Threat Of Shoreline Change In Coastal Katapiang, Padang Pariaman

Widya Prarikeslan[1], Yurni Suasti[2], Rery Novio[3], Deded Chandra[4], Nurhasan Syah[5]
{widya_geo@fis.unp.ac.id[1]}

[1,2,3,4] Geography Department, Universitas Negeri Padang, Padang, Indonesia
[5]Environmental Sciences Department, Universitas Negeri Padang, Padang, Indonesia

Abstract. Various environmental issues in this area, including land conversion, uncontrolled mining exploitation in watersheds, damage to coastal ecosystems. There are 11 watersheds and 2 of them are large rivers, namely Batang Anai and Batang Mangau, one of the major rivers is located in Nagari Katapiang. The purpose of this study is to analyze the spatial and temporal dynamics of shoreline changes in Nagari Kataping and the factors that cause line changes. The method used in this study is to analyze changes in the coastline area with overlays on the map and produce a combined map that has an attribute information from each map, analyzing it with Landsat 8 OLI/TIRS Imagery for 2003-2018. The results obtained from the change in the area of the Kataping beach from 1988-2018 reached 58.18 ha. From statistical data processing, the most dominant factor influencing it is the decreasing vegetation on the Kataping coast by 13.56 in 1988-2018. There is an effect of land cover change on the level of shoreline change in the Batang Anai watershed of <50% and the remaining percentage is affected.

Keywords: Abration; Shoreline; Accretion

1 Introduction

Padang Pariaman Regency consists of 17 Districts, 6 sub-districts located in the coastal area Batang Gasan, Sungai Limau, V Koto Kampuang Dalam, Nan Sabaris, Ulakan Tapakis and Batang Anai. The topography of Padang Pariaman includes a tropical climate which has a very short dry season and the ocean area is highly influenced by sea breezes. This area is crossed by 11 rivers, both large and small rivers, one of which is the Batang Anai [1].

Marine and fisheries strategic issues in West Sumatra, these issues consist of poverty, low education and decreased health of coastal communities, marine and coastal pollution, abrasion, climate change, waste entering the sea, and degradation of ecosystems and natural resources in waters, such as: Damage to 85% of coral reefs, damage to 35% of mangrove forests, Damage to 80% of seagrass beds, Decrease in fish resource stocks, especially in coastal areas of 4 to 12 miles. As a result of uncontrolled onshore development activities, most of them lead to the sea, such as the development of shrimp ponds, construction of [2]tourism facilities (docks and other public facilities). People living in coastal areas are often classified as poor. The coastline is the boundary line between land and sea water, where the position is not fixed and can move according to the tides and coastal erosion that occurs. The coastline has a dynamic nature which is influenced by many things, one of which is the contribution of sediment from river water. Changes in the shape of the coastline due to sedimentation

ICGEO 2022, November 19-20, Padang, Indonesia

DOI 10.4108/eai.19-11-2022.2332298

(accretion) cause problems, including disturbing the coastal ecosystem, expanding the area of land, become chocked with silt at the mouth of the estuary, which can cause flooding around the estuary when the water discharge from the river is high or there is flooding in the upstream of the river .

Population growth increases due to various problems in regional development. Coastal areas also have a high conflict value between aspects of use and environmental sustainability. Interactions between people and the earth lead to changes in the potential for sustainability of natural sources. Unplanned development of coastal areas can trigger biophysical and socio-economic problems[3]. Over the last few decades, the study of Land Use Change has become a prominent research topic, as land use change has been recognized as one of the most important factors of environmental modification. Land use refers to objects that represent human activities that produce the production of goods and services for society[3][4].

Land functions will cause damage through physical, chemical, and biological processes of land as well as will cause environmental problems depending on the environmental conditions such as climate, geophysics and the forest ecosystem environment, and behavior patterns or human behavior in managing the land and the environment. Threats of environmental change caused by natural and human factors in the form of pollution, excessive use of natural resources, coastal abrasion and land use change that are not environmentally based also worsen the situation[5]. The high intensity of use among stakeholders, as well as the tendency for regional authorities to over-intervene in resource areas have serious impacts on vulnerability to coastal damage from both a local and regional perspective. The problem of decreasing the quality of the coastal environment as a result of unplanned and uncontrolled use of coastal areas occurs in coastal areas. The degradation of the coastal environment including pollution, the retreat of shorelines, sedimentation and silting of the bay is caused by a reduction in the capacity of coastal resources [2].

