Mapping the Distribution of Sea Surface Temperature and Chlorophyll-a in the Waters of Pieh Island Conservation Area Using Aqua MODIS Satellite Imagery

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Abstract

Pieh Island Conservation Area is a conservation area that has abundant biodiversity, including coral reefs, turtles, whales, dolphins, and others. This study aims to determine the Mapping of Sea Surface Temperature Distribution and chlorophyll-A in the Pieh Island Conservation Area Waters Using AQUA MODIS Satellite Imagery. The methods used are active participation, literature study, and discussion with field supervisors in the Pieh Island Marine Conservation Area, West Sumatra Province. The results of the Thematic Internship Program MBKM with the title Mapping the Distribution of Sea Surface Temperature and Chlorophyll-A in the Waters of Pieh Island Conservation Area Using Aqua MODIS Satellite Imagery. Based on the graph, the average sea surface temperature and chlorophyll-a concentration in the Pieh Island Waters Conservation Area show that the highest sea surface temperature during 2023 is in February at 30°C, which continues to decrease to the lowest value in May. Then it increases again from June to August, respectively 27.5°C, 27°C, and 27.5°C, and then drops in September by 27.5°C. Furthermore, the chlorophyll-a concentration value has the lowest value in April with a value of 0.182 mg/m3and the highest peak is in August with a value of 0.362 mg/m^3, The results of the correlation test between sea surface temperature and chlorophyll-a show a significance value of 0.152 which is greater than the general significance level of 0.05. Therefore, based on the statistical significance criterion, it cannot be ignored that there is no significant influence between the two variables. At the same time, however, the Pearson correlation value is -0.519, which reflects the negative relationship between sea surface temperature and chlorophyll-a.

1. Introduction

Pieh Island Conservation Area has abundant biodiversity, including coral reefs, turtles, whales, and dolphins. The sea surface temperature has experienced variations from time to time. These changes can occur daily, seasonally, or annually according to the natural conditions that affect it (Azizah & Wibisana, 2020). Temperature is an essential factor for organisms in the sea, which can affect the metabolic activity and proliferation of marine biota, such as phytoplankton.

The use of remote sensing techniques is beneficial for measuring sea surface temperature, where the results obtained have a wide coverage and are pretty accurate (Shabrina et al., 2017). In this study, the AQUA MODIS satellite data were used, where the satellite can observe the Earth's entire surface every one or two days. The data is received in 36 spectral

channels with different wavelengths, namely the visible wave range (channels 1-19), infrared (channel 26), and thermal in the remaining channels. This study provides information on the distribution pattern of SPL and chlorophyll-a in the Pieh Island Conservation Area obtained from the AQUA MODIS image processing.

This internship aims to improve skills and knowledge about mapping the distribution of sea surface temperature and chlorophyll-a and their relationship in the waters of the Pieh Island Conservation Area using Aqua Modis Satellite Imagery, as well as to find out the management of areas. The results of this research analysis can be used as reference material for research related to the marine field, such as determining fish catch areas and ecosystem conservation.

2. Methodology

2.1. Time, Place, and Materials

The internship practice was conducted from September to December 2023 at the LKKPN Working Area of Pieh Island, Padang City, West Sumatra.

2.2. Method

The method used in implementing Field Work Practices is a participatory method where the author works at LKKPN Pekanbaru Pieh Island Working Area, and a descriptive analysis method. The data obtained is secondary data, where the author gets data from the NASA Ocean Color website. The data obtained is then processed, presented in the form of maps, and discussed descriptively based on various references.

2.3. Procedure

The procedure for internship practice is to prepare the tools and materials used. Then, the data used is Aqua MODIS images for 2023 downloaded from the NASA Ocean Color website. After that, the product is processed in SeaDAS, selected data in Microsoft Excel, and continued to ArcGIS software for interpolation to map layouting. Furthermore, a correlation test was conducted to determine the relationship and influence between the two variables.

