Original Research Article

Identification of Surface Current Patterns in Small Pelagic Fishing Areas in the Western Season of the Spermonde Islands, Indonesia

ABSTRACT

Monsoonal wind commonly affects Indonesian waters, blowing in an adversative direction by turns in one year. These are well-known as west and east monsoonal winds. Spermonde Archipelago waters, located on the west coast of the southern part of South Sulawesi, is a water region comprising various islands with relatively shallow waters and situated in Makassar Strait. The study aimed to identify the pattern of current surface movement in each monsoon period, especially on the west monsoon on Small Pelagic Fish Catches Area. Data used in this study consisted of primary and secondary data. Primary data were obtained in the field for three months (April to Jun, second monsoonal transition monsoon into east monsoon). In December, the wind pattern was dominated from the northwest with a maximum speed of 8 knots. The surface current pattern offshore was from the south (0.16 m/s) to the north with decreasing speed (0.03 m/s).Meanwhile, in low tide, the current surface pattern offshore was from the north (speed may reach up to 0.04 m/s) to the south with an increasing speed of 0.20 m/s. The peak of the west monsoon occurs in January to February with high rainfall, and wind speed is dominated from south-west and west directions. Current pattern occurred in the offshore, either at high or low tide, showed similar pattern, which was divided into east and south directions.

Keywords: Surface Current, West Monsoon, Spermonde Archipelago

1. INTRODUCTION

Indonesian waters are the connecting waters between the Pacific Ocean and the Indian Ocean, and are also strongly influenced by the munson climate. This results in unique characteristics for Indonesian waters. With these characteristics, these waters have different water mass circulation patterns and vary munsonally and are influenced by the Pacific Ocean water masses that cross Indonesian waters into the Indian Ocean through the Indonesian cross current called “Indonesian Through Flow”[1]

The Makassar Strait, in the Sulawesi Island region of Indonesia, plays an important role because it is the main gateway to the Indonesian through flow. In general, the Makassar Strait is a low latitude pathway that transfers hot, low salinity from the Pacific Ocean to the Indian Ocean, [2]. One of the island groups located in the Makassar Strait is the Spermonde Archipelago. The waters of the Spermonde islands are shallow waters located in the southwest of South Sulawesi, completely separated from the Sunda Shelf which lies across the Makassar Strait and consists of many islands and shelf banks. The waters of the Spermonde Archipelago are influenced not only by the Makassar Strait, but also by the Java Sea and the Flores Sea. The islands' waters cover the southern part of Takalar district, Makassar city, Pangkep district, and Barru district on the northern part of the west coast of Sulawesi Island in South Sulawesi province.

The width of the Spermonde archipelago is approximately 40 km, and is divided into the Nearest Zone which is heavily influenced by the mainland of South Sulawesi. The central zone is approximately 5 - 12.5 km from the coast of Makassar with many islands in between and shallow areas (taka), andthe outer zone; approximately 30 km from the mainland and is a zone of barrier reefs.

Pangkep district, which is one of the areas of the Spermonde archipelago, was formed as a result of sedimentation and organism activity. The direction of the current is irregular, but based on the state of the tides, it is known that when the water is experiencing a tide then the direction of the current tends to move to the west. While at low tide the direction of the current moves towards the north [3]. This study aims to identify and map the pattern of surface current movement in each seasonal period, especially in the west season in the Small Pelagic Fishing Area. Based on modeling and community perceptions in Spermonde waters.

2. MATERIAL AND METHODS

2.1. Satellite Image Data

The Modis Image Data Used is Acquisition Data from October to June for 2 (two) years. Field data collection for 3 (three) months, namely in April - June. Oceanographic data were taken in conjunction with purse seine fishing activities conducted at night. The data consisted of current direction and speed, surface temperature, salinity, chlorophyll-a content, and depth. In addition, data on wind direction and speed and tides were also used in this study, although both were secondary data. The research location is in areas that are centers or bases (fishing base) of small pelagic fish in the waters of Spermonde, Pangkajene and Island Regency.

