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STUDY OF SNPP-VIIRS SATELLITE IMAGE FOR ESTIMATION SURFACE GILL NETS FISHING GROUND IN SEMARANG WATERS, CENTRAL JAVA, INDONESIA

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Abstract: Gillnet fishermen in Semarang often have difficulty determining the fishing grounds. The aims of the study were to analysed the spatial and temporal distribution of sea surface temperature (SST) and chlorophyll-a, to analysed the relationship between variables and to study the estimation of fishing grounds. The data collection method used purposive sampling. Map processing using the Inverse Distance Weighted (IDW) method. The data processing method uses normality test, classical assumption test and linear regression test. Analysis of image data spatially (4 miles from the shoreline) and temporally (west, east and transition monsoons). SST and chlorophyll-a tend to be high near the shore. The lowest SST (28.82OC) and the highest chlorophyll-a (5.11 mg/L) occurred in the east monsoon. The highest SST (31.74OC) and the lowest chlorophyll-a occurred in the west monsoon (1.31 mg/L). SST and chlorophyll-a have an erratic distribution pattern during the transitional monsoon. The value of SST and chlorophyll-a correlation partially to catch was 14.3% (weak) and 74% (very strong). The correlation value of SST to chlorophyll-a is 30.2% (medium). The correlation value of SST and chlorophyll-a simultaneously with catch is 75.3% (very strong). Determination of fishing areas based on high chlorophyll-a1 values and low SST. The coordinates for determining the fishing ground include 6° 53' 24,858" South Latitude 110° 26' 0.071" east west monsoon, 6° 55' 43,941" LS 110° 24' 47,903" east longitude transitional monsoon I, 6° 55' 29,439" latitude 110° 25' 54,790" east longitude, and 6° 55' 11,394" latitude 110° 26' 15,904" east longitude of transitional monsoon II.
Keywords: Fishing ground, SST, Chlorophyll-a, Semarang, Indonesia

I. INTRODUCTION

Gillnet fishermen in Semarang often have difficulty determining the right fishing grounds. Most still use conventional methods such as habits passed down from generation to generation, instinct and seeing foam in sea water. This method makes fishing ineffective and causes operational costs, especially fuel to be large. The latest way to choose fishing grounds is to use remote sensing technology [7]. The distribution of sea surface temperature and chlorophyll-a are parameters that can be used as indicators of fishing areas. This technology can determine the distribution of chlorophyll-a on the sea surface. [5][27][29]

To identify chlorophyll-a can be seen from the presence of phytoplankton. Phytoplankton has the pigment chlorophyll-a. Phytoplankton occupies the first position in the food chain or primary producers. Sea surface temperature is used as an indicator in estimating fishing areas. SST that is suitable for fish will affect fish metabolism. Through the chlorophyll-a indicator and sea surface temperature, an estimation of the fishing area will be carried out.

II. METHODS

This research was carried out in Semarang waters, Central Java by using surface gill net fishing gear. The study started from March 04 to April 23, 2021. This study used a descriptive method to describe the results obtained. The data used in this study consisted of primary data and secondary data. Primary data includes in-situ data of catch, sea surface temperature, and chlorophyll-a concentration. The secondary data used include data on sea surface temperature and chlorophyll-a concentrations from satellite imagery SNPP VIIRS level 3.

A. Collecting Data Method

This study uses primary data including SST data measured during hauling and chlorophyll-a sample data where during hauling 1500 ml of water samples are taken and chlorophyll-a concentrations are tested in the laboratory. This study also uses catch data and hauling coordinates. to represent all research areas, sampling using purposive sampling method. Data collection was carried out at 7 different stations. [3][22]

The secondary data used include sea surface temperature data and chlorophyll-a satellite imagery of SNPP-VIIRS. The SNPP VIIRS satellite image data used is level 3 (L3) monthly data for the last 5 years (2016-2020). SNPP-VIIRS satellite image data can be downloaded via NASA's Oceancolor website. This study uses SNPP-VIIRS satellite image data because it has an accuracy value of 95% for chlorophyll-a data and 90% for sea surface temperature data. [26][28]

B. Data Processing Method

Data on surface gillnet catches were obtained from fishing with fishermen. Data processing and analysis was carried out descriptively, namely to provide an overview of the catch in this study. This data is also superimposed with the in-situ chlorophyll-a or SST data through graphs to see the correlation between variables. [16]
Map processing in this study using the Inverse Distance Weighting (IDW) interpolation method using SeaDAS software, Ms. Excel and ArcGIS 10.3. The use of the IDW method is intended to provide interpolation of values in empty coordinates (NaN data) which are not much different from the values around the empty point. [23]

C. Data Analysis Method

Chlorophyll-a Concentration Analysis

Analysis of chlorophyll-a concentration based on Boyd's (1984) procedure. The concentration of chlorophyll-a that has been tested in the laboratory is then calculated by the formula:

$$\text{Ca } (\mu g/ml) = (11{,}85 \times A_{664}) - (1{,}54 \times A_{647}) - (0{,}08 \times A_{630}) \quad \text{.........................(1)}$$

$$\text{Chlorophyll-a (mg/L)} = \frac{Ca \times Vc}{Vs \times d} \quad \text{.........................(2)}$$

Description:
A = Absorption of wavelength
Ca = Concentration of chlorophyll-a (μg/ml)
Vc = Volume of extracted acetone (ml)
Vs = Volume of sample water (L)
d = width of cuvette (cm) [10]

Verification of Image Data with In Situ Data

Verification between in-situ data and satellite image data is carried out to determine the error value of the processed satellite image data. Test the data error rate using relative error correction.
The relative error correction can be calculated using the formula:

$$RE = \frac{(X_{in\text{-}situ} - X_{citra}) \times 100\%}{X_{insitu}} \quad \text{.........................(3)}$$

$$MRE = M = \sum_{0}^{n} \frac{RE}{n} \quad \text{.........................(4)}$$

