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GLOBAL WARMING AND ITS IMPACT ON MANGROVE LAND DEGRADATION ON THE NORTH COAST OF BENGKALIS ISLAND, RIAU PROVINCE

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Abstract
Bengkalis Regency is located on the north coast of Riau Province, where the coastal area is very vulnerable to the threat of maritime disasters. Global warming can result in natural disasters, which means catastrophe on earth. Global warming causes an increase in the temperature of the earth's surface. This study aims to analyze the progress of the coastline and sea level rise that occurs and their impact on the degradation of Mangrove land on the north coast of Bengkalis Island, Riau Province. The research method used is the quantitative method through analysis of satellite images to map predictions of abrasion in the future. Data processing is carried out using satellite image data with different temporal, namely 1991, 2002, 2012, and 2021. Analysis of shoreline change predictions is carried out using the Digital Shorelines Analysis System Method. Utilization of GIS data can be used to map areas with the potential for abrasion, and make anticipatory measures against abrasion that may occur. In Bengkalis Regency itself, several efforts have been made by the local government, namely through mangrove planting programs, and increasing public awareness.

Keywords: Geographic Information Systems; Mangroves; Global Warming; Impact; Degradation

Introduction

Global Warming or Global Warming is a term that refers to an increase in the average temperature above the earth's surface. The average air temperature of the earth's surface has increased by about 0.74°C in the last 100 years. Many experts predict that the average temperature will increase from 1.4°C to 5.8°C until 2100. Meanwhile, the Intergovernmental Panel on Climate Change (IPCC) predicts that global temperatures are likely to increase by 1.1°C to 6.4°C in the next 90 years. The most tangible impact of global warming to date is climate change. Global warming has increased the occurrence of global droughts, heat waves, and the frequency of tropical storms. The increase in global temperature will cause the melting of ice in the north and south poles, resulting in the expansion of seawater masses, and sea level rise. Rising sea level causes the expansion of inundated coastal areas. Based on the IPCC report, there will be an increase in sea level with an increase of 2.8-3.6 mm/year. This sea level change is a direct impact of climate change and has been predicted for decades both globally and regionally. The impacts of sea level rise include increased frequency and intensity of floods, changes in ocean currents, widespread damage to mangroves and widespread threats to the socio-economic activities of coastal communities. As an archipelagic country, Indonesia certainly has great potential for the maritime disasters described above. One of them has occurred in Riau Province, namely the threat

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of coastline progress and tidal flooding due to high tides which have an impact on the reduction and loss of mangroves in coastal areas.

Global warming can result in natural disasters, which means catastrophe on earth. Global warming causes an increase in the temperature of the earth's surface. The increasing temperature of the earth can cause various adverse impacts on the environment and other ecosystems due to changes in the world's climate. One example of the impact of global warming is the melting of glaciers and polar ice caps. Negative impact on developing countries and archipelagic countries such as Indonesia, because it can cause small islands to sink.

To achieve this, disaster-prone areas can be mapped using a Geographic Information System (GIS). In relation to maritime disasters, the data that can be managed are tidal data and satellite image data which are then extracted into future coastline predictions using the Digital Shoreline Analysis System (DSAS) method. This study aims to analyze Climate Change and Its Impact on Mangrove Land Degradation in the North Coast of Bengkalis Island, Riau Province. by analyzing the progress of the coastline and sea level rise, and the final result is a formulation of the government's anticipation efforts to tackle maritime disasters that occurred on the north coast of Bengkalis Island, Riau Province.

Literature Review

Goldberg et al. (2020) in Oktorini (2022) stated that the estimated world mangrove loss was 3,363 km2 (2.1%) in 200 and 2016, with an average annual rate of 0.13%. Human activities are the main cause of mangrove loss (62%) of the total global mangrove loss area. The remaining 38% of the total mangrove loss was due to natural causes. Coastline erosion was the second highest percentage of global loss at 27% (912 ± 41 km2) and extreme weather events accounted for 11% of losses (361 ± 31 km2). Abrasion and flooding caused by rising tides have already occurred in a number of coastal areas in Riau. This tidal flood or tidal sea water regularly occurs at the end of the year and submerges several districts, one of which is the most affected is Bengkalis Regency because of its geographical location which is close to the sea.

