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COASTLINE MAPPING IN KOTO TANGAH DISTRICT USING MULTITEMPORAL REMOTE SENSING IMAGES, 2002, 2012 AND 2022

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ABSTRACT: The purpose of this study was to determine changes in the coastline and the extent of abrasion and accretion that occurred from 2002 to 2012 and 2012 to 2022. This study utilized geographic information systems and remote sensing techniques in the form of Landsat 7 imagery in 2002, 2012 and Landsat 8 imagery. in 2022. The research uses the Digital Shoreline Analysis System method 'DSAS' which Net Shoreline Movement (NSM) and Endpoint Rate (EPR). To calculate the area of abrasion and accretion use the Calculate Geometry menu. The results of this study are maps of shoreline changes from 2002 to 2012 and from 2012 to 2022. From 2002 to 2012 the rates and distances that occur are accretions 2012 to 2022, the change in the coastline, the rate and distance that will occur is abrasion. The coastline area due to abrasion increased by 57,702 m in 2002-2012 and 2012-2022, while the coastline area due to accretion in 2002-2012 and 2012-2022 decreased by 61,851 m.
Keywords: Mass Sensing, GIS, Shoreline Change, DSAS, Abrasion, Accretion.

1. INTRODUCTION

Coastal areas are strongly influenced by land and sea conditions, coastlines tend to show a dynamic balance and adjust their morphology, which can disrupt the energy of incoming waves. Big waves and storms have a lot of energy that causes beach erosion. Coastal erosion creates two possibilities, restoration of beach conditions and erosion of coastal plains in one location which is called abrasion because beach material is transported to another location.

Shoreline changes due to abrasion and accretion are the main concern of the public and government. Abrasion and accretion affect changes in the area of the property, disrupting potential coastal activities such as tourism, business and industry (rais, et al, 2004). The famous city in West Sumatra experiencing severe abrasion and accretion is Padang City. The city of Padang is a city famous for its tourism potential, the beach which is a favorite destination for local tourists as well road. The beach area in Padang City that experienced severe abrasion was Pasir Jambak beach in Koto Tangah District.

Changes in the coastline that occurred in Koto Tangah District were caused by currents and sea waves which are characterized by large values of wave and current properties, in other words, the coast is susceptible to abrasion when high waves occur, causing currents, because they move along the coast. at high speed.

Monitoring change coast done by Using remote sensing techniques monitoring coastal changes is very important especially in areas with long coastlines and many islands such as Indonesia (Winarso et al, 2001). Iwan (2015) states that coastal changes using remote sensing techniques are a method of observation that can be carried out multi-temporally to see changes in the coastline and shoreline material.

Technological development Remote sensing, especially satellite imagery, is very fast. Satellite imagery strongly supports the availability of relatively short and widespread local characteristic data, so that a geographic information system in the form of a digital shoreline can be carried out analysis system (DSAS) to provide information about each change with take advantage of technology remote sensing that can be used to automatically detect and calculate shoreline changes in an area. This study aims to see changes in the coastline using Landsat imagery data in 2002, 2012 and 2022 and to determine the extent of abrasion and accretion that has occurred in these areas.

2. RESEARCH METHODS

This research was conducted in Koto Tangah District, which is located at 100°23´14.8´´E 00°52´33.6´´S. Koto Tangah District is located on the west coast of Sumatra Island, which is within 7 km of the city center, directly adjacent to Padang Regency Pariaman. The research location can be seen in the image below:

