Spatial and Temporal Shoreline Changes of the Bang Pakong Subdistrict (Thailand) in 2009–2018

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***Abstract* – Coastal erosion is a major problem facing the world. In this study, satellite images were utilized to study the spatial and temporal shoreline changes of the Bang Pakong District, Bang Pakong Subdistrict, Chachoengsao Province, Thailand in 2009-2018. The shoreline is approximately 1.95 km long, with the transect divided along longitude every 10.81 m. This research aims at analyzing and evaluating the spatial and temporal dynamics of coastal positions and their geometry in assessing the spatial dynamics of the behavior of coastal systems. Satellite imagery from Google Earth Pro with its image processing has been used in mathematical and statistical analysis to describe shoreline changes over time. This includes Shoreline Front Mean (SFM), Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR), and Linear Regression Rate (LRR). The accuracy of the results depends largely on the accuracy of the raw data. In the analysis process, we have written R code using standard relations. The study found that the method used to measure shoreline movement was effective. Quantitative changes in length and geometry were found. The results of this study can be used to map shoreline conditions and to identify erosion and shoreline rise. Which will reflect the coastal environment from the past to the present continuing this research can be further studied in the angle of analysis to find out the real cause of the changes that have occurred.**

Keywords – Spatial and temporal, shoreline changes, transects, Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR)

I. I INTRODUCTION

The shoreline is the fringe of land at the edge of a large body of water. In physical oceanography, a shore is the wider fringe that is geologically modified by the action of the body of water past and present. Shores are influenced by the topography of the surrounding landscape, as well as by water-induced erosion, such as waves [1]. Changes in shoreline could be caused by nature or humans [2-4].

Coastal erosion is a major problem facing the world. It has a direct impact on the environment and also has a wide effect on both the environment Tourism Business which affects the overall economic and social development [5]. For Thailand with a total coastline of approximately 2,600 km, the coastal erosion problem is an environmental problem that affects Thailand very much. Evidence shows that this has changed greatly in recent decades due to the erosion problem.

According to the World Bank, in 2007 it was predicted that Thailand is coastal land was eroded by 2 km2/y. The damage was 6 billion baht, which the government has identified as a critical issue that needs to be resolved urgently [6].

For research aimed at monitoring and evaluating the effects of shoreline changes. It was found that research was ongoing and it tended to increase every year. In [7], Dolan et al. investigated the data of the United States shoreline information system and analyzed using the Endpoint Rate (EPR) method the Average of Rates (AOR), Linear Regression (LR), and Jackknife (JK) methods. They demonstrate the differences in computational methods for estimating shoreline changes and showed how the potential sources of error can bias the final statistics. In [8], Li et al. studied shoreline erosion using high–resolution imagery and examined erosion causes. Spatial modeling and analysis methods were applied to the project area along the south shore of Lake Erie. Their findings explained a coastal spatial information infrastructure to support management and decision–making in the dynamic coastal environment. In [9], Genz et al. found that the LR rate of shoreline change was susceptible to the effects of outlier values because it could underestimate or overestimate shoreline change rate values observed by the EPR method. In [10], Maiti and Bhattacharya carried out along 113.5 km of coast adjoining the Bay of Bengal in eastern India, over the time interval 1973 to 2003. They examined an alternative cost-effective

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methodology involving satellite remote sensing images and statistics. Shoreline interpretation error, uncertainty in shoreline change rate, and cross-validation of the calculated past shorelines have been performed using the statistical methods, namely, Regression coefficient (R2) and Root Mean Square Error (RMSE). The past and future shoreline positions have been estimated over two time periods of short and long terms. In [11], Bouchahma and Yan, used image processing techniques, Digital Shoreline Analysis System (DSAS), and Landsat images along the coast of the island of Djerba, Tunisia. Accretions as well as erosion processes were observed in the study areas between 1984 and 2009. In [12], Oyedotun integrated analytical methods including the Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR), Linear Regression Rate (LRR), and Weight Linear Regression Rate (WLR) to determine the temporal and historical movement of shoreline positions and cliff geometry. In [13], Barman et al. used Linear Regression (LR) and End Point Rate (EPR) to study the shoreline data were integrated for the long–term (about 17 years) and short–term (about 7 years) shift rates analysis and found that the northeastern part of Balasore coast in the vicinity of Subarnarekha estuary and Chandrabali beach undergo high rates of shoreline shift.