2.2. Current Pattern Data

Surface current data obtained by direct measurement in the field using a current meter and drift float (current kite). To describe the pattern of surface current movement in a large area, a surface modeling system (SMS) is used by entering several parameters of wind direction and speed, tide, and depth. In addition, community information about current movement patterns was also explored to be used as a comparison.

This current pattern is needed to determine the distribution of water mass flow that will affect the distribution of other oceanographic parameters, so that the oceanographic dynamics that occur in Spermonde waters in western munson can be described more fully.

2.3. Tidal and wind speed data

Secondary data on tides and wind direction and speed is one of the things needed in this study. This is related to knowing the type of tides as well as the direction and speed of the wind in the study area and also to forecast the pattern of surface current movement in the future using sms software.

2.4. Hydrodynamic modeling with RMA-2 module

The RMA2 module is a risk management approach used in the context of a project or business activity. It aims to provide guidance and a systematic framework for identifying, analyzing, and managing risks associated with a project or activity.

The purpose of this hydrodynamic simulation is to obtain the velocity and direction of the current. The current modeling used is with the RMA-2 numerical model. RMA-2 is a module of sms in the form of a finite element numerical model that is integrated in the vertical direction (water depth can be considered constant relative to its horizontal dimension), so it can be considered as a two-dimensional (2D) problem. The virtue of the rma2 module is that it is capable of calculating surface elevation changes (tidal fluctuations) of waters and horizontal current velocity components for sub-critical free surface flow in a 2-dimensional flow field. Basically, RMA-2 solves the turbulent flow problem of reynolds equation which is derived from navier stokes equation. The effect of roughness is taken into account with manning or chezy coefficients, as governing equations, rma2 uses mass and momentum conservation equations integrated over depth.The RMA-2 module provides a comprehensive framework for managing risks in a systematic and structured manner

3. RESULTS AND DISCUSSION

The Spermonde Islands are waters located in the southern part starting from Takalar Regency, Makassar City, Pangkep Regency, to Barru Regency on the northern part of the West coast of South Sulawesi Province. These waters are an exposure located on the outside of South Sulawesi, completely separated from the Sunda Shelf which lies across the Makassar Strait, consisting of many islands and shelf banks. Pangkep Regency, which is one of the areas of the Spermonde archipelago, consists of 12 sub-districts, namely nine mainland sub-districts and three island sub-districts. The nine sub-districts located on the mainland are Balloci, TondongTallasa, MinasaTene, Pangkajene, Bungoro, Labakkang, Ma'rang, Segeri, Mandalle. The sub-districts located in the islands are LiukangTupabbiring, LiukangTangngaya, and LiukangKalmas, with 112 islands, 74 inhabited with a total

population of 51,469 people (34%). The sea area of Pangkep Regency is 11,464.44 km^2 and the area of small islands is 35,150 Ha. The length of the coastline is 250 km and the area of coral reefs is 36,000 km^2 with the majority of jobs are as fishermen, [4]

The Spermonde Islands are located in the waters of the Makassar Strait, which is the route of the Indonesian Throughflow with water masses sourced from the Pacific Ocean. Transport of water masses from the Pacific Ocean entering the Makassar Strait through the Sulawesi Sea is estimated to range from 7.5 - 12.4 Sv (lSv = 1 Sverdrup = 106m3/det). The movement pattern of the water mass, permanently moving from north to south was found at an average depth of 100 - 350 db (decibele) [5]. However, in surface currents, the influence of arlindo is not dominant due to the influence of tides and regional wind patterns. Gordon (2005) mentioned that surface currents in the Makassar Strait are influenced by regional wind factors. Current conditions in Spermonde waters are influenced by wind and tides.

The Spermonde Islands, especially those within the scope of the administrative area of Pangkep Regency and Makassar City, are an area that has a gentle depth (less than 50 m depth) with the distribution of islands and reef bases in the area. Depths with steep slopes below 50 m depth have been outside the area, namely in the western waters of Langkai Island, leading to Kapoposang Island to Suranti Island as shown in Figure 1.

