Spatio-Temporal Distribution of SST and Chlorophyll-a in WPP 718 Waters during the West Season: Case Study of Merauke Regency Waters, Indonesia

ABSTRACT

Sea surface temperature (SST) and chlorophyll-a are critical factors for determining oceanographic conditions in water bodies. This research aims to analyze the spatial and temporal distribution of these parameters in the waters of the Merauke region using remote sensing technology. Descriptive methods and remote sensing techniques were used to collect and analyze data from Aqua-MODIS satellite images from December 2022 to February 2023. The results indicate that the waters of Merauke Regency are fertile and warm, with the highest surface temperature recorded in December 2022 (25.0 - 30.0 Celsius). C) and the lowest in January 2023 (25.0 – 28.0 degrees Celsius). Chlorophyll-a concentrations peaked in December 2022 (0.26-5 mg/m3) and were lowest in February 2023 (0.2-2 mg/m3). These results provide valuable insights for fisheries management and environmental monitoring, aiding in the sustainable use of marine

Keywords: remote sensing, spatio-temporal distribution, oceanographic conditions, Aqua-MODIS satellite imagery

1. INTRODUCTION

Merauke Regency is one of the districts in the eastern part of Indonesia which has an area of 45,071 km² located at coordinates 6°00'-9°00' South Latitude and 137°–141° East Longitude. The territorial boundaries of Merauke Regency to the north are Boven, Digoel and Mappi Regencies, to the east is Papua New Guinea, and to the west and south is the Arafura Sea. Merauke Regency has very significant seasonal differences between the rainy season and the dry season which are caused by monsoon winds, topography and regional elevation [1].Fisheries resources in Indonesia for the 2015–2019 period are relatively high (34,058,357 metric tons) compared to a number of other countries in Southeast Asia such as Thailand (7,521,543), the Philippines (10,886,035), and Vietnam (17,004,600) [2].However, the contributors to this production figure are not evenly distributed, including the province of Papua whose territorial waters are included in WPP 718, only contributing 1,220,768.38 or around 0.036% of the recorded production [3].

In an effort to support the utilization and development of fisheries resources in waters, it is necessary to provide important information regarding the condition of waters both spatially and temporally using credible approaches using modern technology, one of which is remote sensing. Remote sensing technology is a method for identifying, measuring and recording the existence of objects and information from a distance without direct contact with the object which combines information on oceanographic conditions of waters with capture

fisheries activities into the form of a thematic map [4]. This technology can produce important information about the temporal and spatial dynamics of waters [5].

Oceanographic parameters that can be used to determine the spatio-temporal distribution in remote sensing technology can be sea surface temperature (SST) and chlorophyll-a.Sea surface temperature (SST) is a fundamental physical variable for understanding, measuring and predicting the complex interactions between the ocean and the atmosphere [6]. Apart from influencing the climate, sea surface temperature is also one of the marine parameters that can determine the quality of waters because temperature directly influences the life of organisms such as the rate of plant photosynthesis and animal physiology such as metabolism and reproduction. Indirectly, temperature affects the solubility of oxygen which will be used for respiration of marine biota [7]. The potential of fisheries and marine resources is closely related to the primary productivity of waters produced by phytoplankton. The photosynthetic pigment commonly found in phytoplankton is chlorophyll-a, so the results of chlorophyll-a measurements are used to estimate the phytoplankton biomass of a body of water. Chlorophyll-a is one of the parameters that really determines primary productivity in the sea. The distribution and high or low concentrations of chlorophyll-a are closely related to the oceanographic conditions of a body of water [8].

The study of SST and chlorophyll-a is one of the most important research programs in the marine and fisheries sector. With satellite remote sensing technology, direct measurements of conventional oceanographic factors can gradually be reduced. Satellite remote sensing can cover large and short sea areas, while direct field measurements require a lot of costs, energy and a long time [9]. Information regarding the spatial and temporal distribution of sea surface temperature and chlorophyll-a in the fisheries sector has an important role as a means of estimating and determining the location of upwelling, fronts or eddies currents. These three locations are closely related to potential fish distribution areas [10].Therefore, it is necessary to carry out an analysis of the spatio-temporal distribution in Merauke Regency waters.