In [14], Cellone et al. employed remotely sensed imagery to retrieve the multiple shoreline positions over the period 1943–2013 and analyzed using a statistical approach based on the Digital Shoreline Analysis System. In [15], Warnasuriya et al. developed a methodology to detect shoreline changes using satellite imageries of the northeast coastline of Jaffna in Sri Lanka obtained from the Google Earth platform during 2002 and 2017. Also, change was detected using the Digital Shoreline Analysis System (DSAS) in ArcGIS. They found that there is the shoreline accretion of 6.13 ± 8.74 m with an annual rate of deposition of 0.5 m/y. During the study period, 76.12% of the observed shoreline is found accreted while 23.88% of the shoreline is eroded. Their studies also revealed that the satellite images from the Google Earth platform can be used for time series analysis of shorelines after appropriate corrections. In [16], Esmail et al. focused on the assessment of shoreline kinematics response of Damietta coast, Egypt due to the existence of these structures during the period from 1990 to 2015. Also, the future changes of the shoreline at 2020, 2025, and 2035 were predicted using satellite images, Geospatial tools, and DSAS. The results of this study indicate shoreline trends of the near future which should be under consideration in the planning of the Damietta coastal zone. In [17], Muskananfola et al. investigated the shoreline changes in Sayung coast during 24 years period from 1994 to 2018. Shoreline data were obtained by extracting multi-temporal satellite imagery. Severe erosions were found in Sriwulan, Bedono, and Timbulsoko. Slight accretion occurs in Surodadi which were caused by varying characteristics of waves, and storms surge, tidal currents, bathymetry forms, and mangroves cover.

In the present study, we aim to demonstrate that combined use of satellite imagery and statistical methods can be a reliable method for investigating changes in shoreline or coastal area. Specifically, the objective of this research is to study, analyze, change, and predict the erosion of the coast of Thailand. Chachoengsao, Bangpakong District, Bangpakong Subdistrict, by using the digital images from Google Earth and presenting a new method for extracting shorelines. By using the program R Studio with the coordinate of the coastline using the program WebPlotDigitizer and calculated by statistical method. Here we have tailored made computational analysis as needed. It is to answer the question of how shoreline erosion or shoreline accumulation has been developed and changed. As well as for use in planning or finding appropriate protection of the studied coastal areas. The method from this research is expected to be used as a guideline for further study of other coastal areas. In this work, the new study area has been subtsatially investigated. Some image processing techniques tailored maded are also applied.

This paper is organized as follows. In the Sec. II study area, Satellite Data, image processing, and analyses are presented. In the Sec. III results, detailed discussion, and interpretation are provided. Concluding remarks are finally given in In the Sec. IV.

II. M ATERIAL AND METHODS

A. Study Area

The coast of Thailand spans approximately 2,600 km, covering the Andaman Sea and the Gulf of Thailand. It is divided into 950 km of Andaman coast, covering 6 provinces, and 1,650 km in the Gulf of Thailand, covering 17 provinces [18]. One of them is Chachoengsao Province which is an educational area of Bang Pakong District, Bang Pakong Subdistrict at the boundary of 100°56'12.48"E to 100°57'17.28"E and 13°27'37.44"N. to 13°28'3.36"N (Fig. 1).

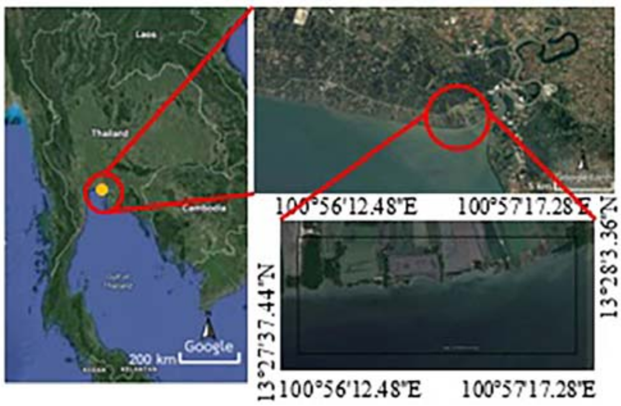

Figure 1. Study area.

The entire area is a mud beach adjacent to the mouth of the Bang Pakong River that connects to the Gulf of Thailand. The ground is sloped, the mangrove forest bordering the coast [19].

The specification in the study area is as follows. The shoreline is approximately 1.95 km long, with the transect divided along longitude every 10.81 m. There is an offshore baseline (blue line) as the coastline and the onshore baseline (brown line) as part of the land shown in Fig. 9 and Table I.