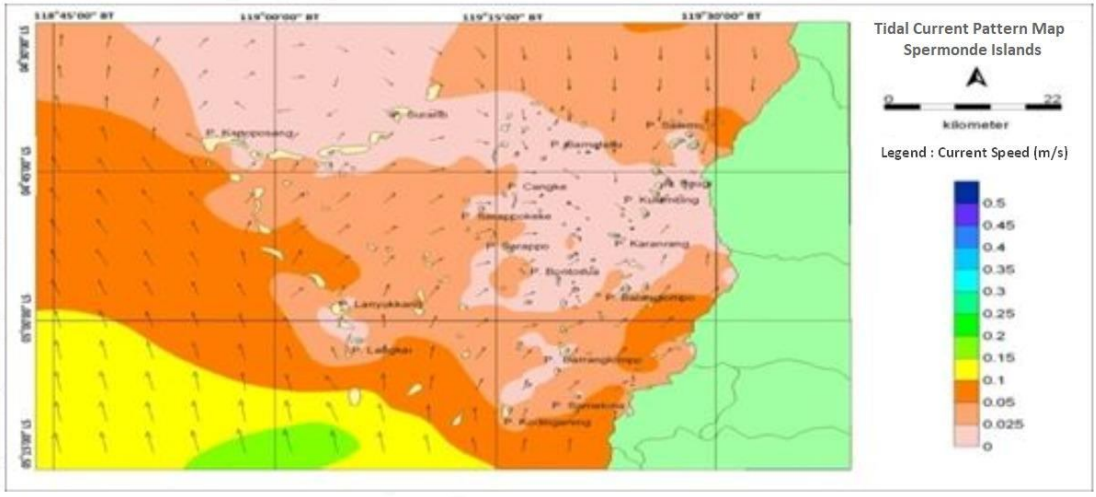

Figure 1: Bathymetry Map of Spermonde Waters

Such bathymetric conditions, causing the mass of water from the high seas (deep sea) in passing through the Spermonde area is inseparable from the role of tidal and wind dynamics around the area. [6] modeling currents caused by wind, showed the pattern of surface currents between western munson and eastern munson. The dominant surface current pattern is from the west towards the east and southeast during western munson. While in the East munson, the current is from the southeast towards the northwest and north.

In the simulation modeling of the Spermonde islands waters in each month through the SMS 8.1 module RMA2 program by including tidal parameters, as well as the direction and maximum wind speed as a current generating factor, shows a surface current pattern that is not entirely the same as the results of [6], due to the additional tidal parameters in the model created.

In December as shown in Figure 2, the wind pattern with a maximum speed of 8 knots from the northwest. At this speed, the dominant current conditions show different patterns at high tide and low tide.

The surface current pattern at high tide in the open sea from the south with a speed of up to 0.16 meters / second towards the north with a decreasing speed of 0.03 meters / second. Another case in the northern part of the Spermonde islands, the current comes from the north (on the coast) with a speed of 0.05 meters / second, then enters the waters of the Spermonde islands through the northern islands with a speed of 0.02 meters / second. The current from the south enters the waters of the Spermonde islands through the southern islands at a speed of 0.06 - 0.08 meters / second heading north to Sarappo Keke Island and Karanrang Island. Then turn to the east (coastal) due to the meeting of currents from the north. The current speed to the east is 0.02 - 0.05 meters/second.

The surface current pattern at low tide in the open sea from the north with a speed of up to 0.04 meters / second to the south with an increasing speed of 0.20 meters / second. The northern part of the Spermonde archipelago has the same pattern as the low tide from the north which then enters the Spermonde waters through the northern islands with speeds reaching 0.01 - 0.02 meters / second. In the waters around the islands near the coast, two current patterns are formed, namely the current leaving the coast (to the west) around Saugi Island and in the waters west of Laiya Island to Karanrang Island with a speed of 0.01 meters / second. The current traveled south around the eastern waters of Laiya Island to the southern islands. The current pattern then turns to follow the current pattern from the open sea to the south when entering the eastern waters of Sarappo Keke Island with a speed of 0.02 - 0.04 meters / second.