Research Method

The research location chosen for this research is along the north coast of Bengkalis Island. Bengkalis Island is one of the islands in Bengkalis Regency, Riau Province. The method used in Research on Climate Change and Its Impact on Agricultural Land Degradation in the North Coast of Bengkalis Island, Riau Province is quantitative. The data used in this study are primary data and secondary data. Primary data is in the form of tidal data on the north coast of Bengkalis Island, Riau Province. Other primary data used in this study are Landsat 5,7 and 8 satellite imagery data in different time periods (1992, 2002, 2012, and 2022). The primary data was obtained by downloading satellite images through the website http://earthexplorer.usgs.gov/. Secondary data as a support in the form of tidal prediction data that can be obtained through the website http://tides.big.go.id/ based on the adjustment of the time of taking satellite images. In addition, the secondary data in this study is also a map of the Indonesian Earth (RBI). Data retrieval of the Indonesian Earth Map is done by downloading the data on the Geospatial info website (www.info-geospatial.com). The downloaded Indonesian Earth Map is an RBI map with the boundaries of the Districts and Regencies in Indonesia.

Processing of Landsat satellite image data is carried out with the help of ENVI 5.3 software for radiometric correction. The calculation of shoreline changes is obtained through ArcGIS 10.5 software which is then processed and analyzed to determine shoreline changes in the study area. Tidal data is used to analyze sea level rise that may occur due to climate change, namely the increase in temperature on the earth's surface. Tidal data was processed using the admiralty method and obtained the MSL (Mean Sea Level) value which can be used to predict

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sea level rise in the next few years. Analysis of Coastline Changes on the north coast of Bengkalis Island using the Digital Shoreline Analysis System (DSAS) method. The type of data used in this research is secondary data. Secondary data is data or information in the form of notes obtained from someone's journal or literature.

Landsat data analysis and interpretation consists of: image cropping, image recovery, image enhancement, geometric correction, digitization, and overlaying. Image cropping is done to take the focus of the research area with consideration for saving memory storage in the computer. Image recovery is carried out to improve the quality of satellite images that are not good as a result of damage to the satellite or due to atmospheric disturbances. Image recovery is done by performing gapfill correction and radiometric correction.

Image processing begins with the geometric correction pre-processing using the polynomial method with resampling type nearest neighbor using the coordinate transformation system WGS 1984 S UTM Zone 48N. Furthermore, radiometric correction is carried out to reduce the influence of the atmosphere which can reduce image quality using the Dark Object Subtraction (DOS) method referring to the Ardiansyah (2015) equation.

$$MNDWI = Green - MIRGreen + MIR$$

Sedangkan pada citra satelit Landsat 8 OLI menggunakan rumus dari Ko et al. (2015):

$$MNDWI = Green - MIRGreen + SWIR$$

In the research flow there are several processes or stages. This stage begins with data collection to get the final results of the analysis of shoreline changes.

Results and Discussion

Bengkalis Regency is the parent of three new regencies (Rokan Hilir Regency, Siak Regency and Meranti Islands Regency) and one city, namely Dumai. In Riau Province. In the book on initiating an incentive policy by Fisip Unri, it is stated that the Bengkalis Regency is located on the eastern coast of Sumatra Island between 2030' North Latitude - 0056' North Latitude and 100052' East Longitude - 102031' East Longitude. The area of Bengkalis Regency is 7,773.93 km2, consisting of islands and oceans. There are 16 main islands in addition to other small islands in the Bengkalis Regency area. From this geographical location, it appears that this district is an archipelagic district which is geographically directly opposite the Malacca Strait. There are four large islands in Bengkalis Regency which are quite potential to experience shoreline changes and have great potential for mangrove land degradation.

Based on the results of the analysis using the Digital Shoreline Analysis System (DSAS) method, it was found that changes in the northern coastline of Bengkalis Island, Riau Province, namely changes in coastline tend to be significant from year to year. The coastline along the north coast of Bengkalis Island from year to year experiences abrasion. This can be seen from the line of change in 1992, 2002, 2012, and 2022. The northern coastal area of Bengkalis Island, Riau Province is one of the outermost boundaries of the Republic of Indonesia which borders the sea with Malaysia. The geographical location of the northern coast of Bengkalis Island which is directly opposite the Malacca Strait makes the coastline very dynamic. With large currents facing the strait directly, abrasion along the northern coast of Bengkalis Island is unavoidable.