Description:
Xin-situ : data from measurements in the field
Xcitra : data from satellite image
n : number of data
RE : relative error
MRE : Mean Relative Error [10]

Parameter Correlation Analysis with Catch Results

Data analysis using SPSS software with linear regression analysis method. Kolmogorov-Smirnov normality test and classical assumption test (multicollinearity and autocorrelation) were performed to prevent bias. Multiple linear regression analysis was used to examine the relationship between several variables. The dependent variable is the catch on surface gill net fishing gear, while the independent variables are SST and chlorophyll-a so that the equation is

$$Y=a+b_1X_1+b_2X_2+\varepsilon \qquad (5)$$

Description:
Y = Catch on surface gill net fishing gear (Kg)
A = Constant
b1 = chlorophyll-a parameter regression coefficient
b2 = SST parameter regression coefficient
X1 = Chlorophyll-a (mg/m3)
X2 = Temperature (^{O}C) [18]

D. Fishing Area Estimation Method

The data used in the estimation of fishing areas are SST data and chlorophyll-a satellite imagery of SNPP-VIIRS. The data can be downloaded via the ocean color website. Image data cropping is done using SeaDas 7.5.3 software with the resulting .txt file format which is still vulnerable to NaN (Not a Number) data. Correction of the NaN data was carried out on Ms. Excel. The file is then saved as an .xls file type which is ready to be processed in ArcGIS 10.3. This study uses the Inverse Distance Weighted (IDW) interpolation method on SST and chlorophyll-a data. Then the chlorophyll-a data was changed in the form of contours. the last is the process of overlaying chlorophyll-a contours, SST, and administrative boundaries (land).[23]

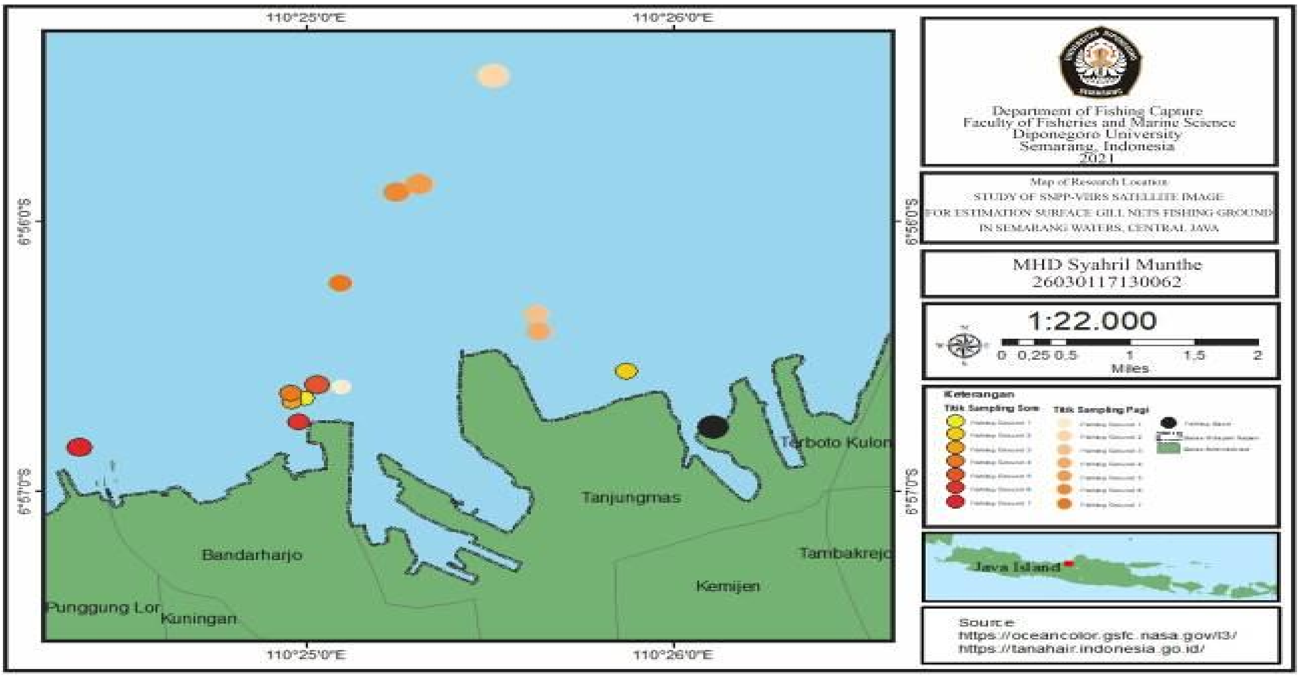


Fig. 1 Map of Research Location

III. RESULTS AND DISCUSSION

A. Spatial Distribution of Sea Surface Temperature

The west monsoon has a more dominant warm SST value. SST in Semarang waters ranges from 29-31OC in the west monsoon. This is caused by the monsoon wind blowing from the Asian continent towards the Australian continent and carrying air and water vapor. The high rainfall in the west monsoon also causes the SST to be colder. West monsoon occurs from December to January. The west monsoon is characterized by high intensity of rainfall. The mass of water moves from the Natuna Sea to the Java Sea. The dominant water mass movement has a warm dominant temperature. The movement of water masses is caused by monsoon winds that blow from the Asian continent to the Australian continent. [1][14]

Transition monsoon I is the transition season from the west to the east monsoon which occurs from March to May. SST Semarang in this season gradually decreased to the range of 30-31 OC. The monsoon winds affect the temperature drop. The movement of surface water masses is influenced by monsoon winds. [30] The transitional monsoon I occurs in March, April and May.

