STUDY OF SHORT MACKEREL CATCH, SEA SURFACE TEMPERATURE, AND CHLOROPHYLL-A IN THE MAKASSAR STRAIT

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Abstract. The Makassar Strait is the major fishing ground for Short Mackerel *(Rastrelliger spp.)* fisheries in South Sulawesi, Indonesia using both commercial fishing vessels and boats with traditional fishing gear. Though Short Mackerel is one of dominant commercial food fishes in South Sulawesi, the annual Catch per Unit Effort (CPUE) has been decreasing from year to year. In 2000, the total of annual CPUE was 22,117 tons and in 2007, it was 17,596 tons. The purpose of this research was to forecast the fishing ground of Short Mackerel employing Moderate Resolution Imaging Spectroradiometer (MODIS) satellite images in Makassar Strait territory with the study interest of 3°S to 5°S and 118°E to 120°E. This research was conducted from September 15 to October 20, 2007. Fishing data were collected from the fishermen including fishing locations, catch, sea surface temperature, and chlorophyll concentrations. To determine the relationship between catch and oceanographic parameters, linear regression was employed. We also examined sea surface temperature (SST) and Chlorophyll-a concentration field data vs. MODIS satellite data. The result showed that SST and Chlorophyll distributions have close relationship with the distribution of fishing location of Short Mackerel. The fishing location tends to spread on the waters with the SST ranged from 26°C to 29°C and Chlorophyll concentration from 1.19mg/m^3 to 1.25mg/m^3.

Keywords: *Chlorophyll-a, MODIS, Sea Surface Temperature.*

1. Introduction

The Makassar Strait is the major fishing ground for Short Mackerel (*Rastrelliger spp)* fisheries on South Sulawesi, Indonesia (Ali, 2005). Both commercial fishing vessels and boats using traditional fishing gear are operated in this area. Based on the statistic data, the total annual CPUE has been decreasing from year to year since the year of 2000 (Figure 1). There are many problems to the fishermen making them difficult to increase their production, such as man power, the increased price of gasoline and limited information of the potential fishing zones. The limited information about the distribution of the potential fishing zone is a major problem in fishery resources utilization. In general, Indonesian fishermen use the conventional methods to fish. They mostly depend on their experiences to find a fishing ground. This method brings them to an uncertain condition and makes their work inefficient.

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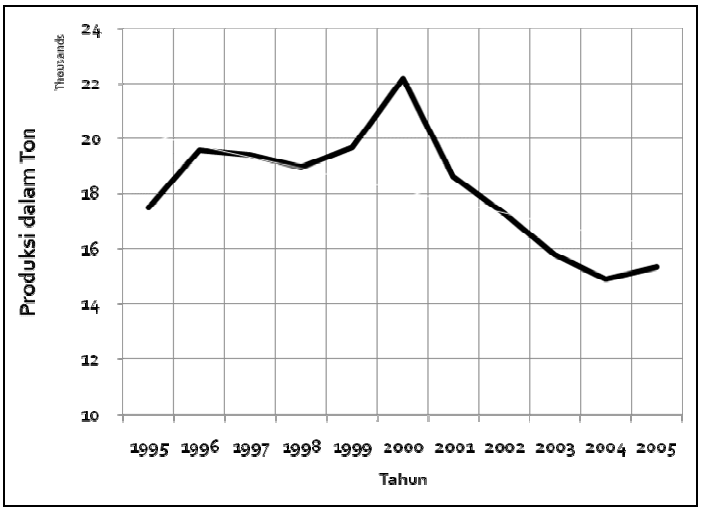

Figure 1. Production of Short Mackerel (*Rastrelliger spp)* in South Sulawesi (Ali, 2005).

To find fishing grounds are not only depend on the experiences, but also the knowledge of habitat of fish. The habitat of fish is closely related to certain value of oceanographic properties, such as sea surface temperature, salinity, current, and the abundance of phytoplankton. Therefore, to be able to manage optimal sustainable fishery resources, the information about the above oceanographic parameters is very important (Ogawa, 1979). The productivity of waters is linearly related to the availabity of phytoplankton (Nontji, 1984). To calculate the biomas of phytoplankton is to measure the concentration of chlorophyll-a and water temperature. One of the methods to estimate the sea surface temperature and Chlorophyll-a concentration is by using the technology of remote sensing satellite.

