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Spatial Model in Determining the Distribution of Tuna Fishery Policy in the Bitung City

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***Abstract*— Characteristic of the nutrient-rich waters, especially on the high seas, is supposed to have the water conditions are very abundant fishery resources, specifically fisheries which have economically important. Spatial model of fisheries area can be considered in making a special tuna fish distribution map that will allow fishermen to do fishing activities. The research objective is to model the spatial distribution of tuna (Thunnus sp.) In consideration of a sustainable fisheries policy in the Bitung waters of North Sulawesi Province. The method used in this research is survey method and spatial analysis. The survey method is an investigation conducted to obtain facts from the symptoms that exist and look for factual information. The data used are secondary data such as sea surface temperature, chlorophyll-a and tuna production data. Potential fishing areas are areas that have good environmental conditions for the life of the organism in them and high fertility. If the amount of chlorophyll-a is high, then the area excellent for fishing areas. Likewise, with environmental conditions based on oceanographic or physical factors such as sea surface temperature. The formation of the fishing area formation by combining the SPL and chlorophyll-a contours makes the decision-making process for fishermen can run properly. The optimum range of the two images can be used as a combination of two characteristics of Tuna fish habitat.**

***Keywords*— fisherman, bitung, tuna, spl**

I. INTRODUCTION

Fisheries, especially tuna fishing [1] is an activity that is very interesting to study because tuna is an excellent fishing industry [2], [3]. The rapid development of fisheries is strongly supported by the condition of the fishing location itself, where oceanographic parameters are very influential as sea surface temperature, salinity, currents, depth and marine chlorophyll concentration [4]–[6], this effect resulted in the dynamics of sea water with the occurrence of horizontal and vertical movements of sea water [6]. The vertical process of water dynamics known as Upwelling [7]–[9] . Upwelling events can be measured directly or indirectly, one of which is remote sensing, which is one of the most up-to-date measurement techniques [6], [10], [11].

Determination of fishing area [6], [9], [10], fishermen tend to use intuition or instinct naturally obtained for generations of ancestors [5], [6], [9], consequently less effective hunting tuna, wasteful of time and fuel, and the result is less than optimal [6], [9].

One area that has considerable fishery potential in North Sulawesi Province is Bitung City [12], [13], abundant marine resources alleged maximum sustainability yield (MSY) reaches 587 thousand tons per year, while around 147 thousand tons are used or 25.04% [14], [15]. Potential tuna fish distributed in Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea, Berau Bay, Sulawesi Sea, and north of Halmahera Island [16]. Marine resources contained in these waters include tuna, skipjack, tuna, long beak, mackerel, squid, reef fish, etc. [13]. Bitung has a strategic location because it is located in the Lembeh strait facing the Sulawesi Sea and the Pacific Ocean that serves as the outer ring of Indonesian fishing ports [5], [13].

The above description outlines the existing problems and thus require good decision making as well as government policies that favor the fishermen, the problem in this research can be defined as follows: lack of information fishing ground, they use intuition and habit were hereditary, and wasteful of fuel [6], [9].

Based on the background of the problem, the problem to be investigated is the need for a digital map of the spatial distribution of tuna as well as taking into account policies that support the increase in fishing yields in the Bitung City. The research objective is: to model the spatial distribution of tuna (Thunnus sp.) In consideration of a sustainable fisheries policy in the Bitung waters of North Sulawesi Province.

II. LITERATURE REVIEW

Sea watercolor remote sensing is one way to find out the state of the ocean and the processes that occur in it based on the concentration of water-leaving radiance is the result of the interaction between solar radiation and water received by satellite [17]. Sensors on the satellite receives the reflected solar radiation from the surface and the water column. Solar radiation on the way to the waters affected by the atmosphere, where sunlight before reaching the waters will be absorbed or scattered by clouds, the air molecule and aerosol [18]. Then, sunlight that enters the water column will be absorbed or reflected by particles in the waters such as phytoplankton, suspended sediment and yellow substances [18]. Research on chlorophyll-a and the sea surface temperatures have been conducted by various researchers using satellite data, as research conducted by [6], [9] which saw the distribution of sea surface temperature and chlorophyll a then overlaying each year so that it can be seen the distribution pattern of alleged regional tuna fisheries.

