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UTILIZATION OF REMOTE SENSING DATA IN IDENTIFYING COASTLINE CHANGES WITH THE BILKO ALGORITHM METHOD IN 2014, 2018, AND 2022 (Case Study of Pasir Baru Beach Area, Sungai Limau District)

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ABSTRACT : The beach is a form of geology composed of sand located in coastal areas and the position of the coastline is dynamic. Identification of shoreline changes is important information that can be obtained from Remote Sensing Data and Geographic Information Systems (GIS) which has advantages and speed in the results of the process. This research was carried out in the Pasir Baru Beach area, Nagari Pilubang, Sungai Limau District using Landsat 8 OLI Satellite Images in 2014, 2018, and 2022 with the aim of determining changes in coastlines in the 2014-2018 and 2018-2022 ranges and knowing the extent of coastline changes in the 2014-2018 and 2018-2022 ranges. The method used to extract the coastline is obtained from the extraction results from the Landsat 8 OLI Satellite Image using the BILKO algorithm method, for the calculation of distance and rate of change of coastlines using a digital coastline analysis system (DSAS) with two statistical methods, namely Net Shoreline Movement (NSM) and End Point Rate (EPR) and for calculating the area of coastline change using the Calculate Geometry menu using attribute information in the software ArcGIS 10.5 in square meters (m2). Based on the results of the study that the coastal process that occurred in the research area from 2014-2022 was an erosion or abrasion event. The amount of erosion increased from 2018 to 2022 with an average erosion rate of 2.11 m / year, while the average abrasion distance was 7.49 m / year which was characterized by the formation of abrasion gawir and the fall of new trunk trees around the beach due to soil erosion. Meanwhile, the average rate for sedimentation or accretion events in 2018-2022 is 0.04 m/year while the average distance of change due to accretion events is 0.15 m/year. With a total area of erosion or abrasion events in 2018-2022 of 48,220.4 m, with an average annual area change of 12,055 m. Meanwhile, the total area of sedimentation or accretion events in 2018-2022 amounted to 449.3 m with an average annual area change of 112.3 m.

Keywords : Identification, Shoreline Change, Abrasion, Accretion, DSAS, Remote Sensing, Landsat 8 OLI Satellite Imagery

1. INTRODUCTION

The beach is one of the central areas of human activities which is used as a center of tourism, government, settlements, ports, fishing industry, aquaculture and so on. This causes land use in coastal areas to be increasingly limited, resulting in the emergence of new problems such as reduced land carrying capacity that causes coastal erosion such as coastal abrasion that destroys settlements or other infrastructure or land arising from sedimentation in coastal areas. On the one hand sedimentation or soil arising in coastal areas can be said to be beneficial due to the emergence of new land, while on the other hand it can cause urban drainage problems in coastal areas (Triatmodjo, 1999). According to (Cui et al, 2011) coastlines tend to be dynamic and their position can change. The geographical condition of West Sumatra Province, which is directly facing the Indian Ocean, makes the west coast vulnerable to abrasion and accretion events. One of the areas on the coast of West Sumatra Province that has coastal abrasion vulnerability problems is the coast of Padang Pariaman Regency, especially in the coastal area of Sungai Limau District.

The geographical condition of West Sumatra Province, which is directly facing the Indian Ocean, makes the west coast vulnerable to abrasion and accretion events. One of the areas on the coast of West Sumatra Province

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that has coastal abrasion vulnerability problems is the coast of Padang Pariaman Regency, especially in the coastal area of Sungai Limau District.

Based on the results of Endriani Rahtin's research which examined changes in coastline in 2016-2020 stated that the largest coastal abrasion event was in Nagari Pilubang with a change in coastline of 114.59 meters and the smallest change in coastline was in Nagari Guguak with a change in coastline of 78.72 meters. Changes in the coastline that occur on the coast of Sungai Limau District are influenced by currents (0.12 - 0.25 m / s), wind (5 - 2 m / s), waves (0.3 - 0.93) and tides (-0.6 - 0.8 meters). The current that moves along the coast formed by wind and waves on the coast of Sungai Limau District causes abrasion. However, according to the results of research (Solihuddin, 2011) which has conducted studies from a geological point of view shows that the lithology of the constituents of the Padang Pariaman beach is dominated by alluvium deposits which have low resistance to the erosion process by currents and sea waves so that they are susceptible to abrasion.