The Batang Anai watershed is a lowland consisting of coastal plains, alluvial plains and flood plains formed from river deposits (recent deposits) and from over flow solver flowing rivers (District of Padang Pariaman in Figures, 2014). Batang Anai It is also the longest river in Pariaman City or Padang Regency Pariaman. Generally large and small rivers, its height is not much different from sea level.

Fig.1. Map of the Batang Anai Watershed shown in green and the Katapiang Coastal Area

Figure 1 shows that the Batang Anai watershed is located in Padang Pariaman District, the downstream part is in the Batang Anai District. The length of the coastline of Batang Anai District is 11.44 km2 and the length of the river is 54.6 km which is the longest river in

Padang Pariaman Regency[1]. The purpose of this research is to analyze changes in the coastline and the factors that influence it and changes in land cover in the Batang Anai watershed from 1988 to 2018, as well as Batang Anai sedimentation. Changes in land cover will also cause river erosion so that sediment is carried away and also have an impact on coastal areas.

2 Methods

This type of research is descriptive quantitative. This study is a study that aims to explain the existing phenomena by using numbers to compare the characteristics of individuals or groups[6].

2.1 Coastline Change

Analysis of the dynamics of changes in the coastline in the downstream part of the Batang Anai watershed in 2003 and 2018 was carried out using data obtained from satellite image processing. The data is in the form of coastlines every year, which is then carried out overlay analysis. Through overlay analysis, a map of changes to the coastline is obtained. This shoreline change map will later show changes in the shoreline of abrasion, accretion or abrasion.

The coastline, which is closely related to the process of change in the coastal area is one of the important factors for monitoring coastal areas related to environmental protection and development activities around it. Shoreline change information is very important in various coastal studies, for example; coastal area management plans, hazard zoning, erosion-accretion studies, as well as coastal morphodynamic analysis and modeling [7].

Wave data is downloaded from the ECMWF website. The downloaded data is in the form of wave period data, sea wave height and breaking wave height, which has a notched (NS) format. The data is downloaded at the coordinates of the Padang Pariaman Regency area. Both data are then converted using Ocean Data View software. The processed data is daily data which will later be searched for on a monthly average with the help of Microsoft Excel software. By processing the data statistically, the factors that influence changes in the coastline in the Nagari Katapiang, Batang Anai District, are obtained.

The method used to calculate how much land area changes the coastline that occurs in the Batang Anai watershed every year is done by overlaying which is calculated through calculate geometry in ArcGIS 10.3 software. Shoreline delineation is done digitized on screen to clearly describe the boundary between land and water, which is used to clarify the position of the coastline in the image. The extraction used for shoreline delineation in this study, namely Landsat 5 TM imagery in 1988 and Landsat 7 ETM+ imagery in 2003, was carried out using the single band method utilizing band-5 because it can obtain information on coastlines covered by soil and rocks and Landsat 8 OLI/TIRS imagery in 2018 using the combined band method (colour composite RGB), namely RGB 543 because the RGB band 543 composite method is best used for determining coastlines using visual interpretation because it will show clear boundaries between sea water and mainland.

2.2 Land Cover Changes

Land cover data can be obtained by downloading data on the website of the Ministry of Environment and Forestry (KLHK). The data obtained is in the form of shapefiles and then the area of each land cover is calculated. Landsat imagery is also used to see changes in land cover from 2003 and 2018[8][9]. While most land use and land cover changes are directly influenced by human activities, they rarely follow standard ecological theory human activities[10].

