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THERMAL FRONT DISTRIBUTION IN PANGANDARAN WATERS

Vadhilah Savetri, Mega Laksmini Syamsuddin [2], Iis Rostini [2] dan Izza Mahdiana Apriliani [2]

[1]*Student at Faculty of Fisheries and Marine Science, Padjadjaran University, Bandung – Sumedang KM. 21 Jatinangor 45363, Indonesia E- mail address: dhilbed@gmail.com*
[2]*Lecturer at Faculty of Fisheries and Marine Science, Padjadjaran University, Bandung – Sumedang KM. 21 Jatinangor 45363, Indonesia*

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SST, current, Thermal front, Pangandaran Waters

ABSTRACT

This research aims to determine the spatial and temporal variability of the thermal front in Pangandaran waters, West Java. This research was conducted from January to February 2018 in Pangandaran Waters, West Java. Aims to find out the location and time of the occurrence of thermal fronts in Pangandaran waters. The data used in this study are SPL derived from AquaMODIS and Geostrophic Flow from ECMWF. The method used is a descriptive method with a spatial and temporal analysis approach. Thermal Front was detected in the sea surface temperature (SPL) raster image data using the Cayulla Cornilon 1992 algorithm with a strong category with a difference of SPL> = 0.5 ° C and weak with a SPL difference of 0.3 ° C. Research results show that the front formed in Pangandaran waters is a temporary front with weak and strong strengths. The most common distribution and frequency of thermal fronts were found in December (west season) with a total of 11 units occurring with an average SPL value of 29.3 ° C and the least distribution was found in April (transition season 1). The highest temperature range of the thermal front is between 30 - 33.8 ° C and the lowest is in the range of 22.8 - 26.5 ° C. Incidents of thermal fronts generally occur in waters off the Indian Ocean.

INTRODUCTION

Indonesian waters are waters located between the Pacific Ocean and the Indian Ocean. The mass of water from the Pacific enters and spreads in Indonesian waters before it flows out of Indonesia. Front is one of the oceanographic processes that affect the physical and biolo conditions of a waters. Olson (1994) there are many variations of possible fronts, namely thermal fronts, salinity fronts, chlorophyll-a fronts. Thermal fronts are fronts that are detected from sea surface temperature. Thermal front is an oceanographic process that affects fish abundance and distribution. Thermal fronts occur because of the meeting of two different water masses (Angraeni et al., 2014). In general, the thermal front can be found in coastal waters. This is because the mass of water from land has a different temperature from the sea water, so that a thermal front is formed.

Fronts are usually associated with the appearance of upwelling. Upwelling is the process of increasing the mass of water from below to the surface that usually carries nutrients. The location of the front followed by an abundance of chlorophyll-a can lead to upwelling. According to Wyktri (1962), Susanto, R.D. et al. (2001), Hendrianti, N. et al. (2005), upwelling potential areas that occur in Indonesian waters are the West Indian Ocean, Sumatra, South Java, Bali, Nusa Tenggara, Makassar Strait, Banda Sea, and Arafura Sea.

SIED (Single Image Edge Detection) is one of the automatic methods of identifying the thermal front developed by Cayulla and Cornillon (1992). In remote sensing this method is included in edge detection. Edge Detection is image processing that results in edges of image objects, the purpose of which is to clarify the part you want detailed in the image or to improve the details of the image that are blurred due to errors from the image acquisition process. Hamzah et al., (2014) concluded in their research that the determination of the front using the SIED method was automatically able to detect the front in the entire extent of the image being analyzed and compared with the visual method. Podesta et al ,. (1993) also apply this method in the Northwest Atlantic.

This research aims to determine the spatial and temporal variability of the thermal front in Pangandaran waters, West Java. The results of the analysis of the number of front events that are formed are expected to be able to find the areas that experience the most front events as one of the predictions of areas with high fertility rates. With this high fertility rate, it can also be predicted that the place has a favorable aquatic environment and is suitable for the habitat of phytoplankton or other aquatic organisms to serve as a good area for fishing.

MATERIAL AND METHODS

This research was carried out in two stages. The first stage is the stage of data collection in Pagandaran waters, the fishing landing base of Pangandaran Fish Landing Port (PPI) which is carried out in January - February 2019. The second stage is data processing. The data used in this research are secondary data including current and SPL data. The SPL data used is level 3 Aqua MODIS (Moderate Resolution Imaging Spectroradiometer) satellite image data, monthly composite with a resolution of 4 km that can be accessed through the Ocean Color website service (http://oceancolor.gsfc.nasa.gov/cms/) during 3 years, January 2016 - December 2018. The downloaded image data is data in the format .nc (netCDF) so that before analyzing using ArcGIS, the data is processed first using ER MAPPER and SeaDAS. Current data used are satellite imagery of geostropic currents, monthly composites with a resolution of 0.125 ° x 0.125 ° which can be accessed via the website https://www.ecmwf.int/. The equipment used in this study is a PC that has been installed ER Mapper 7.1 software, SeaDAS 7.3.1, Arc-GIS 10.3, Microsoft Words, and Microsoft Excel, with an internet connection to download the required image data.