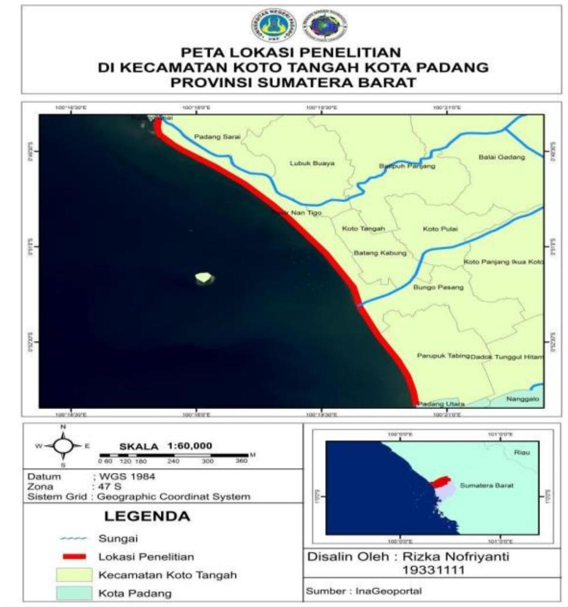

Figure 1. Source: Researchers, 2022

In this study using the type of primary data and secondary data. Primary data is data obtained directly on the object under study through field surveys in the study area in the form of coordinates whether they are in accordance with the results of changes in the coastline. Secondary data is data that already existed before. In this study, secondary data was in the form of Landsat 7 images in 2002 and 2012 and Landsat 8 images in 2022.

Table 1. Research data

No	Data Type	Source
1	Administrative Shp data	Inageoportal site
2	Landsat 7 & 8 imagery	USGS site
3	Field Data	Field Survey

Image data processing process first we do the name of image cropping in accordance with the study area, here just did the name image correction to improve the image damage. Delineation beach using method a *modified Different Water Index* (MNDWI) to highlight the differences between water bodies and urban areas.

This method is one of the best methods for separating land and sea objects in an image (Fuad, et al, 2017). The Modified Different Water Index (MNWDI) was chosen because it can clearly distinguish between water and land when extracting water information with an accuracy of 99.85% (Xu, 2006).

The process of checking the land-sea boundaries of Landsat TM and ETM+ uses the Xu formula (2006), namely

$$MNDWI = \frac{Green - MIR}{Green + MIR}$$

The formula for Landsat 8 OLI/TIRS is:

$$MNDWI = \frac{Green - SWIR\ 1}{Green + SWIR\ 1}$$

The band used in the Modified Different Water Index (MNDWI) formula is a wavelength band of 0.52-0.60 micrometers and a wavelength band of 1.55-1.75 micrometers (Gautam, et al, 2015). The wavelength value of each band in Landsat imagery is used as a reference to determine which band to use.

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The calculation of shoreline changes is carried out using a digital shoreline analysis system with non-or point reference lines baseline. The baselines is placed on the mainland (Onshore). The transect is made to face the sea with the distance between the transects used is 100 m with the assumption that the one transect will represent each image pixel and the transect length is 350 m.
The field test stage of this research was carried out through ground checks in the study area. Ground check is an activity carried out by someone to examine the relationship between maps, drawings and aerial photographs with the actual situation on the ground.

3. RESULTS AND DISCUSSION

3.1 Shoreline change

Abrasion events from 2002 to 2012 have exceeded the number of Transecdid, namely 59 Transects, with the greatest speed found in Transect 81 which is marked in red with a speed of 5.57 m, a distance of 54.93 m with the smallest speed found in Transcet 28 which is marked in green with a speed of 0.01m and a distance of 0.13m.

Accretion events from 2002 to 2012 above show that the number of Transectids is 44 Transects, with the greatest speed found in Transect 3 which is marked in red with a speed of 11.24 m with a distance of 110.84 m. while the smallest speed is found in Transect 103 which is marked in green with a speed of 0 m and with distance 0.01m.

Table 3. Abrasion and Accretion Events from 2002 to 2012

No	*Transect_Id*	Category	EPR (pace m)	NSM (distance m)
1	22	abrasion	-0.79	-7.83
2	23	abrasion	-2.07	-20.45
3	24	abrasion	-1.15	-11.33
4	25	abrasion	-1.05	-10.32
5	26	abrasion	-0.94	-9.26
6	27	abrasion	-0.3	-2.96
7	28	abrasion	-0.01	-0.13
8	29	abrasion	-0.03	-0.26
9	30	abrasion	-0.04	-0.42
10	32	abrasion	-1.27	-12.53
11	33	abrasion	-1.9	-18.76
12	34	abrasion	-1	-9.85
13	35	abrasion	-0.32	-3.11
14	37	abrasion	-0.54	-5.34
15	38	abrasion	-1.18	-11.66
16	42	abrasion	-1.76	-17.34
17	43	abrasion	-2.57	-25.35
18	44	abrasion	-1.5	-14.79
19	45	abrasion	-1.21	-11.93
20	46	abrasion	-2.22	-21.87
21	47	abrasion	-2.45	-24.15
22	48	abrasion	-2.28	-22.49
23	49	abrasion	-1.46	-14.41
24	50	abrasion	-2.18	-21.47
25	51	abrasion	-3.18	-31.34
26	52	abrasion	-1.79	-17.68
27	55	abrasion	-0.97	-9.55

