Tuna Fishing Ground Modeling Based on Geographic Information System in Bitung Sea Waters

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Abstract
Fishing Ground in the ocean is an area targeted fishing. Predicted zone of Tuna fish caught should by detecting the distribution of chlorophyll-a and sea surface temperature distribution from Aqua MODIS image. This study aims to predict the local zone tuna fishing in the sea around the city of Bitung based on the distribution of chlorophyll-a and sea surface temperature by using satellite image Aqua MODIS data level-3. A series of research activities conducted in stages are: image collection, image cutting by the desired area, image extraction, data interpolation, map overlay, and the last is the map layout. The result of sea surface temperature (SST) and chlorophyll-a concentration in the ocean waters of Bitung and surrounding areas shows the chlorophyll-a, and sea surface temperature varies each season. The highest chlorophyll-a distribution is in the second transitional season in September and the lowest in the west season in December. The most top sea surface temperature distribution is in the eastern seasons in June and the lowest in the east of seasons in August. The results showed at some of the most potential fishing points of Tuna in the transitional season II wherein each month in the season potentially forming the Tuna fishing area.
Keywords: Tuna, chlorophyll-a, SST, Aqua, Modis

1. Introduction

The existence of fishing areas in the waters will always be dynamic (Sachoemar et al. 2012.), ever-changing or moving a following the movement of environmental conditions, which naturally fish will choose more suitable habitat (Wikantika and Darmawan, 2006; Ayu, 2015). Whereas the habitat it will be influenced by oceanographic conditions or parameters such as sea surface temperature, salinity, flow, depth, marine chlorophyll concentration (Azmi et al. 2015; Chavula et al. 2012), which affects the dynamics of movement of seawater both horizontally and vertically. Such as the event of rising water from the seabed to the surface as a difference in temperature gradient called Upwelling (Waters 2012). Upwelling regions are then usually there is chlorophyll which is a food fish and is thought to those areas there are much fish called local fishing ground. The parameters of the ocean it can be obtained by direct measurement or survey the field or by using remote sensing satellites (Lidiawati et al. 2015; Lubantobing and Sari 2015).

In determining fishing grounds, fishers tend to use intuition or instinct naturally acquired hereditary (Bakun 1998), Tuna hunting consequently less useful, wasteful of time and fuel, and the result is less than optimal (Inaku 2016). They have not been able to plan fishing operations due to the influence of the weather changes rapidly, in addition to changes in technology such as the use of GPS to locate fish (Kemili & Putri 2012). Consequently, fishers often come home with little or no catch that affects the low level of income.

Satellite remote sensing application is one alternative to the right to accelerate the provision of information about the fishing area, through observation of oceanographic parameters such as sea surface temperature, salinity, ocean currents, ocean chlorophyll-a concentration, etc. (Taglucop et al. 2016). Remote sensing technology has been presented to provide solutions for extensive monitoring, using satellite technology. The satellite technology will offer a considerable benefit for monitoring the oceans in Indonesia. The findings of the satellite sensor system technology can observe a wide variety of conditions or phenomena that occur in the oceans (Kumaat 2012).

Bitung City is one of the areas that have the potential for capture fisheries, especially Tuna, marine resources, and fish have reached approximately 587 thousand tons, while the new utilized 147 thousand tons or 25.04% (www.setkab.go.id/pro-rakyat-1513). Fishery capture potential is spread in the Gulf of Tomini, Maluku Sea, Halmahera Sea, the Seram Sea, and Sulawesi Sea. Bitung is one Minapolitan / industrialization of fisheries of 9 regions in Indonesia (Kumaat et al. 2013), has a strategic location because it is located in the Lembeh strait facing the Celebes Sea and the Pacific Ocean that serves as the outer ring of Indonesian fishing ports. Its existence is facing Asia, and the Pacific enable the development of Bitung became a center of regional economic activity in eastern Indonesia. In addition to its strategic location, seeing the potential of this vast marine and fisheries resource, The Indonesian government has designated Bitung City North Sulawesi as a World Tuna Center, to be used as a foreign exchange income for the country (Barata et al. 2011). Tuna from Bitung has become one of the leading export to several countries in the world who contributed to the growth of the local and national economy (Kumaat et al. 2017).