The shoreline changes from 1992, 2002, 2012 and 2012, as shown in (figure 1), can be seen as continuous abrasion. Almost all of the northern coastal areas of Bengkalis Island from 1992-2022 experienced abrasion. Of course, this is very dangerous and has the potential to threaten maritime disasters in the region. Abrasion that occurs along the north coast of Bengkalis Island is triggered by several factors. The damage to the coastline due to abrasion is triggered by

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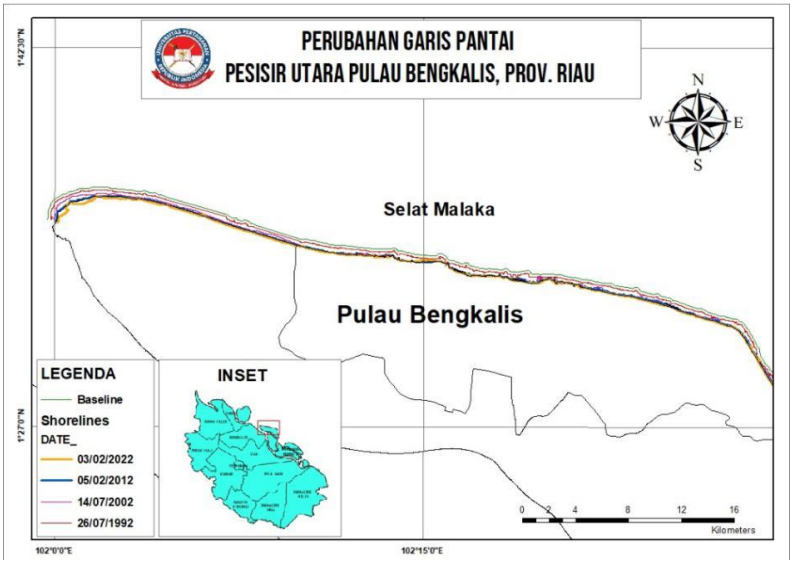
the disruption of the natural balance of the coastal area caused by several factors including; Currents, waves, beach topography, types of coastal sediments and sea level rise.

This was also expressed by the Bengkalis Regency Government Prokopim (2022), that the trigger for abrasion on Bengkalis Island was caused by an increase in sea level caused by melting ice in the polar regions as a result of global warming and the loss of mangrove vegetation (mangroves) on the coast. As is known, mangroves planted on the coast, their roots are able to withstand the waves so as to prevent beach erosion.



The results of the analysis of shoreline changes are then used to make predictions (forecasts) using ArcGIS 10.5 software using the Digital Shoreline Analysis System (DSAS) method. The results of the coastline prediction obtained are shown in Figure 2. Based on the map, it is known that the prediction of the coastline in the next 20 years the north coast of Bengkalis Island will experience abrasion. The highest abrasion occurs on the west coast of the island of Bengkalis.

In addition to the Map of Changes in the Coastline of the North Coast of Bengkalis Island, Prov. Riau in 2042, it was also found that the distance of the change in the coastline of the North

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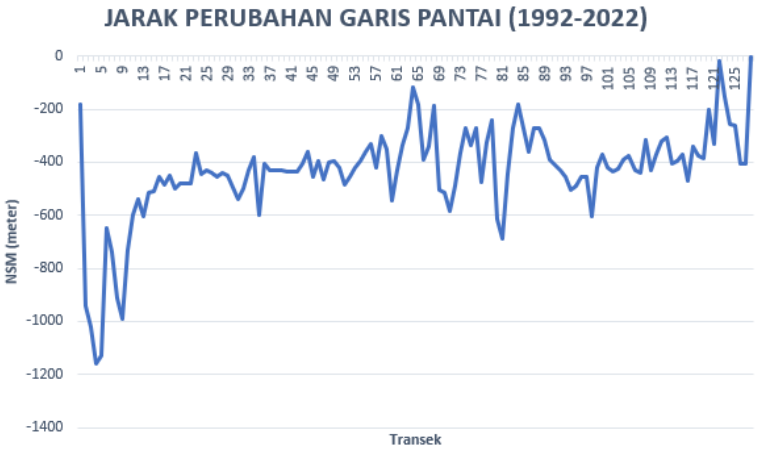
Coast of Bengkalis Island using the Net Shoreline Movement (NSM) value. The Net Shoreline Movement (NSM) measures the distance of shoreline change between the oldest and newest shorelines. The results obtained from the NSM value of 128 transects that the lowest abrasion on transect 128 is located on the southern part of the senekip pambang beach of 1.7 meters. Meanwhile, the highest abrasion is on transect 4, which is the western part of the Sesai Panjang beach with an abrasion of more than 1 kilometer. The graph of the rate of change of the coastline is shown in the following figure.



