The effect of Sea Surface Temperature and Chlorophyll-A on the Total Catches of Lift Net Fishery in the Padang Pariaman Regency, Indonesia

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ABSTRACT

The West Sumatera Waters has the potential to be developed for capture fisheries. This potential is utilized through the application of local knowledge for better fishing operations. Fishermen in West Sumatera in determining fishing ground still use the traditional method, namely using previous experience even though on vessels of > 40 GT and it has been assisted by the fish finder. This study aims to analyze the distribution of sea surface temperature (SST) and chlorophyll-a through Aqua Modis satellite imagery interpretation and analyze its effect on boat lift catch from December 2019 to March 2020. The remote sensing technique via satellite is an efficient method to determine the distribution of sea surface temperature and the distribution of chlorophyll-a. Data from satellites is very helpful in determining temperature and chlorophyll-a. The results obtained are in December 2019 to March 2020 SST distribution ranged from 27 to 30.9°C with dominant SST fluctuating every month and chlorophyll-a concentration ranging from 0.13 to 4 mg m³ with dominant chlorophyll-a concentration fluctuating every month. Sea surface temperature (SST) and chlorophyll-a simultaneously did not affect the catch.

Keywords: fishing ground, aqua modis, remote sensing, Katsuwonus pelamis

INTRODUCTION

Indonesia has an important role in the tuna fishery, especially of Thunnus sp., Auxis rochei, and Katsuwonus pelamis (Sepri et al., 2020). The area of fishing that supports this position is West Sumatera Waters in the Fisheries Management Area (FMA) – 572 which includes the western Indian Ocean, West Sumatera, and the Sunda Strait. Based on data from Capture Fisheries Statistics, the total production of these fish in FMA 572 is 197,410 tons (Suman et al., 2018).

The efforts to predict fishing ground can be done through an approach to oceanographic physical conditions. Almost all fish populations that live in the sea have an optimum temperature range and chlorophyll-a for life (Laevastu & Hela, 1970). A good fishing ground is influenced by chlorophyll-a which is a parameter that greatly determines the primary productivity of the oceans, while sea surface temperature (SST) can be used as a parameter to predict the presence of organisms in water, especially fish (Tangke et al., 2015). one of the indicators to determine the presence of a type of fish is SST (Nugraha et al., 2020).

The remote sensing technique via satellite is an efficient method to determine the distribution of SST and the distribution of chlorophyll-a. Satellite data is very helpful in determining the optimum temperature and chlorophyll-a favored by fish. The SST and chlorophyll-a can then be implemented to predict fishing ground (Tangke et al., 2015).

Material and Methods

Data analysis method

SST measurements are carried out before the set begins with a digital
thermometer. The chlorophyll-a data was collected by processing the Aqua MODIS satellite image data which had been processed using several software, namely: SeaDas 7.5.3 for cropping, Microsoft Excel for NaN data correction, and ArcGIS 10.3 for map overlay and layout (Kurnianingsih et al., 2017). Remote sensing technology is one method that has been effective in conducting surveys over large areas and in narrow straits (Hartoko et al., 2019; Maro et al., 2021). The composition of fish caught can be calculated by the following equation (A. F. P. Nelwan et al., 2015):

\[ p_i = \frac{n_i}{N} \times 100\% \]

Information :
\( p_i \) = abundance of catch (%)
\( n_i \) = number of species caught (kg)
\( N \) = total catch (kg)

In determining CPUE, the formula used is as follows ((A. Nelwan et al., 2015):

\[ \text{CPUE} = \frac{\text{Catch}}{\text{Effort}} \]

Information :
CPUE = Catch per fishing effort in month t (kg/trip)
Catch = Catch in month t (kg)
Effort = catching effort in month t (trip)

**Distribution of Sea Surface Temperature (SST) and Chlorophyll-a Concentration**

SST data and chlorophyll-a concentrations were obtained through remote sensing using the Aqua Modis satellite data which is a non-photo image with a thermal infrared electromagnetic spectrum (Fauziah et al., 2020). From the Aqua Modis satellite image data downloaded from the website (Www.Oceancolor.Nasa.Gfsc.Gov, 2021) for monthly and weekly composite data from December 2019 to March 2020 in Hierarchical Data Format (HDF).