This season has an unclear pattern of sea surface temperature distribution. This condition is caused by monsoon winds, which causes changes in water conditions. The east monsoon is the season with the lowest average SST value compared to the other 3 seasons. [8]

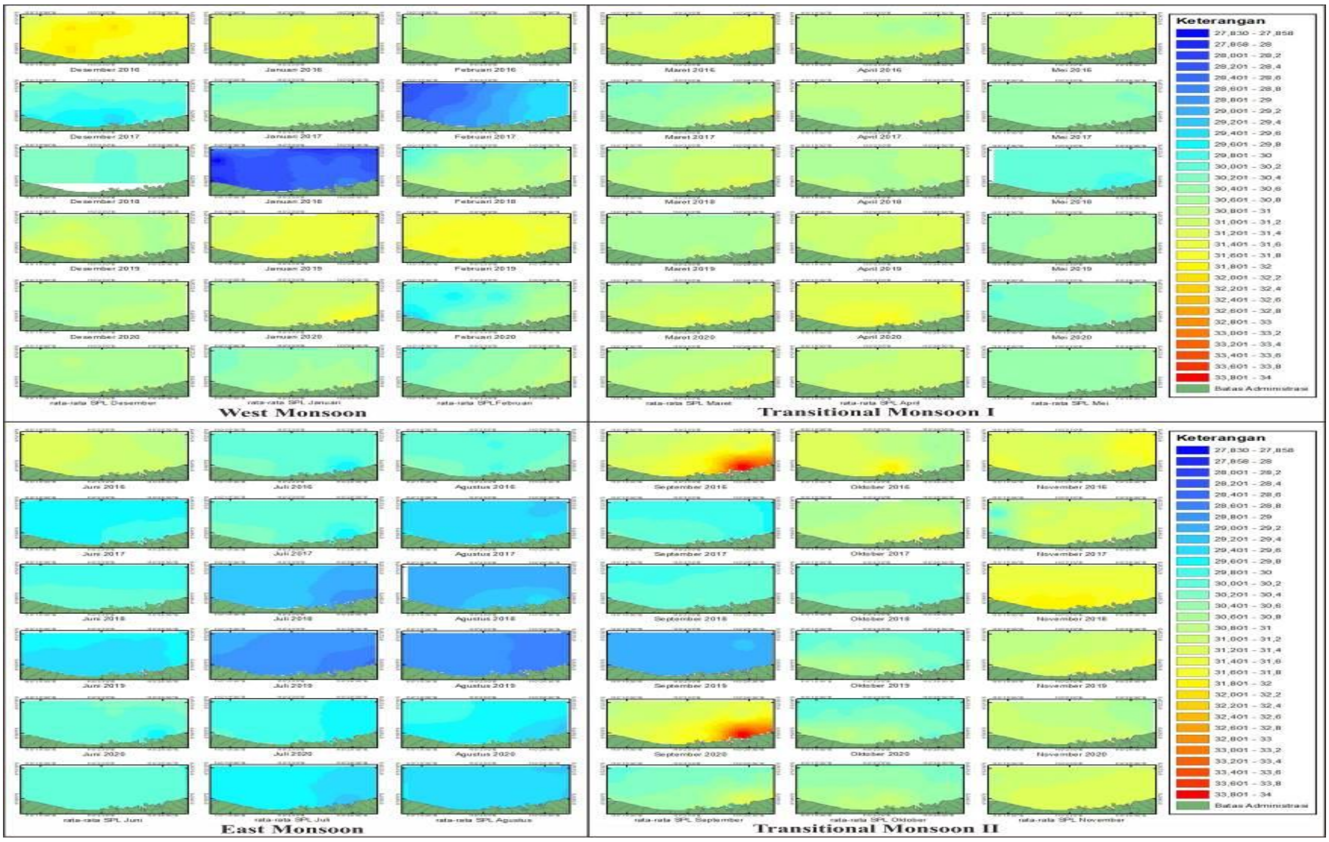


Fig. 2 Sea Surface Temperature Distribution

The east monsoon occurs from June to August. The average SST value of Semarang waters in the east monsoon ranges from 28-30 OC. The cold SST in Semarang is influenced by the mass of water that moves from the Banda Sea to the Flores Sea and then to the Java Sea, including Semarang waters. The movement of this water mass is influenced by the monsoon winds that move from Australia to Asia. The movement of water masses from the Banda Sea, which tends to be cold, causes the Flores Sea and the Java Sea to become colder. the changes in monsoon winds can affect the sea surface temperature of Semarang. The water mass in the Semarang Sea moves from the Banda Sea to the Flores Sea in the east monsoon which occurs from June to August. In the west monsoon the mass of water moves towards the Makassar Strait and the Java Sea and then crosses the Flores Sea to the Banda Sea. [12]

Transitional monsoon II is the transition season from the East monsoon to the West monsoon which occurs from September to November. SST Semarang in this season gradually increases in the range of 30-31 OC. The wind speed in the transitional monsoon II tends to be small which causes the movement of surface water masses to be less dynamic. This also has an impact on SST which tends not to have a clear distribution pattern. the transitional monsoon II was represented by October. In this period the surface currents move on average towards the Northeast with an average speed of 0.14 knots. While the wind is blowing towards the Northwest with an average speed of 7 knots. [8]

B. Spatial Distribution of Chlorophyll-a Concentration

The West monsoon has a Chlorophyll-a value which tends to be smaller than the other 3 seasons. This is because the dominant warm SST causes the growth of chlorophyll-a to be inhibited. Most of the high concentrations of chlorophyll-a are near the coast, especially in the waters of Tambaklorok, Semarang. Chlorophyll-a concentrations began to decrease towards the offshore area with a value of about 0.5 mg/L. [15]a temperature of 18 - 30^{o}C is an ideal temperature estimate for aquatic waters. High SST in the waters can damage the balance of the ecosystem in marine waters. The optimal temperature for the growth of chlorophyll-a is 18 - 30^{o}C. [1]. The average value of chlorophyll-a in Semarang waters in the transitional monsoon I ranged from 1.3 - 2.5 mg/L. The season in Semarang waters for gillnets fishing gear starts in March. The wave conditions began to stabilize, the wind speed tended to be small and the rain intensity was classified as moderate to small, which is a condition that is beneficial for Semarang fishermen to catch fish. Conditions like this allow chlorophyll-a to reproduce optimally. Oceanographic factors are important factors to identify water.