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28	56	abrasion	-0.53	-5.23
29	57	abrasion	-0.16	-1.58
30	58	abrasion	-1.71	-16.82
31	59	abrasion	-1.84	-18.09
32	60	abrasion	-1.91	-18.79
33	61	abrasion	-2.01	-19.83
34	62	abrasion	-1.58	-15.57
35	63	abrasion	-1.06	-10.4
36	64	abrasion	-0.84	-8.26
37	65	abrasion	-0.67	-6.65
38	76	abrasion	-2.3	-22.63
39	77	abrasion	-3.95	-38.91
40	78	abrasion	-1.75	-17.28
41	79	abrasion	-2.63	-25.88
42	81	abrasion	-5.57	-54.93
43	82	abrasion	-4.41	-43.44
44	83	abrasion	-3.59	-35.36
45	84	abrasion	-2.78	-27.4
46	85	abrasion	-4.75	-46.85
47	86	abrasion	-3.93	-38.72
48	87	abrasion	-3.12	-30.77
49	88	abrasion	-2.92	-28.82
50	89	abrasion	-2.79	-27.47
51	90	abrasion	-0.59	-5.82
52	92	abrasion	-1.33	-13.15
53	93	abrasion	-2.51	-24.72
54	94	abrasion	-2.57	-25.34
55	95	abrasion	-1.35	-13.31
56	96	abrasion	-0.5	-4.9
57	100	abrasion	-0.41	-4.04
58	101	abrasion	-0.99	-9.79
59	102	abrasion	-0.41	-4.07
60	2	Accretion	10.58	104.28
61	3	Accretion	11.24	110.84
62	4	Accretion	3.1	30.52
63	5	Accretion	3.02	29.76
64	6	Accretion	2.37	23.37
65	7	Accretion	1.66	16.32
66	8	Accretion	1.59	15.65
67	9	Accretion	1.55	15.26
68	10	Accretion	1.56	15.35
69	11	Accretion	1.61	15.84

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70	12	Accretion	1.85	18.28
71	13	Accretion	1.92	18.9
72	14	Accretion	1.62	15.96
73	15	Accretion	1.32	13.01
74	16	Accretion	1.02	10.07
75	17	Accretion	0.8	7.93
76	18	Accretion	0.62	6.1
77	19	Accretion	0.44	4.32
78	20	Accretion	6.64	65.49
79	21	Accretion	3.71	36.56
80	36	Accretion	0.04	0.42
81	39	Accretion	0.08	0.82
82	40	Accretion	0.54	5.33
83	41	Accretion	0.21	2.11
84	53	Accretion	3.49	34.45
85	54	Accretion	3.21	31.64
86	66	Accretion	0.32	3.19
87	67	Accretion	2.3	22.66
88	68	Accretion	1.99	19.64
89	69	Accretion	1.68	16.61
90	70	Accretion	2.73	26.91
91	71	Accretion	3.98	39.19
92	72	Accretion	3.89	38.35
93	73	Accretion	2.48	24.47
94	74	Accretion	1.61	15.88
95	75	Accretion	0.31	3.04
96	80	Accretion	0.78	7.73
97	91	Accretion	0.88	8.63
98	97	Accretion	0.26	2.54
99	98	Accretion	0.58	5.68
100	99	Accretion	0.5	4.94
101	103	Accretion	0	0.01
102	104	Accretion	1.47	14.46

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103	105	Accretion	1.44	14.24

So the average abrasion rate from 2002 to 2012 is 0.18 m/year. As for the average distance of abrasion shoreline changes from 2002 to 2012, it was 1.73 m/year. So the average accretion rate from 2002 to 2012 was 0.21 m/year, while the average distance of accretion shoreline change from 2002 to 2012 was 2.08 m/year.

