

Analysis Of Changes In The Coastline Of Tabailenge Island North Morotai District, Morotai Island Regency

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ABSTRACT

Shoreline change is a process that occurs dynamically and changes in sea bathymetry. The process of adjusting the coastline is continuously carried out for a natural balance against various impacts that can affect changes in the coastline. The process of changing the coastline can occur naturally and is anthropogenic. Based on this description, it is necessary to study/research changes in the coastline seen from oceanographic factors in the form of currents on Tabailenge Island, North Morotai District, Morotai Island Regency. This research was conducted in November 2022 in the waters of Tabailenge Island, South Morotai District, Morotai Island Regency. Analysis was conducted using field data (primary) and Google Earth software image data (secondary). Analysis was carried out using image data from different years (2009, 2011, 2016, 2019, and 2021). The research phase begins with preparing photo image data that will be analyzed for changes in the coastline using satellite imagery from the Google Earth application for the observation periods of 2009, 2011, 2016, 2019, and 2021. Image data use the JPEG format for different months of observation depending on availability. Cloud-free data contained in Google Earth. Based on data from image interpretation in 2009, 2011, 2016, 2019, and 2021, digitization has been carried out to show that there has been a change in the coastline from year to year. Observation of image data for a period of ± 10 years shows that changes in the coastline occur due to the influence of oceanographic parameters such as currents.

INTRODUCTION

The coast is a transitional area for seawater from land and sea, which has the most potential for natural wealth that is widely utilized. Coastal areas are often used for tourism, settlements, and other activities. The process of adjusting the coastline is continuously carried out for a natural balance against various impacts that can affect changes in the coastline. The coastline is the boundary line between land and seawater, whose position is not fixed and can move according to the tides and the beach erosion process.

Shoreline change is a process that occurs dynamically and changes in sea bathymetry. Arief et al., (2011) stated that shoreline change is a process that occurs continuously through several natural processes on the beach, such as currents along the coast, sediment movement, land use, and the action of sea surface waves.

The process of changing the coastline can occur naturally and is anthropogenic. Natural factors include abrasion, sea level rise, sedimentation, and the geological conditions of the area. Meanwhile, anthropogenic factors include beach dumping, rock/sediment excavation, logging of coastal protection plants, and construction of flood canals. According to (Opa, 2011), Shoreline changes can occur seasonally and also annually from time to time depending on beach conditions, topography, tides, waves, wind, and rocks. One of the most frequent factors is currents, waves, and tides.

The results of the hydrodynamic model simulation show that the circulation of currents in the waters of Tabailenge Island, North Morotai sub-district, shows a current pattern influenced by current conditions from the Pacific Ocean. Suciaty & Rizki, (2012), reported that the current movement pattern affects the shoreline shift's conditions. Meanwhile, Astijaro & Harkins, (2005) stated that changing the coastline, increasing land, and land arising could occur due to current patterns. As a result of the hydro-oceanographic process, sedimentary material is deposited around the coastline.

The coastline can change yearly due to tidal activity, currents, waves, and wind. In addition, activities from the mainland include development activities around the coast, embankments, and other activities. Shoreline changes can be assessed by direct data measurements in the field (primary data) and secondary data. Technological developments have become an instrument in facilitating humans in returning field data. The technology often used in monitoring shoreline changes is to use remote sensing technology through recording satellite imagery in the form of Google Earth. Monitoring shoreline changes can be done using remote sensing from Google Earth because multi-temporal monitoring can be carried out with the availability of data over several years (Suniada, 2012). In addition, the information obtained from the community is that the beach on the island of Tabailenge was larger several years ago than it is today. Based on this description, it is necessary to conduct a study/research on shoreline changes on Tabailenge Island, North Morotai District, and Morotai Island Regency.