1.1. Identification of problems

Based on the description of the background of the problem, the problem in this research can be defined as follows:

- One of the obstacles to catching Tuna is the lack of information on the fishing ground both spatially and temporally.
- In determining fishing grounds, fishers tend to use intuition or instincts obtained from generation to generation.
- Catching Tuna ineffective, wasteful of time and fuel, and the result is less than optimal because of the lack of information fishing ground.

1.2. Scope of problem

From the identification of existing problems, research is limited to Potential identification areas of fishing tuna with Geographical Information Systems in Bitung sea waters.

1.3. Problem Formulation

Based on the background of the problem, this research emphasis on mapping potential areas of fishing tuna by using Geographic Information System technology in marine waters Bitung.

1.4. Research Objectives

The purpose of this study is: Mapping the potential areas of fishing tuna (Thunnus sp.) using Geographic Information Systems in Bitung sea waters.

1.5. Benefits of research

Provide knowledge for researchers, information to the fishermen, the fishing industry and local authorities regarding local conditions Tuna fishing in marine waters of Bitung, so that its potential can be utilized optimally and sustainably.

2. Methodology

The method used in this research is survey method and spatial analysis. Survey method is an investigation conducted to obtain facts from existing symptoms and find factual information (Rasyid 2011). Data used was secondary data, sea surface temperature, chlorophyll-a and production data tuna catches.

The spatial analysis method is used to visually analyze data taken from a MODIS Aqua satellite image. Then the process of obtaining the distribution of sea surface temperature and chlorophyll-a in the waters of Bitung. Data obtained from the interpretation of satellite imagery and field will be presented in the form of maps and tables were analyzed descriptively (Sachoemar *et al* 2012). Data on tuna fish production during the period 2010 to 2015 were obtained directly from the fisheries and marine service office of Bitung City. Oceanographic data collection such as chlorophyll-a and sea surface temperature are data downloaded from http://oceancolor.gsfc.nasa.gov. The image chosen is the image at level 3 (three) and monthly period. Selection of images at level 3 because the image on this level is a processed image that has been corrected radiometric and atmospheric.

The image used has a span of time from April 2015 to March 2016 and the image used has a spatial resolution of 4 km. Satellite images downloaded form of image chlorophyll-a and sea surface temperature image is then cropped image (cropping) using software Seadas 7.3, cutting the image adjusted to the desired area that includes the waters of Bitung and the surrounding waters.

Chlorophyll-a image and sea surface temperature that has been cut according to the desired area then carried out the process of extracting information from each image, information extraction process data using Seadas 7.3 application, resulting ASCII data distribution of chlorophyll-a and SST distribution in the marine waters of Bitung and tabulated data values of the distribution of chlorophyll-a and SST each pixel and the coordinates. ASCII data processing results in Seadas reprocessed using the Microsoft Excel program to calculate the dominant value, range, and average of chlorophyll-a concentration and sea surface temperature.

The calculated concentration value is the value in the area of the waters of the Bitung sea and its surroundings. The value on the coordinates of the study there were some blank pixels on the image so that the area of chlorophyll-a content and the content of the distribution of sea surface temperature cannot be detected. This is one of the disadvantages of MODIS satellites, where MODIS satellite images are interrupted by clouds. In the spatial analysis both in vector and raster format, required data covering all study areas and the interpolation process needs to be carried out to get the value on the blank pixel.

Interpolation is a process to predict unknown values by using known values around. The interpolation process is done by utilizing the ArcGIS 10.1 application. Interpolation in this study using a model Inverse Distance Weighted (IDW). IDW is a method used to analyze data geostatistics. In this study, IDW is used to interpolate the value of the distribution of chlorophyll-a and the distribution of sea surface temperature based on the data samples. So that from the interpolation process will produce a characteristic map of each image, the next process is a combination of images or overlays with the help of ArcGIS 10.1 application. After overlaying where mergers sea surface temperature and chlorophyll-a contours, then form a new map that the prediction zone tuna fishing area.

