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Submission date: 10-Oct-2022 10:12AM (UTC+0700)
Submission ID: 1921158411
File name: Haryani_2019_IOP_Conf..pdf (617.14K)
Word count: 5721
Character count: 29055

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Study of coastal abrasion disasters and their causes in Pariaman City

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Abstract. In 2003 until 2016 on the coast of West Sumatra Province there have been disasters of abrasion and accretion in 32 points in 6 Regencies and Cities covering an area of 732.69 Ha of abrasion and accretion of 55.4 Ha. Pariaman City is one of the coastal cities in West Sumatra Province. The purpose of this study is to examine the characteristics of coastal abrasion in the last 15 years (2003 to 2018) in Pariaman City and its causal factors. The analytical method used is the 2003 coastline comparison method with the coastline in 2018. Congratulations on 15 years of observation, there was coastal abrasion in the coastal area of Pariaman City covering an area of 197.65 ha and accretion of 285.38 ha. This proves that coastal abrasion causes a substantial reduction in land in Pariaman City, which is an average of 13.18 ha / year, while land addition is 19.03 ha / year. Physical factors that most influence the abrasion and accretion of coastal Pariaman City are current factors, shoreline shape, coastal typology and vegetation cover while low wave factors are quite influential.

1. Introduction

Indonesia's reputation as a disaster-prone country is noted in the report of The Atlas of the Human Planet 2017 [1]. The data shows that the threat of natural disasters has doubled in the last 40 years in line with the increasing population.

Historically, West Sumatra is an area that has experienced a lot of disasters from 1943 to 2011. Disasters that have occurred in West Sumatra based on the highest percentage sequence include 43% floods, 18% landslides, 7% fires, floods and land 7% landslide, 6% earthquake, 3% tidal wave / abrasion, and another 7% disaster [2]. Climatologically, summer and rain in West Sumatra Province experience drastic changes and extreme, resulting in vulnerability to landslides, floods and tidal waves and abrasion. To why 3.00% of the tidal and abrasion nature, the coastal areas of West Sumatra are at a high-risk level, 1.71% are at medium risk and 5, 41% are at a low risk level.

From 2003 to 2016 on the coast of West Sumatra Province there have been abrasion and accretion disasters in 32 points in 6 Regencies and Cities covering an area of 732.69 Ha of abrasion and accretion of 55.4 Ha [3, 4]. Abrasion disasters cause a substantial reduction in land in West Sumatra Province, which is an average of 56.3 Ha / year, while the addition of land is only 4.26 Ha / year. This figure proves insignificant between the extent of coastal abrasion and coastal accretion in West Sumatra.

Pariaman City is one of the coastal cities in West Sumatra Province. Geographically, Pariaman City is located between 0 ° 33'00 " - 0 ° 40'43 " LS and 100 ° 04 '46' '- 100 ° 10'55' 'BT. The land area is 79.22 km2 and the sea area is 282.69 km² with 6 small islands namely Bando Island, Gosong Island, Ujung Island, Tangah Island, Angso Island and Kasiak Island with a beach length of approximately 12.7 km. Pariaman City consists of 4 (four) sub-districts namely North Pariaman District, Central Pariaman, East Pariaman and South Pariaman with a total of 16 villages and 55 villages belonging to 12 (twelve) villages [5].

The purpose of this study is to examine the characteristics of coastal abrasion in the last 15 years (2003 to 2018) in Pariaman City and its causal factors.

2. Study of literatur

Almost all regions of Indonesia have a disaster risk both in the hilly, lowland, and coastal areas. Indonesia is one of the countries with high numbers of natural disaster vulnerability. The National Disaster Management Agency [6] noted that 2,175 natural disasters occurred throughout 2017. Although Indonesia is a disaster-prone country, there is a downward trend in the number of disasters that occurred in 2017 when compared to 2016. In 2017 there were 2,271 incidents a disaster that resulted in 372 deaths, 3.45 million displaced, 44,539 housing units damaged and 1,999 public facilities damaged.