2.3 Sedimentation

To find out the area and distribution of sedimentary, image processing and classification of TSS were carried out according to the Jaelani algogitma (2016). The first step in image processing is geometric correct, which is done so that the image is georeferenced and has coordinates. The next step is radiometric correction using the Radiometric Calibration method with a reflectance calibration type so that the digital value in the image becomes a reflectance value. After the Digital Number (DN) becomes a reflectance value, the TSS algorithm process equation (1) is carried out. In order for the reflectance value to be a TSS value, the following Jaelani algorithm in 2016 is used:

$$\log TSS(mg/l) = 1{,}5212 * (\log Rrs(b2)/\log Rrs(b3)) - 0{,}3698 \quad (1)$$

Description :

TSS	: Total Suspended Solid
b2	: Blue channel
b3	: the green channel on Landsat OLI8 while for Landsat 4-5 and 7 the blue channel is in band 1 and the green channel is in band

Sedimentation analysis was carried out by overlaying the sedimentation change maps generated by the TSS algorithm, useful for knowing how wide the distribution area of sediment was in 1988, 2003 and 2018. To obtain sedimentation change data, researchers must examine the area of distribution and sedimentation each year, so you can see the changes over a period of 15 years.

3 Result

a. Coastline
   Coastlines are the result of land-sea interactions, but human activities have changed many coastlines from natural to artificial. In recent years, marine reclamation projects have moved the land and its coastline towards the sea, leading to hydrodynamic changes and affecting the topography and dynamics of sediment erosion in the waters[11][12]. Temporary changes such as tides or changes due to abrasion and accretion over a long period of time so that the zone produces a unique environment and is susceptible to change[13]. The effects of human activities and the significance of human-land, human-

sea and land-sea relations, and the balance between the three. The main factor in shoreline changes is sea reclamation, the expansion of land by filling coastal waters with soil or rock, which increases the action of land in the sea and changes the hydrodynamics of the sea and tidal currents[11]. Based on the results of interpretation of satellite imagery using the on-screen digitization analysis technique of satellite imagery data at a scale of 1:50, 000, it was found that the condition of the coastline in Nagari Katapiang, Batang Anai District, always changes over time (temporal space). This change in the coastline is influenced by several factors, both from natural factors (waves, current velocity and tides) as well as from human activity factors in changing land on the earth's surface. The abrasion that occurred in the Nagari Katapiang , was 22.13 ha (1988-2003), 49.76 (2003-2018), 58.18 ha (1988-2018) and the highest accretion was also in the Katapiang Nagari of 6, 59 ha (1988-2003), while in 2003-2018 accretion decreased to 0.21 ha [14]. The following shows table 1-2 of the area of abrasion and accretion in the coastal area of Nagari Katapiang, Batang Anai District as follows:

Table 1. Beach Abrasion Area by Batang Anai District.

No	Year	Abrasion (ha)
1.	1988 -2003	22.13
2.	2003-2018	49.76
3.	1988-2018	58.18

Source: Data Analysis Using GIS in 2021

Table 2. Beach Accretion Area by Batang Anai District

No.	Year	Accretion (ha)
1.	1988 - 2003	6.59
2.	2003 - 2018	0.21
3.	1988 -2018	1.04

Source: Data Analysis Using GIS in 2021

b. Based on statistical calculations, changes in the coastline that occurred in Nagari Katapiang, Batang Anai District, were influenced by the fast propagation of sea waves, tides and changes in the area of vegetation in this area [14]. The data is presented in table 3 below.

Table 3. The main factors causing changes in the coastline in Nagari Katapiang, Batang Anai District, Padang Pariaman

Main Factor	Year 1988	Year 2003	Year 2018
Fast Slow Wave (m/s)	5,65	8,48	5,83
Wave Speed (m/s)	0,88	0,64	0,99
Tides (m)	1,11	1,27	2,16
Change in Vegetation Area (ha)	-20,45	6,89	-13,56

From table 3 it can be seen that of the 4 factors above that have the highest value is the change in vegetation area where in 1988 and 2018 there was a significant reduction in vegetation area while in 2003 there was a slight increase in vegetation area in the

Katapiang coastal area. Apart from reduced vegetation in this area, another influencing factor is the high wave propagation speed in 1988, 2003 and 2018.

c. Changes in beach area and erosion/acretion processes are significantly controlled by events, in the absence of silt forming along the coastal sector. If silt occurs continuously for several years at a certain location, the beach is continuously increasing and the loss/migration of silt will accelerate erosion. It was also observed that coastal sediments accumulated and severe erosion was found along the stretch of beach. Developing solid knowledge of this local phenomenon will be beneficial in positioning fishing ports and implementing coastal protection measures effectively. In addition to being influenced by the main factors in table 3, changes in the coastline are also influenced by changes in land area in the Batang Anai watershed, which can be seen in table 4 below.