Therefore, more observations are needed to determine changes in the line of Pasir Baru Beach, Nagari Pilubang, Sungai Limau District using remote sensing technology methods, one of which is by utilizing satellite image data. Remote sensing is expected to facilitate the presentation of spatial information, especially related to Shoreline Change using Landsat 8 OLI Satellite Image data in the Pasir Baru Beach area, Sungai Limau District. This research is expected to later be used as spatial data with a faster and more efficient method in identifying Coastline Changes.

The specific purpose of this study is to determine the changes in the coastline and the extent of coastline changes that occurred at Pasir Baru Beach, Nagari Pilubang, Sungai Limau District, Padang Pariaman Regency in 2014, 2018, and 2022.

2. RESEARCH METHODS

2.1 Research Location

The location of this final project research is in the coastal area of Padang Pariaman Regency, namely Pasir Baru Beach, Nagari Pilubang, Sungai Limau District. Sungai Limau District is geographically located at 0°33'00" South Latitude and at 100°07'00" East Longitude.

2.2 Tools and Materials

The tools used in this study are Lenovo leptop, envi 5.1 software, arcgis 10.5 software, oppo A83 smartphone, avenza maps application, and stationery. Meanwhile, the materials used in this study are Landsat 8 satellite images in 2014, 2016, and 2022.

2.3 Types of Research and Data Sources

This type of research is a type of quantitative descriptive research with a spatial analysis approach. While the types of data used in this study are primary data and secondary data. Primary data is obtained directly through field surveys or ground checks by taking into account geomorphological characteristics, soil characteristics, constituent materials, and processes that occur in the field. While the secondary data used in this study are landsat 8 satellite images in 2014, 2018, and 2022 where the data can be downloaded on the http://earthexplorer.usgs.gov/ page. as well as https://glovis.usgs.gov/ and maps of administrative boundaries that can be downloaded on the Ina-Geoportal page.

2.4 Data Processing Stage

2.4.1 Pre Processing Data

The imagery used is Landsat 8 OLI imagery acquired in 2014, 2018 and 2022 with the acquisition of 30 meters of image accuracy. Landsat 8 satellite imagery is downloaded via the Earth Explorer USGS web and then processed with ENVI software for pre-processing stages such as radiometric correction and atmospheric correction, then continued data processing on ArcGIS 10.5 software.

2.4.2 Processing Data

2.4.2.1 Shoreline ekstraction

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In this study, making coastlines using arcgis 10.5 software by applying the BILKO algorithm method which was done manually by analyzing landsat 8 satellite images. In applying the BILKO formula, it uses an infrared band (band 5), because infrared waves themselves have low reflectance to water and high reflectance to land (Ario Damar Wicaksono et al, 2020). Which means that, water objects have low spectral reflections. This is due to the nature of water absorbing more electromagnetic energy (low reflectance) at infrared wavelengths, while non-water or terrestrial objects reflect more energy (high reflectance). Reflectance is the ability of the earth's surface to reflect electromagnetic signals. The BILKO formula used is as follows, (Hanifah et al, 2004) :

BILKO = ((INPUT1/((N*2)+1)*(-1))+1)

Information :
N = Minimum value of land BV in Landsat 7 imagery is (30) and Landsat 8 image is (7,000)
INPUT1 = Band 4 (Landsat 7), Band 5 (Landsat 8)

2.4.2.2 Calculation of the area of change of the Pasir Baru coastline

The calculation of coastline changes in this study I used a digital coastline analysis system (DSAS). The statistical methods used in this study are Net Shoreline Movement (NSM) and End Point Rate (EPR). The NSM method is used to determine the change in distance from the oldest coastline to the most recent coastline. Distance data that is positive (+) indicates a forward coastline and distance data that is negative (-) indicates a backward coastline. While the EPR method is used to calculate the rate of change of coastline by dividing the distance between the oldest coastline and the current coastline by the time. Rate data with a positive value (+) experienced accretion and rate data with a negative value (-) experienced abrasion (Umami, A. Harahap, Syamsudin, and Sunarto, 2018). The following calculation formula for statistical analysis of NSM and EPR is as follows:

NSM = Oldest Coastline – newest coastline

$$\textbf{EPR} = \frac{\textbf{Distance between the initial coastline and the final coastline}}{\textbf{The difference in time from the initial and final coastlines}}$$

The formula for the rate per year is:

$$\textbf{Rse} = \frac{\textbf{Xo}}{\textbf{T}}$$

Information :
Rse = Rate of change (m/year)
Xo = Distance between coastline and other coastlines
T = Length of observation time

To recognize the position of abrasion formation and accretion, an overlay was carried out based on the results of information analysis of coastline changes in 2014-2018 and 2018-2022. The technique used to calculate the area of coastline change is to use the Calculate Geometry menu using attribute information in ArcGIS 10.5 in units of square meters (m2).