Oceanographic factors generally used are SST, chlorophyll-a, wind speed, salinity, current, wave height and bathymetry (into the water). Factors that affect the high concentration of chlorophyll-a in the waters are SST, nutrients, currents, wave height and wind speed. In general, chlorophyll-a in the waters will be high if it begins to enter the transitional monsoon I to the end of the east monsoon. In that season, SST ranges from 27-31^{O}C where this temperature is suitable for photosynthesis. [17]

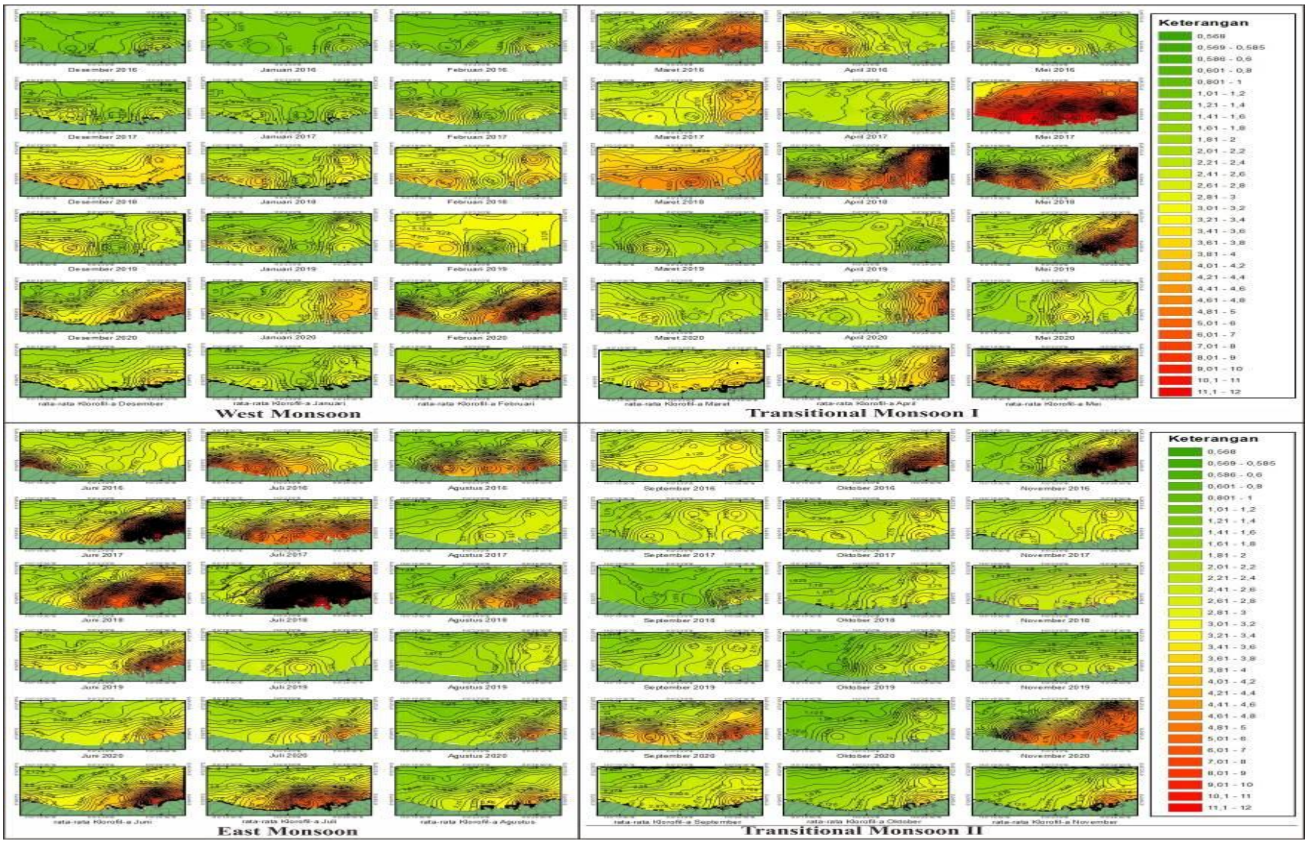


Fig. 3 Chlorophyll-a Concentration Distribution

The average value of chlorophyll-a concentration in Semarang waters in the east monsoon is between 2 - 5.5 mg/L. Water conditions with chlorophyll concentration of 2 - 5.5 mg/L are included in mesotrophic waters. Mesotrophic waters are waters with moderate nutrient concentration. Waters with a chlorophyll value of up to 5 mg/L were included in the classification of mesotrophic waters. [24] The average value of chlorophyll-a in Semarang waters at transition monsoon II is from 1.6 - 3.5 mg/L. chlorophyll-a concentration during the transitional monsoon II tended to decrease. This is due to changes in the direction of the monsoon winds. Transitional monsoon II is marked by increased rainfall intensity, sea surface temperatures begin to rise and a change in the direction of the monsoon wind which initially from the Australian continent to the Asian continent slowly changes its direction from the Asian continent to the Australian continent. the characteristics of the transition season are irregular wind direction, hot air, sudden rain with high frequency and in a short time. This has an impact on the distribution of chlorophyll-a is uneven and tends to be small. [15]