Table 4. Land Area in the Batang Anai Watershed

No	Land Cover	Large (Ha)1988	Large (Ha) 2003	Large (Ha) 2018
1	Like	0.4	0.4	0.4
2	Forest	41.214	41.2	41.316
3	Field	2.479	2.449	2.328
4	Open field	0.274	0.341	0.257
5	Rice field	9.806	9.633	9.451
6	Pond	0.3	0.6	0.71
7	River	0.354	0.354	0.353
8	Buil Up Area	2.329	2.551	3.163
9	Shrubs Land	4.771	5.543	3.895
10	Plantation	8.939	7.795	8.993
	Total	70.866	70.866	70.866

Figure 2-4 is a map of land cover in 1988, 2003 and 2018 wherein certain land covers there have been quite large changes in area such as forests, increasing in area, fields with a decreasing area, paddy fields also seem to decrease, there is an increase in the area, followed by an increase in built-up land along the Batang Anai watershed.

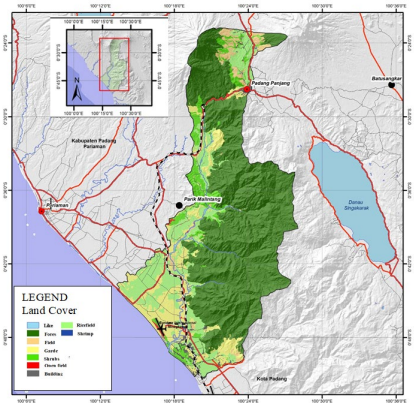

Fig.2. 1988 Land Cover Map of the Batang Anai Watershed

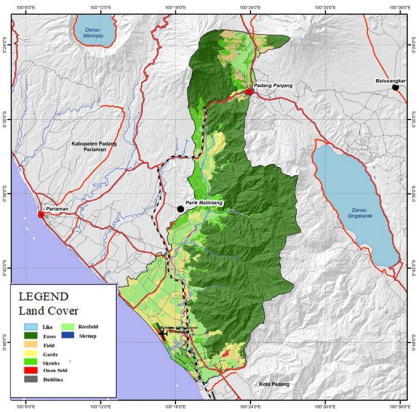

Fig.3. 2003 Land Cover Map of the Batang Anai Watershed

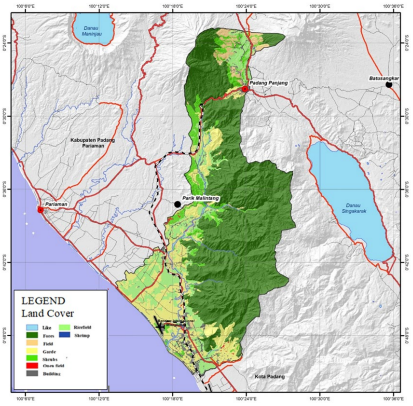

Fig.4. 2018 Land Cover Map of the Batang Anai Watershed

All types of activities carried out by humans must have an influence on the surrounding environment. Various human activities in the coastal area will slowly have a positive or negative impact on changes in the natural environment in which they live. Most of the influences produced by humans on their environment have negative impacts, although not a few are also environmentally friendly behaviors carried out by humans to improve the environment[15]. Human behavior that affects the environmental balance that has a negative impact such as cutting down trees or reducing coastal vegetation or in the watershed will increase the risk in the form of an increase in changes in the area of the beach or an increase in the danger of abrasion and accretion in a coastal area. The coastal area is an abiotic component that is greatly influenced by the biotic component, namely coastal vegetation if there is a reduction or change in the amount of vegetation due to community activities (culture) that change vegetation land to other forms such as ponds, housing and other places of business, it will have an impact on the abiotic component in the form of increased catastrophic abrasion and accretion. If the abrasion, increases, it will pose a risk to property and the lives of the surrounding community. Changing land cover will also cause sedimentation in Batang Anai, shown in table 5.