Disasters can be caused by natural disasters (natural disaster) or by human activities (man-made disaster). Factors that can cause disasters include natural hazards and human-caused dangers. According to the United Nations International Strategy for Disaster Reduction (UN-ISDR) [7] can be grouped into geological hazards (geological hazards), hydrometeorological hazards (biological hazards), biological hazards, technological hazards (technological hazards) and environmental degradation (environmental degradation), high vulnerability of the community, infrastructure and elements in the city / region at risk of disaster and low capacity of various components in the community.

More than 90% of disaster events are hydrometeorological events [6]. Likewise, with the disaster of coastal abrasion that occurred in Indonesia which increased from time to time. In 2011 there were only 17 abrasions recorded, but in 2012 it increased to 29 times, as did the following year, in 2013 there were 36 incidents. But in 2014 the incidence of abrasion decreased by only 20 times. In 2016 the incidence of coastal abrasion in Indonesia increased by 300% more than the previous year (in 2015), which was only 7 times to 23 incidents. Coastal abrasion in Indonesia occurs in an area of 1,888,085 Ha with a total of 4,917,327 people exposed. Physical losses caused by coastal abrasion are Rp. 22,042,350 (M) and economic losses of Rp. 1,290,842 (M) and cause environmental damage of 460,252 Ha [6].

The coastal area is one of the areas threatened by tsunami, coastal abrasion, sea water intrusion, storms, floods, extreme waves / tidal waves. For this reason, actions that can be carried out on disaster management include prevention, mitigation, preparedness and emergency response [8]. Threat / danger is a natural or artificial phenomenon that has the potential to threaten human life, property losses and environmental damage.

Beach erosion, which is also called abrasion, has recently tended to increase in various regions. Abrasion is erosion or reduction of land (beach) due to wave, current and tidal activity. In this connection land compaction caused the land surface to fall and be flooded by sea water so the coastline changed. In this connection land compaction caused the land surface to fall and be flooded by sea water so the coastline changed. The beach is said to experience abrasion when sediment transport occurs to a point greater than the amount of sediment transported out of that point [9].

The main parameters needed to understand coastal abrasion as one of the problems in the coastal zone are:

- Coastal geomorphology, which is the type of coastline and the sensitivity of coastal occurrence
- Wind is the main factor that causes waves

- Waves are the most important force causing coastal abrasion
- Tide is an influential force on coastal morpho dynamics
- Coastal vegetation is a component that maintains coastal slope stability and shoreline protection
- Human activities along the coast affect coastline stability; onshore and offshore activities, sand mining and coral reefs, and estuary dredging can increase coastal abrasion (shore abrasion).

In addition to the influence of oceanographic hydrocoography, currents and tides, human intervention in the form of exploitation of coastal resources and rock conversion and mangrove forests helps accelerate the rate of coastal degradation of Ambon Bay [10]. Strong currents and waves, as well as the destruction of coral reef ecosystems along the waters of Padang Beach, have caused worsening of the abrasion, which is compounded by the damage to natural and artificial beach protectors which have a negative impact on residential areas along the coast of Padang [11].

Factors that cause abrasion besides being influenced by the ocean and waves are also caused by wind. Longshore currents due to deep ocean waves and lifted by wind. The abrasion process occurs in the concentrated area of coastal waves with lithology composed of non-compact rock formations. Coastal and topographic geomorphology also affects coastal changes, as well as lithology of coastal sediments consisting of alluvium material with the dominance of gravel and sand and triggered by sediment transport from rivers [12].

Abrasion and accretion occur at different levels which indicate that ecosystems play an important role in controlling abrasion, especially in areas where mangrove ecosystems are located. Abrasion is more due to natural factors than human activity. Therefore, integrated management in the form of synchronization programs with relevant agencies, initiated and developed a series of schemes that become regional development priorities [13].

The cause of abrasion is based on the Engineering Details of the Abrasion and Rob Handling of Demak Regency [14] namely; a) Land Subsidence, b) Mangrove Forest Damage, c) Damage due to wave hydrodynamic forces, d) Damage caused global climate change and e) Damage due to other human activities.

