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Conference Paper

The Influence of Sea Surface Temperature on the Distribution of Tuban Coastal Salinity Concentration Using Landsat 8 Satellite Image Data

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ABSTRACT

The coast of Tuban is an area that has a relatively sloping coastal structure so that sea currents that enter the shoreline can influence the land directly adjacent to the seaside. One form of infiltration from seawater is the influence of salinity on the coast where by knowing the amount of salinity it can be known whether the salt content on the shoreline can affect the existing infrastructure on the coast. This study aims to obtain a mathematical model of salinity concentration by considering the magnitude of other parameters, namely sea surface temperature. This quantity is taken as a form of independent variable which is believed to affect the amount of salinity present. The measurement method carried out is to use Landsat 8 satellite image data and field samples for correlation and regression tests. The results shown show that the rise and fall of sea surface temperatures more or less contribute to the amount of salinity on the coast. The optimum mathematical model algorithm of sea surface temperature is SST = 19,671ln(Rrs_B4) + 87,136 and for salinity obtained Sal(o/oo) = 896,49 (Rrs_B4) - 15,943. For the correlation of sea surface temperature to salinity itself, an optimum mathematical relationship is obtained Sal = 6,8908e0,0505*T, so from this form it can be said that sea surface temperature has an exponential correlation with the amount of salinity on the coast of Tuban. This still needs further proof of variable behavior on the south coast which has larger waves.

Keywords: Sea surface temperature, salinity, remote sensing, coast of Tuban

Introduction

Remote sensing, as one of the branches of geospatial science, has become a very important tool in understanding and monitoring the dynamics of the atmosphere and oceans around the world. Remote sensing allows scientists to obtain information on various environmental parameters, including sea surface temperature and salinity concentration, which are key factors in understanding global oceanographic systems. Sea surface temperature and salinity concentration are two very important variables because they affect the physical and chemical properties of the oceans, as well as have a significant impact on the global climate and marine life (Bulgin et al., 2015; Donguy & Meyers, 1996; Palacios, 2003; Pastor, 2021; Takahashi et al., 2002).

Sea surface temperature is a key indicator in understanding the thermal dynamics of the ocean. Sea surface temperatures affect ocean current patterns, atmospheric circulation, and storm formation. By monitoring sea surface temperatures using remote sensing, scientists can identify temperature anomalies, observe seasonal changes, and analyze their impact on marine life, including the distribution of fish species and other marine animals (Etnoyer et al., 2006; Quishpe-Vásquez et al., 2019; Wibisana et al., 2018, 2019, 2022; Zainab et al., 2022).

The concentration of salinity, or salt content, in seawater also plays a key role in marine ecosystems and thermohaline circulation. Different salinity levels can result in variations in seawater

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density, which in turn affects vertical and horizontal ocean current patterns (Anguelova & Huq, 2017; Hoang et al., 2016; Li et al., 2013; S. L. Palacios et al., 2009; Paramygin et al., 2016). Through remote sensing, scientists can monitor the spatial and temporal distribution of salinity concentrations, understand changes in thermohaline circulation, and predict changes in ocean stratification.

By knowing the understanding of salinity levels on the coast, it will be predictable in the future that seawater intrusion that can occur will bring with it salt ions due to salinity levels that change along with changes in parameters that affect salinity concentrations, one of which is sea surface temperature which in this study is taken as an independent variable. Research on salinity has been carried out as well as observations of sea surface temperatures on the coast where sea surface temperature and salinity have their sensical characteristics, but if the two are considered correlated, it will show a new phenomenon that can be taken as a reference in taking the policy of coastal management, especially in dealing with the process of seawater intrusion. The use of remote sensing as one of the global scale mapping technologies is very helpful in mapping salinity levels for a wide scope, where the existing salinity distribution already has several articles that have been published in various journals (Huang et al., 2015; Nguyen et al., 2020; Pattanaaik et al., 2008; Wibisana et al., 2018; Yusuf et al., 2021; Zainab et al., 2020), likewise with sea surface temperature, but to see the influence of sea surface temperature on the rise and fall of salinity levels on the coast, not many have done it mainly on the coast of Tuban, East Java, so that by conducting this research can contribute to the study of the correlation of two correlated parameters.