METHODOLOGY

Location and Time of Research

This research was conducted in November 2022 on Tabailenge Island, South Morotai District, Morotai Island Regency (Figure 1). Analysis was conducted using field data (primary) and Google Earth software image data (secondary). The analysis used different years (2009, 2011, 2016, 2019, and 2021). The data processing results in the field were validated with satellite data, where a field survey was conducted on 8-12 November 2022. In addition, interviews were also conducted with local people who were met at the research location. The tools used in this study were laptops, GPS, cameras, ArcGIS 10.0 applications, satellite imagery data, meter rolls, water passes, current meters, and stationery.

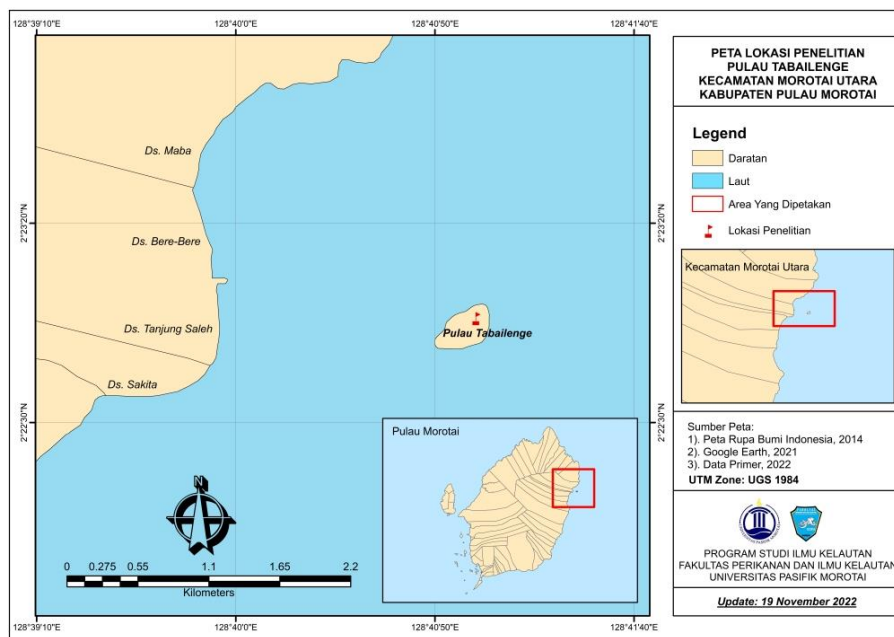


Figure 1. Research Locations

Sampling

Primary data is a way of collecting data by direct observation at the research location where there is an abrasion of the phenomena that occur at the research location. Primary data collection to provide a direct description of the object of study with the theory that has been carried out was observed using a GPS (Global Positioning System). Primary data measurements in the field include currents, beach width, and beach slope. Secondary data was obtained from the Google Earth software for 2009, 2011, 2016, 2019, and 2021. Current parameters were obtained from Copernicus marine data. The image process is carried out to determine the coastline manually, and the results are compared with the observations in the field. The shoreline overlay process for all observation years estimates the extent of abrasion. It is assumed that if the shoreline of Tabailenge advances, abrasion changes yearly.

The research phase begins with preparing satellite imagery data which will be analyzed for changes in the coastline using satellite imagery from the Google Earth application for the observation periods of 2009, 2011, 2016, 2019, and 2021. Image data use the JPEG format for different months of observation depending on availability. Cloud-free data contained in Google Earth. JPEG data that has been converted to TIFF format is projected as a geographic reference so that the digitization process can be carried out on a computer/laptop screen using the Google Earth facility.

All analyses, such as coastline changes and land area increases, are carried out through visual interpretation by digitizing on a computer/laptop screen (on-screen digitizing) in the Google Earth application. The area size of each digitized polygon is calculated using the polygon measurement facility from Google Earth pro (Malarvizhi et al., 2016). For JPEG data analysis, it is necessary to carry out a geometric correction process by carrying out GCP (Ground Control Point) at 4 (four) points placed in the corners of the image for rectification.