Table 5. Sedimentation in 1998, 2003 and 2018

No.	Year	Sedimentation	
		Score (mg/L)	Distribution Area (ha)
1.	1988	-1,37 – 1,77	945
2.	2003	0,39 – 1,18	1.108
3.	2018	0,58 – 1,19	1.107

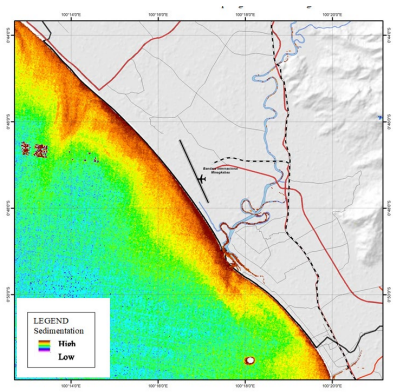

Fig.5. 1988 Sedimentation Map of the Katapiang and Lower Batang Anai Coastal Areas

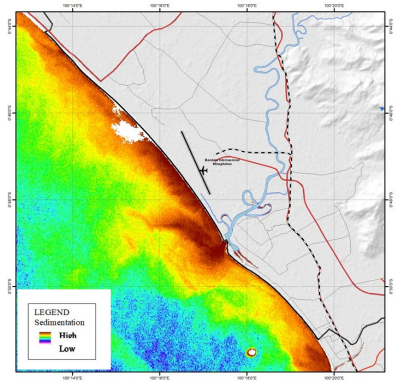

Fig.6. 2003 Sedimentation Map of the Katapiang and Lower Batang Anai Coastal Areas

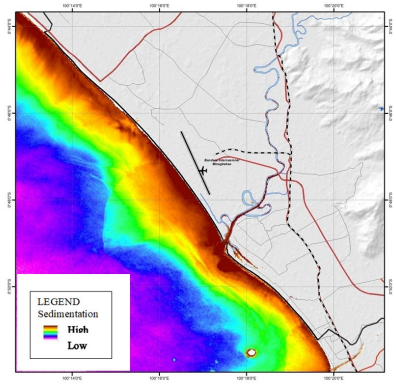

Fig.7. 2018 Sedimentation Map of the Katapiang and Lower Batang Anai Coastal Areas

As seen in Figure 5-7 the results of the TSS analysis above, the greatest sedimentation occurs around the Batang Anai estuary, indicating a brown color has a high sedimentation rate and other colors have a smaller value as the seas bathymetry changes. Sedimentation from table 4 can be seen that in 2003 the sedimentation was widespread, reaching 1,108 ha. From the sedimentation process, only part of the sediment flow in the river is transported out of the watershed, while the others settle in certain locations of the river, therefore the researchers follow up by identifying river flow patterns to see the flow of sedimentation movement.

The effect of changes in the land cover area from 1988 to 2003 on changes in the coastline area from 1988 to 2003 was 48.6%, while the remaining 51.4% was influenced by other variables, namely wave velocity, current speed, tides and changes in the coastal vegetation area. Whereas from 2003 to 2018 it was found to be 0.492 which can be interpreted that the influence of changes in the land cover area from 2003 to 2018 on changes in coastline area from 2003 to 2018 was 49.2%, while the remaining 50.8% was influenced by other variables, namely the speed of wave propagation, current velocity, tides and changes in the coastal vegetation area. The most dominant land cover changes occurred in Padang City and Padang Pariaman Regency, which administratively and geographically these 2 areas are the largest areas traversed by the Batang Anai Watershed, land cover changes in the Batang Anai Watershed are mostly dominated by agricultural land and natural land. By the watershed boundary that starts from the upper reaches of Mount Marapi and Tadikek to the mouth of the Batang Anai river. The coastal area is one of the most complex and non-living resource ecosystems, therefore the coastal area has great social and economic importance.