3. Results and Discussion

3.1. Characteristics of Chlorophyll-a and Sea Surface Temperature in the Waters of the Bitung Sea and its Surroundings

The distribution of chlorophyll-a (Chl-a) which is extracted from MODIS Aqua satellite image recording results of April 2015 to March 2016 resulted in variations in the concentration of chlorophyll-a value that is around Bitung Sea and surrounding waters. Value distribution of chlorophyll-a result of extraction of the image of the distribution of chlorophyll-a western season, the season of transition I, seasons East and transitional season II, in December - November showed that the content of the distribution of chlorophyll-a median on the third of the season highest in July amounted to 0,367 mg/m^3, the value of the content distribution of chlorophyll-a lowest average in March of 0.125 mg/m^3, and the range of the value of the content distribution of chlorophyll-a high of 0.122 to 1.524 mg/m^3 there in August and the lowest range there in January amounted to 0.077 to 0.822 mg/m^3.

Distribution of Sea Surface Temperature (SST) in the waters of Bitung and surrounding by the extraction of Aqua MODIS satellite imagery by recording between April 2015 to March 2016. The lowest temperature was detected in February, while the highest temperature was detected in June. The value of the distribution of sea surface temperature in the west season, the transition season I, the East season and the transition season II, in April 2015 - March 2016 showed that the highest value of the distribution of sea surface temperature in these three seasons was in June of 25.853^{0}C - 30.460^{0}C, while the lowest value of the distribution of sea surface temperature is in February of 25.630^{0}C - 28.986^{0}C.

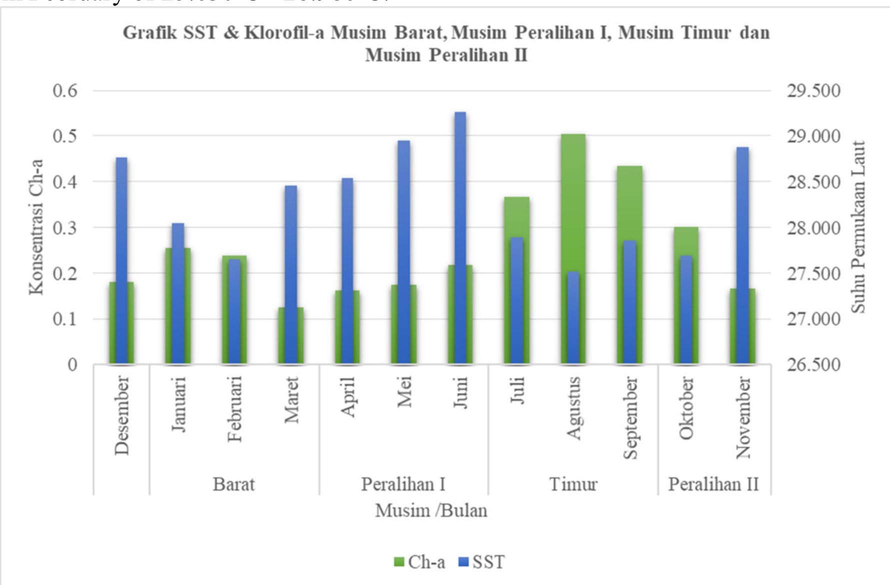
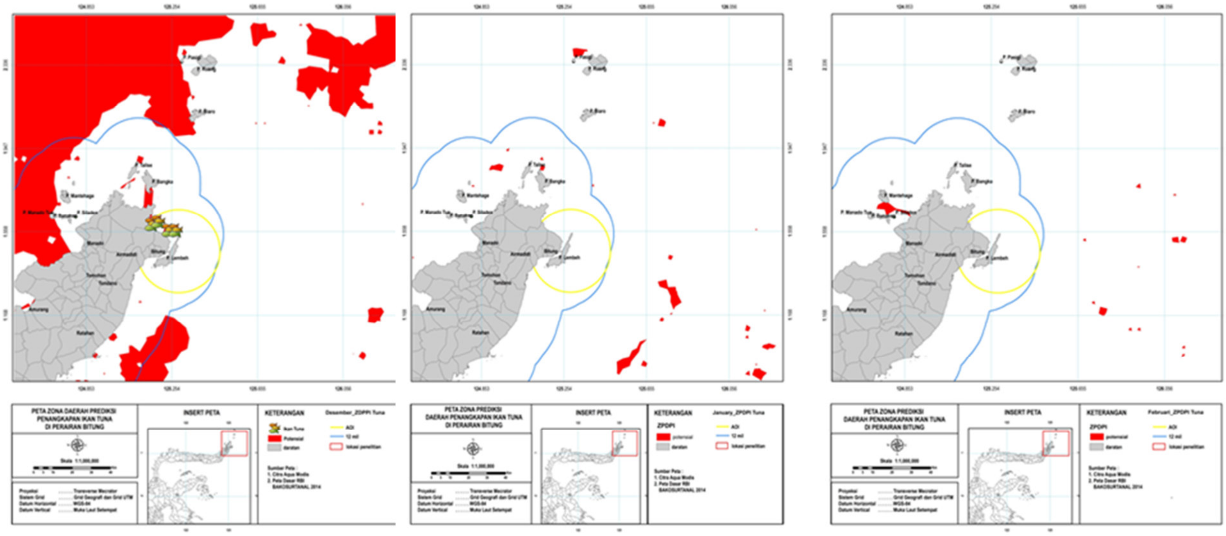