3. Research methods

3.1. Research Approach Method

The study approach method used is descriptive quantitative, visual and triangulation. Quantitative descriptive approach, namely data and information obtained, processed and presented using forms of frequency tables and percentages. The 2003 Pariaman City coastline map with 2018 Pariaman City coastline map was overlaid. The results obtained are any beaches in Pariaman City that experience abrasion and / or accretion.

Visual approach, namely direct depiction of objects and the analytical tool used in the form of maps and the latest object images.

Triangulation approach, namely the examination of the validity of the results of the initial analysis with the results of interviews on the factors that cause abrasion and accretion. Triangulation is carried out with different techniques and various data sources, namely interviews, observations and useful documents to further strengthen the results of the study.

3.2. Method of Data Collection

Data collection methods used are primary survey methods and secondary surveys. Primary survey is a method of conducting direct observations into the field, namely observing the progress of abrasion or accretion in the coastal area of Pariaman City in order to find out the existing (actual) conditions.

Secondary surveys are methods by collecting data from various agencies and literature studies related to the substance of study objects in Pariaman City in the form of thematic maps, books and articles in relevant scientific journals that are processed into one data and information. In detail the maps (secondary data) and sources can be seen in the following table.

Table 1. Types of Secondary Data and Resources

Data	Data Type	Analitical Method	Data Source
Landsat ETM image data for 2003 2018 Landsat OLI image data of Pariaman City	Secondary data are: Satellite imagery from Landsat obtained from USGS *(U.S. Geological Survey)*	Using the Band-Ratio method and the Single Band Method to obtain delineation of land and water boundaries (pixel value limits) whose purpose is to obtain the coastline in each good Landsat ETM image in 2003 and Landsat OLI 2018.	USGS *U.S.* or the United States Department of Domestic Geological Survey

3.3. Analysis Method

The analytical method used is the 2003 coastline comparison method with the coastline in 2018. The analysis method can be seen in Table 2.

Table 2. Analysis Method

The first stage	Second Stage	Third phase	Fourth Stage
2003 Landsat ETM image data and 2018 Landsat OLI or acquisition year adjacent to the main criteria of each selected dataset is cloud-free, the Landsat dataset requirements for analysis and download are cloud content data ≤ 10% and have not experienced defects on Scan Line Corrector (SLC)	To facilitate the analysis, the multi-spectral band types of both datasets (Landsat-7 ETM and Landsat-8 OLI) are made in the form of stacking layer bands (merged) in each dataset. Because the scope of the research area (all of the West Sumatera Coastal Areas) requires 3 scenes (paths / rows), this step produces 6 stacking files for the needs of coastline analysis.	Delineation Land and water boundaries to get the coastline by using the Band-Ratio method to obtain a more informative pixel value limit. In the Band-Ratio method, the NIR band ratio with the Green band (b4 / b2 on Landsat-7; b5 / b3 on Landsat-8) will produce a land-water boundary on the coastal area covered by vegetation. Land areas that are not vegetated are included in water (sea) pixels. In contrast to the SWIR-1 band ratio with the Green band (b5 / b2 on Landsat-7; b6 / b3 on Landsat-8) the coastline is obtained from areas covered by sand and soil.	To help extract the land-sea boundary information that will be a shoreline feature, a composite band technique or a combination of false colours is used to display the limit of each object observed. raster to vector conversion results. This polyline vector file is the same vertex size as the spatial resolution of the original dataset (Landsat ETM and Landsat OLI) which is 30 meters. So as to refine and edit it, improvements are made. Improvements are made using line smooth tools in ArcGIS

4. Results and discussion

4.1. Beach Abration of Pariaman City

Kota Pariaman is one of the coastal cities in West Sumatra Province which borders the Indian Ocean. As a coastal city, it has various disaster threats, one of which is coastal abrasion.

The following is a profile of coastal abrasion that occurred several years back in Pariaman City and actions and efforts made by the Pariaman City Government and the local community.