The digitized data was rectified using the RBI (Rupa Bumi Indonesia) base map to equalize the geographical position in the ArcGis 10.0 software. For further analysis, the digitized data is converted into a shapefile format with a projected coordinate system using UTM 52N datum WGS 1984. Then an overlay process is performed to compare the temporal shoreline changes in the observed area according to satellite imagery with periods of years 2009, 2011, 2016, 2019, and 2021. The Overlay results will provide information about changes in the coastline in the Tabailenge island area.

Data Analysis

The data that has been collected is analyzed using data analysis software (software) and numerical analysis methods to produce data and information that is needed.

RESULTS

The results of image interpretation in 2009, 2011, 2016, 2019, and 2021 have been digitized, showing that there has been a change in the coastline from year to year. These changes are in the form of significant abrasion and sedimentation at the study site.

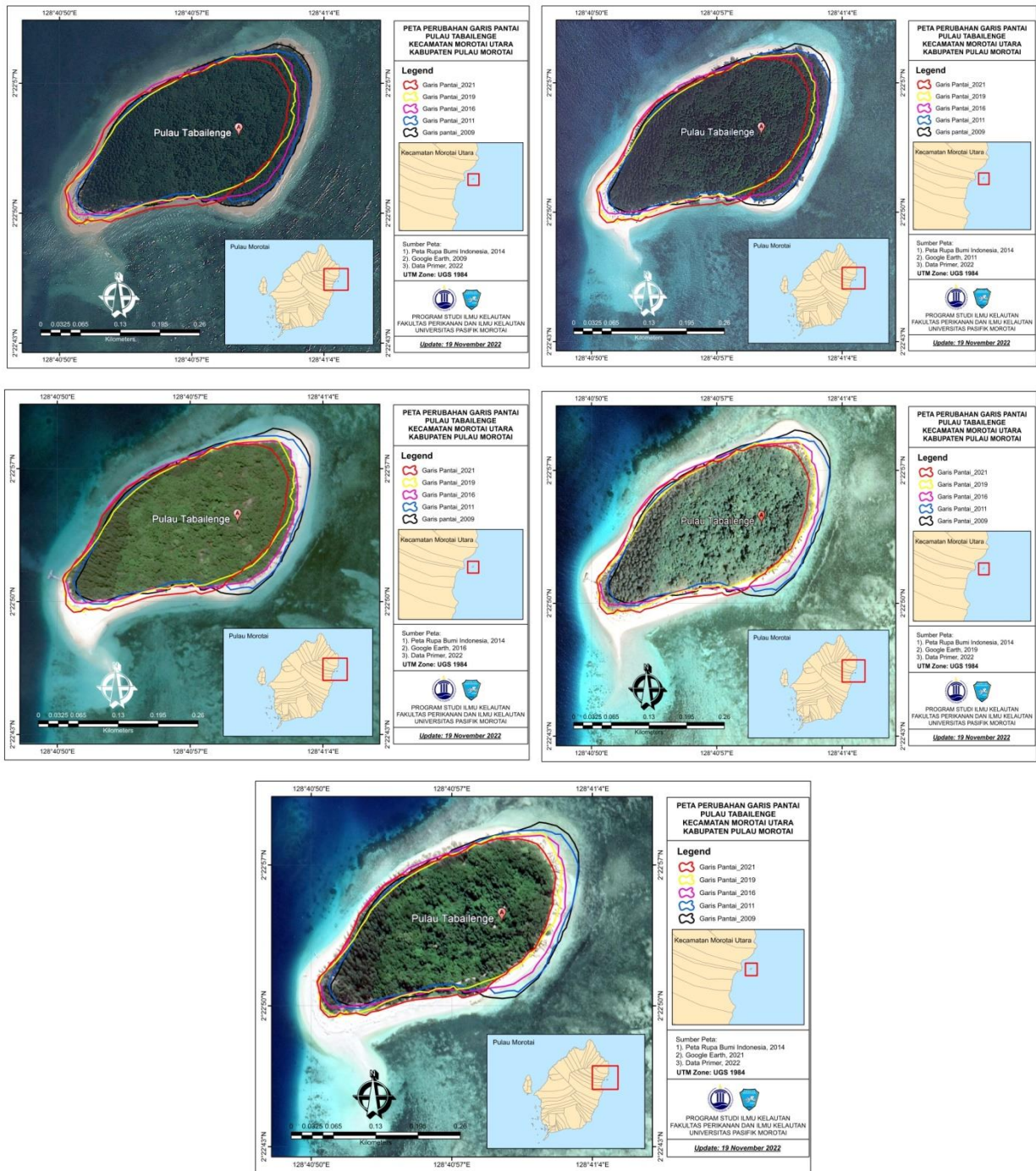


Figure 2. Shoreline change map a.2009,b. 2011, c.2016, d.2019, and e.2021