So the average rate of change of coastline due to abrasion and accretion in 2002 to 2012 is 0.19 m, while the average distance to coastline due to abrasion and accretion in 2002 to 2012 is of 1.90 m. It can be concluded that the dominant change in coastline from 2002 to 2012 was accretion.

Figure 2. Source: Researchers, 2022

The abrasion events from 2012 to 2022 above have 75 TranscetdId, with the largest rate occurring in Transect 3 which is marked in red with a speed of 13.08 m, and a distance of 133.2 m. while the smallest speed is found in Transect 51 which is marked in green with a speed of 0.02 m, and a distance of 0.25 m.

Accretion events from 2012 to 2022 above have 29 Trasectid numbers, with the highest speed value found in Transect 73 which is marked in red with a speed of 2.88 m, a distance of 29.37 m. as for speed the smallest is in Transect 63 which is marked in green, with a speed value of 0.04 m, a distance value of 0.37 m.

NO	*TransectId*	Category	Speed (EPR) m	Distance (NSM) m
1	2	abrasion	-12.05	-122.72
2	3	abrasion	-13.08	-133.2
3	6	abrasion	-2.37	-24.14
4	7	abrasion	-3.86	-39.27
5	8	abrasion	-4	-40.78
6	9	abrasion	-3.5	-35.63
7	10	abrasion	-3.53	-35.93
8	11	abrasion	-3.56	-36.23
9	12	abrasion	-3.59	-36.53
10	13	abrasion	-3.42	-34.8
11	14	abrasion	-2.86	-29.1
12	15	abrasion	-2.46	-25.01

13	16	abrasion	-2.61	-26.53
14	17	abrasion	-2.25	-22.96
15	18	abrasion	-1.79	-18.26
16	19	abrasion	-1.44	-14.65
17	20	abrasion	-7.75	-78.94
18	21	abrasion	-5.36	-54.55
19	22	abrasion	-1.02	-10.34
20	24	abrasion	-0.84	-8.57
21	25	abrasion	-1.11	-11.27
22	26	abrasion	-1.39	-14.12
23	27	abrasion	-1.9	-19.38
24	28	abrasion	-1.81	-18.48
25	29	abrasion	-1.66	-16.89
26	30	abrasion	-1.46	-14.9
27	31	abrasion	-1.91	-19.44
28	32	abrasion	-0.89	-9.07
29	33	abrasion	-0.22	-2.24
30	34	abrasion	-0.13	-1.33
31	39	abrasion	-0.07	-0.7
32	40	abrasion	-0.52	-5.26
33	41	abrasion	-0.21	-2.09
34	42	abrasion	-0.22	-2.2
35	43	abrasion	-0.24	-2.42
36	44	abrasion	-1	-10.21
37	45	abrasion	-1.59	-16.17
38	46	abrasion	-0.67	-6.79
39	47	abrasion	-0.48	-4.85
40	48	abrasion	-0.48	-4.85
41	49	abrasion	-3.79	-38.6
42	50	abrasion	-1.27	-12.94
43	51	abrasion	-0.02	-0.25
44	52	abrasion	-1.06	-10.8
45	53	abrasion	-5.71	-58.1
46	54	abrasion	-5.31	-54.05
47	55	abrasion	-1.5	-15.25
48	56	abrasion	-0.97	-9.83
49	57	abrasion	-1.56	-15.85
50	58	abrasion	-0.31	-3.11
51	67	abrasion	-0.42	-4.28
52	74	abrasion	-1.25	-12.7
53	75	abrasion	-1	-10.14
54	76	abrasion	-0.6	-6.12
55	77	abrasion	-0.63	-6.38