C. Temporal Distribution of Sea Surface Temperature and Chlorophyll-a

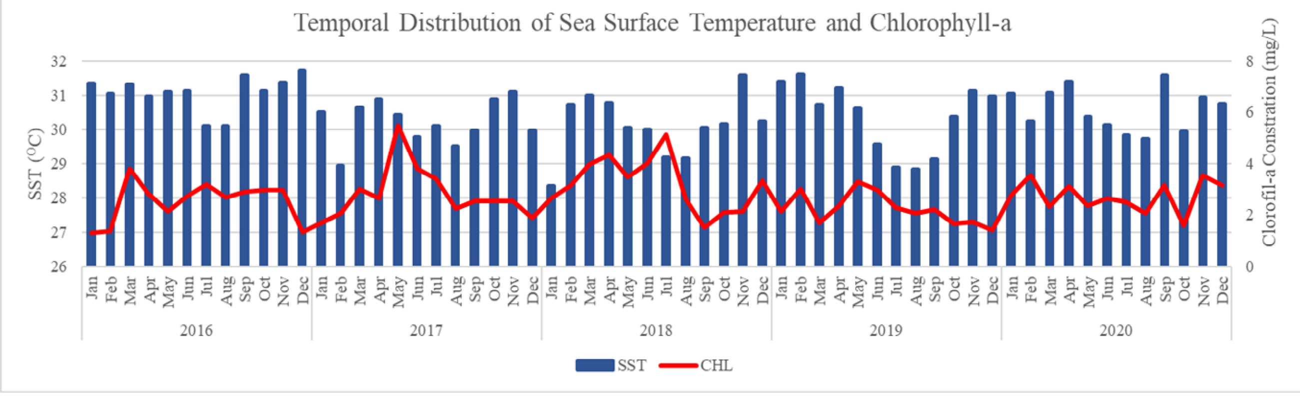


Fig. 4 Temporal Distribution of Sea Surface Temperature and Chlorophyll-a

Sea surface temperatures and chlorophyll-a in 2016-2020 fluctuated. The lowest SST occurred in August 2019 with a value of 28.82^{o}C. The highest SST occurred in December 2016 with a value of 31.74^{o}C. The lowest chlorophyll-a concentration occurred in January 2016 with a value of 1.31 mg/L. The highest chlorophyll-a concentration occurred in July 2018 with a value of 5.11 mg/L. The distribution of sea surface temperature and chlorophyll-a concentration is influenced by the intensity of sunlight, rainfall, water mass movement, monsoon winds and water topography. Currents and winds affect the distribution and abundance of phytoplankton as plants containing the pigment chlorophyll-a. [2]

D. Verification of Image Data with In-situ Data

Table 1. In-situ Data Verification Results with SNPP-VIIRS Satellite Image Data

Sampling	Time	In-situ data	Image data	Error value			
		SST (^{o}C)	CHL (mg/L)	SST (^{o}C)	CHL (mg/L)	SST (%)	CHL (%)
1	Morning	29	1.621	30.119	1.564	3.859	3.544
	Night	30	1.685	30.110	1.564	0.367	7.220
2	Morning	30	1.691	30.162	1.691	0.541	0.005
	Night	30	2.47	30.174	1.691	0.581	31.588
3	Morning	31	1.913	30.178	1.991	2.652	4.070
	Night	30	2.210	30.116	1.564	0.388	29.269
4	Morning	31	2.366	30.178	1.691	2.653	28.523
	Night	29	1.889	30.125	1.564	3.879	17.243
5	Morning	31	2.072	30.187	1.891	2.623	8.718
	Night	28	1.451	30.109	1.564	7.532	7.735
6	Morning	32	2.189	30.150	1.691	5.781	22.754
	Night	28	1.585	30.119	1.564	7.566	1.347
7	Morning	32	1.786	30.143	1.991	5.804	11.481
	Night	29	1.956	30.069	1.564	3.685	20.094
mean relative error (ΣRE)	3.422	13.828					

The accuracy of the SNPP-VIIRS image data for sea surface temperature is 96.578%. The ΣRE value of chlorophyll-a was 13.828%. The level of accuracy of chlorophyll-a SNPP-VIIRS image data is 86.172%. The difference in in-situ values and image data is influenced by the way of data collection and environmental conditions including sea surface temperature, clouds, atmosphere, and wind speed. [25] this difference is generally caused by atmospheric conditions and the intensity of sunlight at the time of in-situ SST data collection and satellite image recording. The difference between the in-situ sea surface temperature value and the sea surface temperature value recorded by satellite imagery is less than 1^{o}C. The difference between in-situ data and image data occurs because the transformation is carried out from image data using a spatial distribution model.[12]

E. Relationship of Oceanographic Parameters with Catch

Relationship of SST Parameters with Catch

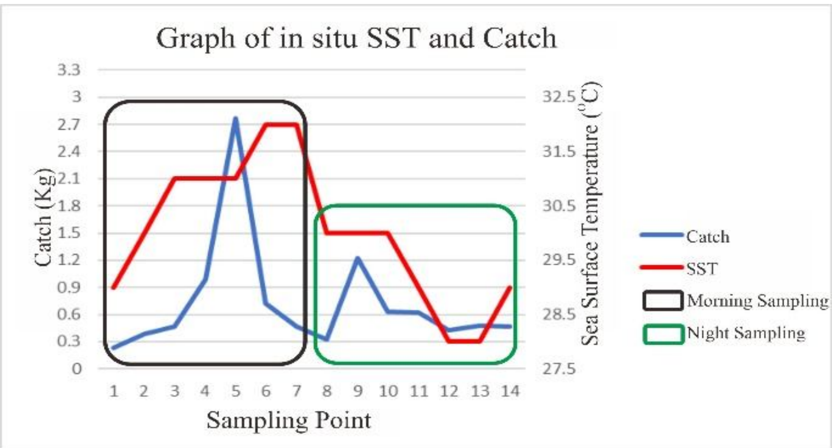


Fig. 5 Graph of insitu SST and Catch

The area of graph analysis is divided into 2, namely morning sampling and evening sampling. In the morning sampling, the SST data is directly proportional to the catch data. Sea surface temperatures increase and catches increase. The highest data in the morning sampling occurred at sampling point 5, namely the SPL value of 31^{o}C and the catch of 2,771 Kg. Data on night sampling tends to be relatively low. This is because night sampling is carried out from afternoon to evening. SST at night tends to be smaller and catches are relatively small. [5][11]