Table 3. Beach Abrasion of Pariaman City 2013-2017

10/10/2017	• abrasion on the Nareh coast of North Pariaman District • abrasion along the coast of Padang Biriak-Biriak Village, North Pariaman Subdistrict, residents are quite dense. • "Pasia Maelo"; land ownership rights or beaches that become land are threatened with loss • some of the land around the shoreline is certified, if the abrasion continues to expand then the ownership rights are automatically lost • 12 houses were abrasion • has eroded up to 80 meters inland • only two breakwater stones have been installed, at least need seven.	 **Figure 1.** Abration October 2017 • APBD Amendments and central government assistance in installing breakwater stones at some points. • the local community was also asked to work together to build a temporary embankment
11/1/ 2017	• abrasion of Gandoriah Beach, Anas Malik Beach, Angso Duo Island, Kasiak Island and Nareh Beach in North Pariaman District • Gandoriah Beach to Anas Malik Beach which is located in the District of Central Pariaman is approximately affected by abrasion around 35 to 40 meters • tourism facilities and infrastructure that have been built are also threatened (Development of Anas Malik Park area, Republic of Indonesia Navy Monument, ASEAN Monument, and a number of other tourist parks) • beach abrasion that occurs is predicted to be purely due to natural phenomena due to extreme weather • Around 500 meters of Nareh Beach's lips have not been protected	 **Figure 2.** Abration January 2017 breakwater stones need Rp. 30 billion
2014	• coast of Nareh Beach, North Pariaman District	BNPB provided assistance of Rp 30 billion for the installation of breakwater stones
2013	• coast of Nareh Beach, North Pariaman District	BNPB provided assistance of Rp 40 billion for the installation of breakwater stones

4.2. Analysis of The Development of Abrasion and Accretion

4.2.1. Pariaman City Coastline in 2003 and 2018. The coastline in 2003 of Pariaman City was taken from Landsat ETM (Enhanced Thematic Mapper) Image Data in 2003 or acquisitions that were close to the main criteria of each selected dataset which were cloud-free. The requirements of the Landsat dataset used for analysis and download are cloud content data ≤ 10% and have not experienced defects in Scan Line Corrector (SLC).

The coastline of 2003 Pariaman City was taken from the 2018 Landsat OLI Image Data or the acquisition which is adjacent to the main criteria of each selected dataset is cloud-free. The requirements of the Landsat dataset used for analysis and download are cloud content data ≤ 10% and have not experienced defects in Scan Line Corrector (SLC).

4.2.2 Abrasion and Accretion of Pariaman City in 2003 and 2018. The results of the analysis of the study of the development of coastal abrasion and accretion in the City of Pariaman are by overlapping the 2003 map with the 2018 map of the coastline so that the coastlines experience abrasion (shoreline retreat) or accretion (beach addition). Map analysis is done by delineating land and water boundaries to get a coastline covered by vegetation. Land areas that are not vegetated are included in water (sea) pixels. In contrast to the SWIR-1 band ratio with the Green band (b5 / b2 on Landsat-7; b6 / b3 on Landsat-8) the coastline is obtained from areas covered by sand and soil.

Beach abrasion and accretion of Pariaman City in 2003 to 2018 can be seen in the following tables and maps.