In figure 2, the black circle shows the coastline in 2009, and the blue line showed the coastline in 2011. In 2016 the coastline changed to pink, 2019 shows, the coastline was yellow; in 2021, the coastline is shown to be red. In figure 2, the black circle shows the coastline in 2009, and the blue line showed the coastline in 2011; in 2016, the coastline changed to pink, 2019 shows, the coastline is yellow, and in 2021, the coastline is shown red.

Table 1. Shoreline Changes Based on Image Recording Year

Tahun	Panjang Garis pantai (m)	Laju Perubahan (m)
2009	1100	9.65
2011	1100	
2016	1000	15.96
2019	1000	9.73
2021	1000	12.18

Table 1 provides information on shoreline changes based on the year of image recording with the time range 2009–2021, which shows the value of abrasion changes occurring yearly, although sedimentation also occurs. The highest level of abrasion was in 2009–2011 (9.65 m), with an abrasion rate of -6.31 m. In 2016–2019 (6.23 m) and 2019–2021, the abrasion rate (-2.45 m).

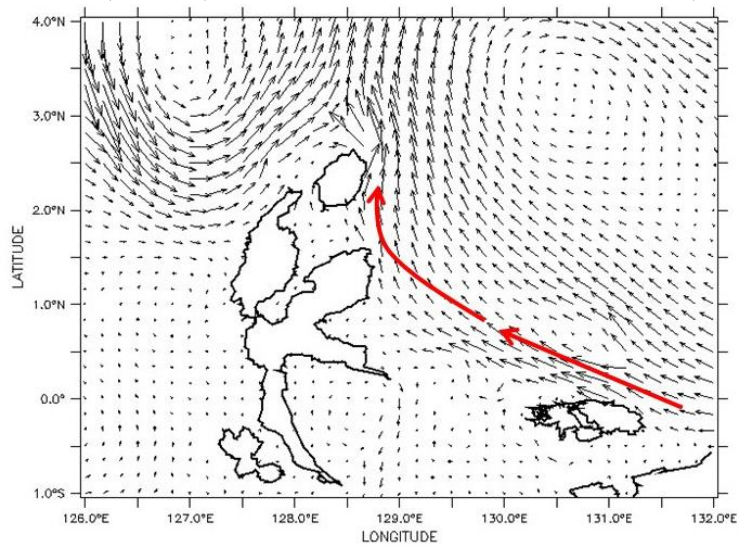
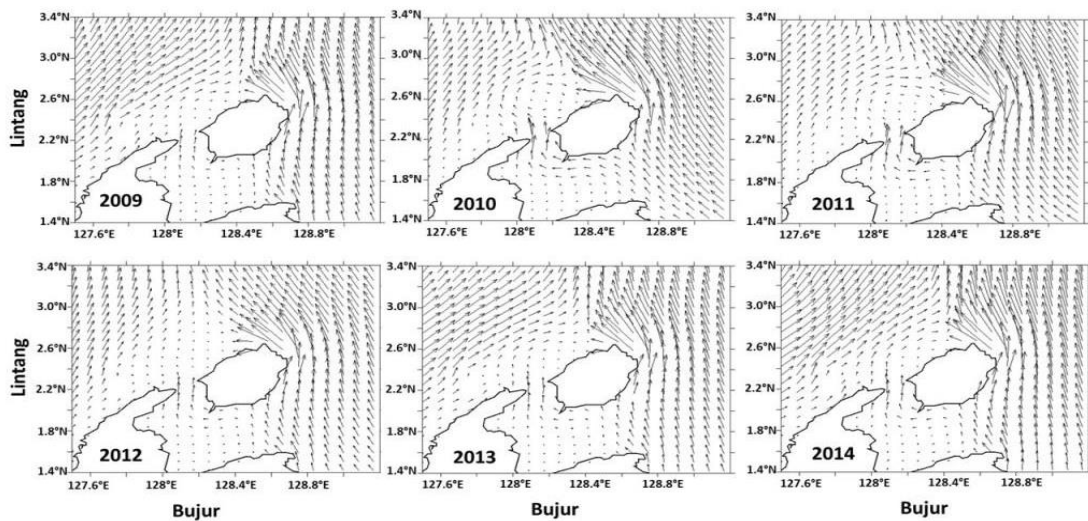