The importance of seeing data through remote sensing because what fishermen face in catching tuna is the uncertainty of the distribution area and the abundance of fast swimmer fish [9]. Determination of tuna fishing areas accurately and accurately can be done by making forecasting, ie utilizing the biological characteristics of the fish in relation to the oceanographic conditions of a waters such as the distribution of sea surface temperature (SPL), water depth, density, chlorophyll-a, etc [5], [6].

III. RESEARCH METHODS

The method used in this research is survey and spatial analysis methods [19]. The survey method is an investigation conducted to obtain facts from the symptoms that exist and look for factual information [20]–[22]. The data used are secondary data such as sea surface temperature, chlorophyll-a and tuna production data.

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 [6], [9], [10]. 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 using software Seadas 7.3, cutting the image adjusted to the desired area that includes the waters of Bitung and the surrounding waters.

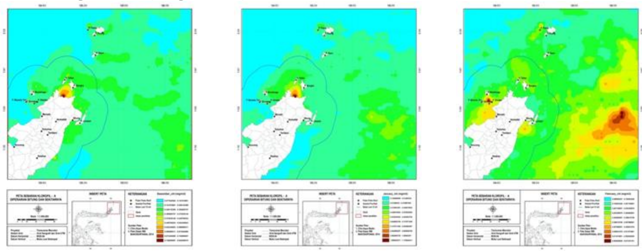
Chlorophyll-a image and Sea Surface Temperature that has been cut according to the desired area then carried out the process of extracting information from each image, information extraction process data using Seadas 7.3 application, resulting ASCII data distribution of chlorophyll-a and SST distribution 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 10.5. After overlaying where mergers sea surface temperature and chlorophyll-a contours, then form a new map that the prediction zone tuna fishing area.

IV. RESULTS AND DISCUSSION

The distribution of SST and chlorophyll-a extracted from Aqua MODIS satellite images from April 2015 to March 2016 results in variations in the concentration value of chlorophyll-a around Bitung seawaters. Sea Surface Temperature and Chlorophyll-a distribution value of extraction from the image of the distribution of chlorophyll-a west season, transition season I, east season and transition season II, in December - November shows that the average value of chlorophyll-a distribution in the three seasons is the highest in the month 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 (Figure 1).



West seasons

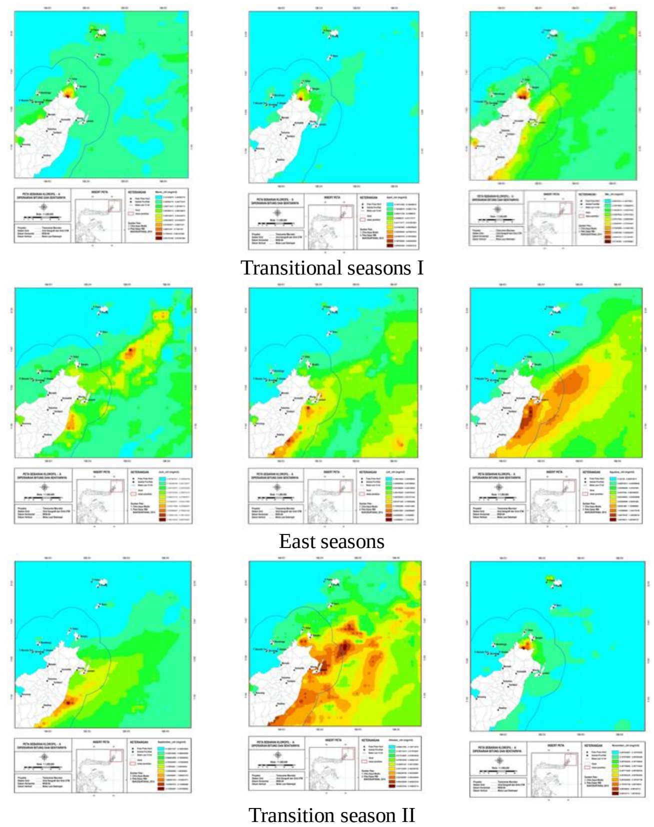
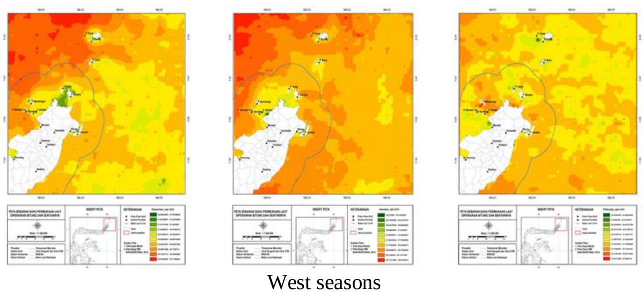