Figure 1. Distribution of Chlorophyll-a West season, Transitional Season I, East season and Season Transition II.

3.2. Tuna Fishing Ground Prediction Zone

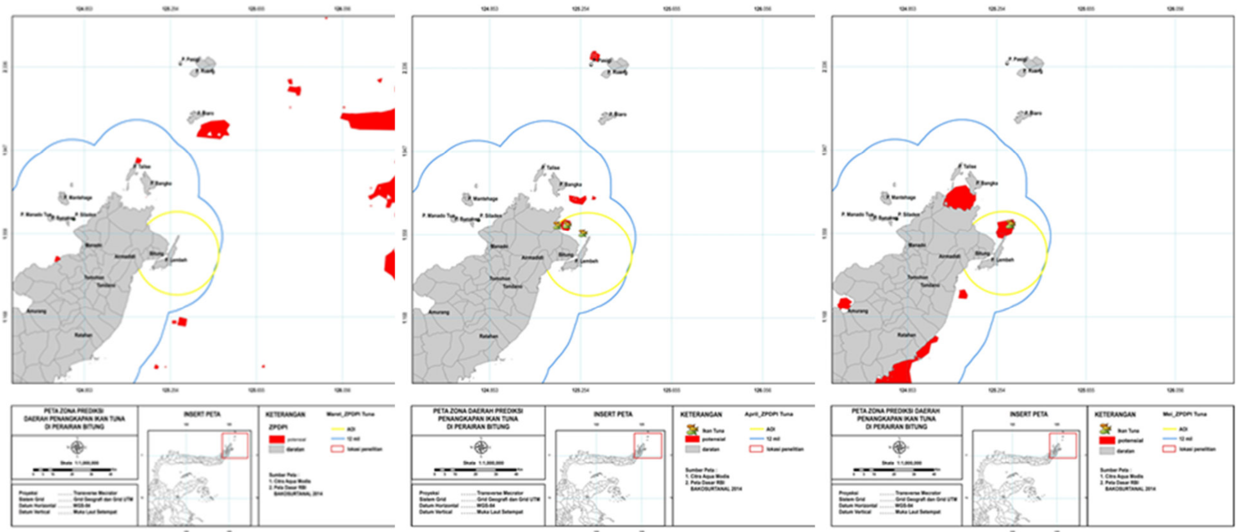
The monitoring results in Aqua MODIS image of the distribution of chlorophyll-a and the distribution of sea surface temperatures in the surrounding ocean waters of Bitung and displayed in the form of a map shows that the distribution of the fishing areas is to be found in the ocean waters. Information about the optimum range of sea surface and chlorophyll-a temperatures for tuna fishing can be used as a reference to determine productive fishing areas known as the optimum fishing zone. With the overlapping technique between optimum sea surface temperature and optimum chlorophyll-a, it will show the distribution of both suspected as potential fishing locations for tuna, the result of overlaying these two images will form a new map with specific information about productive fishing areas known as the optimum fishing zone (Zainuddin, 2011). Nevertheless, there are studies showing that chlorophyll-a more appropriate as an indicator of tuna fishing areas of the sea surface temperature (Silvia, 2009).