TABLE I. THE SPECIFICATION IN THE STUDY AREA

Parameters	Shoreline study
Shoreline length (km)	1.95
Total number of transects	181
Transects spacing (m)	10.81
Offshore baseline (Latitude)	13.4620
Onshore baseline (Latitude)	13.4677

B. Satellite Data

Studying shorelines using satellite imagery is a highly effective method [15]. This study uses satellite imagery from Google Earth Pro with the usability of medium to high–resolution images and able to retrace the period of the study area [20]. It will select images with high definition and select the time of the month with the most information which is from October to December. In other words, the accuracy that estimates of the shoreline change reflect changes and predict future changes based on the proximity of observing the actual change. Considering the interval between measurements [7], with the limitations of the 2013 and 2016 data, there is no data during the month or the satellite image is not clear. Therefore, we selected the nearest next month of each year to have reasonable pictures of February and March, respectively, shown in Table II.

TABLE II. SATELLITE IMAGES FROM THE GOOGLE EARTH PRO PLATFORM

Date	Source	Image type
13/12/2009	Google Earth Pro	Satellite imagery
21/12/2010	Google Earth Pro	Satellite imagery
03/11/2011	Google Earth Pro	Satellite imagery
01/02/2013	Google Earth Pro	Satellite imagery
15/11/2014	Google Earth Pro	Satellite imagery
25/10/2015	Google Earth Pro	Satellite imagery
01/03/2016	Google Earth Pro	Satellite imagery
10/10/2017	Google Earth Pro	Satellite imagery
20/11/2018	Google Earth Pro	Satellite imagery

C. Methodology

In this section, the whole picture of the data collection, data analyses, and interpretation processes is summarized in the flowchart. Briefly there are three main processes to investigate the input data, namely shoreline extraction, shoreline change analyses, and interpretation. The detailed explanation for each compartment is elaborated in the subsequent subsection as follows.

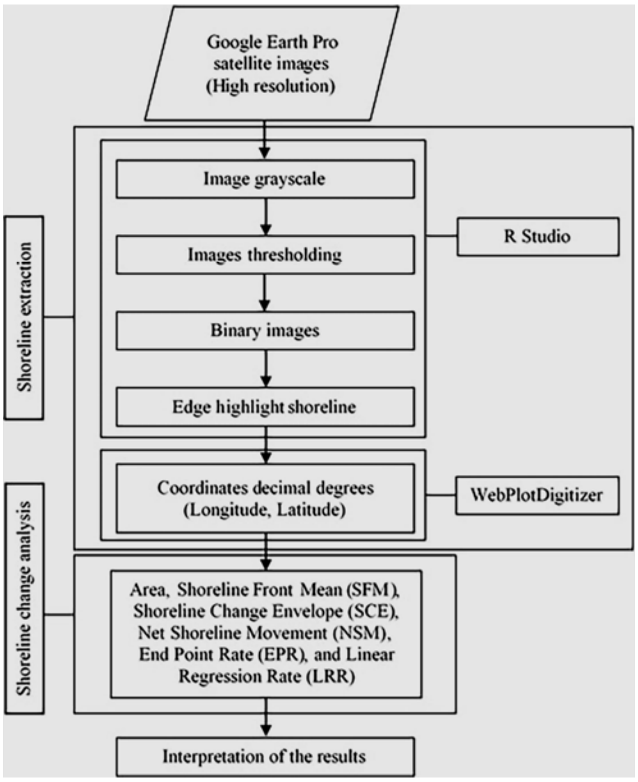

Figure 2. Workflow diagram of the method.

C1. Extraction of Shorelines

The accuracy that the shoreline rate estimation reflects actual changes and predicts future changes depends on the accuracy of the shoreline obtained from the data collection of shoreline positions [7]. The first part is the retrieval of satellite imagery from Google Earth Pro of each year of the coastline study area, defining the extent to which 100° 56'12.48"E to 100°57'17.28"E and 13°27'37.44"N to 13° 28'3.36"N from eye height 2.59 km (Fig. 3).

C1a. R Studio: When receiving satellite images of the coastline area each year. The second part is the process of dividing land and sea. Which has vegetation that grows along the coastline as the line of the coast [14]. Using R Studio to reduce shoreline drawing errors with the visual interpretation method. And self–interpretation [21]. This method is based on the personal skills [22], that requires knowledge and expertise of the facility. Studied [23]. By taking a shoreline image (Fig. 3) to make a black and white image using packages imager, use the grayscale function to make it a black and white image and adjust with thresholding, shown in Fig. 4, and use the highlight function to reveal the division of the land side. With the seashore more clearly as in Fig. 5.