56	78	abrasion	-3.52	-35.81
57	79	abrasion	-2.59	-26.41
58	80	abrasion	-4.75	-48.33
59	81	abrasion	-1.81	-18.46
60	82	abrasion	-1.66	-16.94
61	83	abrasion	-2.05	-20.89
62	84	abrasion	-2.24	-22.78
63	85	abrasion	-0.44	-4.5
64	86	abrasion	-1.41	-14.33
65	87	abrasion	-2.15	-21.86
66	88	abrasion	-1.95	-19.89
67	89	abrasion	-1.7	-17.27
68	90	abrasion	-1.74	-17.76
69	91	abrasion	-2.34	-23.83
70	97	abrasion	-0.25	-2.54
71	98	abrasion	-0.56	-5.68
72	99	abrasion	-0.49	-4.94
73	103	abrasion	-0.48	-4.87
74	104	abrasion	-0.5	-5.06
75	105	abrasion	-0.52	-5.34
1	4	Accretion	0.07	0.75
2	5	Accretion	0.07	0.68
3	23	Accretion	0.23	2.34
4	35	Accretion	0.2	2.06
5	36	Accretion	0.24	2.49
6	37	Accretion	0.49	5.02
7	38	Accretion	1.14	11.66
8	59	Accretion	0.07	0.74
9	60	Accretion	0.63	6.39
10	61	Accretion	1.2	12.2
11	62	Accretion	0.67	6.8
12	63	Accretion	0.04	0.37
13	64	Accretion	0.59	5.97
14	65	Accretion	1.32	13.47
15	66	Accretion	0.47	4.78
16	68	Accretion	1.3	13.2
17	69	Accretion	1.58	16.05
18	70	Accretion	1.19	12.12
19	71	Accretion	0.77	7.88

20	72	Accretion	1.31	13.38
21	73	Accretion	2.88	29.37
22	92	Accretion	0.17	1.75
23	93	Accretion	1.4	14.3
24	94	Accretion	1.54	15.66
25	95	Accretion	0.6	6.1
26	96	Accretion	0.16	1.59
27	100	Accretion	0.4	4.04
28	101	Accretion	0.96	9.79
29	102	Accretion	0.23	2.33

Source :DSAS Processing Results, 2022

So the average abrasion rate from 2012 to 2022 is 0.21 m/year, while the average change in coastline abrasion from 2012 to 2022 is 2.14 m/year. So the average rate of change of coastline due to accretion in 2012 to 2022 is 0.08 m/year, while the average distance of change of coastline due to accretion in 2012 to 2022 is 0.77m/yr.

So the average rate of change of coastline due to abrasion and accretion in 2012 to 2022 is 0.14 m, while the average distance to change of coastline due to abrasion and accretion in 2012 to 2022 is 1.45 m. It can be concluded that the dominant change in the coastline from 2012 to 2022 is abrasion.

Figure 3. Source: Researchers, 2022.

3.2. Areas of Abrasion and Accretion

Overall, the area of abrasion from 2002 to 2012 was 105432 m, with an average annual change of 10543 m. For the area of accretion events from 2002 to 2012 it was 86996.3 m2, with an average annual change of 8699 m. Then the total number of all abrasion and accretion events in 2002 until 2012 amounted to 192,428.3 m with an annual average of 9,621 m.

The area of abrasion events from 2012 to 2022 is 163134 m, with an average change16.313 m annually. while the area of accretion events from 2012 to 2022 is 25145.1 m2, with an average annual change of 2514 m. The total number of abrasion and accretion events from 2012 to 2022 is 188,278.1 with an average change9,413 m annually.

4. CONCLUSION

Based on the results of a study regarding the mapping of shoreline changes in the Koto Tangah sub-district it can be concluded that Koto Tangah District is one of the sub-districts that has experienced quite severe shoreline changes by utilizing remote sensing imagery with the DSAS calculation method which gives different results every year. In 2002-2012 the changes that occurred for speed and distance were accretion. In 2012-2022 the changes that occur for speed and distance are abrasion.

The area of change in the coastline in Koto Tangah Subdistrict from 2002 to 2012, 2012 to 2022. The area of change due to abrasion from 2002 to 2012 and 2012 to 2022 has increased by 57,702 m, while the area of shoreline changes due to accretion from 2002 to 2012 and 2012 to 2022 decrease as big 61.851 m.

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