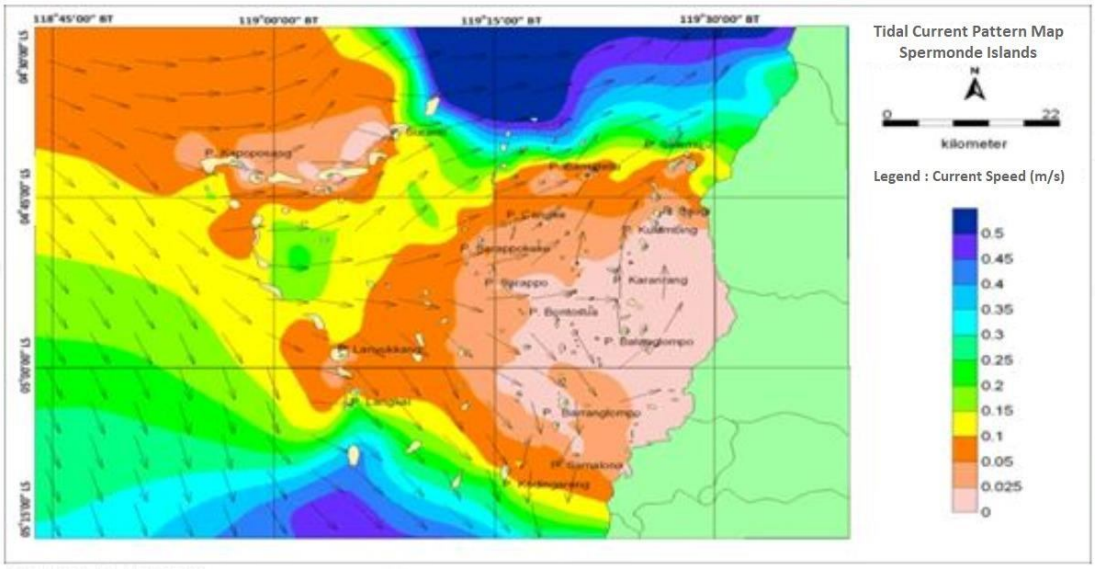

Figure 2. Tidal Flow Patterns in December

Based on the results of the analysis, the December current pattern shows the influence of tides even though the wind blows from the northwest but at a low speed of 8 knots. At this speed, the influence of wind pressure on the sea surface is still weak and has not been able to affect the current pattern due to differences in sea surface elevation at high tide and low tide. January and February are the peak of the western munson characterized by high rainfall and high wind speeds dominated from the northwest and west. In the last two years

(2008 - 2009), maximum wind speeds of up to 24 knots were recorded. The strength of the wind affects the pattern of surface currents generated by the tides, as shown in Figure 3.

