

Coastal Abrasion and Accretion Studies of West Sumatera Province in Period 2003-2016

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Abstract: West Sumatera province has 19 cities and regencies where 6 of them often experience abrasion and accretion disaster, because it is a coastal area directly adjacent to the Indian Ocean. This study aims to examine the characteristics of abrasion and accretion disasters along the coast of West Sumatera Province from 2003 to 2016. By knowing the characteristics of abrasion and accretion from 2003 and 2016, it will be known which beaches are experiencing abrasion or accretion. This research is qualitative and quantitative descriptive research with GIS (Geographic Information System) analysis method to get characteristic of abrasion and accretion disaster in coastal area of West Sumatera. There has been a disaster of abrasion and accretion in 32 points spread across 6 districts and cities, namely West Pasaman District, Agam Regency, Padang Pariaman District, Pariaman City, Padang City and Padang Pariaman District, an abrasion disaster in the coastal area of West Sumatera Province of 732.69 Ha and 55.4 Ha of acres. This proves that the abrasion debacle causes the decrease of land in West Sumatera Province which is big enough that is average 56.3 Ha/year, while the addition of land is only 4.26 Ha/year. The farthest abrasion disasters are located in South Pesisir Regency, which is 45.70 m or 3.52 m/year on average. While the farthest accretion is in the South Pesisir Regency, and is as far as 36.91 m or an average of 2.84 m/year.

Key words: Abrasion, accretion, coastal, disaster, West Sumatera.

1. Introduction

According to the Law of the Republic of Indonesia Number 24 Year 2007, disaster is an event or series of events that threaten and disrupt the lives and livelihoods of people caused by both natural and/or non-natural factors and human factors resulting in the occurrence of human lives, environmental damage, property loss and psychological impact. Disasters occur because of threats, impacts and vulnerabilities [1]. Indonesia region is one of the countries with high potential to experience natural disasters such as tsunamis, volcanoes and landslides. The high potential of disaster, especially the tsunami and the eruption of Mount Merapi is due to the Indonesian territory consists of the order and geological process located on three plates of the earth that is Indo-Australia, Eurasia

and Pacific. According to BNPB (Badan Nasional Penanggulangan Bencana) 2016 data [2, 3], 80% of Indonesia is at risk of hydrometeorological disaster. There are 10 types of disasters that are at risk in Indonesia, such as floods, flash floods, extreme weather, abrasion and extreme waves, earthquakes, forest and land fires, drought, eruption of Mount Merapi, landslides and tsunamis. Compared to the number of disasters by 2015, the incidence of disasters in 2016 increased by 35%. Of these, 92% of the disaster this year is a hydrometeorological disaster that is dominated by floods, landslides and tornadoes.

During 2016, there were 766 floods, 612 landslides, 669 tornadoes, 74 floods and landslide combinations, 178 forest and land fires, 13 earthquakes, 7 volcanoes and 23 tidal waves and abrasion.

In Indonesia, the risk of abrasion and extreme wave disasters occur in an area of 1,888,085 Ha, with the

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number of people exposed to 4,917,327 and can cause physical losses of Rp. 22,042,350 M, economic loss Rp. 1,290,842 M and environmental damage 460,252 Ha [2].

On the island of Sumatera, there are 21 cities/districts are at high risk of disaster. The dominant disaster risks are floods, earthquakes, forest and land fires, landslides, tsunamis, volcanic eruptions and flash floods. The target of declining disaster risk index in Indonesia is 30% up to the year 2019 with the strategy of increasing the capacity index in the Regency/City. Increased capacity index among others is the readiness of institutional components, early warning, education, mitigation and preparedness. In line with the RPJMN (Rencana Pembangunan Jangka Menengah Nasional) policy and strategy direction [4], the reduction of vulnerability to disaster is one of building and growing local wisdom in development and disaster [5-7].

Historically, West Sumatera is an area that has experienced many disasters. The previous disasters in West Sumatera were ranked by the highest percentage 43% of floods, 18% of landslides, 7% of fire, floods and landslides, 6% of earthquake, 3% of tide/ abrasion, and 7% of other disasters [3]. These disasters have caused a lot of casualties, damages, and losses that are not small either from the community or the government of Indonesia.