Table 4. Coastal abrasion and accretion of Pariaman City in 2003-2018

No	Coordinate		Long Change (m)	Change	Location
	X	Y			
1	623781	9932734	22.18	Abrasion	Pauh
2	623695	9932913	30.25	Abrasion	Pauh
3	623916	9932448	29.8	Abrasion	Pauh
4	624010	9932246	33.35	Abrasion	Pauh
5	624095	9932028	16.05	Abrasion	Pauh
6	624151	9931862	8.62	Abrasion	Pauh
7	624152	9931766	25.14	Accretion	Pauh
8	624177	9931552	22.36	Accretion	Pauh
9	624076	9930827	21.56	Abrasion	Pasir
10	624134	9930601	22.05	Accretion	Pasir
11	624388	9930184	8.54	Accretion	Pasir
12	624599	9929941	4.53	Abrasion	Kel.Lohong
13	624827	9929640	25.03	Accretion	Kel.Lohong
14	624891	9929547	39.35	Accretion	Karan Aur
15	625708	9928331	56.45	Abrasion	Karan Aur
16	627383	9926841	39.15	Abrasion	Marunggi
17	623020	9934204	31.89	Accretion	Apar
18	622809	9934573	11.99	Accretion	Manggung
19	622022	9935799	25.88	Accretion	Naras 1
20	622270	9935399	61.43	Abrasion	Naras Hilir
21	622452	9935115	41.06	Accretion	Naras Hilir
22	626160	9928069	109.24	Abrasion	Taluak
23	621432	9936983	38.05	Abrasion	Padang Birik 2
24	621658	9936445	32.09	Accretion	Balai Naras

Source: Results of analysis of Arc Gis Image Map, 2018

There were 24 points in 12 villages observed abrasion and accretion along the coast of Pariaman City from 2003 to 2018 (15 years of observation). There are 5 locations that experience abrasion and

accretion at the same time, namely Pauh Village, Pasir Village, Lohong Village, Karan Aur Village, Naras Hilir Village. This shows normality where one location experiences abrasion while experiencing accretion. For more information on abrasion and accretion locations in Pariaman City, see the following table.

Table 5. Sub-districts that experience abrasion and accretion in Pariaman City in 2003-2018

No	Sub Districts	Abrasion	Accretion
1	Pauh	v	v
2	Pasir	v	v
3	Lohong	v	v
4	Karan Aua	v	v
5	Marunggi	v	-
6	Apar	-	v
7	Manggung	-	v
8	Naras 1	-	v
9	Naras Hilir	v	v
10	Taluak	v	-
11	Padang Birik-birik	v	-
12	Balai Naras	-	v
	Jumlah	**8**	**9**

Source: Data processing results, 2018

There were 13 points experiencing abrasion and 11 accretion points scattered in 12 villages in Pariaman City. During the last 15 years there has been abrasion (land loss) as far as the range of 4.51 m to 109.24 m while the accretion (addition of land) occurs as far as 8.54 m to 41.06 m.

4.3 Area Analysis of Coastal Pariaman Abrasion and Accretion in 2003-2018

With the same method, the results of the extensive abrasion and accretion analysis that occurred on the coast of Pariaman City were by overlapping the map in 2003 with a map of 2018 obtained by shoreline experiencing abrasion (shoreline retreat) or accretion (addition of beaches) and the length of the area experienced change. By knowing the length and changes that occur to the shoreline, the area of the coast / coast that experiences abrasion or beach accretion is obtained.

There were 24 points that experienced changes in both abrasion and accretion during this period spread along the coast of Pariaman City. Beach abrasion in Pariaman City is found in 8 sub-district (13 points / locations) where the smallest area is 1.57 ha in Padang Birik-Birik and the widest coastal abrasion is at point 22, which is 33.42 ha in the Village / Taluak Village. The widest beach accretion (beach addition) occurs at point 14 of the sub-district / Karan Aur Village, namely selus 45.12 ha and the smallest accretion at point 19 of the Village / Village Naras 1, which is 4.09 ha. The results of the analysis on the extent of coastal abrasion and accretion in Pariaman City period 2003 - 2018 can be seen in Table 6.

Table 6. Area of abrasion and accretion of Pariaman City in 2003-2018

No	Coordinate		Length (m)	Area (Ha)	Change	Location (Sub-districts)
	X	Y				
1	623781	9932734	22.18	15.65	Abrasion	Pauh
2	623695	9932913	30.25	20.66	Abrasion	Pauh
3	623916	9932448	29.8	19.98	Abrasion	Pauh
4	624010	9932246	33.35	9.87	Abrasion	Pauh
5	624095	9932028	16.05	9.47	Abrasion	Pauh
6	624151	9931862	8.62	21.62	Abrasion	Pauh