Relationship of Chlorophyll-a Parameters with Catch

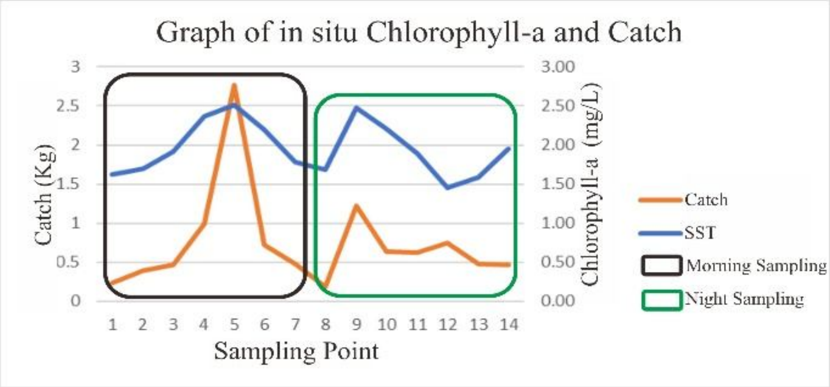


Fig. 6 Graph of insitu Chlorophyll-a and Catch

The area of graph analysis is divided into 2, namely morning sampling and evening sampling. In the morning sampling, the value of chlorophyll-a tends to increase until noon. The catch data and chlorophyll-a are directly proportional where if the chlorophyll-a value is high, the catch is more. At night sampling, the value of chlorophyll-a tends to decrease because the intensity of sunlight is getting less so that chlorophyll-a cannot carry out photosynthesis. In night sampling, the catch data and chlorophyll-a were directly proportional and tended to decrease. [6][21]

Relationship of SST and Chlorophyll-a Parameters with Catch

Table 2. Normality Test Using the Kolmogorov-Smirnov Method

One-Sample Kolmogorov-Smirnov Test		
	Unstandardized Residual	
N	14	
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	.13294152
Most Extreme Differences	Absolute	.147
	Positive	.147
	Negative	-.088
Test Statistic	.147	
Asymp. Sig. (2-tailed)	.200[c,d]	

Table 3. Partial Relationship between SST and Chlorophyll-A on the Catch

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.	Collinearity Statistics			
	B	Std. Error	Beta			Tolerance	VIF	
1	(Constant)	-.811	.984		-.824	.427		
	SPL	-.028	.037	-.135	-.754	.466	.698	1.432
	Klorofil-a	.725	.139	.934	5.207	.000	.698	1.432

Table 4. Correlation Rate and Correlation Value Partially

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1. SPL	.378[a]	.143	.071	.25757
2. Klorofil-a	.860[a]	.740	.718	.14190

Table 5. Correlation of SST to Chlorophyll-A

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.		
	B	Std. Error	Beta			
1	(Constant)	-2.410	1.917		-1.257	.233
	SPL	.145	.064	.549	2.277	.042

Table 6. Correlation Level and Correlation Value of SST to Chlorophyll-A

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.549[a]	.302	.244	.29951

Table 7. Correlation of SST and Chlorophyll-A on Catch Results Simultaneously

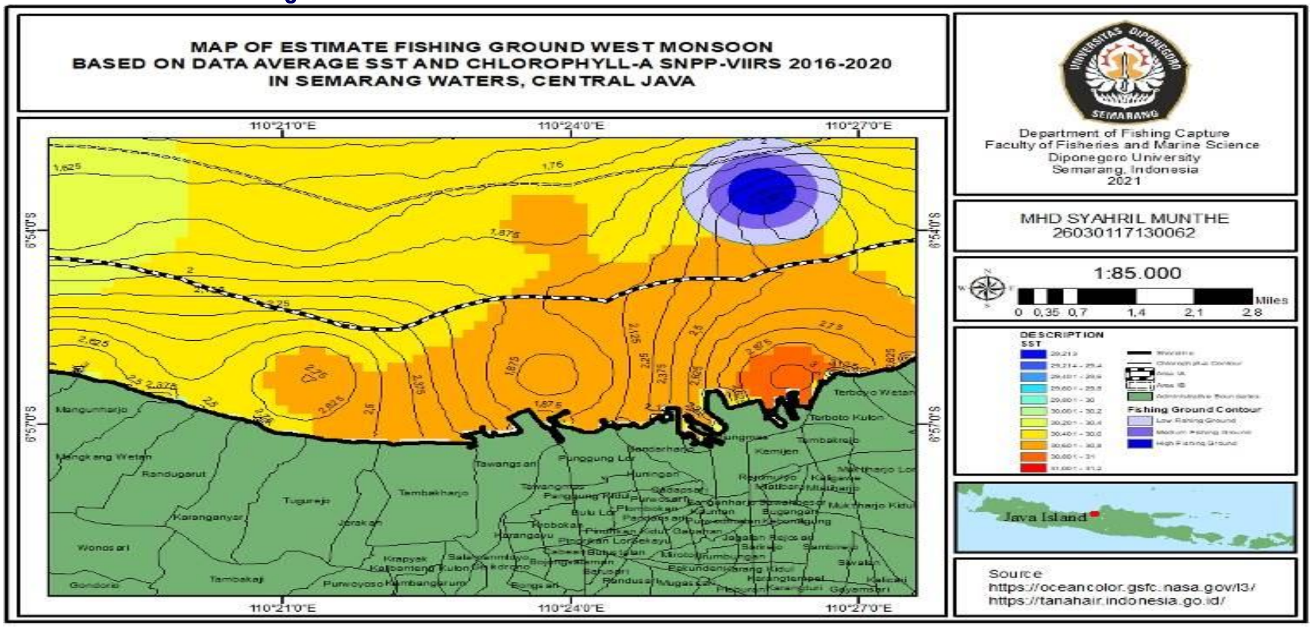
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.699	2	.349	16.732	.000[b]
	Residual	.230	11	.021		
	Total	.929	13			