Although the tidal wave disaster only happened as much as 3%, according to research Bambang Istijono [8], from 1918 has happened erosion of beach Padang average 2.20 m/year. The coastline of Padang is relatively straight, most of the beach is composed of sand, behind the coast of a vast alluvial plain. The basic concept of Padang beach abrasion is to reduce the influence of sea wave energy with the installation of 0.50-1.50 m diameter stone and coastal sand threatened its stability. Groin with stone material that fitted into the sea 15-25 m with 50 m intervals and coastal dikes is a form of coastal protection, and is quite successful in the city of Padang, which began

built in 1974 until now.

The result of Haryani, H.'s research [9], the level of disaster vulnerability that threatens Padang Beach (case study of Pasie Nan Tigo Sub-district Koto Tangah Sub-district) consists of main disaster and catastrophic disaster. Major disasters included, storms and tsunami threats are key vulnerabilities, coastal abrasion and second tidal wave vulnerability, sea water intrusion and third susceptibility sedimentation and low vulnerability are floods. As for catastrophic disasters that occupy major vulnerabilities are the economic vulnerability, the two physical vulnerabilities, the vulnerability of the three environments and the vulnerability of all four social vulnerabilities.

Meanwhile, from 19 cities and regencies in West Sumatera Province, 6 of them are coastal cities/regencies bordering the Indian Ocean. Cities and coastal districts are West Pasaman District, Agam District, Padang Pariaman District, Pariaman City, Padang City and South Coast District. City and coastal districts are generally a densely populated area of Padang City which is the capital of the Province. The geographical condition of West Sumatera Province bordering the Indian Ocean, has the potential for abrasion and accretion. Therefore, the problem in this research is how the characteristics of coastal abrasion and accretion disaster from 2003 and 2016 in coastal region of West Sumatera Province.

The purpose of this study is to examine the characteristics of abrasion and accretion disasters from 2003 and 2016 in the coastal areas of West Sumatera Province and any coast that experienced abrasion or accretion.

2. Materials And Methods

2.1 Research Approach

The study approach method used is descriptive quantitative. Quantitative descriptive approach, ie data and information obtained, processed and presented

using the forms of frequency tables and percentages. The coastline map of 2003 with 2016 shoreline map overlap (overlay). The results obtained are any beach that has abrasion and or accretion.

2.2 Method of Collecting Data

Data collection method used is by secondary survey method. Secondary survey is a method by collecting data from various agencies and literature studies related to the substance of the object of study in the form of thematic maps of books and articles in the relevant scientific journals that are processed into one data and information. Detailed maps (secondary data) and sources can be seen in Table 1.

2.3 Analysis Method

The method of analysis used is the coastline comparison method of 2003 with the coastline of 2016. The method of analysis can be seen in Table 2.

3. Results and Discussion

3.1 The Development of Abrasion and Accretion in 2003 and 2016

The results of coastal abrasion and accretion analyzes by overlapping the 2003 map with 2016 map of the coastline of Western Sumatera are obtained coastline that has abrasion (coastline retreat) or accretion (coastal addition). Map analysis is done by delineation of land and water boundaries to obtain coastline covered by vegetation. Non-vegetated terrestrial terrain is further explained into water pixels (sea). In contrast to the SWIR-1 band ratio with the Green band (b5/b2 at Landsat-7; b6/b3 at Landsat-8), the coastline of the area covered by sand and soil is obtained.

The aeriality and accumulation of the West Sumatera coastline from 2003 to 2016 can be seen in Table 3.

Table 1 Types of data and source.

Data	Data type	Analysis method	Data source
Landsat ETM image data of 2003, Landsat OLI image data of 2016.	Secondary data: satellite imagery from landsat obtained from USGS (U.S. Geological Survey).	Using Band-Ratio and Single Band Methods to obtain delineation of terrestrial and water boundaries (pixel value limits) for the purpose of obtaining shorelines in each image of both ETM landscapes in 2003 and OLI landscapes 2016.	USGS U.S. Department of the Interior USGS or the Department of Home Affairs of the USGS.

Table 2 Analysis method.