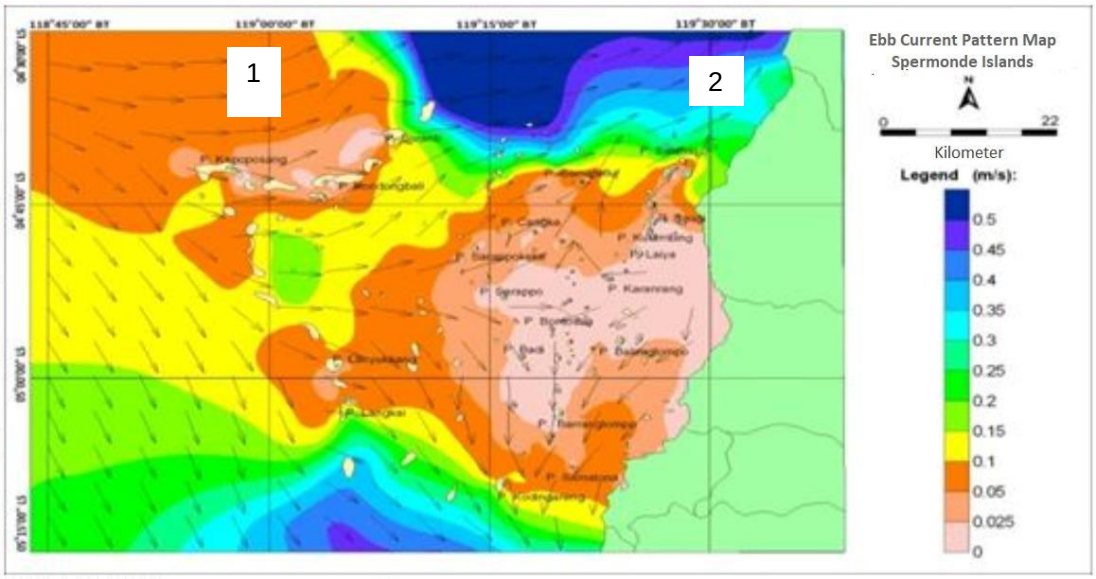

figure 3. Pattern of Sea tide (1) and Low Tide (2) on January

Current patterns that occur in the high seas both at high and low tide show the same pattern that is from the north and divided to the east and south. The current to the east occurs in the sea north of Kapoposang Island along the edge of Kapoposang Island to Suranti Island with a speed of 0.44 meters / second, the current speed is getting stronger when entering shallow waters in the northern part of the Spermonde archipelago reaching 0.91 meters / second in strong wind conditions and in the south reaching 0.49 meters / second.

The current entering the Spermonde area to the east passes through the sea between Langkai Island and Kapoposang Island with a speed of 0.22 meters / second. Then the current splits to the northeast, east, and southeast. The northeastward current passes through the northern Spermonde islands at a speed of 0.16 meters/second and meets the westward current north of the Spermonde islands. The eastward current reaches 0.1 meters/second through the central islands, then the current turns north around Karanrang Island and south around Balang Lompo Island with a speed of 0.02 meters/second.

Differences in current patterns during high and low tides are seen in the sea between the coast of Pangkep Regency and Balang Lompo Island to Laiya Island. The tidal current tends to head north with a pattern parallel to the coast with a speed of 0.03 meters/second. While the ebb current tends to leave the coast to the west, northwest, and southwest with speeds reaching 0.02 meters/second.

The current conditions in the waters of the Spermonde archipelago as above also follow the description of the current pattern mentioned by the islanders who mentioned that the current around Sanane Island goes to the east, and around Sarappo Lompo Island the same trend of current direction at high tide, but at low tide the current tends to go north. On Balang Lompo Island, the current around the island is southward at high tide, and westward at low tide. In Salemo Island, the currents around the island predominantly head north, as can be seen in Figure 4. In addition, the current patterns are described by residents by pointing with their hands and some mention the cardinal directions.