A good fishing ground is an area that has good environmental conditions for the life of the organism inside and high fertility, if the amount of chlorophyll-a is high then the area excellent for fishing ground areas so too, the environmental conditions or physical oceanography based on factors such as sea surface temperature. The formation of fishing areas by combining contour SST and chlorophyll-a made the decision-making process for the fishermen can operate correctly. The optimum range of the two images can be used as a combination of two characteristics of tuna fish habitat. Tuna Fishing Prediction Zone which is located in 12 Miles of the Exclusive Economic Zone of Bitung seawaters. In West season (December, January, February), Regional Zone Prediction Tuna Fishing only in December that has a four-point catching Tuna. During the Transition I season (March, April, May) the Tuna Fishing Prediction Zone is in April with three catching points and in May with a catching point. For the East season (June, July, August) Zone Prediction Tuna Fishing only in the month of June, with three points for the arrest and transition Season II (September, October, November) Tuna Fishing Zone Prediction present in all months. In September with one catching point, October is one point of catching and November with three catching points.



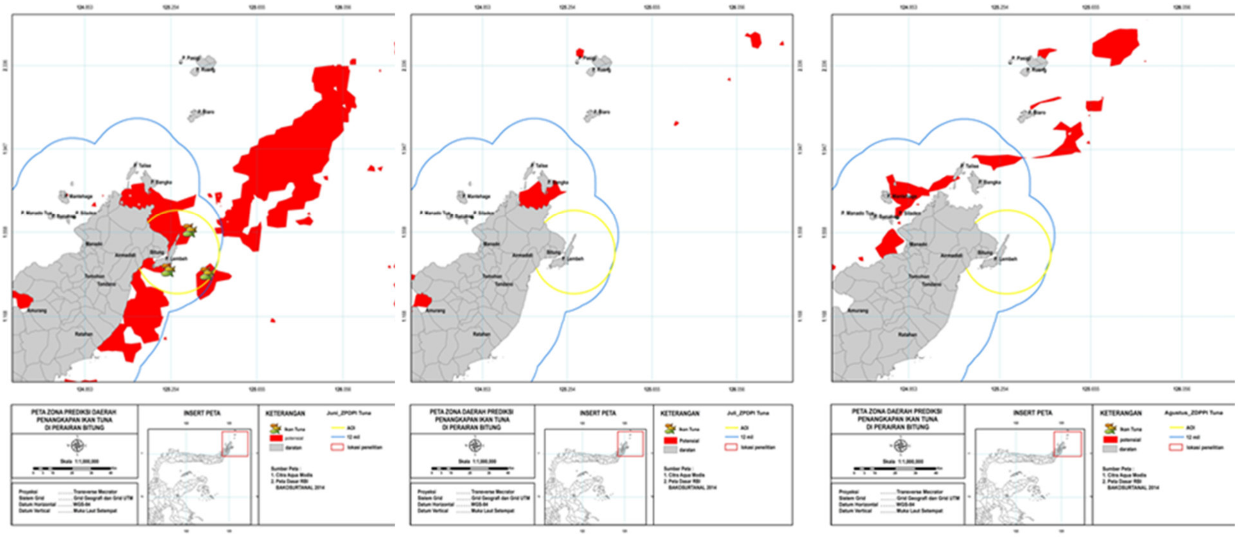
December 2015 January 2016 February 2016

