ANALYSIS OF CHANGES IN COASTLINES IN DISTRICT OF BANGKALAN MADURA WITH GEOGRAPHIC INFORMATION SYSTEM APPROACH AND LANDSAT 8 SATELLITE IMAGERY

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INTRODUCTION
The coastline is the boundary that separates the land side from the ocean side. In this area, there are many dynamic changes in which the forms of change that occur vary, starting from changes in the existing ecosystem due to natural processes and as a result of development activities carried out by local residents. Besides that, the morphological shape of the coast has also changed, in this case it can be seen from changes in the shoreline whether it is increasing or decreasing. This phenomenon of change lasts for years along with various other natural changes such as climate change which causes changes in sea surface temperature, intensity of rainfall on the coast, wind direction and waves that also affect these changes.

Changes in the coastline are interesting to study because these changes have an impact on the lives of people in coastal areas and also on existing infrastructure along the coast. These changes are not fixed in nature, but constantly change over time, only what can be seen here is whether these changes will have a positive or negative impact on the surrounding community. Researchers from various countries have carried out measurements and mapping of coastlines using various sensors in satellite imagery [1]–[4].
The process of shoreline change is known as 2 forms, namely the addition of coastlines or the accumulation of sediment along the coast throughout the year to form new land, the other is the reduction of the shoreline or the usually is called coastal erosion and if it occurs over a long period of time it will reduce the land due to erosion, solids on land and carried by the waves to a new place.

To monitor this change, a technology device capable of recording data for a certain period of time is needed, and this technology can be done by using remote sensing, one of which is through Landsat 8 satellite imagery which has a resolution of 30 meters [5]–[7]. This resolution is sufficient to map the coastline, especially with the presence of a canal on Landsat which has a resolution of 15 meters which is called the panchromatic channel so changes in the coastline can be monitored throughout the year.

The purpose of this study is to map the changes in the coastline that occurred in Bangkalan district over a period of 5 years starting from 2016 to 2020, and from the shape of the existing coastline a mathematical model will be created that can describe the process of change over time.

**RESEARCH METHOD**

1. **Research Location**
   
   The research location was taken in the coastal area of Bangkalan Madura district with selected coordinates of Longitude 689000 meters to 695000 meters and latitude 9220000 meters to 9227000 meters. These coordinates are located on the northern side of Bangkalan which faces the Java Sea as seen in Figure 1.

2. **Landsat Images Satellite**
   
   For the purposes of shoreline changes, a shoreline digitization process is carried out from satellite images obtained for 5 years with the image file name according to the acquisition time as shown in Table 1:

3. **Coastline Calculation**
   
   Measurements were carried out by digitizing Landsat satellite imagery with the ArcGIS program package for 5 years, then an overlay process was carried out to see the changes that occurred. The measurement of the length of the coastline was carried out using “Calculate Geometry” from the ArcGIS package and the length was obtained in meters.

![Figure 1. Research Location at District of Bangkalan Madura](image)

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RESULT & DISCUSSION
The results obtained from the digitizing process of the coastline are shown in Figure 2 for the 2016 coastline, Figure 3 for the 2017 coastline, Figure 4 for the 2018 coastline, Figure 5 for the 2019 coastline and Figure 6 for the 2020 coastline.

Figure 2. Coastline of District Bangkalan Madura on March 2016

Figure 3. District of Bangkalan Madura on March 2017

Figure 4. District of Bangkalan Madura on March 2018

Figure 5. District of Bangkalan Madura on March 2019
Figure 6. District of Bangkalan Madura on March 2020

Table 2. Coastline Data for 2016-2020 years

<table>
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<th>YEAR</th>
<th>COASTLINE (meters)</th>
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<tr>
<td>2016</td>
<td>6593.354</td>
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<td>2017</td>
<td>6384.31</td>
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<td>6307.739</td>
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<td>2019</td>
<td>6489.159</td>
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<td>2020</td>
<td>6545.074</td>
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Source: calculation with in ArcGIS

To determine which mathematical model is the most optimum by analyzing the scatter diagram and performing forecast analysis using several linear, exponential, logarithmic, power and polynomial models, the results are shown in Figure 8 for the linear model, Figure 9 for the exponential model, Figure 10 for the logarithmic model, Figure 11 for the power model, Figure 12 for the degree 2 polynomial model and Figure 13 for the degree 3 polynomial model.

Furthermore, the measurement of the length of the beach for each year is carried out and the results of the length of the beach are obtained as shown in Table 2.
Figure 7. Coastline change in coast of Bangkalan Madura along 5 years 2016-2020
From the forecasting results for the most suitable model, the optimal polynomial model, either quadratic or polynomial degree 3 or cubic, is obtained with a correlation value of $R$ of 0.9323.
CONCLUSION

Landsat 8 satellite imagery can be used as a tool in forecasting shoreline changes because it has an image resolution of 30 meters, which is sufficiently detailed to show the existing coastline. Likewise, the resulting mathematical model shows that the polynomial model is the most suitable model for describing shoreline change trends.

ACKNOWLEDGEMENT

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REFERENCES