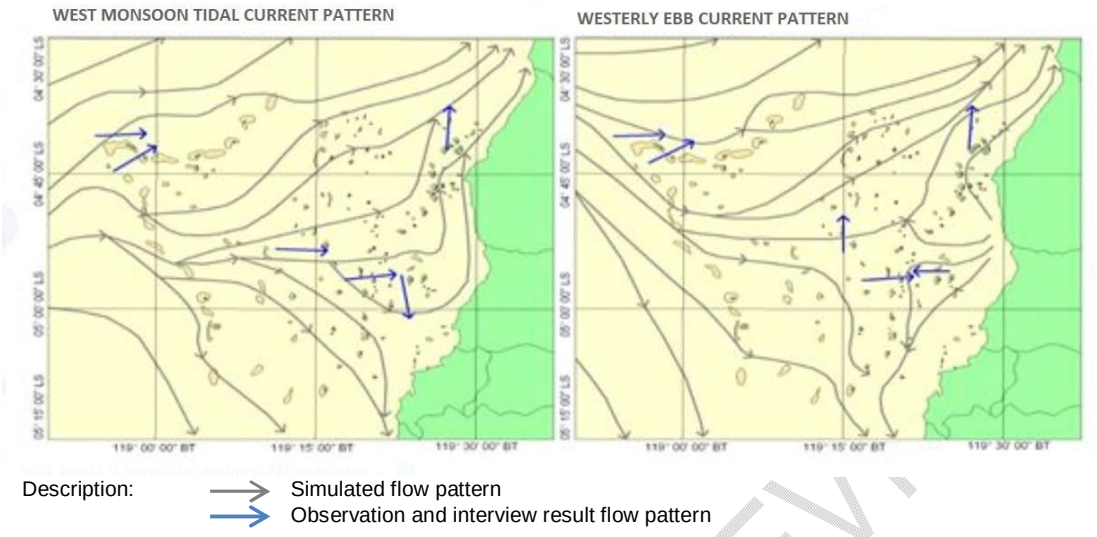

Figure 4. Simulated Tidal Current Pattern in January

The current conditions in January and February, which show relatively the same pattern both at high and low tide, are caused by the dominant wind factor. The western munson current pattern in the western high seas of the Spermonde archipelago waters, generally originating from the north has been influenced by wind pressure from the west so that it turns to the east and is divided towards the northwest, east and south. The current entering the waters of the Spermonde islands to the east passes through the sea between Langkai Island and Kapoposang Island, then the current splits to the northeast, east, and southeast until it reaches the coast. In the western Munson, the surface current moves with the main direction from west to east [5]. [7] Explains that the flow of water masses in the surface layer of the Makassar Strait is correlated with regional wind direction, where during western munson the mass flow from the Java Sea moves eastward. He also added that the Makassar Strait water mass pattern in February and March has the greatest speed and flows towards the Flores Sea in the south.

Winds with a high speed of 24 knots have put pressure on the surface in the high seas (deep sea) so as to push the surface water mass to the east towards the waters of Spermonde. When passing through the islands and outer reefs of the Spermonde archipelago, which has a relatively shallow depth with steep slopes, the surface of the sea water mass increases due to the push of water masses from the west and also with the dominant tidal influence in shallow waters. As a result, the sea surface elevation is higher on the outer reef than the surrounding area. These conditions cause surface water masses from the open sea (deep sea) to only partially pass through the coral reef base due to high surface elevations [8][9], and some turn towards the southeast in the southern part of Kapoposang Island and to the northeast in the northern part of Kapoposang Island

The rise of sea level at the base of the outer reef causes the surface elevation to be high compared to the waters behind it so that the water mass tends to move at a higher speed towards the east entering the waters of Spermonde. The flow of surface water masses accompanied by wind pressure on the surface to the mainland, the influence of tides in shallow waters and the presence of islands and reef bases causes an increase in sea level elevation from the waters around the coast to around the central Spermonde islands

[10]. Such conditions cause the flow of water masses from the west to be obstructed, and cause the current speed to decrease and patterned towards the northeast - north and southeast – south [11]. The flow of water masses in coastal waters is strongly influenced by waves due to wind patterns, namely speed and direction, as well as the influence of tides [12].

CONCLUTION

The wind pattern in December was dominated from the northwest with a maximum wind speed of 8 knots. The surface current pattern at high tide in the open sea from the south with a speed reaching 0.16 meters / second heading north with a decreasing speed of 0.03 meters / second. While at low tide, the surface current pattern in the open sea from the north with a speed reaching 0.04 meters / second heading south with an increasing speed of 0.20 meters/ second. In January and February is the peak of the western munson which is characterized by high rainfall and high wind speeds and is dominated from the northwest and west. Current patterns that occur in the high seas both at high and low tide show the same pattern that is from the north and divided to the east and south. The pattern of surface current movement based on the results of calculations with the model shows the same pattern as the perception of current movement patterns by the community.

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