C1b. WebPlotDigitize: The last part is to extract the data extraction of the longitude and latitude coordinates of the shoreline using the program. WebPlotDigitize because the program is reliable to extract data from a study by [24], taking satellite imagery of each year of the coastline (Fig. 5), the procedure is as follows:

- Open the program WebPlotDigitize. And import the highlighted photos of R Studio (Fig. 5)
- Select the plot type as 2D XY and set the coordinate boundary. Using the coordinates in decimal degrees, X1 = 100.9368 (100°56'12.48"E) to X2 = 100.9548 (100°57'30.24"E) and Y1 = 13.4604 (13°27'37.44"N) to Y2 = 13.4676 (13°28'3.36"N) is shown in Fig. 6.
- Select highlight the data you want to extract. Here it is used to retrieve data along a coastline that divides land–shore and sea–shore and set to retrieve data every distance along the axis Longitude equal to 0.0001 will be shown in Fig. 6.
- The data obtained are used to calculate and analyze shoreline changes.

Figure 3. Satellite imagery from Google Earth Pro.

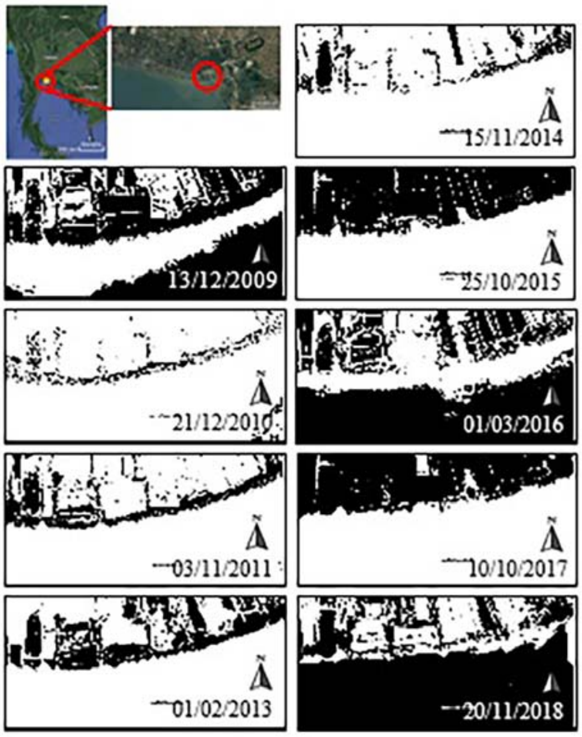

Figure 4. Line art of satellite imagery using R Studio.

Figure 5. Shows a highlight of the shoreline border.

Figure 6. WebPlotDigitize retrieves the coordinates of the shoreline.

C2. Shoreline Change Analysis

C2a. Area and Shoreline Front Mean (SFM): The coastal area calculation is part of a preliminary assessment of how shorelines have changed over time. Here the shoreline is divided into individual transects and each position of the shoreline is connected by a straight line. Therefore, the area of each channel is calculated and put it together as in Fig. 7(a) (gray area).

The calculation of Shoreline Front Mean (SFM) is a preliminary quantitative method indicating shoreline changes, calculated by measuring the distance from offshore to each point on the shoreline as Fig. 7(b) (orange line).

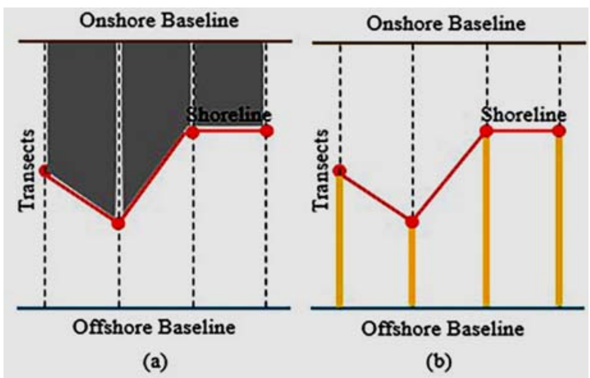

Figure 7. (a) shows the determination of the coastal area and (b) shows the Shoreline Front Mean (SFM).

C2b. Shoreline Change Envelope (SCE) and Net Shoreline Movement (NSM): The Shoreline change analysis is a method of calculating the distance of a coastline. The calculation of the Shoreline Change Envelope (SCE) and Net Shoreline Movement (NSM) method was used as follows [25].