Material and Methods

Research location

The location for this study took place in the coastal area of Tuban, East Java, where the coast of Tuban is bordered by Lamongan Regency to the east and Rembang Regency to the west. Tuban coastline has a relatively flat beach morphology without cliffs so this coastline is suitable to be the object of research from variables that often affect aquatic environmental ecosystems such as salinity, total suspended solids, acidity, and sea surface temperature. The research location on the coast of Tuban can be seen in Figure 1.

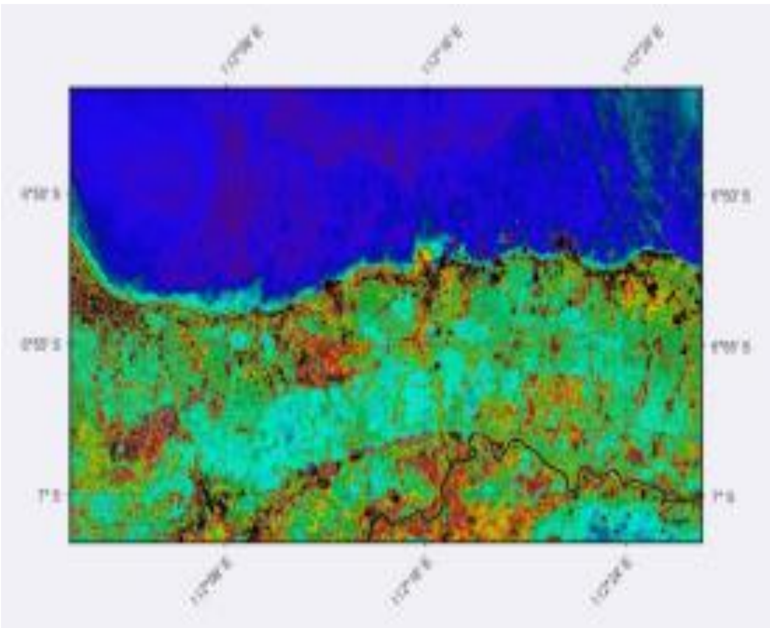

Figure 1. Research location at coast of Tuban East Java

The coordinates of the location are between -6.82oto -6.899o south latitude, and 112.276o to 112.41o east longitude.

Field data retrieval

Field data collection is carried out using fishing boats that move according to predetermined coordinates. At existing coordinates, seawater is detected using a salinometer for measuring salinity levels. Meanwhile, sea surface temperature data collection is carried out using a digital thermometer dipped in seawater surface with an average depth of 10 to 20 centimeters. The sample data collection point is shown in Figure 2.

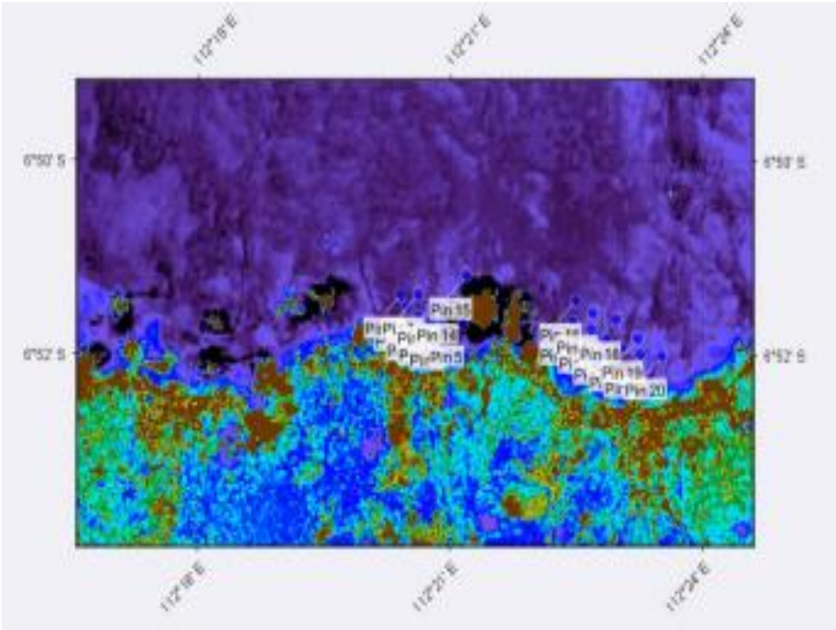

Figure 2. Salinity and sea surface temperature sample data collection points

Results and Discussion

Table 1. Mathematical model and value of reflectant correlation to sea surface temperature

