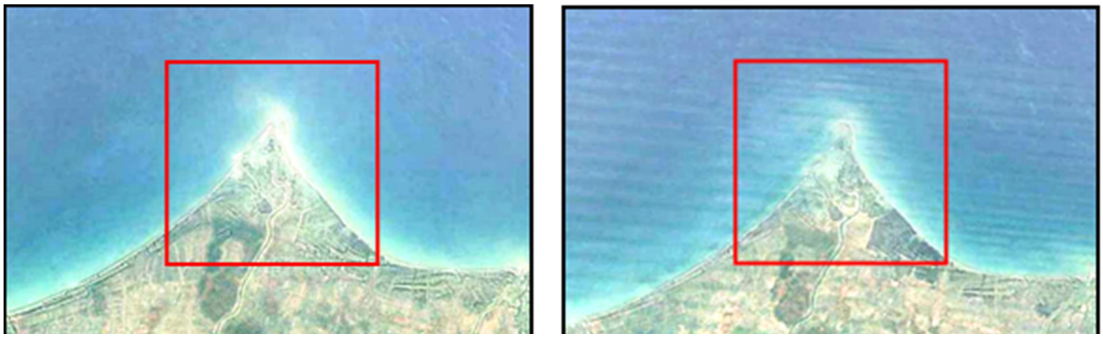

Figure 8. Images of the Comal River Delta inyear2002 (left) and 2007 (right)

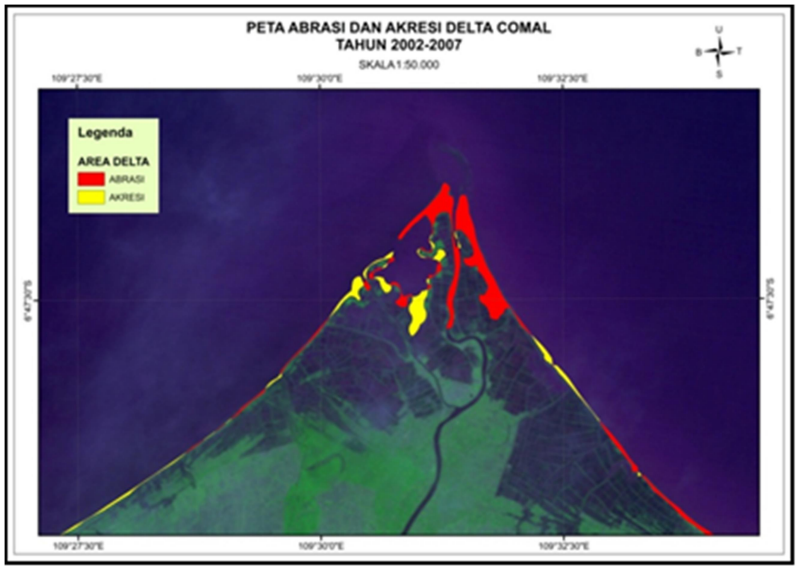

Figure 9. Map of Regional Abrasion and Accretion 2002 - 2007 River Delta Comal

In the period **2007 to 2012** (for five years), Delta Comal morphodinamic is still relatively stable. The channel of the Comal River to the west and northwest seems to be functioning but has not been able to restore the shoreline. Therefore the tip of the northwest delta is still concave / bay. This proves that the sedimentary material from the flow of the river to the northwest is still many longshore currents drifted to the southwest, while the sediment carried by the flow of the river Comal to the north much distributed to the east-southeast. However, the process of sedimentation of the delta growth to the north seems to run effectively so that the shape of the delta is more pointed (see fig 10)

Based on the extent, during 2007 to the year 2012 narrowed to 13.08 ha or an average of 2.61 ha per year with dominance in the process of Abrasion. The distribution of abrasion process as shown in (figure 12) above includes the urban areas of pesantren, sub-district mojo and sub district limbangan. Then associated with the length of the beach, during the period of 5 years coastline also increased in length reaches 0.12 km or an average of 0.024 km per year. This coastline increase due to Delta coast morphology form becomes more winding due to abrasion and accretion that goes balanced.

Figure 10. Picture of the Comal River Delta inyear 2007 (left) and Year 2012 (right)