3. Result and Discussion

Description of the Study Area

The Pieh Island Conservation Area has five islands: Bando Island, Pieh Island, Pandan Island, Water Island, and Toran Island. The islands are located in Padang Pariaman Regency, West Sumatra. This area is 39,920 Ha and has been established through the Decree of the Minister of Marine Affairs and Fisheries No.31/KEPMEN-KP/2022 concerning the Pieh Island National Marine Conservation Area and the surrounding Sea. Pieh Island is geographically located at 99° 59'36" - 100° 59'28" East to 00° 45' 10" - 01° 03' 08" LS, the distance from the mainland of Padang Pariaman Regency is ± 17 miles, which is reached by motorboat in 2 hours. While administratively, this area is included in the Ulakan Tapakis District, a fraction of the Nan Sebaris District, Padang Pariaman Regency.

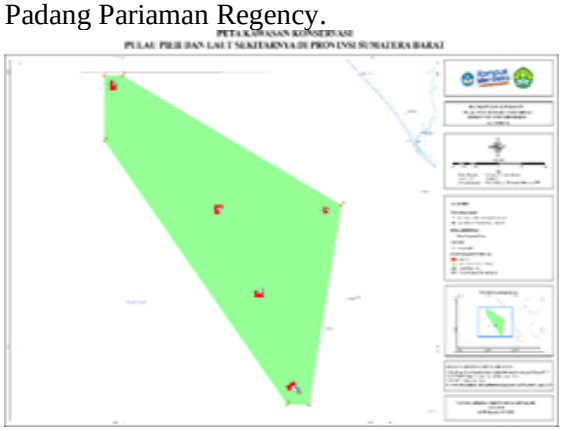

Figure 1. Pieh Island Conservation Area

Sea Surface Temperature

The distribution of SST values in 2023 for the January-September period experienced the highest temperature peak in the East Season (January and February). In contrast to the SPL conditions in the Transitional Season I (March, April, May), which showed a decrease in the lowest temperature reaching 26.5ºC. SST values in the 2023 West Season ranged from 27º-28.5ºC. The low value of SPL compared to other seasons indicates an upwelling phenomenon. This condition is based on the statement (Has et al., 2018) that the low value of SPL compared to the previous months indicates an upwelling phenomenon; water masses will fill the vacuum of water masses that occurs at the surface from the lower layers whose temperature is cooler.

Seawater temperature is vital in understanding the ocean's role as a heat reservoir. Changes in temperature cause variations in the properties of seawater and the life it supports. Seawater temperature is a factor that has received much attention, especially with the problem of rising global sea temperature. Temperature significantly affects the life and growth of aquatic biota; temperature in water

bodies is influenced by season, latitude, time of day, air circulation, cloud cover, flow and water depth. Water temperature plays a role in controlling the aquatic ecosystem. Increased temperature leads to increased decomposition of organic matter by microbes (Alfajri et al., 2017).

Meteorological conditions such as rainfall, evaporation, temperature, air humidity, wind speed, and solar radiation intensity influence SST. Surface temperature changes can affect these waters' physical, chemical, and biological processes (Ate et al., 2021). Therefore, sea surface temperatures usually vary by season, although slight differences exist. In addition to these factors, sea surface temperature is also influenced by the time of day, air circulation, cloud cover, and flow and depth of the water body (Insanu, 2019).

Table 2. Distribution of SPL of Pieh Island Conservation Area 2023

Period	Lowest temperature (°C)	Highest temperature (°C)	Average temperature (°C)
January	27	30	28.5
February	30	30	30
March	27	28	27.5
April	27	27	27
May	26	27	26.5
June	27	28	27.5
July	27	27	27
August	28	29	28.5
September	27	28	27.5

Table 3. Chlorophyll-a Concentration of Pieh Island Conservation Area 2023

Period	Minimum concentration (mg/L)	Maximum Concentration (mg/L)	Average concentration (mg/L)
January	0,158	0,485	0.256
February	0,157	0,343	0.209
March	0,114	0,587	0.249
April	0,119	0,350	0.182
May	0,228	0,538	0.362
June	0,214	0,418	0.262
July	0,192	0,562	0.297
August	0,160	0,513	0.246
September	0,229	0,326	0.276

The chlorophyll-a concentration value in the Pieh Island Conservation Area in 2023 for the January-September period was in May, with a concentration value in the range of 0.228 - 0.538 mg/L and an average of 0.362 mg/L. At the same time, the lowest chlorophyll-a concentration was obtained in April, with concentration values in the range of 0.119 - 0.350 mg/L and an average of 0.182 mg/L. The status of waters based on chlorophyll-a concentration in the waters of Pieh Island Conservation Area is classified as low, referring to Nontji (1984, namely low chlorophyll-a concentration is < 0.3 mg/m3, medium chlorophyll-a concentration is between 0.3 - 1 mg/m^3, and high chlorophyll-a concentration is > 1 mg/m^3.