2.4.3 Sampling

Sampling in this study is random sampling which is random sampling for field surveys. Making sample points accuracy test accuracy test is a process carried out to check between the results of processing in the image and measurements in the field. The number of samples needed is calculated using a formula in binomial probability theory according to Fitzpatrick-Lins (1982), namely:

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$$N = \frac{Z^2 \times p \times q}{E^2}$$

Information :
N = Number of samples
Z = 2 (Normal standard deviation for confidence level)
p = Expected accuracy
q = Difference between 100-p
E = Allowed errors

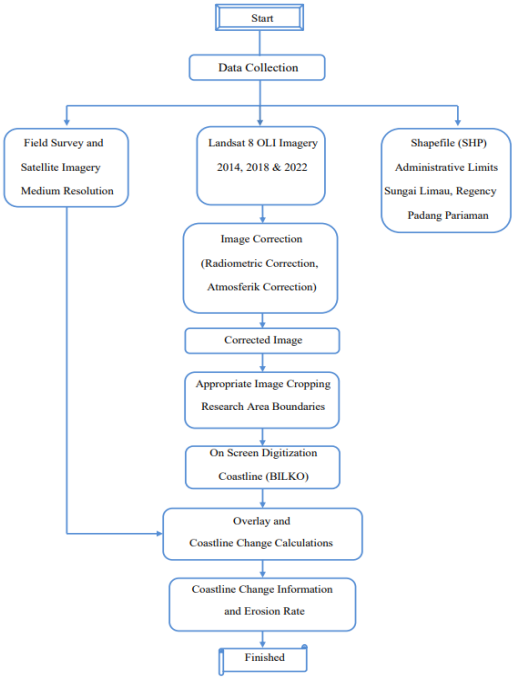
2.4.4 Field Survey / Field Inspection

Field checking activities are carried out to obtain information about real field conditions or conditions as a complement to information and compare between the appearance of objects in the image and the appearance of the same object in the field. Field observations also refer to existing shoreline change data. For example, at the first point there is an abrasion event, now at this stage it is checked whether the abrasion is true or not at the intended location point.

2.4.5 Accuracy Test

Accuracy tests were conducted to assess the accuracy of data identifying changes in coastlines from processing using Landsat satellite images. Accuracy testing is a process that shows the truth of the research conducted. Accuracy tests are carried out by taking samples on maps digitized from images and then matching data in the field. Because the time of the study is not the same as the time of image recording, the researchers took several points which have the closest time to the observation, and are expected to represent the overall results of the points taken as much as 50% of each change with the nearest time span.

2.4.6 Research Flow Chart



3. RESULTS OF RESEARCH AND DISCUSSION

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3.1 Changes in the New Sand Coastline of Nagari Pilubang in Sungai Limau District From 2014-2018 and 2018-2022

By conducting research on changes in coastlines in the coastal areas of Pasir Baru, Nagari Pilubang, Sungai Limau District using remote sensing data, namely Landsat 8 OLI Satellite Image data in 2014, 2018, and 2022 to make a map of coastline changes, the results obtained by the study are :