The usage of remote sensing satellite data becomes important to provide the information of potential fishing zone. Many researches, for example Hasyim (2003 and 2004) and Paena (2002) have developed a method using satellite data to investigate the potential fishing zone. However, there is no research to study the potential fishing zone for Short Mackerel in Makassar Strait. The purpose of this research is to determine the fishing ground of Short Mackerel using MODIS satellite images in Makassar Strait.

2. Methods

This study is conducted in Makassar Strait located between 118^{o}E to 20^{o}E and 3^{o}S to 5^{o}S (Figure 2). The Makassar Strait has a complex oceanic characteristic due to the Indonesian Through Flow which has a significant effect on fishing activities. In general, methods of this research are classified into the following steps. First of all, we collect the in-situ data. Those data consist of fishing locations, catch, sea surface temperature, chlorophyll-a, salinity, and depth. The relationship between catch and oceanographic parameters is examined by using the simple regression. The MODIS satellite images used in this research are taken simultaneously with in-situ measurement. The satellite data used to identify distribution of Chlorophyll are channel 3 (459 to 479 nm), channel 9 (438 to 448 nm) and channel 12 (546 to 556 nm). While to observe the distribution of SST, channel 20 (3.660 to 3.840 μm), 31 (10.780 to 11.280 μm) and 32 (11.770 to 12.270 μm) are used. Then, the observed

satellite data are validated with in-situ data to generate local algorithms. These algorithms are used to estimate the SST and Chlorophyll concentrations. Finally, GIS software (ErMapper 7.0 and ArcView GIS 3.3) is used to map the potential fishing location of Short Mackerel. Figure 3 shows the steps of the methods to determine a potential fishing location.