The separate shorelines were extracted from multiple images and the geographic database was prepared using R Studio software. The shoreline movements related to the position of the reference line (baseline) are considered land movements (erosion) and seaward shift (accretion) in each segment range and the statistical values of the measurements were expressed as negative (–) for the erosion rate and positive (+) for the accumulation rate. Among the various computational operations of R Studio, the SCE and NSM values are used to measure the short-term net shoreline change in meters (distance) between 2009 and 2018. In this analysis, the SCE is estimated as the distance between the shorelines farthest and closest to the baseline at each transect. The total changes in shoreline movement were represented for all available shoreline positions and the rate of erosion and accretion of the coast has been considered concerning baseline positions. The SCE function is described using an in Equation (1) that represented as:

$$SCE_i = F_i - C_i \tag{1}$$

where:

SCE_i is a shoreline change distance (m) at a particular transect (i).

F_i is distance between baseline and farthest shoreline (m) at a particular transect (i).

C_i is distance between baseline and closest shoreline (m) at the same above transect (i).

Similarly, the NSM also calculates the distance of shoreline movement between the oldest and youngest shorelines at the point of intersection in each transect. Equation (2) is used to calculate the NSM and it is expressed as:

$$NSM_i = D_i\,(after) - D_i\,(before) \tag{2}$$

where:

NSM_i is the net movement of shoreline (m) at a particular transect (i).

D_i *(after)* is the distance between baseline and shoreline (m) in the oldest date at a particular transect (i).

D_i *(before)* is the distance between baseline and shoreline (m) in the youngest date at the same above transect (i).

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C2c. End Point Rate (EPR) and Linear Regression Rate (LRR): The EPR is calculated by dividing the distance between two shorelines by the number of years between the dates of the two shorelines [17] as given in equation (3),

$$EPR_i = \frac{NSM_i}{T_1 - T_0} \tag{3}$$

where:

NSM_i is the net movement of shoreline (m) at a particular transect (i) calculated using Eq. (2).

T_0 and T_1 is the dates of the two shoreline positions (y).

The linear regression method is a statistically robust quantitative method. It is a popular statistical technique for the rate of change. In this method, the rate of change statistics is determined by fitting the least regression line to all coast points for a specific movement [26].

III. RESULTS AND DISCUSSION

A preliminary study of the coastal areas of Bang Pakong Subdistrict, Bang Pakong District, Chachoengsao Province, when considering the coastline from 2009 to 2018 with a visual approximation. Set to use latitude 13°27'50.40"N It is an observation line and 2009 is the year of the commencement of the study (Fig. 8).

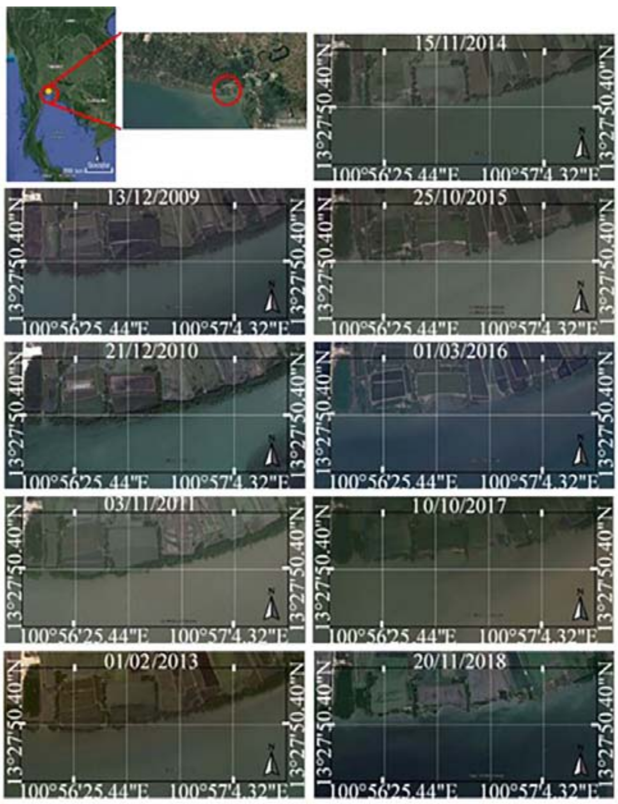

Figure 8. Shows the visual impression of changes in the coastline from 2009 to 2018

Over the years 2010–2013, the shoreline changed gradually but continued until 2014. The coastline range (columns 2 and 3). More changes caused sustained erosion over the years 2015–2016. The shoreline was also showing a gradual increase in erosion from 2014 and through 2017–2018, the coastline was significantly eroded. This can be observed from all positions of the coastline, it is higher and far from the observation line. It can be found that over time, the studied coastal area has changed significantly and when the coordinates of each year of the coastline were plotted using the same axis of longitude and latitude, the coastline was clearly eroded over time. Various statistical methods are used to calculate shoreline changes. Which has the following study results.