4 Conclusion

The threat of changing the orphanage line in Nagari Katapiang Batang Anai is increasingly worrying, this can be seen in the data presented in the article above. There are main factors that greatly influence the occurrence of this shoreline change, such as those caused by nature (wave velocity, current speed and tides) and from human activity (land conversion). Especially in Nagari Katapiang, both on the coast and in the Batang Anai watershed, what really affects is the reduced vegetation due to land conversion. For this reason, we must jointly promote tree planting both on the Katapiang coast and in the Batang Anai watershed. so that it can reduce sediment entering the sea.

Acknowledgements

The authors thank the Heads of Research and Community Service Institutions and the Chancellor of Universitas Negeri Padang, Padang, West Sumatra, Indonesia.

References

[1] B. P. S. K. P. Pariaman, *Statistik Daerah Kabupaten Padang Pariaman*. 2021.

[2] T. J. Kakisina, S. Anggoro, A. Hartoko, and Suripin, “Analysis of the Impact of Land Use on the Degradation of Coastal Areas at Ambon Bay-mollucas Province Indonesia,” *Procedia Environ.*

Sci., vol. 23, no. Ictcred 2014, pp. 266–273, 2015.
[3] I. Dewata and U. Iswandi, "Dynamic model of forest area on flood zone of Padang City, West Sumatra Province-Indonesia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 149, no. 1, 2018.
[4] N. Syah and S. Edinov, "The contributions of discipline and environmental knowledge on clean behavior of students in Public Elementary School 19 Kampung Baru Pariaman, West Sumatra," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 314, no. 1, 2019.
[5] K. M. Salik, S. Jahangir, W. ul Z. Zahdi, and S. ul Hasson, "Climate change vulnerability and adaptation options for the coastal communities of Pakistan," *Ocean Coast. Manag.*, vol. 112, pp. 61–73, 2015.
[6] T. Solihuddin, "Karakteristik pantai dan proses abrasi di pesisir Padang Pariaman, Sumatera Barat," *Globe*, vol. 13, no. 2, pp. 112–120, 2011.
[7] R. J. Chant, *Interactions between Estuaries and Coasts: River Plumes - Their Formation, Transport, and Dispersal*, vol. 2. Elsevier Inc., 2012.
[8] W. Prarikeslan*, D. Hermon, E. Barlian, I. Dewata, and I. Umar, "A Land Cover Changes Model Based on Carbon Stock in the Mount Patah Region of, Bengkulu-Indonesia," *Int. J. Manag. Humanit.*, vol. 4, no. 9, pp. 1–5, 2020.
[9] W. Prarikeslan, D. Hermon, Y. Suasti, and A. Putra, "Density, coverage and biomass of seagrass ecosystem in the Lobam Island, Bintan Regency - Indonesia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 314, no. 1, 2019.
[10] P. S. Roy and A. Roy, "Land use and land cover change in India: A remote sensing & GIS prespective," *J. Indian Inst. Sci.*, vol. 90, no. 4, pp. 489–502, 2010.
[11] X. Xu *et al.*, "Land-ocean-human interactions in intensively developing coastal zone: Demonstration of case studies," *Ocean Coast. Manag.*, vol. 133, pp. 28–36, 2016.
[12] B. L. et al Cui, "No TitleCoastline Change of the Yellow River Estuary and Its Response to the Sediment and Runoff.," *Geomorphology*, vol. 127, 32, no. 127, pp. 32–40, 2011.
[13] K. G. Parvathy, V. Noujas, K. V. Thomas, and H. Ramesh, "Impact of Mudbanks on Coastal Dynamics," *Aquat. Procedia*, vol. 4, no. Icwrcoe, pp. 1514–1521, 2015.
[14] W. Prarikeslan, N. Syah, and Y. Nanda, "Evolution of the Coastline in Padang Pariaman Regency, West Sumatra, Indonesia: Analysis Period from 1988 to 2018," *Phys. Oceanogr.*, vol. 29, no. 5, pp. 536–547, 2022.
[15] W. Prarikeslan, D. A. Arif, E. Barlian, N. Syah, Y. Nanda, and W. Sutriani, "Shoreline Change Detection Using Dsas in Pariaman City, West Sumatera," *Geogr. Environ. Sustain.*, vol. 15, no. 2, pp. 116–123, 2022.