7	624152	9931766	25.14	25.39	Accretion	Pauh
8	624177	9931552	22.36	10.28	Accretion	Pauh
9	624076	9930827	21.56	6.26	Abrasion	Pasir
10	624134	9930601	22.05	9.86	Accretion	Pasir
11	624388	9930184	8.54	21.78	Accretion	Pasir
12	624599	9929941	4.53	8.70	Abrasion	Lohong
13	624827	9929640	25.03	21.74	Accretion	Lohong
14	624891	9929547	39.35	45.12	Accretion	Karan Aur
15	625708	9928331	56.45	25.79	Abrasion	Karan Aur
16	627383	9926841	39.15	16.89	Abrasion	Marunggi
17	623020	9934204	31.89	28.97	Accretion	Apar
18	622809	9934573	11.99	13.58	Accretion	Manggung
19	622022	9935799	25.88	4.09	Accretion	Naras 1
20	622270	9935399	61.43	7.77	Abrasion	Naras Hilir
21	622452	9935115	41.06	7.79	Accretion	Naras Hilir
22	626160	9928069	109.24	33.42	Abrasion	Taluak
23	621432	9936983	38.05	1.57	Abrasion	Padang Birik2
24	621658	9936445	32.09	27.06	Accretion	Balai Naras

Source: Results of analysis, 2018

Over the past 15 years there has been a significant loss of land in Pariaman City due to coastal abrasion, fearing that the day is getting bigger. In Pariaman City there were 13 abrasion locations with abrasion area of 197.65 ha and 11 beach accretion points with an accretion area of 285.38 ha. This is different from the beaches in the region of West Sumatera Province in general where on the coast of Pariaman there are additional beaches of 285.38 ha or 144.39% greater than the area of beach loss which is only 197.65 ha. More can be seen in the following table 7.

Table 7. Extent of abrasion and accretion in Pariaman City in 2003-2018

No	Sub-Districts	Abrasion (hectare)	Accretion (hectare)
1	Pauh	97,25	35,67
2	Pasir	6,26	31,64
3	Lohong	8,7	21.74
4	Karan Aua	25,79	45.12
5	Marunggi	16,89	-
6	Apar	-	28.97
7	Manggung	-	13.58
8	Naras 1	-	4.09
9	Naras Hilir	7,77	7.79
10	Taluak	33,42	-
11	Padang Birik-birik	1,57	-
12	Balai Naras	-	27.06
	Total	**8**	**9**

Source: Data processing results, 2018

Table 8. Extensive annual abrasion and accretion in Pariaman City

Total Point	Area(ha)	Abrasion/Accretion	Average hectare / year
13	197,65	Abrasi	13,18
11	285,38	Akresi	19,03

Source: Results of analysis, 2018

Theoretically, if an area occurs abrasion, there will be other areas of coastal accretion. The city of Pariaman also experienced coastal abrasion and beach accretion even though in a less balanced comparison.

The results of the analysis of the image map, it can be concluded that the annual average of land reduction in Pariaman City is 13.18 ha / year. This land loss rate is quite high and very dangerous considering Pariaman City is a coastal city that is quite densely populated and as a center of government and a trade center. The addition of the coastal land of Pariaman City is 144.39% equivalent to 19.03 ha / year greater than the land loss which is only 13.18 ha / year.

This condition if no coastal mitigation efforts are carried out, will threaten the balance of the coastal environment, where the loss of the coast continues to threaten the City of Pariaman. Meanwhile accretion that occurs will also raise new problems related to land ownership status due to beach accretion (growing land).

4.4 Analysis of Factors Affecting Beach Abrasion and Accretion

There has been abrasion and accretion over the last 15 years along the coast of the City of Paraiman. The factors analyzed by map processing with the GIS Arc method include wave factors, coastal typologies, shoreline shapes, vegetation and currents. The results of the study can be seen that the main factor influencing coastal abrasion in Pariaman City is the current factor. This can be seen from the high currents of the Pariaman City waters which are 0.513 - 0.7 (m / s). With high current velocities, the high threat of abrasion disasters occurs.