Image data cropping is done through SeaDas 7.4 software. NaN data is the result of reflection from clouds or objects that are not detected numerically by satellite imagery, so corrections are needed. The result of the NaN data filter from Microsoft Excel is data with the type of .xls file which is ready for further processing in ArcGIS 10.3. (Muhsin, 2015). The Inverse Distance Weighted (IDW) interpolation method was used to simplify the data analysis process. This method assumes that the interpolation value is similar to the nearest sample data in the vicinity (Maulina et al., 2019).

**Correlation between catch with sea surface temperature and chlorophyll-a**

To determine the relationship between SST and chlorophyll-a at the same position and time, it is analyzed by presenting a coefficient of determination table and then looking at the Adjusted R² value. The data that has known the correlation coefficient then tested again using multiple linear regression (Rukajat, 2018; Sugiyono, 2013). The use of SPSS software is to simplify the calculation of multiple linear regression analysis. The multiple linear regression formula s as follow:

\[ Y = a + b_1X + b_2X_2 \]

Information :
\( X_1 \) = variable sea surface temperature (SST)
\( X_2 \) = variable Chlorophyll-a
\( Y \) = number of catches
\( a, b_1, b_2 \) = constant

SST variable data took directly during the research (in situ) and chlorophyll-a variable which is weekly composite data from November 28, 2019, to May 15, 2020, a spatial resolution of 4 km from the Aqua MODIS satellite image (ex-situ).

**Result and Discussion**

**Total Catch**

The number of fish caught from December 2019 to March 2020 tends to fluctuate. The catch in February 2020 decreased more than December 2019, January 2020, and March 2020, which was 5,280 kg with a CPUE of 1,760 kg/trip. In January 2020 it was 31,881 kg with a CPUE of 2,452.3 kg/trip. Meanwhile, in December 2019 the catch was less than January 2020, which was 20,680 kg with a CPUE of 6893.33 kg/trip and
the catch in March 2020 was 14,520 kg with a CPUE of 4,840 kg/trip (Figure 1).

**Figure 1.** Total Catches and CPUE for December 2019 to March 2020.

**Catch Composition**

The composition of catches in January 2020 and February 2020 tended to be different from the composition of catches in December 2019 and March 2020. When January 2020 and February 2020 were dominated by *Decapterus*, while December 2019 and March 2020 were dominated by *E. affinis*, *K. pelamis*, and *T. albacares* (Table 1).

This fluctuating CPUE can be influenced by various factors, including differences in fishing effort, adequate fishing vessels, and the skills of the fishermen themselves, different weather conditions every month, as well as the presence or absence of food sources and the presence of fish in the area. Capture and oceanographic factors that affect fish life (Akoit & Nalle, 2018; Jupitar et al., 2020) where from December 2019 to March 2020 the catch was dominated by *E. affinis* and *D. koheru*. Different geographical conditions and locations can also cause different catches at the same time of capture (Nasution, 2017).

**Table 1.** Composition of Catches for the period December 2019 – March 2020

<table>
<thead>
<tr>
<th></th>
<th>Dec 2019</th>
<th>Jan 2020</th>
<th>Feb 2020</th>
<th>Marc 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. affinis</em></td>
<td>9,360</td>
<td>0</td>
<td>0</td>
<td>2,560</td>
</tr>
<tr>
<td><em>K. pelamis</em></td>
<td>1,080</td>
<td>0</td>
<td>0</td>
<td>8,000</td>
</tr>
<tr>
<td><em>T. albacares</em></td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>160</td>
</tr>
<tr>
<td><em>A. rochei</em></td>
<td>1,560</td>
<td>0</td>
<td>4,800</td>
<td>3,960</td>
</tr>
<tr>
<td><em>D. koheru</em></td>
<td>8,640</td>
<td>26,360</td>
<td>680</td>
<td>0</td>
</tr>
<tr>
<td><em>Loligo sp</em></td>
<td>80</td>
<td>0</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td><em>C. ignobilis</em></td>
<td>320</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>D. macarellus</em></td>
<td>0</td>
<td>4,600</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>D. tabi</em></td>
<td>0</td>
<td>920</td>
<td>120</td>
<td>0</td>
</tr>
</tbody>
</table>

**Distribution of Sea Surface Temperature**

The distribution of SST in West Sumatera waters, especially on fishing grounds around the position of 01°10'45”S - 100°07'7”E, 01°09'51” S - 099°29'47”E, 02°01 '34” S - 099°21'13” E, and 01°06'10” S - 100°15'35 ”E are presented in the form of satellite imagery containing information on the distribution of sea surface temperature with color (*pallet*) and contours different SST in each temperature range in different places. The processed SST images show that the SST from December 2019 to March 2020 shows SST that varies from the lowest temperature of 27°C to the highest temperature of 30.9°C. Figure 2 below is the result of the SST image for the period December 2019 – March 2020 for the West Sumatera region.