The rate of change of the North Coast of Bengkalis Island, Prov. Riau is obtained by using the value of EPR (End Point Rate). End Point Rate is defined as the calculation of the rate of change of the coastline by dividing the distance between the longest coastline and the current coastline by the time. The formula used is as follows;

$$EPR = \frac{Oldest\ and\ Newest\ Shoreline\ (m)}{longest\ and\ newest\ shoreline\ time\ span\ (tahun)}$$

The average change in coastline in Indonesia is 14.8 meters per year. Furthermore, the results obtained from the EPR value of 128 transects that the lowest abrasion is on transect 128, namely the southern part of the Senekip Pambang beach at 0.1 meters per year. The highest abrasion on transect 4 is on the west coast of Sesai Panjang at 39 meters per year. The graph of the rate of change of the coastline is shown in the following figure.

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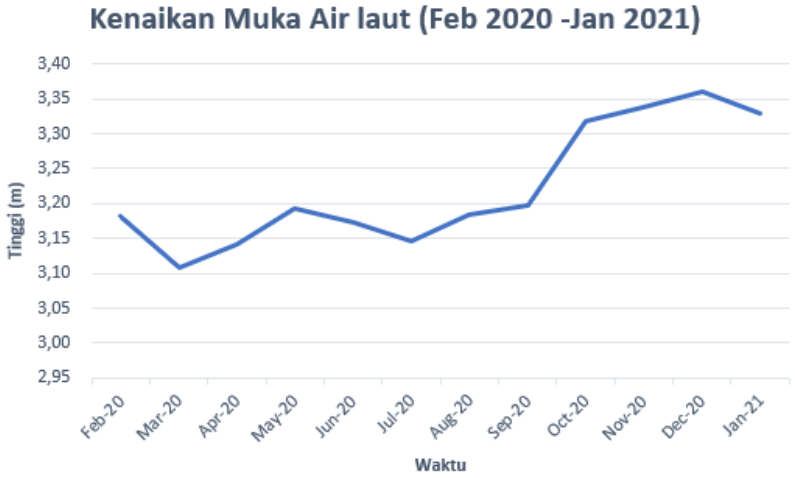
The results of tidal data processing downloaded from https://hdc.pushidrosal.id/e-navigasi/ for a duration of 1 year from 12 February 2020 to 12 February 2021 are shown in the image below. This determination of the timing of tidal data collection is because there are several months for which tidal data cannot be displayed. The results of this tidal data processing also showed that in the span of 1 year there was an average sea level rise of about 0.15 meters in one year with an average sea level rise rate of 1 cm per year. This means that the graph of sea level rise is presented in the following figure;



Bengkalis Regency is one of 11 regencies in Riau Province. The geographical location of Bengkalis Regency consists of islands with coastal areas around the coast. In addition to having the advantage of beautiful scenery and has high tourism potential because it is a coastal area, there are several potential disasters that must be known and watched out for in Bengkalis Regency. What will be discussed in this article is the disaster of abrasion or the advancement of the coastline and sea level rise which causes the degradation of Mangrove land in Bengkalis Regency.

The currents in Bengkalis waters have a very large and strong current flow pattern. This is due to the large influence of the flow of water from the South China Sea. In field conditions, during high tide conditions the current speed can range from 2-3 knots. The north coast of Bengkalis Regency gets great influence from the Malacca Strait. This causes the current to flow very strong and large, but the existence of small islands to the east of Bengkalis Regency is able to reduce the strength of the current flowing along the Malacca Strait. Overall, the wave conditions in Bengkalis Regency are 3-4 m. Along the northern coast which is directly opposite the Malacca

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Strait and on the southern promontory of Bengkalis Island, abrasion reaches 2-7 m/year. The rate of abrasion that occurred in Bengkalis is certainly not reasonable, and if it is allowed to continue, it will be detrimental. Not only harming the people living in Bengkalis, but also harming the Indonesian government. If accumulated, the Bengkalis border body has moved as much as 2 km to the mainland. In addition, abrasion will also have an impact on the loss of community settlements in coastal areas.