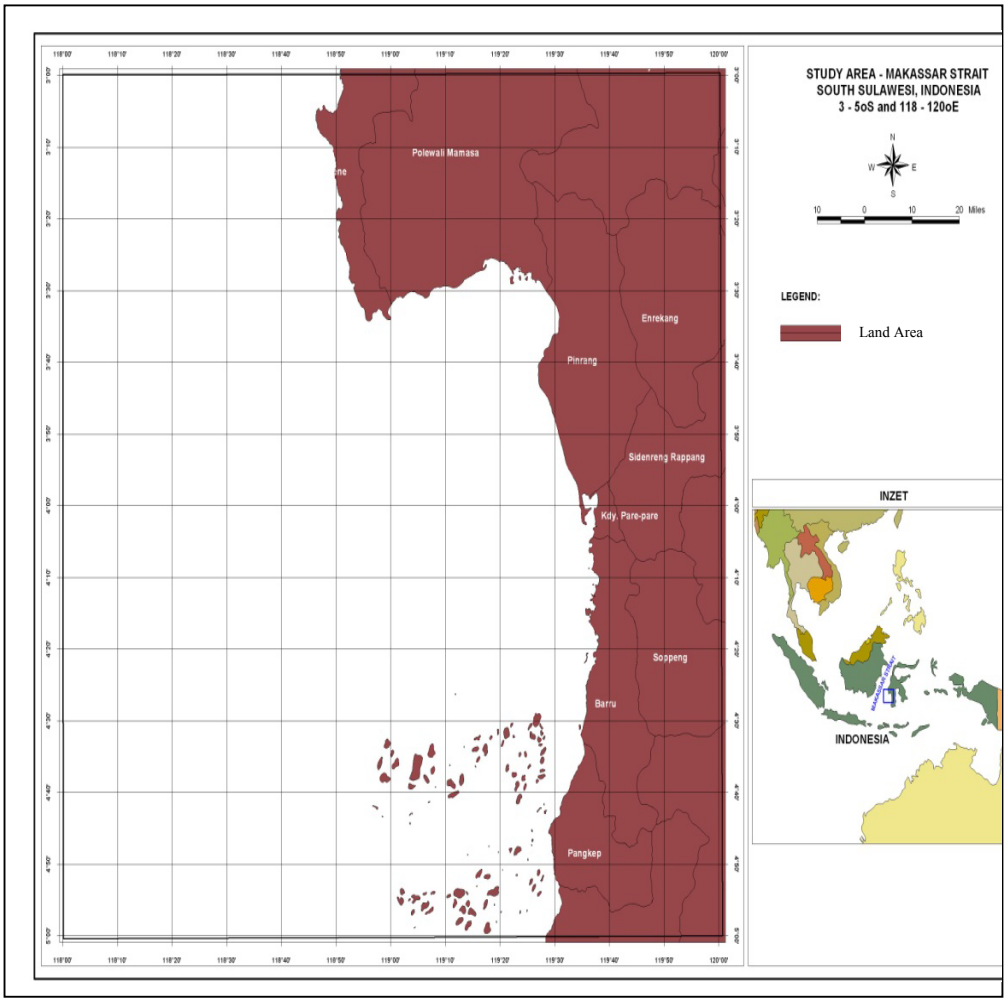

Figure 2. Map of study area.

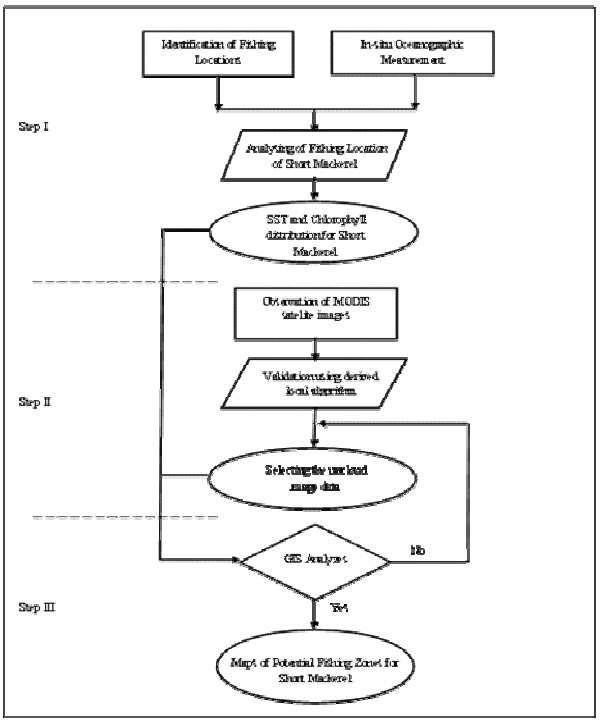

Figure 3. Flowchart of determining fishing location of short mackerel.

3. Results and Discussion

3.1. Fish Catch

During the field measurement, the Short Mackerel (*Rastreliger spp.*) is the most abundance species captured (2,232.9 kg), the remaining species capture in decreasing trend are the Goldstripe Sardinella (922.3 kg), Indian Scad (428.4 kg), Skipjack (397.8 kg), and other species (174.9 kg) (Figure 4).

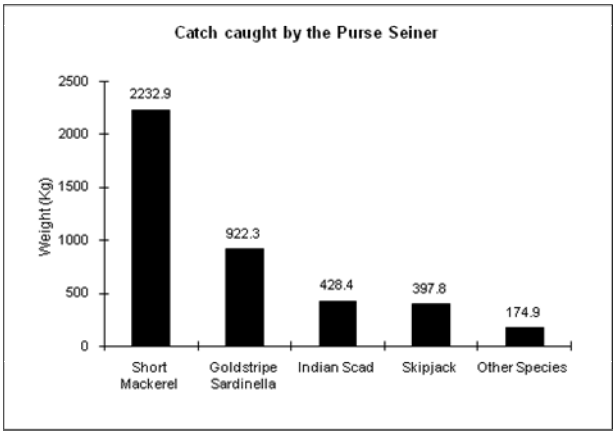

Figure 4. Composition of catch caught by the Purse Seiner during the observation.

3.2. SST

The results of this study showed that in September and October 2007, the Short Mackerel tended to spread in the SST values ranging from 26°C to 29°C. Figure 5 allows a comparison of the SST determined from in-situ with the SST estimated from the MODIS data. Results show that the validation of the MODIS-derived SST values with in situ measurements have a high correlation $r^2 = 0.8428$.