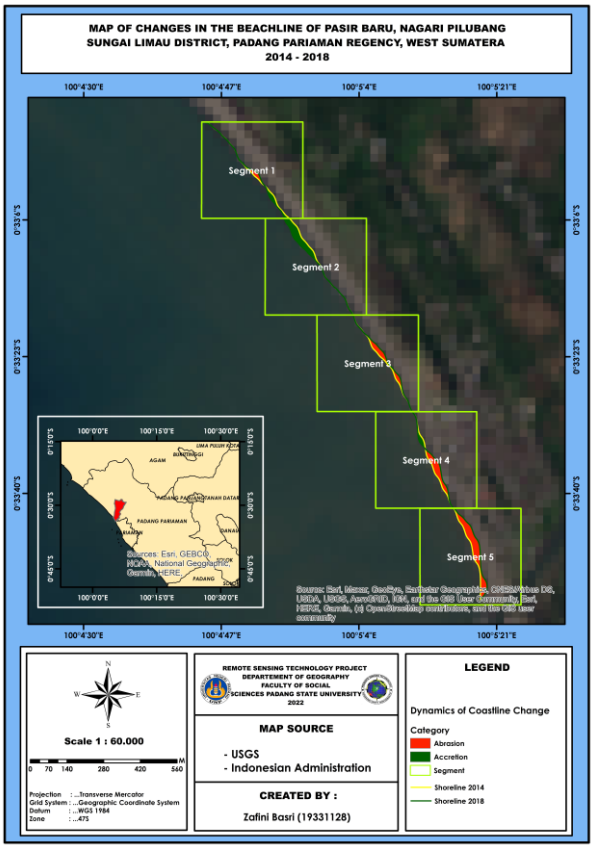

Figure 1. Map Of Coastline Changes In 2014 - 2018

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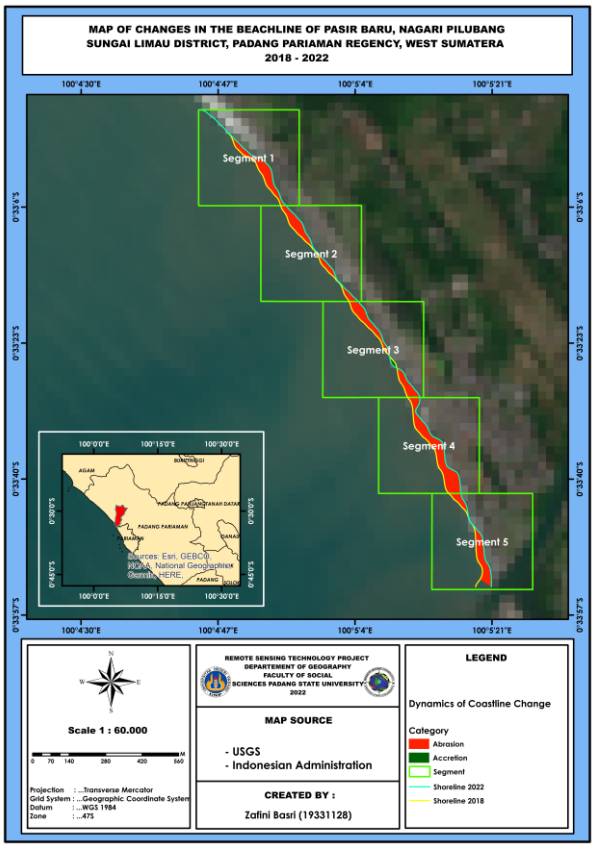

Figure 2. Map Of Coastline Changes In 2018 - 2022

Tabel 1. Average Rate and Distance of Coastline Change in 2014-2018

Category Coastal Dynamics	Average Rate of Coastline Change (2014 - 2018)	Average Distance of Coastline Changes (2014 - 2018)
Abrasion (-)	**0.91**	**4.26**
Accretion (+)	0.37	1.73
Amount	**1.28**	**5.99**
Average	**0.64**	**2.99**

Based on table 1 above, the average rate of change in coastline due to abrasion and accretion events in 2014 - 2018 is 0.64 m. While the average distance of coastline changes due to abrasion and accretion events in 2014 - 2018 is 2.99 m. It can be concluded that the dynamics of the beach in the range of 2014 - 2018 in the coastal area of Pasir Baru, Nagari Pilubang, Sungai Limau District, are dominant, namely abrasion events.

Tabel 2. Average Rate and Distance of Coastline Change in 2018-2022

Category Coastal Dynamics	Average Rate of Coastline Change (2018 - 2022)	Average Distance of Coastline Changes (2018 - 2022)
Abrasion (-)	**2.11**	**7.49**
Accretion (+)	0.04	0.15
Amount	**2.15**	**7.64**
Average	**1.08**	**3.82**

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Based on table 2 above, the average rate of coastline change due to abrasion and accretion events in 2018 - 2022 is 1.08 m. Meanwhile, the average distance of coastline changes due to abrasion and accretion events in 2018 - 2022 is 3.82 m. It can be concluded that the dynamics of the beach in the range of 2018 - 2022 in the coastal area of Pasir Baru, Nagari Pilubang, Sungai Limau District, are dominant, namely abrasion events.