Monitoring and analysis of changes in the area and position of the coastline is very useful in providing information about which areas are experiencing abrasion and accretion in the analyzed coastal area. From the results of the study, it was found that the causes of abrasion that occur on the coast according to the Directorate of Coastal and Small Islands Utilization are divided into 2 types, namely natural factors and human factors. Natural factors, natural factors that can cause abrasion, among others, such as tides, wind over the ocean, ocean waves and ocean currents that are destructive. Of course, the natural factors that cause this abrasion cannot be avoided because the sea has its own cycle. Because at a certain period the wind will blow very hard so that it produces waves and large ocean currents which can cause coastal erosion. While the Human Factor, there are several human behaviors that contribute to the occurrence of coastal abrasion. One of them is the imbalance of marine ecosystems where there is massive exploitation by humans of the wealth of marine resources such as fish, coral reefs and other biota. So if there is a current or big wave, it will go directly to the beach which can cause abrasion.

Global warming is also one of the triggers for coastal abrasion, such as motor vehicle activity or from industrial factories and forest fires. The smoke that produces carbon dioxide will block the release of the sun's heat reflected by the earth. As a result, the heat will be trapped in the atmosphere, which can cause the temperature on earth to increase. If there is an increase in temperature on earth, the ice at the poles will melt and sea levels will increase which can affect low-lying coastal areas. Sand mining activities carried out by humans on a large scale are also a factor causing coastal abrasion. This has a direct effect on the speed and direction of sea water when it hits the coast. Because if you don't bring sand, the power to hit the beach is getting bigger. We can also see the current global warming from rising sea levels.

Among several things that can cause abrasion, among others: Land subsidence. Global climate change. There are few plants that inhibit the rate of abrasion. Damage to wave hydrodynamics. Economic activities of the people living around the coast such as the opening of ponds that do not pay attention to environmental sustainability. Additional information that the author got from Admiral TNI (Ret.) Dr. Widodo, M.Sc. as the Maritime Security Lecturer at UNHAN RI, that the typology of the beach in the northern waters of Bengkalis has a type of muddy sand which if dredging occurs at the bottom, the upper part of the land will also collapse. This is also said to be one of the high abrasion factors on the north coast of Bengkalis Island. The impact of the increase in abrasion that occurred on the coast of Bengkalis Island is actually very worrying. The impact can be in the form of coastline shrinkage so that the mainland's land is decreasing and endangering coastal communities living on the coast.

Mangrove damage along the coast, thus increasing the risk of disaster. As well as reduced fish and germplasm resources due to the destruction of mangrove forests. In addition, other natural disasters that threaten such as tidal flooding and loss of productive land for coastal communities have an impact on the community's economy. This was also confirmed by M. Azmir S.Hut.T., M.Sc. as Plt. Head of the environmental department of Bengkalis Regency. He stated that the abrasion that occurred along the north coast of Bengkalis Island could reach 1 kilometer, with a coastline change rate of more than 30 meters per year. This is in accordance with the findings of our research, namely coastal abrasion that occurs at 39 meters per year and the average rate of change in coastline is 14 meters per year.

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Mangrove forest is a forest ecosystem that has a distinctive and unique function. Mangrove forests provide protection for various organisms, both land animals and aquatic animals, to settle and breed. Of course, the loss of mangrove land will have a major impact not only on humans but also on the entire ecosystem that inhabits coastal areas. In terms of dealing with the ongoing degradation of mangrove land in Bengkalis Regency, the government has made several efforts to minimize the disaster. However, the efforts made cannot eliminate the threat of disaster, only minimizing the loss and damage that can occur. The following are the efforts that have been late by the government in tackling maritime disasters on the north coast of Bengkalis Island, namely carrying out a mangrove planting program.

Mangrove rehabilitation in Bengkalis Regency is carried out by the government through the Economic Recovery Program (PEN) KLHK, BRGM, BPDAS-HL Indragiri Rokan and the Bengkalis Island Forest Rescue Unit (KPH) in 2020-2021 reaching an area of 1,369 Ha in 5 sub-districts namely Bengkalis, Bantan, Rupat, North Rupat and Bukit Batu. The number of mangrove seedlings planted and stakes is 7,729,800 stems with the involvement of 40 community groups (1,781 people) with a total HOK (Daily People Work) of approximately 65,631. Mangrove planting is carried out for the purpose of reducing the level of abrasion that occurs, filtering sea water into the land, and reducing the threat of sea water intrusion.