West Tuna Season ZPPI



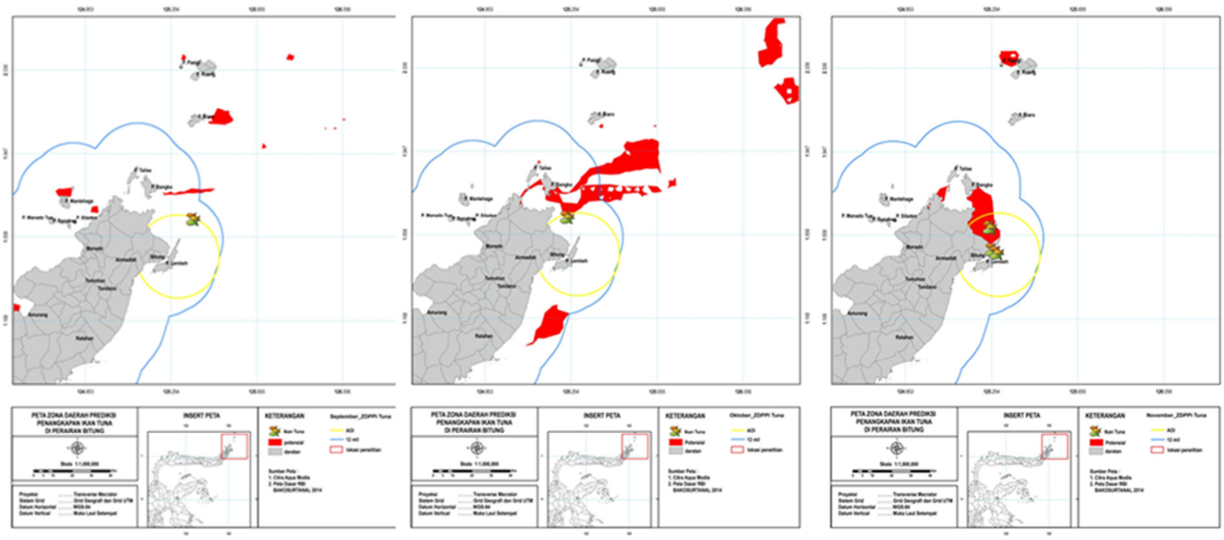
March 2016 April 2015 May 2015

ZPPI Tuna Transition Season I



June 2015 July 2015 August 2015

East Tuna Season ZPPI



Septembre 2015 Octobre 2015 Novembre 2015

ZPPI Tuna Transition Season II

4. Conclusion

Based on the research, identification via Aqua MODIS satellite imagery in the sea waters of Bitung shows the results of the distribution of sea surface temperature and chlorophyll-a varied each month. Distribution of Sea Surface Temperature in the West Season ranges from 25.630^{0}C to 29.179^{0}C. At the first transition season, Sea Surface Temperature ranges from 25,815^{0}C -29.737^{0}C. In the East Season, SST ranges between 24,235^{0}C - 30,460^{0}C. Chlorophyll-a distribution in the waters of Bitung Waters in the West Season, Transition Season I, East Season, and Transition Season II, ranged from 0.077 mg/m^3 - 2.357 mg/m^3. Chlorophyll-a distribution in the Western Season ranges between 0.077 - 1.176 mg/m^3. In Transition Season I, Chlorophyll-a ranged from 0.093 to 0.943 mg/m^3. In the East Season Chlorophyll-a ranged from 0.087 - 1.524 mg/m^3 and in Transition Season II, Chlorophyll-a ranged between 0.095 mg/m^3 - 2.357 mg/m^3. Prediction Zone for the most potential Tuna fishing in the West Season is only in December, with four catching points. At the first transition season, there ZPPI in April and May. Furthermore, in the East Season, ZPPI was found in January because there were three catching points. For Transition Season II, ZPPI was found in September, one catching point, in October one catching point and November three catching points. In the second transitional season is the season with the most potential for the third month this season all have a point of fishing.

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