The second factor is the land cover / vegetation factor. In general, the areas in the North Pariaman and South Pariaman areas have a thicker vegetation cover that is 30% - 65% compared to Central Pariaman with a density of only 30-32%. Then the southern and northern regions of Pariaman City have a Medium index, while the Central Pariaman District in the High index is based on the classification of BNPB regulation No. 2 of 2012 [15]. This means that the coast of Pariaman City lacks coastal vegetation as a mitigation thus triggering an increasingly high abrasion disaster. Lack of land cover by vegetation or beach structure adds to the high threat of abrasion that will occur on the coast of Pariaman City.

The third factor that influences the coastal abrasion of Pariaman City is due to the shoreline form factor. The form of the beach in Pariaman City is generally a straight and straight beach form with a straight length of 12.7 Km. Looking at the data in the form of a straight beach is included in the high index, which is mostly located in the District of North Pariaman, while the form of a straight beach is almost located on the majority of the coast of Pariaman City which belongs to the medium category. This means that using a straight or straight coastline, the higher the abrasion. The fourth factor that influences the coastal abrasion in Pariaman City is the low-grade wave factor. The waters of North Pariaman Subdistrict, Central Pariaman and South Pariaman have a wave height of 0.69 to 0.92 m, where this condition is included in the Low category.

The fifth factor is caused by coastal typology factors in Pariaman City, namely sandy and muddy. Typology of sandy beaches is included in the medium index and typology of muddy beaches including high index categories. The results of the analysis showed that the coastal typology in Pariaman City was included in the medium to high typology which affected the occurrence of coastal abrasion. The factors that influence the abrasion and accretion on the coast of Pariaman City can be seen in the following table.

Table 9. Indicators that affect coastal abrasion and accretion

No	Indicators	Index Class			Total weight
		Low	Medium	High	
1	Wave height	< 1 m	1 – 2,5 m	> 2,5	30 %
2	Current	< 0,2	0,2 – 0,4	> 0,4	30 %
3	Land cover/vegetation	> 80 %	40 – 80 %	< 40 %	15 %
4	Beach shape	Hug	Straight hug	Straight	15 %
5	Beach typology	Rocky	Sandy	Muddy	10 %

Source: Perda BNPB No 2 Year 2012

Table 10. Factors influencing the abrasion and accretion of Pariaman City

Wave category	Coastal typology index	Shoreline shape index	Vegetation index	Current index
0,78 - 0,83 m	Muddy & sandy	Straight & straight-headed	30% - 65%	0,513 - 0,7 (m/s)
Low	Medium-high	Medium-high	Medium-high	Low

Source: Processing Analysis of Arc Gis, 2018

5. Conclusion

From 2003 to 2018 (15 years of observation) on the coast of Pariaman City there has been beach abrasion and accretion in 24 points or 12 villages. The number of abrasion points occurred in 13 points or 8 villages with an abrasion area of 197.65 ha and 11 points of beach accretion or 9 villages with an accretion area of 285.38 ha. Congratulations on 15 years of observation, there was a coastal abrasion on the coast of Pariaman City covering an area of 197.65 ha and accretion of 285.38 ha. This proves that coastal abrasion causes a substantial reduction in land in Pariaman City, which is an average of 13.18 ha / year, while land addition is 19.03 ha / year. This figure proves quite significant between the area of land / beach loss and the addition of beaches in Pariaman City.

During the last 15 years there has been an abrasion as far as the range 4.53 m to 109.24 m while the accretion occurs as far as the range 8.54 m to 41.06 m. The farthest abrasion is in point 22 (Taluak), which is as far as 109.24 m or an average of 7.28 m / year and closest to point 12 (Lohong) as far as 4.53 m. Whereas the accretion in which the furthest coastline advances is found at point 21 (Naras Hilir) which is 41.06 m or an average of 2.74 m / year. Almost all physical factors affect the coastal abrasion and accretion of Pariaman City, namely current factors, shoreline shape, coastal typology and vegetation cover except low wave factors.

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