Variations in the distribution of chlorophyll-a concentrations are caused by differences in temperature, wind direction distribution patterns, seasons, and nutrients entering the waters. Chlorophyll, a phytoplankton content in a body of water, can be used to measure phytoplankton biomass and as a clue to the fertility of waters. Good water quality is a good place to live for phytoplankton, because the chlorophyll-a content of phytoplankton itself can indicate the high and low productivity of a body of water (Salam, 2022).

Correlation of Sea Surface Temperature and Chlorophyll-a in the Pieh Island Conservation Area

The result of the correlation test between sea surface temperature and chlorophyll-a shows a significance value of 0.152, which is greater than the general significance level of 0.05.

Based on the statistical significance criteria, it cannot be ignored that there is no significant influence between the two variables (Adelia & Riorini, 2023).

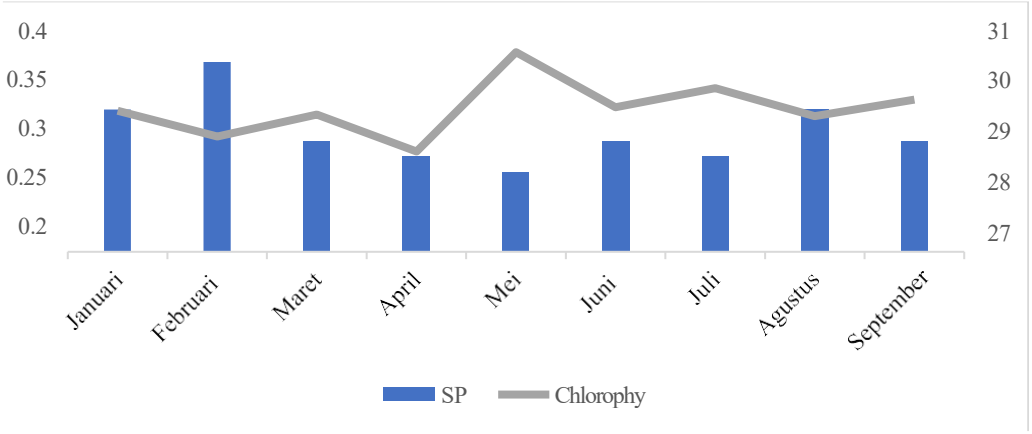

Figure 2. SPL and Chlorophyll-a in Pieh Island Conservation Area

However, at the same time, the Pearson correlation value shows -0.519, which reflects a negative relationship between sea surface temperature and chlorophyll-a. This indicates that there is an incompatible relationship between the two variables. In this case, a decrease in sea surface temperature leads to a high chlorophyll-a concentration (Donya et al. 2020).

However, although not statistically significant, the results of this correlation may suggest a link between sea surface temperature and chlorophyll-a (Djemma et al., 2023). These results are likely influenced by seasonal variations, ocean circulation patterns, or other ecological factors shaping the relationship between SST and Chl-a variables. Further elucidation or additional analysis may be needed to understand this relationship better, which is something to consider for further research.

4. Conclusion

It can be concluded that the highest chlorophyll-a concentration value in the Pieh Island Conservation Area in 2023 for the January-September period is in May, with a concentration value in the range of 0.228 - 0.538 mg/L and an average of 0.362 mg/L. At the same time, the lowest chlorophyll-a concentration was obtained in April, with concentration values in the range of 0.119 - 0.350 mg/L and an average of 0.182 mg/L.

The correlation test result between sea surface temperature and chlorophyll-a shows a significance value of 0.063, greater than the general significance level of 0.05, meaning there is no significant relationship between the two variables. However, at the same time, the Pearson correlation value showed -0.519, which reflects a negative relationship between sea surface temperature and chlorophyll-a. This indicates an incompatible relationship between sea surface temperature and chlorophyll a.

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