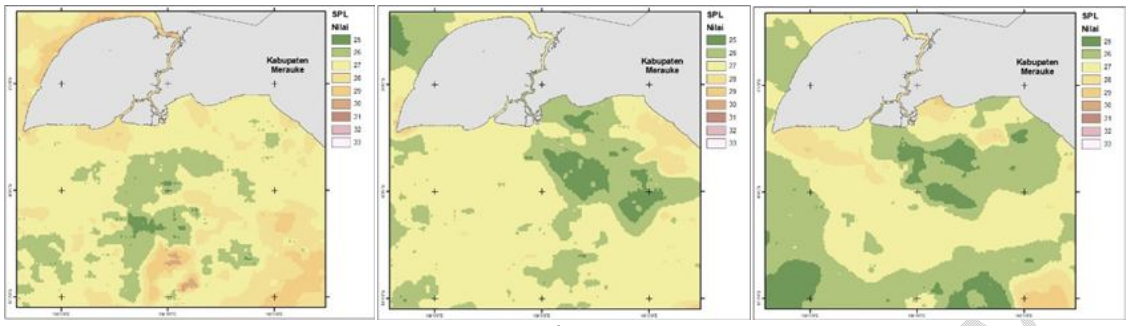
2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

The research was conducted in the western season, over a period of 3 months from December 2022 to February 2023 using descriptive methods in the nature of case studies and remote sensing methods. The secondary data were used this study namely oceanographic data usedfrom satellite images in the form of SST and chlorophyll-a concentrations obtained from the Terra - Aqua MODIS satellite with standard map images in HDF format via the website (http:// oceancolor.gsfc.nasa.gov/cms/) with a data resolution of 4 km both longitude and latitude which is processed and extracted using the SeaDas 7.3 application, then the processed results are input into the ArcGis 10.8 application so that a spatial and chlorophyll-a distribution map is obtained temporal.

3. RESULTS AND DISCUSSION

3.1 Sea Surface Temperature (SST) Conditions in the West Season in Merauke Regency Waters

Sea surface temperature is an oceanographic parameter that is easy to measure and greatly determines the abundance and distribution patterns of fish. The physiological condition and abundance of fish food are directly affected by the temperature of a body of water [11]. Therefore, sea surface temperature is an important oceanographic factor to determine the distribution and abundance of fish in a body of water. SST observations in the waters of Merauke Regency are in the range of 25.0 – 30.0°C which is shown in detail in Figure 1.



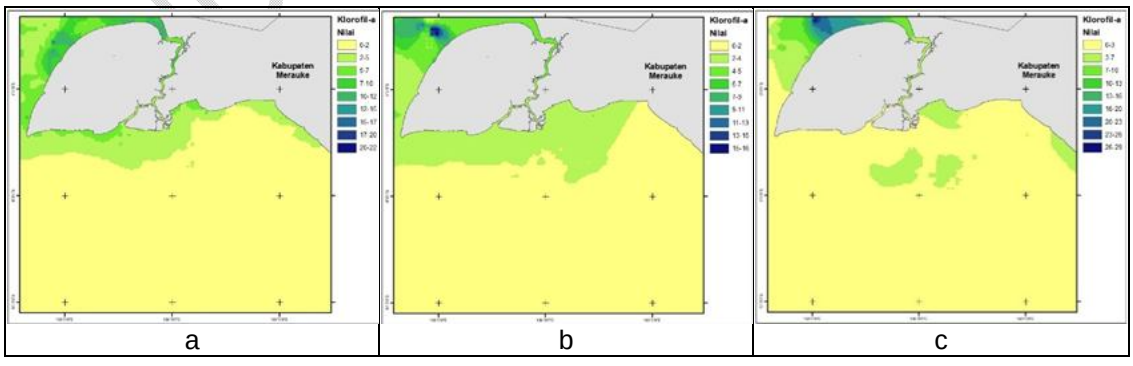
a b c

Fig. 1. SST Conditions in Merauke Regency Waters (a) December 2022; (b) January 2023; (c) February 2023