Figure 1. Distribution of Chlorophyll-a West season, Transitional season I, East season and Transition season II.

Sea Surface Temperature Distribution (SST) in Bitung and surrounding waters based on Aqua MODIS satellite image extraction by recording between April 2015 and March 2016. The lowest SST was detected in February, while the highest occurred in June. Sea surface temperature distribution values in the west season, transition season I, east season and transition season II, in April 2015 - March 2016 show that the highest sea surface temperature distribution values in these three seasons were in June ranging between 25.853^{0}C - 30.460^{0}C, while the lowest sea surface temperature distribution contained in February showed variations of 25.630^{0}C - 28.986^{0}C (Figure 2).



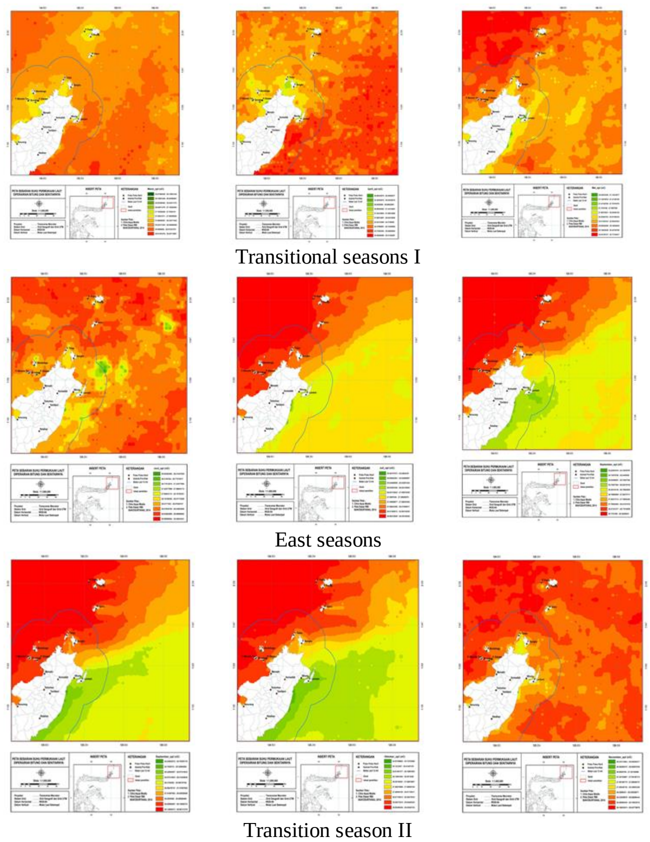
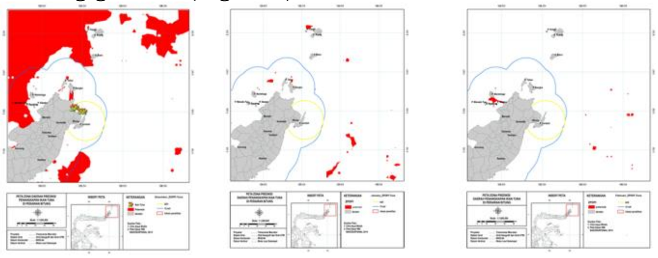