The first stage	Phase two	Phase third	Phase four
Landsat ETM image data of 2003 and Landsat OLI in 2016 or acquisitions that year adjacent to the main criteria of each selected dataset is cloud-free, Landsat dataset requirements used for analysis and download are cloud content data $\leq 10\%$ and not yet defect on SLC (Scan Line Corrector).	For ease of analysis, the multi-spectral band types of the two datasets (Landsat-7 ETM and Landsat-8 OLI) are made in the form of band layer stacking (combined) in each dataset. Because the scope of research area (Coastal of West Sumatera) need 3 scene (path/row), then with step like this, resulted 6 pieces file stacking for requirement of coastline analysis.	Delineation of land and water boundaries to obtain coastline using Band-Ratio method to obtain more informative pixel value limits. In the Band-Ratio method, the ratio of NIR bands with Green bands (b4/b2 at Landsat-7; b5/b3 at Landsat-8) would result in a land-water boundary in coastal areas covered by vegetation. Non-vegetated terrestrial terrain is further explained into water pixels (sea). In contrast to the SWIR-1 band ratio with the Green band (b5/b2 at Landsat-7; b6/b3 at Landsat-8), the coastline of the area covered by sand and soil is obtained.	To facilitate the extraction of sea-border information which will be a coastline feature, a composite band or false color combination is used to display the limit of each observed object. The result of converting raster to vector. This polyline vector file is the same vertex size as the spatial resolution of the original dataset (Landsat ETM and Landsat OLI) of 30 meters. So to refine and edit it done repairs. Improvements are made using the line smooth tools in ArcGIS.

Table 3 Disaster abrasion disasters and accretion West Sumatera Province 2003-2016.

No	Cordiant		Long (m)	Change	Location
	X	Y			
1	623020	9934204	21.30	Accretion	Pariaman
2	618248	9941318	26.63	Accretion	Padang Pariaman
3	594519	9964605	27.22	Accretion	Agam
4	706582	9766915	16.72	Accretion	Pessel
5	696741	9801707	27.61	Accretion	Pessel
6	682308	9822788	28.96	Accretion	Pessel
7	676526	9846948	12.93	Accretion	Pessel
8	674485	9850775	36.91	Accretion	Pessel
9	638703	9916028	23.73	Abrasion	Padang Pariaman
10	637659	9916994	24.26	Abrasion	Padang Pariaman
11	635030	9919600	14.80	Abrasion	Padang Pariaman
12	623781	9932734	18.77	Abrasion	Pariaman
13	616836	9943023	7.66	Abrasion	Padang Pariaman
14	595941	9963671	21.42	Abrasion	Agam
15	597213	9962799	17.65	Abrasion	Agam
16	591843	9966170	17.40	Abrasion	Agam
17	589217	9972094	23.40	Abrasion	Agam
18	585107	9981676	28.98	Abrasion	Pasaman Barat
19	584171	9989685	24.72	Abrasion	Pasaman Barat
20	546839	10016208	22.69	Abrasion	Pasaman Barat
21	720378	9732211	16.57	Abrasion	Pesisir Selatan
22	712287	9740537	38.12	Abrasion	Pesisir Selatan
23	690377	9811442	26.18	Abrasion	Pesisir Selatan
24	689557	9812399	24.74	Abrasion	Pesisir Selatan
25	682175	9824383	16.35	Abrasion	Pesisir Selatan
26	682077	9825964	35.14	Abrasion	Pesisir Selatan
27	680472	9830554	18.70	Abrasion	Pesisir Selatan
28	677849	9835173	45.70	Abrasion	Pesisir Selatan
29	674753	9843750	31.37	Abrasion	Pesisir Selatan
30	651126	9890829	10.54	Abrasion	Padang
31	650338	9892911	13.55	Accretion	Padang
32	647709	9905662	15.68	Abrasion	Padang

Table 4 Abrasion beach at District of Pasaman Barat 2003-2016.

No.	Long (m)	Abrasion/Accretion
1	28.98	Abrasion
2	24.72	Abrasion
3	22.69	Abrasion

There are 32 observed points of abrasion and accretion along the coast of West Sumatera period 2003 to 2016. Here are the results of the analysis of abrasion and accretion disasters that occurred in each region in the City/District period of 2003 until 2016. In Pasaman Barat District during the period 2003-2016 observed a third (3) point abrasion occurred. The abrasion occurred on average as far as 25.46 m, the abrasion eroded the furthest coast 28.98 m and the closest 22.69 m, while the accretion is not available in Pasaman Barat Kabuapten. More can be seen in Table 4.