From December 2019 to March 2020 the temperature distribution tends to fluctuate every month. SST fluctuations in waters are influenced by patterns of movement of the sun, wind, and air pressure (D. Simbolon & Girsang, 2009). The SST in coastal areas is higher, due to a decrease in the absorption of sunlight intensity (Hutagalung, 1988). Solar radiation that enters aquatic ecosystems is absorbed by autotrophic organisms such as phytoplankton and some others will experience assimilation and are recorded by the thermal band and accumulate into surface temperature (Ibrahim et al., 2016).
On 1 to 10 December 2019 the lowest SST in the waters of West Sumatera with SST ranging from 27.9 to 28.4°C, then in the following days the SST in West Sumatera tends to increase until February 18 to March 12, 2020, where SST range from 29.5 to 29.8°C. The distribution of the SST can be illustrated in Figure 3.

**Distribution of Chlorophyll-a Concentration**

In the waters of West Sumatera, especially in the fishing ground at a position of 01°10'45"S - 100°07'7"E, 01°09'51"S - 099°29'47"E, 02°01'34"S - 099°21'13"E, and 01°06'10"S - 100°15'35"E. The processed chlorophyll-a concentration distribution image shows that the content of chlorophyll-a concentration from December 2019 to March 2020, the chlorophyll-a concentration varied from the lowest concentration of 0.13 mg m\(^3\) to the highest concentration of 4 mg m\(^3\) (figure 4).
Figure 3. Distribution of SST in West Sumatera Waters in December 2019 to March 2020.

Figure 4. Satellite Image of Chlorophyll-a distribution in West Sumatera Waters.

Figure 4a shows that the concentration of chlorophyll-a in West Sumatera Waters ranged from 0.4 to 4 mg m³. The distribution of the dominant chlorophyll-a concentration ranged from 0.8 to 1.4 mg m³ which was spread almost evenly throughout the waters area. The lowest concentration of chlorophyll-a ranged from 0.4 to 0.6 mg m³ which was found in the west of Sipora Island. Meanwhile, the highest concentration of chlorophyll-a, 3.4 to 4 mg m³, was found in the east of Sipora Island.
Figure 4b shows that the concentration of chlorophyll-a in the waters of West Sumatera ranged from 0.13 to 2 mg m³. The distribution of the dominant chlorophyll-a concentration in the waters ranges from 0.25 to 0.38 mg m³ which is almost evenly distributed throughout the waters and is also the lowest chlorophyll-a concentration value. Meanwhile, the highest concentration of chlorophyll-a ranged from 1.2 to 2 mg m³ which was found along the coast of the south coast regency and in the east between Siberut Island and Sipora Island.

Figure 4c shows that the concentration of chlorophyll-a in the waters of West Sumatera ranges from 0.15 to 1.4 mg m³. The distribution of the dominant chlorophyll-a concentration in the waters ranged from 0.15 - 0.2 mg m³ which was spread almost evenly throughout the waters and was also the lowest chlorophyll-a concentration value. Meanwhile, the highest chlorophyll-a concentrations ranged from 1.1 to 1.4 mg m³ along the coast of the South coast regency.

Figure 4d shows that the concentration of chlorophyll-a in the waters of West Sumatera ranges from 0.15 to 1.1 mg m³. The distribution of the dominant chlorophyll-a concentration in the waters ranged between 0.15 to 0.2 mg m³ which was evenly distributed throughout the waters and was also the lowest chlorophyll concentration value. Meanwhile, the highest value of chlorophyll-a concentration ranged from 0.75 to 1.1 mg m³ which was found along the coast of Pesisir Selatan Regency.