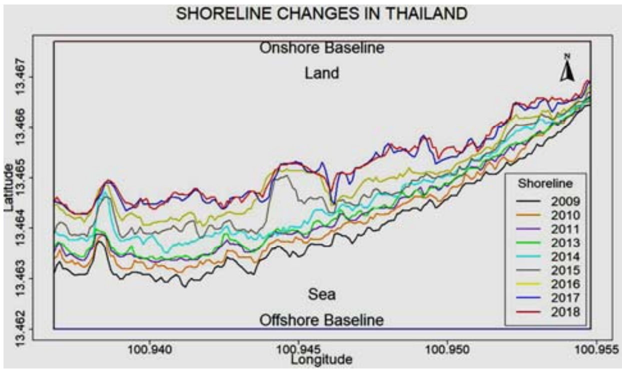

Figure 9. Show the shoreline line and specification in the study.

To have more insight into changes qualitatively, we analyze the data in Fig. 8 and recast into the more quantifiable information as shown in Fig. 9. It is seen that shorelines change substantially over time during 2009–2018. Though the shoreline pattern and roughness does not change much, the shoreline height and shoreline areas change. From our estimation, the depleted area is about 0.266 km2 or 33.50%.

TABLE III. AREA AND SHORELINE FRONT MEAN (SFM)

Date	Area (km^2)	Shoreline Front Mean (SFM) (km)
13/12/2009	0.794	0.226
21/12/2010	0.755	0.247
03/11/2011	0.725	0.262
01/02/2013	0.717	0.266
15/11/2014	0.673	0.288
25/10/2015	0.638	0.306
01/03/2016	0.589	0.332
10/10/2017	0.537	0.358
20/11/2018	0.528	0.363

Table III and Fig. 10, provide information about changes in areas and the shoreline front. They are inconsistent with the data as previously shown in Fig. 8, namely the corrosion has continually occurred overtime to make the shoreline front moving toward the mainland. And the coastal are diminished due to natural corrosion. Overall, once again the accumulated corrosion between 2009 and 2018 is 0.266 km2 or about 33.50% as shown in Fig. 10(a). We also find the linear relation between the change of area and shoreline front as shown in Fig. 10(b).

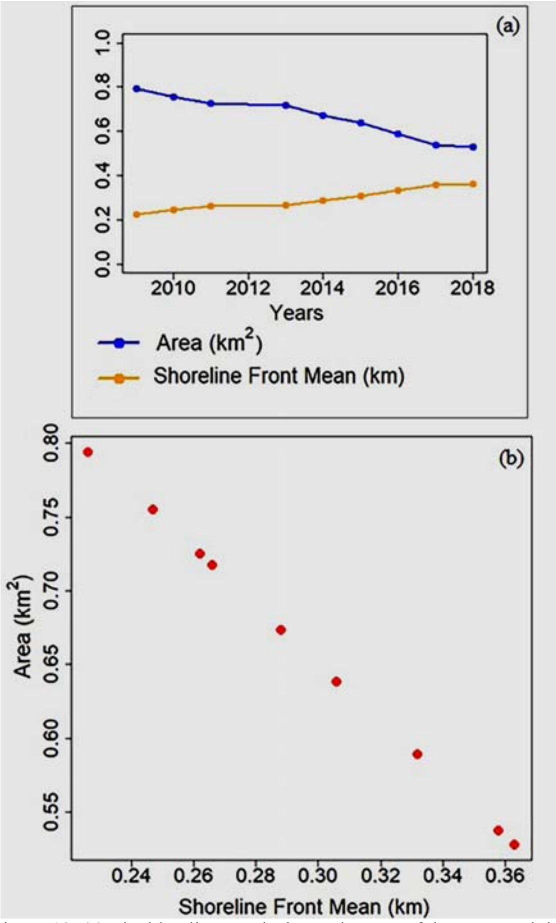

Figure 10. (a) The blue line graph shows the area of the coast and the orange line shows the Shoreline Front Mean (SFM) of the past 2009 to 2018. (b) The graph shows the relationship between the shoreline area and the Shoreline Front Mean (SFM).

It can be seen that coastal areas have patterned erosion, which is predicted that in the next year, coastal areas will have more erosion than 2017–2018 and will continue to erode. If not fixed in this area this is because the study area is relatively easy to change, just like the study of [19].