In Kabupaten Agam, there are 5 locations observed abrasion or accretion where 4 locations occur abrasion and 1 location of accretion. Abrasion occurs as far as 23.40 m while accretion occurs as far as 27.22 m. In contrast to West Pasaman District which only happened abrasion, in Agam Regency happened abrasion, average as far as 19.97 m at the same time happened accretion. The completeness of the abrasion point and the magnitude of each accretion and accretion can be seen in Table 5.

Accretion and abrasion occur also in Padang Pariaman District. Average abrasion occurred as far as 17.61 m, where abrasion happened at 5 point, while accretion happened at 1 point as far as 26.63 m in Table 6. Almost the same as Pariaman City happened

Table 5 Abrasion of beach and accretion in District of Agam 2003-2016.

No.	Long (m)	Abrasion/Accretion
1	27.22	Abrasion
2	21.42	Abrasion
3	17.65	Abrasion
4	17.40	Abrasion
5	23.40	Abrasion

Table 6 Abrasion of beach and accretion in District of Padang Pariaman 2003-2016.

No.	Long (m)	Abrasion/Accretion
1	26.63	Accretion
2	23.73	Abrasion
3	24.26	Abrasion
4	14.80	Abrasion
5	7.66	Abrasion

Table 7 Abrasion of beach and accretion in Pariaman City 2003-2016.

No.	Long (m)	Abrasion/Accretion
1	21.30	Accretion
2	18.77	Abrasion

1 point accretion as far as 21.30 m and 1 point abrasion as far as 18.77 m. More abrasion and accretion that happened in District of Padang Pariaman and Pariaman City can be seen in Table 7.

In the city of Padang, abrasion occurs at 2 points i.e. as far as 10.5 m and 15.68 m while accretion is at 1 point as far as 13.55 m in Table 8.

Compared with the City/District in West Sumatera, the largest distribution of abrasion and accretion is in District of Pesisir Selatan. There are 14 abrasion and accretion sites with 5 accretion points and 9 coastal abrasion points. Furthest acceleration of 36.91 m stretch of farthest abrasion 45.7 m and nearest 16.35 m. More abrasion and accretion that happened in Padang City and Pesisir Selatan Regency period 2003 to 2016 can be seen in Table 9.

3.2 Wide Area of Abrasion and Sumatera Coastal Accretion Analysis 2003-2016

With the same method, the results of the analysis of the area of abrasion and accretion that occurred coastal of West Sumatera Province by overlapping map of year 2003 with map of year 2016 obtained coastline which have abrasion (coastline retreat) or accretion (addition of beach) and length of area experiencing changes. By knowing the length and the changes that occur to the coastline, the coastal/coastal area that is abrasion or coastal accretion is obtained.

The results of the analysis of the area of abrasion and coastal accretion of West Sumatera for the period

Table 8 Abrasion of beach and accretion in Padang City 2003-2016.

No.	Long (m)	Abrasion/Accretion
1	10.54	Abrasion
2	13.55	Accretion
3	15.68	Abrasion

Table 9 Abrasion of beach and accretion in District of Pesisir Selatan 2003-2016.

No.	Long (m)	Abrasion/Accretion
1	16.72	Accretion
2	27.61	Accretion
3	28.96	Accretion
4	12.93	Accretion
5	36.91	Accretion
6	16.57	Abrasion
7	38.12	Abrasion
8	26.18	Abrasion
9	24.74	Abrasion
10	16.35	Abrasion
11	35.14	Abrasion
12	18.70	Abrasion
13	45.70	Abrasion
14	31.37	Abrasion

of 2003-2016 can be seen in Table 10. There are 32 points that undergo changes in both abrasion and accretion during this period that are spread along the coast of West Sumatera Province. Distribution of abrasion and accretion that mostly occurred in the South Coast is 14 locations, which consists of 9 points abrasion and 5 beach accretion points. While the distribution of smallest abrasion and accretion location in Pariaman City is 2 points (abrasion and accretion).

In District of Pasaman Barat, there are only 3 coastal abrasion points without any accretion, but the abrasion area in Kabuapten is the second largest after abrasion and coastal accretion in District of South Coastal is 425.11 Ha. More can be seen in Table 11. Significant loss of land in District of West Pasaman due to coastal abrasion, it is feared that the day is getting bigger because it is not accompanied by accretion (addition of land).