The distribution of chlorophyll-a concentration is shown in the visualization using a green to blue color degradation where the bluer indicates the higher chlorophyll-a concentration. Based on Figure 4, it can be seen that spatially, the chlorophyll-a concentration on the coast is higher than offshore. The concentration of chlorophyll-a in offshore waters is lower than in coastal waters (Ulqodry & Aryawaty, 2013). The high concentration of chlorophyll-a in coastal areas is thought to occur due to the accumulation of nutrients carried by rivers to sea waters in coastal areas (Putra et al., 2012).

On December 1 to 10, 2019 was the highest concentration of chlorophyll-a in the waters of West Sumatera with chlorophyll-a concentrations ranging from 1.1 to 1.4 mg m³, then on the following days the concentration of chlorophyll-a in West Sumatera tended to decrease to February 25 to March 12, 2020, where the concentration of chlorophyll-a ranged from 0.1 to 0.3 mg m³ (Figure 5).

Figure 5. Distribution of Chlorophyll-a Concentration in December 2019 to March 2020

Effect of Sea Surface Temperature and Chlorophyll-a on Catch Results.

Figure 6 shows that the highest production was on January 17 to 24, 2020 where the average catch was 1,783 kg with an SST of 29.5°C and a concentration of chlorophyll-a 0.22 mg m³, followed by March 5 to 12, 2020 average catch is 1,721 kg with SST 29.8°C and chlorophyll-a concentration 0.16 mg m³.

While the lowest production of Scad was from February 2 to 9, 2020 where the average catch was 80 kg with an SST of 29.2°C and chlorophyll-a concentration of 0.24 mg m³, followed by 26 February to 4 March 2020 the average catch was 120 kg with an SST of 29.7°C and chlorophyll-a concentration of 0.14 mg m³.

Figures 6 and 7 show that there is an inverse relationship between SST and chlorophyll-a concentration on the average
weekly catch from December 2019 to March 2020. In Figures 6 and 7, it is also clear that SST and concentration chlorophyll-a partially still has a significant relationship to the average catch when observed simultaneously there is an inverse relationship between the SST and chlorophyll-a to the average catch, which means that there is no significant relationship between SST and chlorophyll-a to the average catch.

Determining the effect of SST and chlorophyll-a on catches more clearly, multiple linear regression statistical analysis was used. The variables analyzed covered sea surface temperature (SST) (X₁) and Chlorophyll-a (CHL-A) (X₂) which as independent variables while the average catch per week (Y) is used as the dependent variable. Several classical assumption tests have been done, including the multicollinearity test, heteroscedasticity test, and normality test.

**Multicollinearity Test**

Testing for the presence or absence of multicollinearity symptoms is carried out by taking into account the value of the correlation matrix generated during data processing and the value of VIF (Variance Inflation Factor) and Tolerance. Then if the VIF value is < 10 and the tolerance value is > 0.10, it is
concluded that the regression model does not have multicollinearity (Ghozali, 2013).

**Table 3. Multicollinearity Test**

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Partial</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>.607</td>
</tr>
<tr>
<td>SST (X₁)</td>
<td>.619</td>
</tr>
<tr>
<td>CHL (X₂)</td>
<td>.619</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Average Catch (Y)

Based on table 3 above, it can be seen that the regression model does not experience multicollinearity disorders. This can be seen in the tolerance value of each variable 0.207 < 0.10 and the results of the VIF calculation also show that the VIF value of each variable is 4.824 < 10. So it can be concluded that there is no multicollinearity between the independent variables in the regression model.

**Heteroscedasticity Test**

To conclude whether or not heteroscedasticity occurs in the following way:

1. What if the value of Sig. (P Value) > (α = 0.05) then there is no heteroscedasticity;
2. What if the value of Sig. (P Value) < (α = 0.05) then heteroscedasticity occurs.

**Table 4. Heteroscedasticity Test**

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>-5172.335</td>
<td>7684.344</td>
<td>.673</td>
</tr>
<tr>
<td>SST (X₁)</td>
<td>195.023</td>
<td>257.470</td>
<td>.422</td>
</tr>
<tr>
<td>CHL (X₂)</td>
<td>-128.419</td>
<td>379.066</td>
<td>-.189</td>
</tr>
</tbody>
</table>

a. Dependent Variable: abs_RES

Based on this statement, we can see in table 4 the value of Sig. SST (X₁) 0.466 > 0.05 and the value of Sig. CHL (X₂) 0.742 > 0.05. It can be concluded that there is no heteroscedasticity in the two independent variables. So that this regression model can be continued on the next classic assumption test.