Figure 3. The movement pattern of Morotai water currents



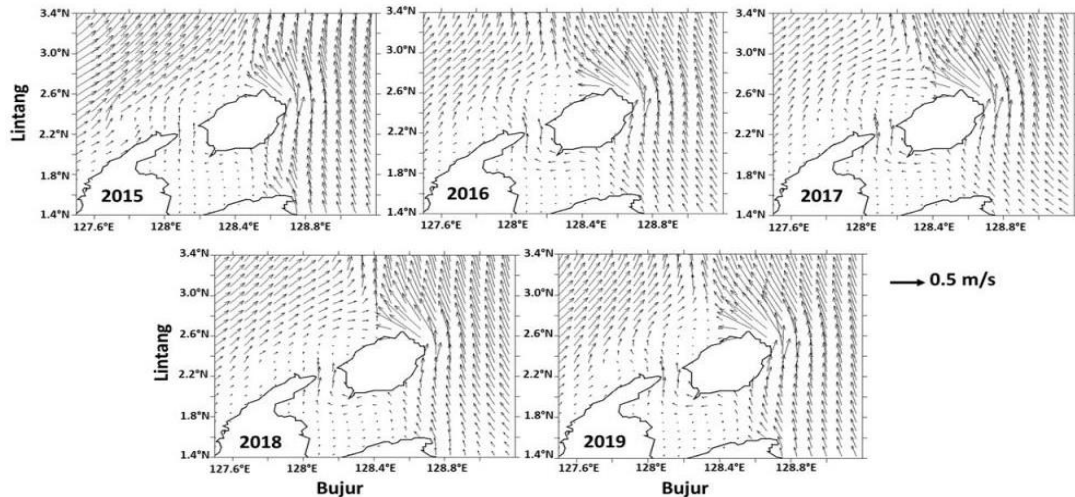


Figure 4. The current annual pattern of Morotai Island waters

Based on the current movement from 2009 to 2019, the current movement for each year is different and adjusts to image data; the direction of the current is moving towards Tabailenge Island. The results of the analysis of current data obtained in the field at the time the research was conducted obtained data in the direction and magnitude of ocean currents in the waters of Tabailenge Island. The current velocity along the coast is $V = 0.2 \text{ m/s}$; the current direction is from north to south of Tabailenge Island, and the current speed is very strong in Tabailenge waters. This is very influential and reduces the value of the potential owned in the Tabailenge tourism area. Abrasion occurs when a beach is viewed as experiencing loss/reduction of sediment. The current is a sediment transport medium, and erosion and sediment will move with the current.