In Kabupaten Agam, there are 5 locations of abrasion and accretion, consisting of abrasion at 4 points and

Table 10 Space abrasion beach and accretion in West Sumatera Province 2003-2016.

No.	Kordinat		Perubahan	Lokasi	Luas (Ha)
	X	Y			
1	638703	9916028	Abrasion	Pariaman	18.66
2	637659	9916994	Abrasion	Padang Pariaman	3.32
3	635030	9919600	Abrasion	Agam	8.30
4	623781	9932734	Abrasion	Pessel	2.03
5	623020	9934204	Accretion	Pessel	4.84
6	618248	9941318	Accretion	Pessel	3.42
7	616836	9943023	Abrasion	Pessel	3.68
8	595941	9963671	Abrasion	Pessel	6.59
9	597213	9962799	Abrasion	Padang Pariaman	2.25
10	594519	9964605	Accretion	Padang Pariaman	9.86
11	591843	9966170	Abrasion	Padang Pariaman	21.78
12	589217	9972094	Abrasion	Pariaman	8.70
13	585107	9981676	Abrasion	Padang Pariaman	133.42
14	584171	9989685	Abrasion	Agam	265.90
15	546839	10016208	Abrasion	Agam	25.79
16	720378	9732211	Abrasion	Agam	16.89
17	712287	9740537	Abrasion	Agam	108.97
18	706582	9766915	Accretion	Pasaman Barat	13.58
19	696741	9801707	Accretion	Pasaman Barat	4.09
20	690377	9811442	Abrasion	Pasaman Barat	7.77
21	689557	9812399	Abrasion	Pesisir Selatan	7.79
22	682308	9822788	Accretion	Pesisir Selatan	2.74
23	682175	9824383	Abrasion	Pesisir Selatan	1.57
24	682077	9825964	Abrasion	Pesisir Selatan	27.06
25	680472	9830554	Abrasion	Pesisir Selatan	9.47
26	677849	9835173	Abrasion	Pesisir Selatan	21.62
27	674753	9843750	Abrasion	Pesisir Selatan	25.39
28	676526	9846948	Accretion	Pesisir Selatan	10.28
29	674485	9850775	Accretion	Pesisir Selatan	6.26
30	650338	9892911	Accretion	Padang	0.33
31	651126	9890829	Abrasion	Padang	1.94
32	647709	9905662	Abrasion	Padang	3.80

Table 11 Space abrasion beach and accretion in District of West Pasaman 2003-2016.

No.	Long (m)	Large (ha)	Abrasion/Accretion
1	28.98	133.42	Abrasion
2	24.72	265.90	Abrasion
3	22.69	25.79	Abrasion
Total		425.11	Abrasion

Table 12 Space abrasion beach and accretion in District of Agam 2003-2016.

No.	Long (m)	Large (ha)	Abrasion/Accretion
1	27.22	9.86	Accretion
2	21.42	6.59	Abrasion
3	17.65	2.25	Abrasion
4	17.40	21.78	Abrasion
5	23.40	8.70	Abrasion
Total		9.86	Accretion
		39.32	Abrasion

only 1 point of accretion. The area of abrasion that occurs is 39.32 Ha and accretion area of 9.86. This means that the reduced land area due to abrasion is not proportional to the extent of coastal accretion that occurs. More can be seen in Table 12.

Likewise in Padang Pariaman there are 5 locations consisting of abrasion at 4 points and accretion at 1 point. The area of abrasion disaster in Padang Pariaman beach is 33.96 Ha, while accretion is only 3.42 Ha in Table 13. This also shows no equivalent land area lost with the addition of land in District of Padang Pariaman.

In Pariaman City, there is only 1 point of abrasion location and 1 coastal accretion point with maaing of 2.03 Ha abrasion area and 4.84 Ha accretion area. This is different from other areas where the area of abrasion is smaller (2.03 Ha) than the accretion area greater than twice the abrasion of 4.84 Ha. More can be seen in Table 14.

As the capital of West Sumatera Province, Padang City did not escape the disaster of abrasion and coastal accretion. There has been a reduction of land area due to coastal abrasion of 5.74 Ha while land addition is only 0.33 Ha. This condition is very prudent considering that as the capital of the Province, Padang

Table 13 Space abrasion beach and accretion in District of Padang Pariaman 2003-2016.