Table 8. Correlation Rate and Correlation Value Simultaneously

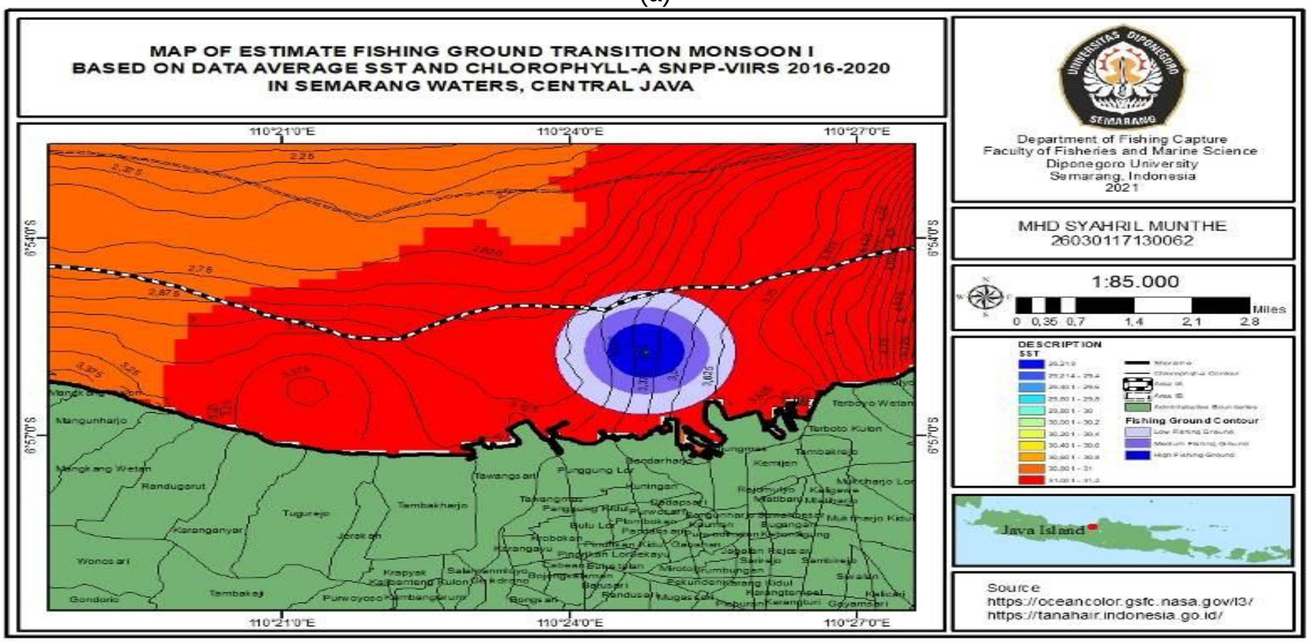
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.868[a]	.753	.708	.14452	1.865

Based on table 2, it is known the significant value. Sign, which is 0.2 > 0.05, means that the data is normally distributed. Partially sea surface temperature does not affect the catch. It is known from the sig value of sea surface temperature to catches of 0.466 > 0.05. Meanwhile, chlorophyll-a affected the catch with a sig value of 0.000 < 0.05. This value can be seen in table 3. In table 4 it is known that the partial correlation value of sea surface temperature to the catch is 14.3% while the partial correlation value of chlorophyll-a to the catch is 74%. It is known that the correlation between sea surface temperature and chlorophyll-a is 0.042 < 0.05. This means that sea surface temperature affects chlorophyll-a. The correlation value of sea surface temperature to chlorophyll-a is 30.2%. The correlation value of sea surface temperature on chlorophyll-a is presented in tables 5 and 6. Tables 7 and 8 present data on the simultaneous correlation of sea surface temperature and chlorophyll-a to catches. It is known that the sig correlation value is 0.000 <0.05, which means that sea surface temperature and chlorophyll-a simultaneously affect the catch. This is evidenced by the simultaneous correlation of sea surface temperature and chlorophyll-a to the catch of 75.3%. [9][10]

F. Estimation of Fishing Ground



(a)