To better understand the shoreline changes Thus, the Shoreline Change Envelope (SCE) and Net Shoreline Movement (NSM) methods have been used, and to allow for deeper and specific interpretations. We, therefore, divide our consideration into zones using the same zoning principle as [27] and found that the coastline can be divided into five areas (A, B, C, D, and E).

Fig. 11, shows the variability of the transects calculated as the percentage between the sample variance of the distribution of each transects observed position and the maximum of these variances. This plot indicates Transect 79 as the most movable. The whole considered coastal sector can be divided into five main sections (clusters of transects) characterized by two different types of susceptibility to coastal dynamics (zones A to E in Fig. 11).

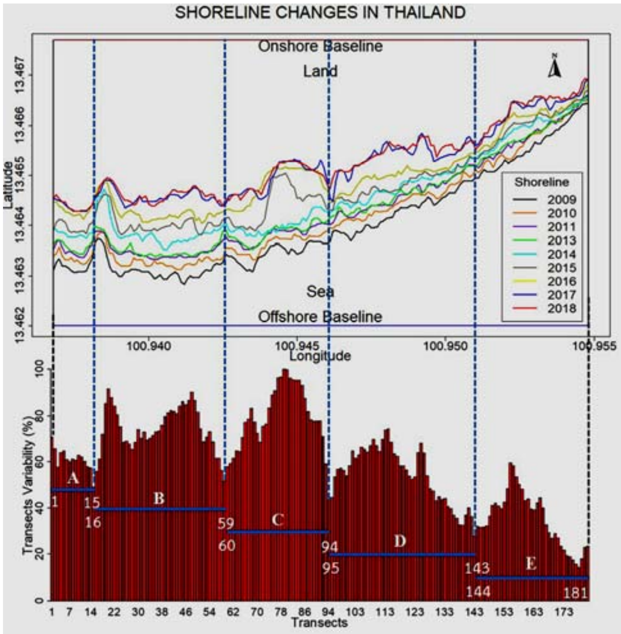

Figure 11. The transects variance, calculated from the sample variance of the observed position distribution of each transect scaled to the maximum variance.

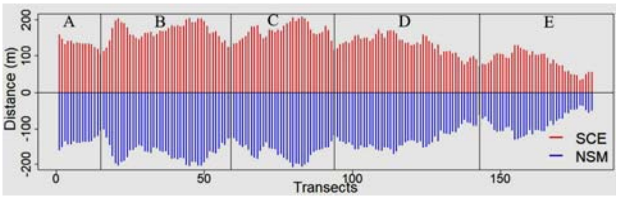

Figure 12. Shows Shoreline Change Envelope (SCE) and The Net Shoreline Movement (NSM) rate along the study area.

The results in Fig. 12, shows the amount of change in each coastline with SCE and NSM methods, which yielded relatively symmetrical results.

The Shoreline Change Envelope (SCE) of the study area is shown in Fig. 12, which highlights the distance between the shoreline farthest from and closest to the baseline at each transect. This represents the total change in shoreline movement for all available shoreline positions and is not related to their dates. The result reveals that the highest SCE value is observed in the zone C configuration with a value up to 116.99–207.34 m (transect number 83)

The Net Shoreline Movement (NSM) reports a distance, not a rate. The NSM is associated with the dates of only two shorelines. It reports the distance between the oldest and the most recent shorelines for each transect. The NSM value is shown in Fig. 12, which indicates mostly negative values. This highlights that there is sustained erosion observed over time as the distance between the oldest (2009) and youngest shorelines (2018) drastically varies in different transects with a mean value of –134.30 m in zone A, –167.57 m in zone B, –164.58 m in zone C, -129.99 m in zone D and –84.63 m in zone E (Table IV).

From the amount of coast change given, either way, the above is merely indicative of a shoreline change. Which is next, it shows the rate of shoreline change by End Point Rate (EPR) and Linear Regression Rate (LRR).

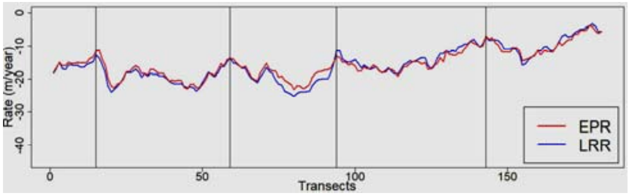

Figure 13. Shows the shoreline change rate values calculated using End Point Rate (EPR) and Linear Regression Rate (LRR).