No.	Long (m)	Large (ha)	Abrasion/Accretion
1	26.63	3.42	Accretion
2	23.73	18.66	Abrasion
3	24.26	3.32	Abrasion
4	14.80	8.30	Abrasion
5	7.66	3.68	Abrasion
Total		3.42	Accretion
		33.96	Abrasion

Table 14 Space abrasion beach and accretion in the Pariaman City 2003-2016.

No.	Long (m)	Large (ha)	Abrasion/Accretion
1	21.30	4.84	Accretion
2	18.77	2.03	Abrasion

City requires a fairly high land for development. From the analysis, it can be concluded that on average, there is a reduction of 0.44 Ha/year. This figure is quite high considering the city of Padang is a coastal town that is quite dense population and area terbangunnya.

More coastal abrasion and accretion data that happened last 13 year in Padang City can be seen in Table 15.

Most abrasion and accretion disasters are found in District of Pesisir Selatan which is spread over 14 points. The abrasion disaster for the last 13 years is 226.53 Ha and 36.95 Ha accretion in Table 16. On average, there has been a reduction of land area of 17.4 Ha and this is a big enough figure to be concerned by the Pesisir Selatan District Government.

The largest coastal eruption occurring on the coast of West Sumatera in the last 13 years is District of West Pasaman which is 265.90 Ha and in District of Pesisir Selatan of 108.97 Ha. This is very worrying if the continent of the mainland will be reduced especially in coastal areas. The increasingly diminishing land area will trigger land use problems and land tenure status.

While the accretion is the largest addition of land that is found in District of Pesisir Selatan of 10.28 Ha and District of Agam covering 9.86 Ha. Extensive accretion is the addition of coastal land area in West

Table 15 Space abrasion beach and accretion in Padang City 2003-2016.

No.	Long (m)	Large (ha)	Abrasion/Accretion
1	10.54	1.94	Abrasion
2	13.55	0.33	Accretion
3	15.68	3.80	Abrasion
Total		0.33	Accretion
		5.74	Abrasion

Table 16 Space abrasive beach and accession in District of Pesisir South 2003-2016.

No.	Long (m)	Large (ha)	Abrasion/Accretion
1	16.72	13.58	Accretion
2	27.61	4.09	Accretion
3	28.96	2.74	Accretion
4	12.93	10.28	Accretion
5	36.91	6.26	Accretion
6	16.57	16.89	Abrasion
7	38.12	108.97	Abrasion
8	26.18	7.77	Abrasion
9	24.74	7.79	Abrasion
10	16.35	1.57	Abrasion
11	35.14	27.06	Abrasion
12	18.70	9.47	Abrasion
13	45.70	21.62	Abrasion
14	31.37	25.39	Abrasion
Total		36.95	Accretion
		226.53	Abrasion

Table 17 Space abrasion beach and accretion in West Sumatera Province 2003-2016.

No.	County/town	Abrasion (Ha)	Accretion (Ha)
1	Pasaman Barat	425.11	-
2	Agam	39.32	9.86
3	Padang Pariaman	33.96	3.42
4	Pariaman	2.03	4.84
5	Padang	5.74	0.33
6	Pesisir Selatan	226.53	36.95
Amount		732.69	55.4

Sumatera region only 55.4 ha, and much smaller land loss due to coast abrasion that is equal to 732.69 Ha in Table 17.

4. Conclusion

From 2003 to 2016 (13 years of observation), on the coast of West Sumatera Province there has been abrasion and accretion disaster in 32 points spread

across 6 districts and cities, namely Pasaman Barat District, Agam District, Padang Pariaman District, Pariaman City, Padang City and Pesisir Selatan District. The highest number of points of abrasion and accretion is found in Pesisir Selatan District and only 2 points of abrasion and accretion are in Pariaman City.

Congratulations 13 years of observation, abrasion disaster in the coastal area of West Sumatera Province of 732.69 Ha and 55.4 Ha of acres. This proves that the abrasion debacle causes the decrease of land in West Sumatera Province which is big enough that is average 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 Sumatera.

The farthest abrasion disasters are located in South Coast Regency as far as 45.70 m or 3.52 m/year average. While the farthest accretion is in the South Coast Regency is as far as 36.91 or an average of 2.84 m/year. From the rate of coastline retreat and the advance of coastline in Pesisir Selatan, the addition of land (accretion) can be as far as 2.84 m/year.

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