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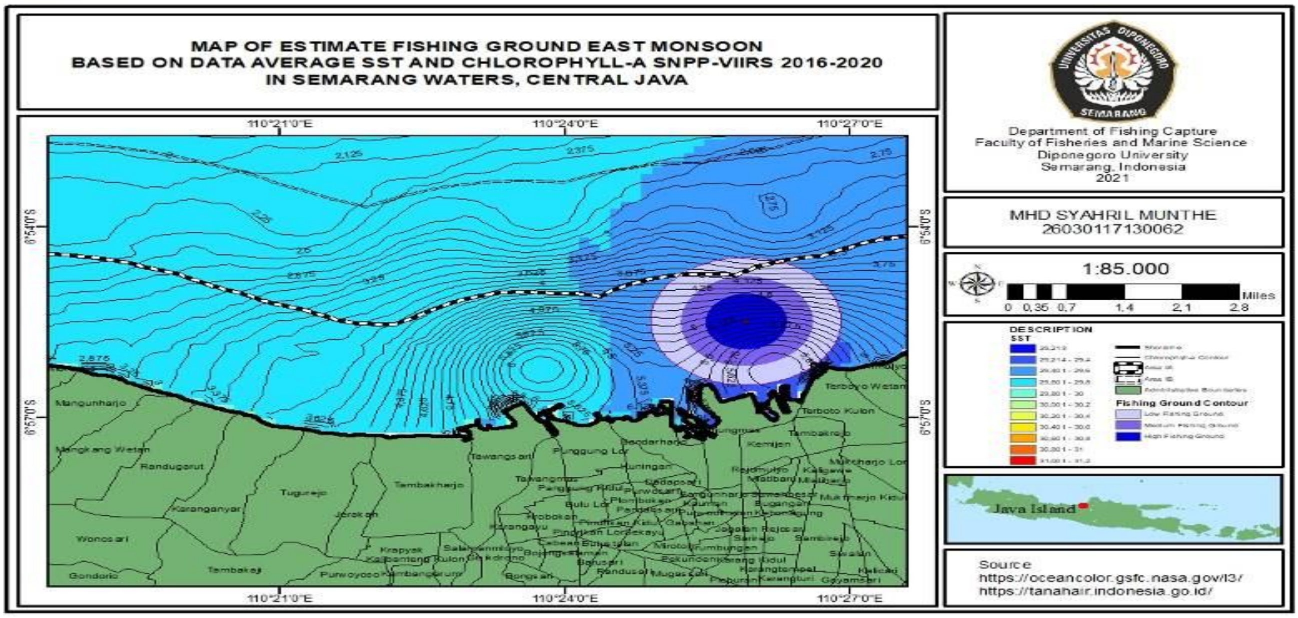
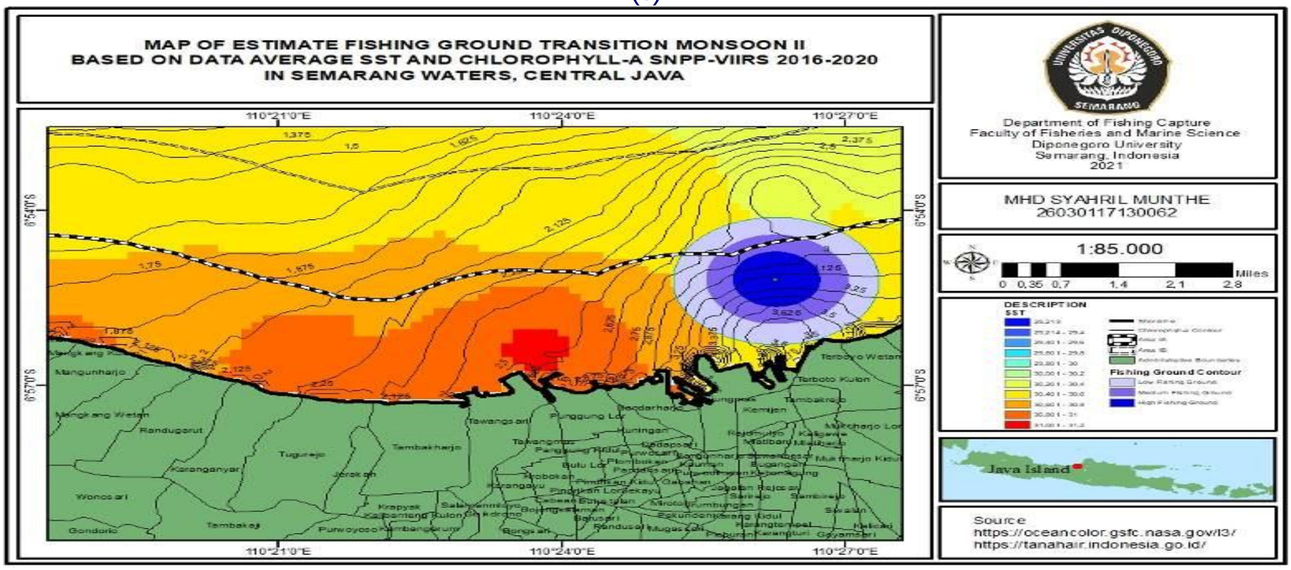


(c)



(d)

(a)Map of Estimation Fishing Ground West Monsoon
(b)Map of Estimation Fishing Ground Transition Monsoon I
(c)Map of Estimation Fishing Ground Eat Monsoon
(d) Map of Estimation Fishing Ground Transition Monsoon II
Fig. 7 Map of Estimation Fishing Ground, Semarang, Central Java, Indonesia

The data used in making the fishing ground map in the image above is a 5-year average monthly data (2016-2020). The data includes chlorophyll-a and SST data from SNPP-VIIRS satellite image. To represent the west monsoon, the average data for January is used, the transition monsoon I is represented by the average data in April, the east monsoon is represented by the average data in July, and the transition monsoon II is represented by the average data for October. Determination of fishing ground based on the dominance of high values of chlorophyll-a and SST between 28-31^{O}C. SST 28-31 ^{O}C is the optimal temperature for chlorophyll-a growth. The coordinates for determining fishing ground include 6°53'24,858" South latitude 110°26'0.071" east longitude in the west monsoon (figure 7a), 6°55'43,941" South latitude 110°24'47.903" east longitude in the transitional monsoon I (figure 7b), 6°55'29,439" South latitude 110° 25' 54,790" east longitude in the east monsoon (figure 7c), and 6°55'11.394" South latitude 110°26'15.904" east longitude in the transitional monsoon II (figure 7d). data that determines the distribution of fish areas, namely the content of chlorophyll and SST. It is hoped that this data can save fishing operation costs and increase fishermen's catches. Most of the fishing grounds that have been processed are located close to the shoreline. When taking field data, not a few fishermen make arrests according to the fishing ground map that was made. It's not even just gillnet fishermen, there are also sodo fishermen at night, trap fishermen and anglers. [4][13][19][20][31]

IV. CONCLUSIONS

A. Conclusions

1. Image data analysis was carried out spatially (4 miles from the shoreline) and temporally (based on the west, east and transition monsoon). Spatially, Sea Surface Temperature and chlorophyll-a image data will be higher the closer to the shoreline. Temporarily, the Sea Surface Temperature is dominantly warm in the west monsoon (December-February), the Sea Surface Temperature in the east monsoon is dominantly cold, and the SEA Surface Temperature in the transitional monsoon I and II tends to have no distribution pattern.
2. The correlation value of Sea Surface Temperature and chlorophyll-a partially to the catch is 14.3% (including a weak relationship) and 74% (including a very strong relationship). The correlation value of Sea Surface Temperature to chlorophyll-a is 30.2%, which means it is moderate. The correlation value of Sea Surface Temperature and chlorophyll-a simultaneously to the catch is 75.3% (very strong). SPL and chlorophyll-a variables can be used as variables in determining Fishing Ground
3. Most of the processed DPI are located close to the shoreline.

B. Recommendation

It is recommended that sampling and hauling coordinate points are reproduced so that the data obtained is more accurate.

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