The normality test is one part of the data analysis requirements test or the classical assumption test. The purpose of the normality test is to test whether in a regression model, the dependent variable and the independent variable or both have a normal distribution or not. A good regression model is a normal or close to normal data distribution. To determine a variable has a normal distribution or cannot be seen in the following way:

1. What if the value of Sig. (P Value) > (α = 0.05) then the data is normally distributed;
2. What if the value of Sig. (P Value) < (α = 0.05) then the data is not normally distributed.

**Table 5. Normality test**

<table>
<thead>
<tr>
<th>Tests of Normality</th>
<th>Kolmogorov-Smirnov*</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Statistic</td>
<td>df</td>
</tr>
<tr>
<td>SST (X₁)</td>
<td>.211</td>
<td>13</td>
</tr>
<tr>
<td>CHL (X₂)</td>
<td>.236</td>
<td>13</td>
</tr>
<tr>
<td>Average Catch (Y)</td>
<td>.190</td>
<td>13</td>
</tr>
</tbody>
</table>

In table 5 there are Tests of Normality Kolmogorov-Smirnov and Tests of Normality Shapiro-Wilk. To see the normality of all variables, you can see one of the Sig values (P Value) Tests of Normality on the data. In the Tests of Normality Shapiro-Wilk, there is a Sig value. SST (X₁) 0.066 > 0.05, the value of Sig. CHL (X₂) 0.052 > 0.05, and the value of Sig. Average catch (Y) 0.064 > 0.05. It can be concluded that all variables data are normally distributed and can continue to make regression models.
Multiple Linear Regression coefficient tests (F Test)

The purpose of the F test is to see whether or not there is an effect that is given simultaneously by the independent variables of sea surface temperature (X₁) and chlorophyll-a (X₂) on the dependent variable on the average catch (Y). To be able to determine whether or not there is an effect of the independent variable sea surface temperature (X₁) and chlorophyll-a (X₂) on the dependent variable on the average catch (Y). The hypothesis is made as follows:

1. H₀ = There is no influence between the independent variable and the dependent variable on the catch;
2. H₁ = There is an influence between the independent variable and the dependent variable on the catch;
3. Determine the 95% confidence level (α = 0.05);
4. What if the value of Sig. (P Value) < 0.05 then H₀ is rejected and H₁ is accepted;
5. What if the value of Sig. (P Value) > 0.05 then H₀ is accepted and H₁ is rejected;

Table 6. F test (ANOVA)

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regression</td>
<td>2575944.896</td>
<td>2</td>
<td>1287972.448</td>
<td>3.674</td>
<td>.064</td>
</tr>
<tr>
<td>Residual</td>
<td>3505517.487</td>
<td>10</td>
<td>350551.749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6081462.383</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Average Catch (Y)
b. Predictors: (Constant), CHL (X₂), SST (X₁)

From the results of the F test in this study, the calculated F value was 3.674 with the Sig number. (P-value) of 0.064. With a significance level of 95% (α = 0.05). Value of Sig. (P-value) of 0.064 > 0.05. Based on this comparison, H₀ is accepted and H₁ is rejected or it means that the sea surface temperature variable and chlorophyll-a do not have a significant effect simultaneously on the average catch variable.

This condition can occur because of the possibility that the SST value and chlorophyll-a concentration in the study area can still be tolerated by the fish species present there and other oceanographic factors have a greater influence on catches in West Sumatera Waters.

Multiple Linear Regression coefficient tests (Coefficient of Determination)

The coefficient of determination (R²) was carried out to see whether there was a perfect relationship or not, which was shown in the change in the independent variable SST (X₁) and chlorophyll-a (X₂) followed by the dependent variable on the average catch (Y) in the same proportion. This test is done by looking at the value of R Square (R²). The value of the coefficient of determination is between 0 to 1. Furthermore, a small R² value means that the ability of the independent variables to explain the variation of the dependent variable is very limited. A value close to 1 means that the independent variables provide almost all the information needed to predict the dependent variable (Yuliara, 2016).