DISCUSSION

From the research data, there has been a change in the coastline. This change indicates the occurrence of abrasion or reduction of the land area resulting in a decline in the coastline and sedimentation or addition of land area, which erodes the ocean causing the coastline to advance towards the sea. Natural phenomena that occur continuously cause the longer coastline to change (Purnaditya & Gusti, 2012).

This indicates that this area is experiencing an abrasion process which causes a change in the shape of the coastline retreating towards the land or the retreating beach. Shoreline changes occur due to abrasion and sedimentation; the main cause of abrasion is the influence of currents, waves, tides, and wind. The dynamic processes that influence the shape of a coast are wave action, influencing currents, winds, and tides. The process of moving waves to the beach due to the wind occurs. Coastal abrasion that occurs can reduce or eliminate the potential of a coastal area. Abrasion occurs when a coastal area under review experiences a reduction or even loss of a coastal area. Likewise, the sedimentation process that occurs is the process of transporting sediment rather than being deposited. Opa, (2011), states that abrasion is caused by

oceanographic factors, namely currents, tides, and waves. Raihansyah *et al.*, (2016) state that shoreline changes generally take place slowly, but if supported by factors (natural or unnatural) that cause shoreline changes, these changes can occur very quickly.

Coastal changes occur when geomorphological processes occur in coastal segments that exceed the processes that occur. This process affects parameter factors such as currents, waves, and tides. Current is one of the factors that play a role in the transportation of sediment in the coastal area, the movement of flowing water masses caused by wind, tides, solar radiation, density differences, and wave crashes.

Observations at ± 10 years show that changes in the shoreline occur due to the influence of oceanographic parameters such as currents. This is by the conditions at the study site, which are influenced by the main current from the South Pacific, namely the Papua coastal current. Tabailenge Island is directly related to the Pacific Ocean's dynamics, causing abrasion. Hydro-oceanographic factors such as currents, waves, and tides affect the condition of the coastal area on Tabailenge Island, which has an impact on changes in the coastline which then causes land changes on the coast of Tabailenge.

In this study, changes in the coastline (abrasion and sedimentation) occurred purely due to hydro-oceanic factors such as currents from 2009 to 2021. Tejakusuma, (2011) states that the coast experiences abrasion if the current year's coastline is more inland than the coastline. Beach the year before. While sedimentation occurs due to the increase in the area of sediment carried to the mainland. According to (Try Al Tanto *et al.*, 2017), when currents lead inland to carry sediment particles which cause sedimentation, the direction of the current can affect material carried to land.

The results showed that the speed of fast ocean currents is 0.2 m/s. The highest surface current speed occurs at high tide with the direction of movement from east to north, and wind speed affects surface currents, Fadila *et al.*, (2021) state that currents at high tide are felt most quickly in shallow waters. Currents occur along with the rise and fall of the sea level caused by the force of the tidal generator. In the simulation results, the average current velocity model has a value of 0.5 m/s with the dominant east to the north current direction. The occurrence of currents affects the transport of sediments, which can disrupt the balance between the incoming and outgoing supply of sea waters. Lubis *et al.*, (2020) reported that the frequency of strong currents and the impact of sea waves could accelerate the abrasion process and erode material layers to move to a location. The same thing was conveyed by Purnawan and Setiawan, (2012) in Koroy, *et al.*, (2020) that current speed affects sediment transport where high turbulence moves easily and tends to be faster.

CONCLUSIONS AND RECOMMENDATIONS

Based on data from image interpretation research results in 2009, 2011, 2016, 2019, and 2021, digitization has been carried out to show that there has been a change in the coastline from year to year. Observation of image data for a period of ± 10 years shows that changes in the coastline occur due to the

influence of oceanographic parameters such as currents. This is by the conditions at the study site, which are influenced by the main current from the South Pacific, namely the Papua coastal current. Tabailenge Island is also directly related to the dynamics of the Pacific Ocean, causing abrasion.

FURTHER STUDY

Further research is needed to process coastline data using satellite imagery.

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