3.2 Area of Abrasion and Accretion Events of Nagari Pilubang New Sand Beach, Sungai Limau District from 2014-2018 and 2018-2022

3.2.1 Changes to the coastline in 2014-2018

Tabel 3. Area of coastline changes in 2014-2018

Category Coastal Dynamics	Total Area Coastal Dynamics Events In 2014 - 2018	Average Area Change Peryear
Abrasion (-)	14173.7	3.543
Accretion (+)	6396.4	1.599
Amount	**20.570.1**	**2.571**

Based on table 3 above, the area of abrasion events that occurred in 2014 - 2018 amounted to 14173.7 m, with an average annual change of 3,543 m. As for the area of accretion events in 2014 - 2018 amounted to 6396.4 m, with an average annual change of 1,599 m. Thus, the total number of all coastal dynamics events that occurred (abrasion and accretion) in 2014 - 2018 amounted to 20,570.1 m, with an annual average of 2,571 m.

Tabel 4. Area of coastline changes in 2014-2018 according to segment division

Category Coastal Dynamics	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Abrasion (-)	883.2	4.6	2733.6	3374.3	7176.6
Accretion (+)	1213.2	4347.2	42.4	793.4	-
Amount	2096.4	4351.8	2776	4167.7	7176.6
Average Changes In Coastline Area In 2014 - 2018	1048.2	2175.9	1388	2083.85	3588.3
Average Annual Change In Coastline Area	524.1	1087.95	694	1041.925	1794.15

Based on table 4 above that in 2014 - 2018 the dominant beach process in the study area was abrasion (beach erosion), almost along Pasir Baru Beach there was an abrasion process with different intensities. The beach worst affected by abrasion is located in segment 5 with a total of 7,176.6 m, with an average change in coastline area in the range of 2014 - 2018 of 3,588.3 m, and for an average change in coastline area per year of 1,794.15 m. While those that are not severely affected by abrasion are located in segment 2 with an amount of 4.6 m and the number of accretion events in the segment is 4,347.2 m. So, the total average area change in the 2014 - 2018 period in segment 2 is 2,175.9 m and the average annual area change is 1,087.95 m.

3.2.2 Changes to the coastline in 2018-2022

Tabel 5. Area of coastline changes in 2018-2022

Category Coastal Dynamics	Total Area Coastal Dynamics Events In 2018 - 2022	Average Area Change Peryear
Abrasion (-)	48220.4	12.055
Accretion (+)	449.3	112.3

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Amount	**48.669.7**	**6.083**

Based on table 5 above, the area of abrasion events that occurred in 2018 - 2022 amounted to 48220.4 m, with an average annual change of 12,055 m. Meanwhile, the area of accretion events in 2018 - 2022 is 449.3 m, with an average annual change of 112.3 m. Thus, the total number of all coastal dynamics events that occurred (abrasion and accretion) in 2018 - 2022 amounted to 48,669.7 m, with an annual average of 6,083 m.

Tabel 6. The area of coastline changes in 2018-2022 according to segment division

Category Coastal Dynamics	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Abrasion (-)	7548.7	8324.2	9338.2	14784.4	8205
Accretion (+)	22.1	-	427.2	-	-
Amount	7570.8	8324.2	9765.4	14784.4	8205
Average Changes In Coastline Area In 2018 - 2022	3785.4	4162.1	4882.7	7392.2	4102.5
Average Annual Change In Coastline Area	1892.7	2081.05	2441.35	3696.1	2051.25

Based on table 6 above, there was an increase in area due to abrasion that occurred in 2018 - 2022, where almost along Pasir Baru Beach there was an abrasion process. The beach most severely affected by abrasion is located in segment 4 with a total of 14,784.4 m, with an average change in coastline area in the range of 2018 - 2022 of 7,392.2 m, and for an average change in coastline area per year of 3,696.1 m. While the smallest area change due to coastal dynamics (abrasion and accretion) is located in segment 1 with the total area of change due to abrasion of 7,548.7 m and for the amount of change due to accretion events in the segment of 22.1 m. So, the total average change in coastal dynamics area (abrasion and accretion) in the range of 2018 - 2022 in segment 1 is 3,785.4 m and the average annual area change is 1,892.7 m.