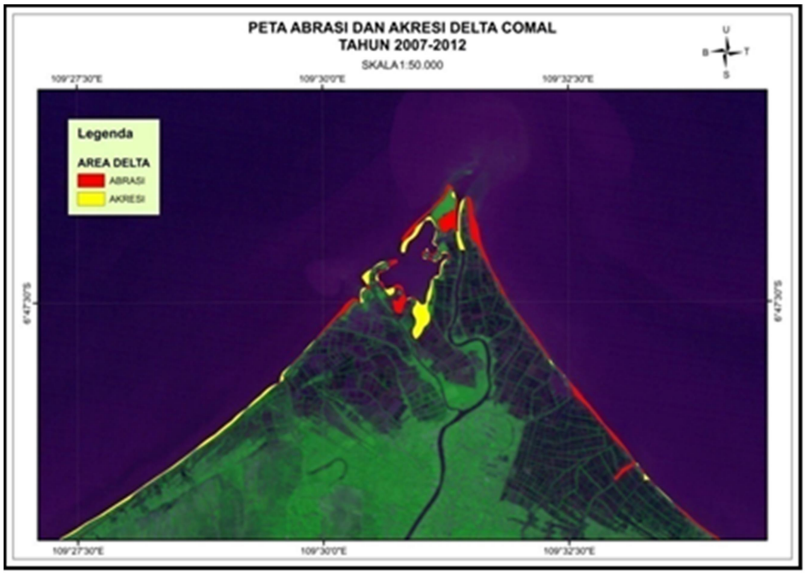

Figure 11. Map of the Abrasion and Accretion Area of the 2007 - 2012 Delta of the Comal River

In the period of **2012 to 2017** (over the last 5 years), Delta Comal's morphodynamics are still relatively stable. The channel of the Comal River to the west and northwest, seems to be functioning but has not been able to restore the shoreline. Therefore the tip of the northwest delta is still concave / bay. However, when the field check, the condition of the land has been sedimentation. This proves that the sediment material from the stream of the Comal river partially settles on the land. For sediments carried by the Comal river to the north are distributed to the north of the estuary and partly to the south-east. Nevertheless, the process of sedimentation of the delta growth to the north seems to run effectively so that the shape of the delta is sharper. Sedimentation land has been overgrown with mangrove so it indicates that it is mature enough and stable (see Figure 12)
Based on its extent, during 2012 to 2017 it has expanded to 25.32 ha or an average of 5.06 ha per year with dominance in the Accretion process. The distribution of the accretion process includes the urban areas of pesantren and sub-district mojo for more clearly related to the distribution map of affected areas of accretion and abrasion can be seen in (figure 14). Then associated with the length of the beach, during the period of 5 years coastline also increased in length reaches 11.76 km or an average of 2.35 km/year.

Figure 12. Picture of the Comal River Delta ofyear 2012 (left) and Year 2017 (right)

Figure 13. Map of the Regional Abrasion and Accretion of 2012 - 2017 Delta of the Comal River

3. Trends of Comal Delta Morphodynamics 1987 to 2017

Comal Delta morphodynamics shows dynamic dynamics both regarding the extent and length of the coastline. While from the aspect of the form then the delta Comal remain unchanged that is in the form of CuspateDelta. The Delta cuspate form indicates that the marine power of Wave and longshore current is relatively dominant. This resulted in the material of the river deposits in the estuary distributed so that the accumulation of material is rarely encountered.

From the aspect area of Delta Comal experiencing an inclination that tends to widen the 1987 area of 3325.02 ha to an area of 3504.25 ha in 2017. The analysis results with the trendline line shows the linear line equation for:

y = 5,0673x - 6702,3with determinant value **R^2 = 0,657**

From the long aspect of the Delta coastline it appears that the length of the shoreline actually grew longer. This is due to the abrasion process and the accretion that took place to make the irregular chopping line irregularly so as to extend the coastline. The longest coastline occurs in 2017, which is 40.08 kilometers long. For more clearly can be seen in table 1 below, while the graph of linear equations of development of the Comal Comal can be seen in Figure 15 below.

Table 1. Morphodynamic Coastal Delta Line Comal Year 1987 and Year 2017

No	Year	Area (Ha)	Length (km)
1	1987	3325,02	38,48
2	1992	3392,70	34,55
3	1997	3492,74	26,24
4	2002	3411,52	27,56
5	2007	3492,01	28,18
6	2012	3478,93	28,31
7	2017	3504,25	40,08

Source: Results of Research Processing, 2017

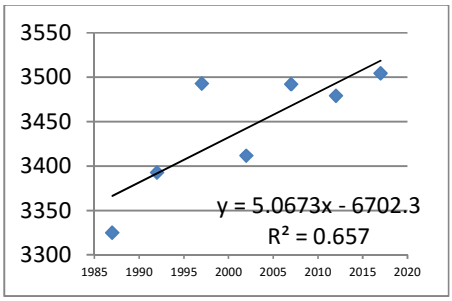

Figure 14. Graph of Broad Developments of Delta Comal Th. 1987-Th 2017

4. Conclusion

Comal Delta morphodynamics are quite dynamic and tend to expand. The most notable extent of expansions occurred between 1987 and 1997. This indicated that the management of the Comal Basin at that time was poor. Although it is getting wider, but the form of Delta Comal is relatively fixed, it is made of cuspate deltas.The Delta Cuspate form indicates that the marine power of Wave and longshore current is relatively dominant.

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