In addition, some of the causes of global warming are lifestyle, consumption patterns and irregular population growth, coupled with various human activities that sometimes damage the environment. In essence, the cause of global warming is human activity, so it is very important to provide education to the public with the aim of making people aware of the importance of saving the environment because of the impact of global warming.

Conclusion

Global Warming or Global Warming is a term that refers to an increase in the average temperature above the earth's surface. The increase in global temperature will result in the expansion of seawater masses, and sea level rise. Rising sea levels cause the expansion of inundated coastal areas. Based on the IPCC report, there will be an increase in sea level with an increase of 2.8-3.6 mm/year. As an archipelagic country, Indonesia certainly has great potential for maritime disasters. One of them has occurred in Riau Province, namely the threat of coastline progress and tidal flooding due to high tides that cause mangrove land degradation. With technological advances, the government can take advantage of geographic information system technology. GIS can be used for spatial analysis and modeling using measurement data and satellites. Through GIS, the government can get tidal data, coastline progress data, and land subsidence data. With the data from the GIS, the government can be more comprehensive in gathering input to make decisions, map disaster-prone areas, and create scenarios for anticipating and adapting to mangrove land degradation that may occur. In Bengkalis Regency itself, several efforts have been made by the local government, carrying out mangrove planting programs, and increasing public awareness.

References

Ardiansyah, A., Subiyanto, S., & Sukmono, A. (2015). Identifikasi lahan sawah menggunakan NDVI dan PCA pada citra landsat 8 (Studi Kasus: Kabupaten Demak, Jawa Tengah). Jurnal Geodesi Undip, 4(4), 316-324.

Azmir, M. (2022). “Upaya Rehabilitasi dan Penanganan Abrasi Kabupaten Bengkalis”. (Presented at kegiatan KKDN prodi Keamanan Maritim, Universitas Pertahanan RI)

Badan Penanggulangan Bencana Daerah Kabupaten Bengkalis. https://bpbd.bengkaliskab.go.id diakses tanggal 12 Februari 2022.

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E-ISSN: 2829-2421
https://doi.org/10.47709/joa.v1n02.1574

Badan Perencanaan Pembangungan Daerah Kabupaten Bengkalis. (2007). Masterplan Penanggulangan Abrasi Pantai Kabupaten Bengkalis tahun 2007.

Damayanti, Anggraeni. (2016). Analisis Dampak Perubahan Iklim Berdasarkan Kenaikan Muka Air Laut Terhadap Wilayah Kota Surabaya. Surabaya: Institut Teknologi Sepuluh November.

Fisip Unri. (2020). Menggagas Kebijakan Insentif. https://ap.fisip.unri.ac.id/wp-content/uploads/2020/02/BAB-III-BUKU-MENGGAGAS-KEBIJAKAN-INSENTIF.pdf

Ko, B. C., Kim, H. H., & Nam, J. Y. (2015). Classification of potential water bodies using Landsat 8 OLI and a combination of two boosted random forest classifiers. Sensors, 15(6), 13763–13777.

Oktorini, Yossi. 2022. Mangrove Riau: sebaran dan status perubahan .Dinamika Lingkungan Indonesia, Januari 2022, p 50-57 e-ISSN 2655-8114 Volume 9, Nomor 1

Prokopim Pemkab Bengkalis. (2022). Abrasi Pantai Pulau Bengkalis. https://prokopim.bengkaliskab.go.id/web/detailberita/2465/2016/03/14/abrasi-pantai-pulau-bengkalis.

Sutikno, Sigit. (2015). Analisis Laju Abrasi Pantai Pulau Bengkalis dengan Menggunakan Data Satelit.

Syaifullah, M. Djazim. (2015). Suhu Permukaan Laut Perairan Indonesia Dan Hubungannya Dengan Pemanasan Global. Jakarta Pusat: BPPT.

Xu, H. (2006). Modification of normalised difference water index (NDWI) to enhance open water features in remotely sensed imagery. International Journal of Remote Sensing, 27(14), 3025–3033.