3.3 Field Ground Check (Accuracy Test)

Sampling was carried out randomly as many as 22 points which were made field observations and field observations also referred to existing coastline change data. This amount is considered sufficient to represent the entire study area. True and false from the distribution of sample points are then entered into a suitability table that is useful for facilitating the process of calculating accuracy values. The overall accuracy calculation is as follows :

$$\textbf{Assess the level of accuracy} = \frac{\textbf{Number of correct points on the field}}{\textbf{The total number of point taken}} \times 100$$

$$= \frac{19}{22} \times 100\%$$

$$= 86.36\%$$

The overall accuracy calculation of the field survey results is 86.36%. This value is in accordance with the minimum limit that has been set as an accuracy requirement. The level of accuracy assessment used must be not less than 85%.

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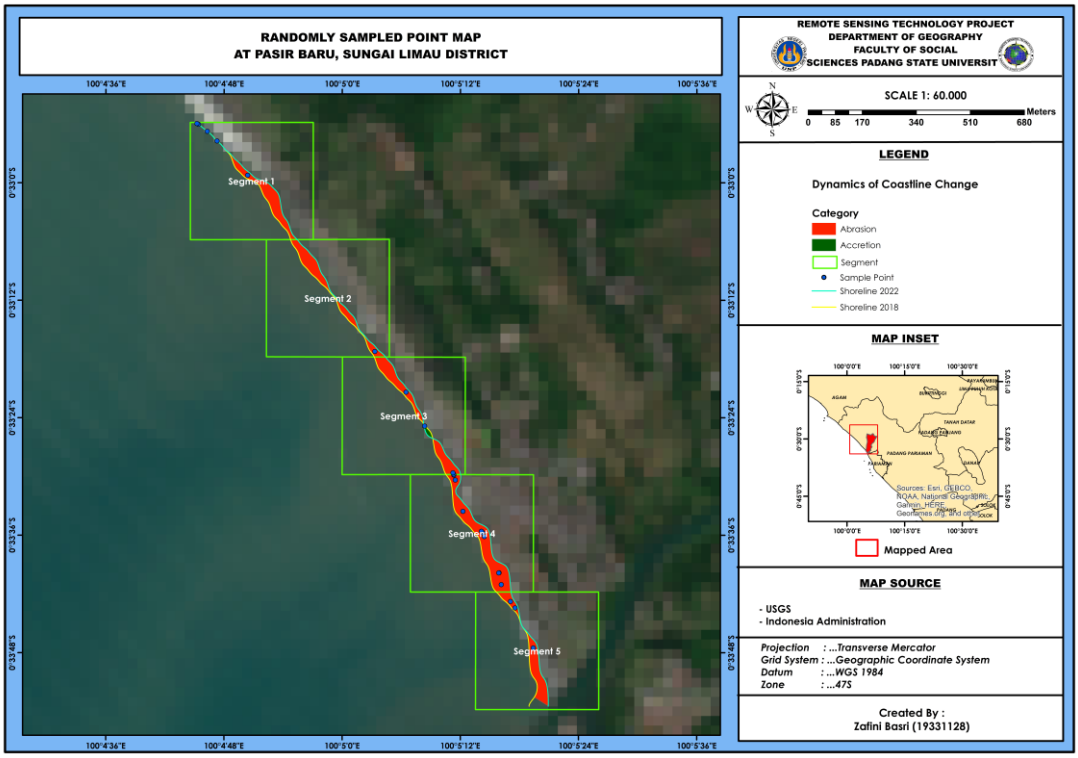

Figure 3. Random Sampling Map

4. CONCLUSION

Nagari Pilubang New Sand Beach is one of the coastal areas located in Sungai Limau District, Padang Pariman Regency which has experienced severe coastline changes from year to year using Remote Sensing Technology, one of which is by utilizing Landsat 8 OLI Satellite Image data for 2014, 2018, and 2022 combined with GIS and DSAS and can be used in analyzing coastline changes. For the period of 2014 - 2018, it can be seen that in the coastal area of Pasir Baru Nagari Pilubang, Sungai Limau District, the dominant coastal dynamics occur, namely abrasion events. As for the range of 2018 - 2022, it can be seen that in the coastal area of Pasir Baru Nagari Pilubang, Sungai Limau District, the dominant coastal dynamics occur, namely abrasion events (beach erosion). The extent of changes in the coastline of Pasir Baru Nagari Pilubang Sungai Limau District from 2014, 2018, to 2022. The area of coastline change due to abrasion events (coastal erosion) in 2014 to 2018 and from 2018 to 2022 the danger of erosion increased by 34,046.7 m, while the area of coastline change due to accretion in 2014 to 2018 and 2018 to 2022 decreased by 5,947.1 m.

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