In this case, the value used in the study is the Adjusted R² value because this value can increase or decrease if one independent variable is added to the model being tested. The adjusted R² value can be seen in Table 7 below:

Table 7. Regression Test (Coefficient of Determination)

<table>
<thead>
<tr>
<th>Model</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. The error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.651a</td>
<td>.424</td>
<td>.308</td>
</tr>
</tbody>
</table>
a. Predictors: (Constant), CHL (X2), SST (X1)

In Table 7 it can be seen that the Adjusted R² value is 0.308. This means that the independent variables (SST and chlorophyll-a) can explain the dependent variable (the average catch) of 30.8%, while the remaining 69.2% is explained by other factors not examined. Several other factors that are thought to influence the catch include water depth, currents, and water salinity, as well as upwelling conditions. Increased fish production in water can be caused by upwelling because the movement of water brings cooler temperatures and higher salinity and brings rich nutrients such as phosphate and nitrate to the surface (Nontji, 2005; D. Simbolon & Girsang, 2009).

**Multiple Linear Regression coefficient tests (T-Test)**

After performing the F test and the determination test, the next step in the multiple linear regression process is to perform a T-test to be able to determine the effect of the independent variables of SST (X₁) and chlorophyll-a (X₂) individually (partial) on the dependent variable on the average catch (Y). Then the hypothesis is made as follows:

1. \( H_0 = \) There is no effect between the independent variable and the dependent variable on the catch;
2. \( H_1 = \) There is an influence between the independent variable and the dependent variable on the catch;
3. Determine the degree of confidence 95% (\( \alpha = 0.05 \));
4. What if the value of Sig. (P Value) < 0.05 then \( H_0 \) is rejected and \( H_1 \) is accepted;
5. What if the value of Sig. (P Value) > 0.05 then \( H_0 \) is accepted and \( H_1 \) is rejected;
6. Determine the regression model \( Y = a + b_1 X_1 + b_2 X_2 \) by looking at the Unstandardized Coefficients B column in the T-test table.

**Description:**
\( X_1 = \) Variable SST (°C)  
\( X_2 = \) Variable Chlorophyll-a (mg/m³)  
\( Y = \) Total catch (kg)  
\( a, b_1, b_2 = \) Constant

**Table 8. T test**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>-50671.849</td>
<td>19619.334</td>
<td>-2.583</td>
<td>.027</td>
</tr>
<tr>
<td>SST (X₁)</td>
<td>1679.208</td>
<td>642.346</td>
<td>1.487</td>
<td>2.614</td>
</tr>
<tr>
<td>CHL (X₂)</td>
<td>3903.756</td>
<td>1460.680</td>
<td>1.520</td>
<td>2.673</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Average catch (Y)

In Table 8 the SST variable (X₁) with a significance level of 95% (\( \alpha = 0.05 \)). Shows Sig. (P Value) on the direct evidence variable is 0.026 <0.05. Based on this comparison, \( H_0 \) is rejected and \( H_1 \) is accepted or it means that the SST variable (X₁) has a significant influence on the average catch variable (Y).

Variable CHL (X₂) with a significance level of 95% (\( \alpha = 0.05 \)). Shows Sig. (P Value) on the direct evidence variable is 0.023 <0.05. Based on this comparison, \( H_0 \) is rejected and \( H_1 \) is accepted which means that the CHL variable (X₂) has a significant effect on the average catch variable (Y).

In Table 8 it can also be seen that the multiple linear regression model from this study by assessing the value of Unstandardized Coefficients B (constant) -50671.849, SST (X₁) 1679.208, and CHL (X₂) 3903.756 with this regression model obtained is \( Y = -50671.849 + 1679.208 X_1 + 3903.756 X_2 \).
Figure 8. Map of Potential Fishing Ground in West Sumatera.
(a) December 2019, (b) January 2020, (c) February 2020, (d) December 2020.
(www.oceancolor.nasa.gsfc.gov).