The amount of the coast rate change calculated using the End Point Rate (EPR) and Linear Regression Rate (LRR) methods are shown in Fig. 13. EPR is the calculation of the coast rate change. It is calculated from the distance between the coastline of the study start date and the last study date divided by the number of years of the difference between the last study date and the commencement date for each transect. For LRR, it uses yearly coastal position data and calculates the rate of change statistics as appropriate Least squares regression.

The results showed that both methods worked in the same direction and were closely related across all zones. The first noticeable thing is that all locations of each zone do not have a for accretion rate, which indicates that all positions of the coastline are eroded. By the way, LRR had the highest average erosion rate at zone C, –19.99 m/y while EPR had the highest average erosion rate at zone B, –18.83 m/y. However considering zones A to D, the average erosion rate of more than 5 m/y means that the erosion is severe [28]. Because it is an area that has no defense line waves and currents according to the physical characteristics of the area studied according to Fig. 1. In zone E there are both more and less than 5 m/y of shoreline positions, with locations with erosion rates of less than 5 m/y in the east of zone E. Because of the east, this area is characterized by the physical, crooked area of the estuary of Bang Pakong River.

Coastal change results by the SCE and NSM approach obtained from this research were consistent. The shoreline rate of change calculated using the EPR and LRR methods also yield the same results and this is consistent with Bheeroo's research [25]. This is because the coastal area studied is a mud beach adjacent to the mouth of the Bang Pakong River sensitive to change. This resulted in severe average erosion of more than 5 m/y, consistent with the study of Saengsupavanich [19].

TABLE IV. TOTAL STATISTICAL SUMMARY OF THE STUDY AREA DURING 2009 TO 2018

Statistics	Zones					Total
	A	B	C	D	E	
Total number of transects	15	44	35	49	38	181
Standard deviation of rate shoreline change						
SCE (m)	12.79	23.26	21.81	26.72	26.88	40.02
NSM (m)	13.03	24.52	23.52	26.07	26.90	39.50
EPR (m/y)	1.46	2.75	2.64	2.93	3.02	4.44
LRR (m/y)	1.30	2.56	3.32	3.07	3.29	5.10
Mean rate of shoreline change						
SCE (m)	134.52	169.17	170.33	132.27	85.55	138.98
NSM (m)	-134.30	-167.57	-164.58	-129.99	-84.63	-136.65
EPR (m/y)	-15.09	-18.83	-18.49	-14.60	-9.51	-15.35
LRR (m/y)	-15.93	-19.48	-19.99	-13.90	-9.01	-15.58
Minimum rate of shoreline change						
SCE (m)	103.57	113.68	116.99	71.62	34.61	34.61
NSM (m)	-102.77	-99.85	-116.99	-62.47	-34.61	-34.61
EPR (m/y)	-11.55	-11.22	-13.14	-7.02	-3.89	-3.89
LRR (m/y)	-12.64	-13.66	-11.48	-7.15	-3.41	-3.41
Maximum rate of shoreline change						
SCE (m)	160.02	203.87	207.34	172.81	130.78	207.34
NSM (m)	-160.02	-203.87	-206.18	-169.99	-128.55	-206.18
EPR (m/y)	-17.98	-22.90	-23.16	-19.10	-14.44	-23.16
LRR (m/y)	-18.27	-24.04	-25.26	-18.53	-15.76	-25.26

In Table IV, identifies the mean rate, standard deviation, highest erosion, and highest accretion for Linear Regression Rate for the total study area. Overall, the results of the negative mean rates of the EPR and LRR indicate coastal erosion occurring throughout the case study area.

The results of overall erosion in the study area do not account for the possible geographic variability in the study area. Therefore, in Table IV below, we see the standard deviation, mean, minimum, and maximum for each zone in the study area. This result indicates that from 2009–2018, the coastline in this study area of Bang Pakong has eroded overall. The results also convey that the changing shoreline is eroding more severely in zones A to D.

IV. CONCLUSION

The spatial and temporal dynamics of coastal positions and their geometry are of great importance in assessing the spatial dynamics of the behavior of coastal systems. Satellite imagery from Google Earth Pro with its image processing has been used in mathematical and statistical analysis to describe shoreline changes over time. This includes Shoreline Front Mean (SFM), Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), End Point Rate (EPR), and Linear Regression Rate (LRR). The accuracy of the results depends largely on the accuracy of the raw data. In the analysis process, we have written R code using standard relations. The study found that the method used to measure shoreline movement was effective. Quantitative changes in length and geometry were substantially changed. The results of this study can be used to map shoreline conditions and to identify erosion and shoreline rise. Which will reflect the coastal environment from the past to the present continuing this research can be further studied in the angle of analysis to find out the real cause of the changes that have occurred.

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