Figure 6 shows contours of SST distribution generated from SST MODIS image. The contours indicate the range of SST between 26°C and 29°C.

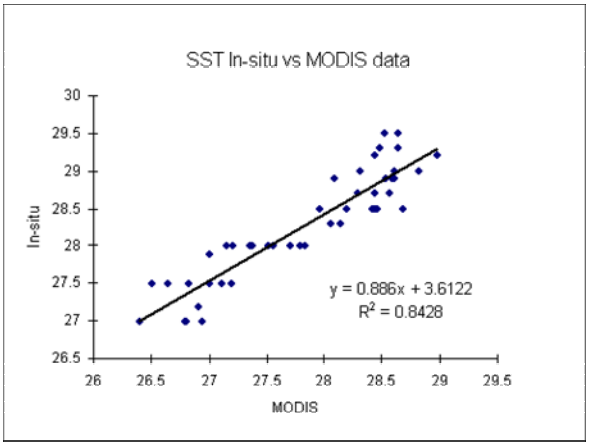

Figure 5. A good relationship between the sea truth measurement and satellite data for estimating SST value (r2 = 0.84).

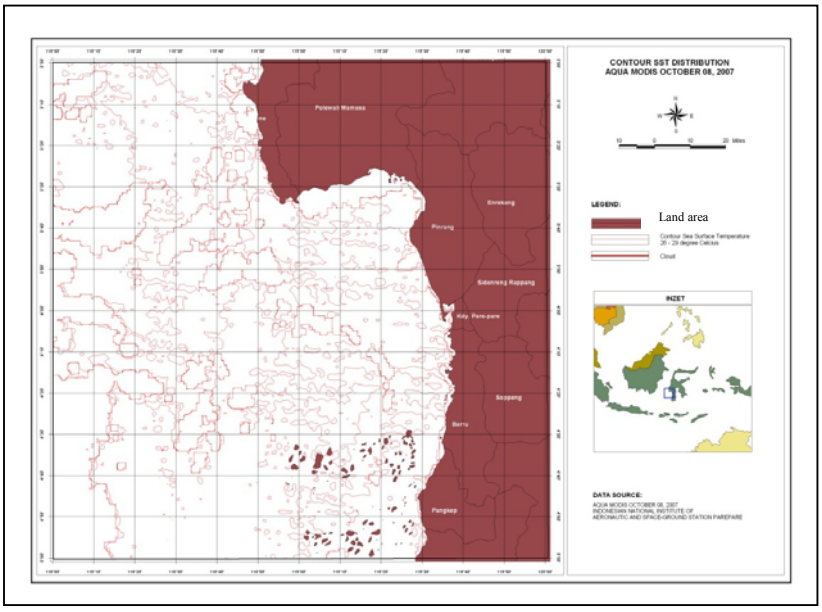

Figure 6. Contours of SST distribution (Thin red lines) generated from MODIS image. October 8, 2007.

3.3. Chlorophyll Concentration

Based on the in-situ measurements, during September to October 2007, the short mackerels were mostly captured in the waters with the chlorophyll concentration ranging from 1.19 mg/m^3 to 1.25 mg/m^3.

Figure 7 presents a relationship between the chlorophyll concentrations determined from in-situ with the chlorophyll concentration as it is estimated from the MODIS data. The validation of the MODIS-derived chlorophyll concentration values with in situ measurements shows a good correlation $r^2 = 0.7706$.

Figure 8 shows contours of chlorophyll concentration distribution produced from the ocean color MODIS image. The contours indicate the range of chlorophyll concentration distribution between 0,5 mg/m^3 and 2,5 mg/m^3.

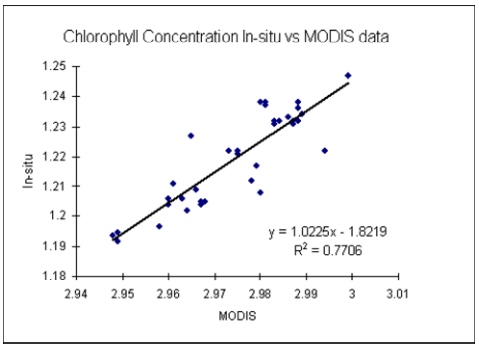

Figure 7. Comparasion between the sea truth measurement and satellite data for estimating Chlorophyll concentration value (r2 = 0.77).