Table 9. Map of potential fishing areas

<table>
<thead>
<tr>
<th></th>
<th>December 2019</th>
<th>January 2020</th>
<th>February 2020</th>
<th>March 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>High potential of fishing ground</td>
<td>west of the coast of Padang City, South of Padang City</td>
<td>west of the coast of Padang City, east of the coast Sipora island, south of Siberut Island</td>
<td>west of the coast of Padang City, South of the coast Regency of Padang City</td>
<td>east of Sipora Island</td>
</tr>
<tr>
<td>SST (°C)</td>
<td>28.2 to 28.6 to 1.5</td>
<td>29.4 to 29.9 to 0.75 to 1.5</td>
<td>30 to 30.2 to 0.2 to 0.3</td>
<td>30 to 30.3 to 0.15 to 0.2</td>
</tr>
<tr>
<td>chlorophyll-a concentration (mg m³)</td>
<td>1 to 1.5</td>
<td>0.75 to 1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low potential fishing ground</td>
<td>west of the border between Padang City, and Padang Pariaman Regency East Siberut island</td>
<td>west coast of Padang Pariaman Regency</td>
<td>The west coast of Padang City border</td>
<td>the west coast of Padang City border</td>
</tr>
<tr>
<td>SST (°C)</td>
<td>27.6 to 28.4 to 0.5</td>
<td>29.8 to 30</td>
<td>29.8 to 30</td>
<td>30.6 to 30.9</td>
</tr>
<tr>
<td>chlorophyll-a concentration (mg m³)</td>
<td>0.5 to 1</td>
<td>1.38 to 2</td>
<td>1.38 to 2</td>
<td>0.2 to 0.3</td>
</tr>
<tr>
<td></td>
<td>E. affinis</td>
<td>Decapterus</td>
<td>Auxis rochei</td>
<td>K. pelamis</td>
</tr>
</tbody>
</table>
**Potential Fishing Ground**

In Figure 6, it is clear that the fishing spots are concentrated on the border waters of Padang Pariaman Regency to the waters of the border area of South coast Regency and Padang City in the Mentawai Strait. The indicators used in determining the fishing ground by (Surbakti, 2012) are the concentration of chlorophyll-a and catch per unit effort (CPUE), while the indicators used by (Mustasim et al., 2019; Z. M. Simbolon et al., 2005) include catch, fish length, salinity, and sea surface temperature. In this study, the factors that indicate the potential for fishing areas are the large number of catches and CPUE which are influenced by sea surface temperature and chlorophyll-a concentrations in the waters of West Sumatera.

Optimum conditions in waters will increase the preference of a type of fish or fish schooling which in turn will encourage an increase in the intensity of the fishing fleet in the area/area because it is considered a potential fishing area (Figure 8).

In Table 9, it can be seen that the catch in West Sumatera Waters is dominated by Decapterus, K. pelamis, E. affinis and Auxis rochei. Based on the map overlay of potential fishing areas, the optimum temperature for the distribution of Decapterus, K. pelamis, E. affinis, and Auxis rochei ranged from 28.2 to 29.9°C. This is in accordance with the opinion (Fuadi et al., 2018) which states that the optimum temperature for scad fish to be caught is around 20 to 30°C and is not much different from the opinion (Gunarso, 1985; Pamungkas et al., 2020) which states that the optimum SST for K. pelamis catching in Indonesian waters is 28 to 29°C.

**Conclusion.**

Spatially the distribution of SST in West Sumatera Waters in December 2019 to March 2020 ranged from 27 to 30°C with a dominant range of 29°C and the concentration of chlorophyll-a ranged from 0.13 to 4 mg m³ with a dominant range of 0.25 mg m³ and the catch ranges between 1,000 kg to 2,500 kg/setting. The relationship between SST and chlorophyll-a concentration based on statistical analysis does not significantly affect the average catch per week, this can be seen from the value of Sig. (P-value) on the F test is 0.064 > 0.05. There is also the coefficient of determination of SST and the concentration of chlorophyll-a on the average catch per week in terms of the Adjusted R² value of 0.308. This shows that SST and chlorophyll-a concentration have a simultaneous effect of 30.8% on the average catch per week.

In December 2019 the SST ranged from 28.2 to 28.6°C and the concentration of chlorophyll-a ranged from 1 to 1.5 mg m³ with the dominant catch of E. affinis. In January 2020 the SST ranged from 29.4 to 29.9°C and the concentration of chlorophyll-a ranged from 0.75 to 1.5 mg m³ with the dominant catch of Decapterus. In February 2020 the SST ranged from 30 to 30.2°C and the concentration of chlorophyll-a ranged from 0.2 to 0.3 mg m³ with the dominant catch of Auxis rochei. In March 2020 the SST ranged from 30 to 30.3°C and the concentration of chlorophyll-a ranged from 0.15 to 0.2 mg m³ with the dominant catch of K. pelamis.

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