Based on Figure 1, the spatial distribution of sea surface temperatures in the waters of Merauke Regency in December 2022 – February 2023 has decreased evenly from month to month. Meanwhile, temporally, the highest SST will occur in December 2022, ranging from 25.0 - 30.0°C, and the lowest SST will occur in January 2023, ranging from 25.0 - 28.0°C. The water temperature in Merauke Regency in the west season ranges from 26.0 – 32.0°C with an average SST of 29.0°C [12]. High sea surface temperature penetration originates from the northwest of Arafura towards the east of Papua New Guinea.The distribution of sea surface temperatures has increased and decreased, thought to be due to the movement of relatively warmer water masses, and also due to erratic rainfall [8]. The distribution of sea surface temperature if related to the movement of wind direction and speed will strengthen the statement that high or low sea surface temperature values are influenced by wind and seasonal changes [13]

3.2 Chlorophyll-a Concentration Conditions in the West Season in Merauke Regency Waters

The distribution of chlorophyll-a concentrations in waters varies both geographically and in terms of water depth. Differences in nutrient concentrations and the intensity of incoming light are the main factors in varying chlorophyll-a concentrations in waters. The higher the concentration of chlorophyll-a in a body of water, the higher the number of fish that live and breed in that water [11]. The distribution of chlorophyll-a concentrations in the waters of Merauke Regency can be seen in Figure 2.



a b c

Fig. 2. Chlorophyll-a Concentration Conditions in Merauke Regency Waters (a) December 2022; (b) January 2023; (c) February 2023

The concentration of chlorophyll-a in the western season based on Figure 2 is shown in color levels. The chlorophyll-a concentration value is in the range of 0.2 – 5 mg/m^{-3}. The highest chlorophyll-a concentration was found in December 2022, ranging from 0.26-5 mg/m^{-3} and the lowest occurred in February 2023, ranging from 0.2-2 mg/m^{-3}. The high concentration of chlorophyll-a is caused by the rainy season in land areas, bringing nutrients to river estuaries [14]. The chlorophyll-a content in a body of water can indicate the amount of phytoplankton that fish feed on and can be an indication of water productivity. A chlorophyll-a concentration that exceeds 0.2 mg/m^{-3} is an indicator of the presence of optimal and adequate phytoplankton to maintain and support the survival of aquatic organisms [15]. The availability of chlorophyll-a through analysis of phytoplankton in waters is influenced by anthropogenic activities that enter the coast. The concentration of chlorophyll-a in waters is very dependent on the availability of nutrients and the intensity of sunlight [16]. Changes in the distribution of chlorophyll-a concentrations are very necessary in order to predict changes in fish habitat.

4. CONCLUSION

The spatio-temporal distribution of SST and chlorophyll-a in the waters of WPP 713 for the period fromDecember 2021 to November 2022 has different characteristics in each month. The highest sea surface temperature distribution in December 2022 ranges from 25.0 – 30.0°C and the lowest occurs in January 2023, ranging from 25.0 – 28.0°C. Meanwhile, the highest distribution of chlorophyll-a was found in December 2022, ranging from 0.26-5 mg/m^{-3} and the lowest occurred in February 2023, ranging from 0.2-2 mg/m^{-3}. The distribution of SST and chlorophyll-a in the waters of Merauke Regency each month is said to be fertile and warm, as can be seen from the distribution classification for each month.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Declaration of competing interest should be placed here. All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. If no such declaration has been made by the authors, SDI reserves to assume and write this sentence: “Authors have declared that no competing interests exist.”.

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