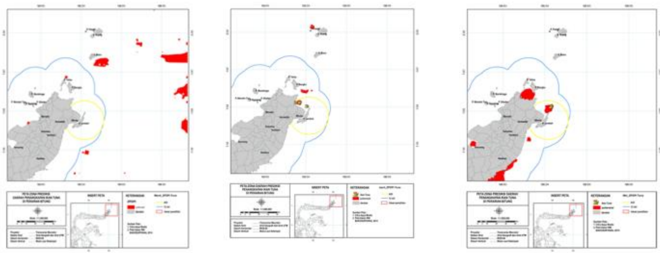
Figure 2. Distribution of Sea Surface Temperature West season, Transitional season I, East season and Transition season II.

The results of monitoring of Aqua MODIS imagery on the distribution of chlorophyll-a and the distribution of sea surface temperature in the waters of Bitung and surrounding waters which are displayed in the form of a map shows that the distribution is a fishing ground that is well established in these waters. Information on the variation of SPL and chlorophyll-a optimum for tuna fishing can be used as a reference to determine productive fishing areas known as the optimum fishing zones. The combination between the SPL and chlorophyll-a optimum done by overlaying on any existing data, thus showing the location of a potential arrest for tuna in the waters of Bitung. The digital map is the result of overlaying two images are then generates a new map with specific information regarding the productive fishing areas known as the optimum fishing zone [4]. However, there are studies that show that chlorophyll-a is more appropriate as an indicator of skipjack fishing areas than sea surface temperature [5], [6], [9].

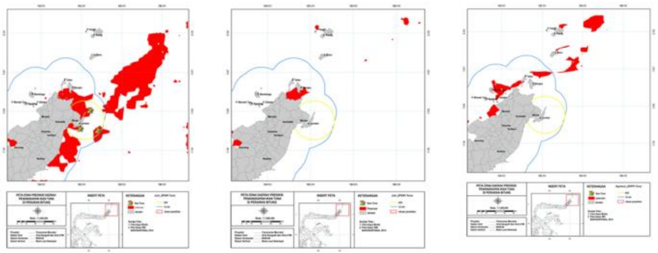
The findings of potential fishing areas that can be interpreted as areas that have good environmental conditions for the life of organisms in them and high fertility. If the amount of chlorophyll-a is high then the area is good for fishing, as well as environmental conditions based on supporting oceanographic factors such as sea surface temperature. The model formed is the fishing area model by combining the varied SPL and chlorophyll-a contours, so that in the decision-making process for fishermen or related stakeholders can run properly. The model with the optimum range of values derived from the two images can be used as a combination model for the characteristics of Tuna fish habitat or fishing grounds (Figure 3).



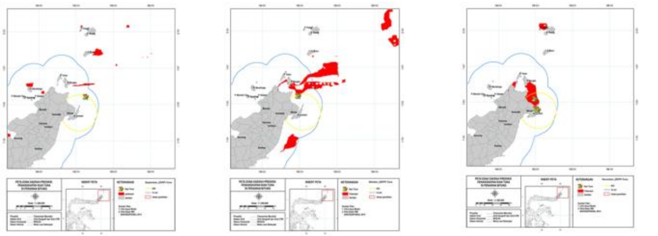
West Tuna Seasons



Transition Seasons I



East Tuna Season



Tuna Transition Season II

Figure 3. Tuna Fishing Prediction Zone

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