No	Algorithm	Mathematical model	R^2
1	Linear	SST=385,69X + 8,8728	0,743
2	Exponent	SST= $14{,}215e^{13{,}64x}$	0,7405
3	Logarithmic	SST= 19,671 ln(x)+87,136	0,7463
4	Power	SST= $226{,}97x^{0{,}6966}$	0,7441

Source: calculation result

Table 1 shows a comparison of several algorithms to produce a mathematical model with the correlation value of the model where for the logarithmic model of red tape (B4) the Landsat satellite image has the most optimal correlation value compared to the others with a value of 0.7463, although when viewed from the average value there is not too significant a difference. This sea surface temperature value shows almost the same results as research that has been conducted in the Ujung Pangkah Gresik area, so it can be said that the red band from Landsat satellite images can be used as one of the variables to detect the distribution of sea surface temperatures on the north coast of Java in general.

Table 2. Mathematical model and value of reflectant correlation to salinity of seawater

No	Algorithm	Mathematical model	R^2
1	Linear	$Sal_{(o/oo)}$ = 896,49x – 15,943	0,8868
2	Exponent	$Sal_{(o/oo)} = 6,3085e^{30,295x}$	0,8818
3	Logarithmic	$Sal_{(o/oo)}$ = 45,617ln(x)+165,65	0,8866
4	Power	$Sal_{(o/oo)} = 2929,6x^{1,5429}$	0,88859

Source: calculation result

Table 2 shows a comparison of algorithms for salinity concentrations that occur on the coast of Tuban, where from the table can be seen the value of the most optimal mathematical model obtained from the linear model with a correlation value of 0.8868. When viewed again, the correlation value of each model is not too different with a difference that is not too significant for the calculation error rate of each model of 5%. For mapping using Landsat satellite images, red tape can be used which provides significant results when viewed from the correlation value which is close to 88.7%, this is not too much different from research conducted by the same researcher, on the distribution of salinity using MODIS aqua satellite images on the coast of Madura island.

Table 3. Mathematical models and correlation of sea surface temperature to salinity values

No	Algorithm	Mathematical model	R^2
1	Linear	Y= 1,5039x-13,581	0,4997
2	Exponent	$Y= 6,8908e^{0,0505x}$	0,5217
3	Logarithmic	Y= 41,1891n(x)-108,66	0,4816
4	Power	$Y= 0,2819x^{1,3843}$	0,5061

Source: calculation result

Table 3 shows the combination of the two parameters studied, where the results shown in the table show that the exponent model has the largest correlation value R2 among others, so to describe this phenomenon into a thematic map of Landsat satellite images can use the exponent model algorithm, where every 1 degree of temperature increase will increase salinity concentration by 0.05x degrees where x is the temperature increase. The exponent model produced in the calculation of salinity to sea surface temperature has the following mathematical model form:

$$Sal\left(\frac{o}{oo}\right) = 6.8908 * \exp(0.05 * T)$$

Where Sal = salinity concentration and T = is the temperature in Celsius.

Conclusion

The wavelength of the red color or Band 4 represents the wavelength of visible light which provides optimal results to the mathematical model algorithm of the distribution of sea surface temperature and also the distribution of seawater salinity.

The correlation between sea surface temperature and salinity concentration on the coast of Tuban does not show significant changes, where the correlation value shown is below 60% so statistical measurements have not shown significant said to have a significant close relationship and mutually affect changes on the coast, so in the future it is necessary to do a more accurate algorithm analysis by involving mathematical analysis of the algorithm that is compiled and also involving the blue and green wavelengths of visible light wavelengths (RGB) in Landsat 8 satellite imagery. Field detection for salinity distribution values is also still within reasonable limits and has not shown anomaly that causes soil quality on the coast to experience quality degradation which results in plants difficult to grow and produce by farmers, the same is also known that the quality of waters on the coast of Tuban is still within the required threshold so that capture fisheries carried out by fishermen are still running well.

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