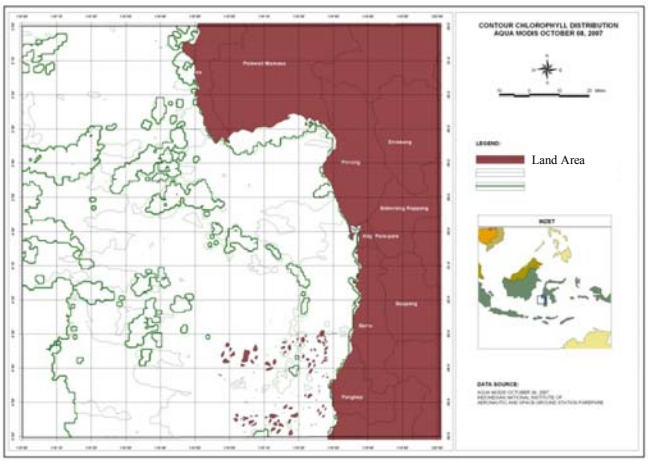

Figure 8. Contours of chlorophyll concentration distribution (thin green lines) produced from MODIS image October 8, 2007.

3.4. Potensial Fishing Zone

The potential fishing zones of short mackerel are estimated by overlaying the contour image of SST and the contour image of chlorophyll concentration. The meeting points between the contours generated from SST and Chlorophyll distribution are likely good fishing locations for Short Mackerel fisheries, especially in September and October. We record that on October 15, 2007, a purse seiner caught as much as 140.40 kg of the short mackerel at location of 118°39'0.52"E and 4°00'14.3"S. This location close to one of the cross section generated from the contours of SST and chlorophyll on October 8, 2007 **(**Figure 9).

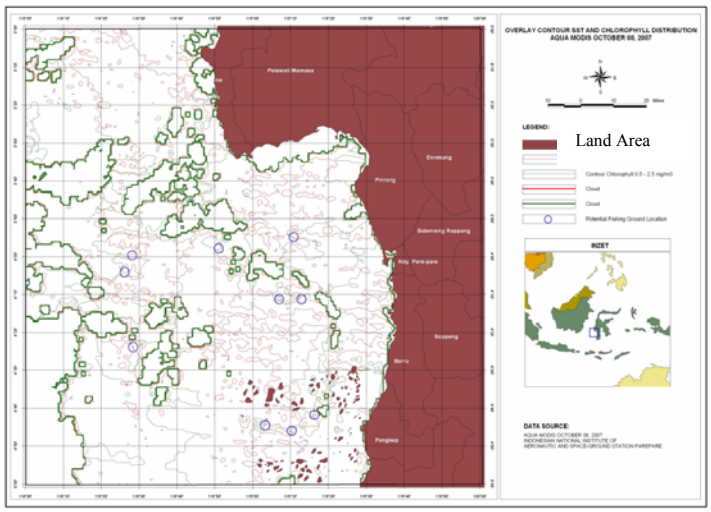

Figure 9. Contours of SST and chlorophyll distributions generated from MODIS satelitte image, October 8, 2007. Intersection points (blue circles) indicated the potential fishing zones of Short Mackerel fisheries.

4. Conclusions

In general, Short Mackerel in high abundance spreads in the areas which had SST distribution ranging from 26°C to 29°C and chlorophyll concentration ranging from 1.19mg/m^3 to 1.25mg/m^3. The potential fishing zones of Short Mackerel can be forecasted by using MODIS satellite images. The result of the study revealed that the overlay between the contour maps of SST distribution and those of the chlorophyll concentration distribution can be used as a tracer for the fishing locations of Short Mackerel in Makassar Strait.

Local algorithm has been used to generate the contour image of SST and chlorophyll concentration distributions. The regression coefficients for *in-situ* and satellite of MODIS SST and chlorophyll concentration distributions in Makassar Strait wee 0.84 and 0.77, respectively. Although the results of validation were encouraging, further *in-situ* measurements need to be done to compare the variability of the SST and chlorophyll concentration distribution in all seasons.

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