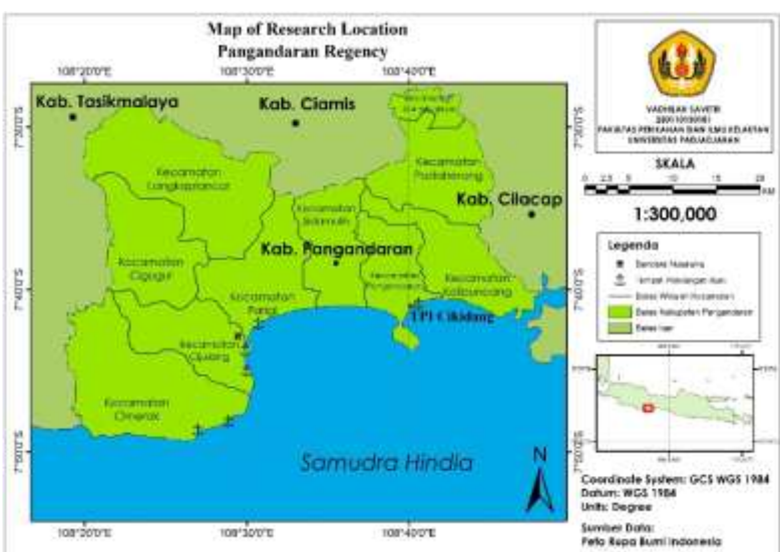

Figure 1. Research map

MATERIAL AND METHODS

The research method used is the survey method which includes field data collection (in-situ) and visual image analysis (ex-situ). In-situ data are field data covering the fishing operation time, fishing position, and mackerel fishing production obtained from the Pangandaran Fish Landing Port. Ex-situ data in the form of currents and temperature images obtained from satellite images that have been detected. In addition, to validate the fishing position data obtained, interviews were conducted with several fishermen.

Data Analysis

Thermal front analysis is done by taking monthly data. Data obtained from a MODIS aqua sesor with a spatial resolution of 4 Km. Input data used for thermal front detection processes, namely SPL data from the results of the processing or the results of automatic processing. The algorithm used, namely Single Image Edge Detection (SIED) and has been implemented using SPL data from MODIS Aqua satellite data downloaded by Wesite. Image data that was killed from the website is in hdf (hierarchical data format) format with floating data type. To be applied to the SIED toolbox in ArcGIS, the data type will be changed from floating to integrer with truncation. The scheme of the thermal front detection procedure can be seen in Figure.

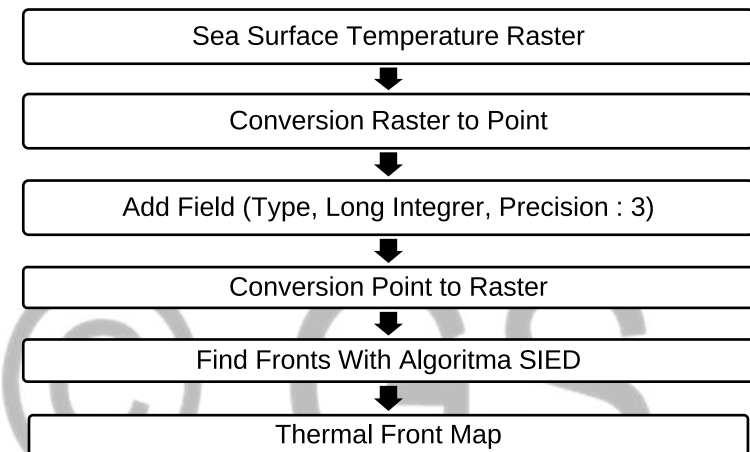

Figure 2. Procedure for detecting thermal fronts

The Cayula and Cornillon SIED algorithm (1995) are operated into 3 levels, namely:

1. Picture level, where static level is more dominant, i.e. determine the probability of segmented areas especially those affected by the presence of clouds, this is done by computing the entire image
2. Window level, at this level is to look for statistics of the possibility of sea surface temperature thermal fronts in all windows.
3. Local window, determine statistics on pixels by considering neighboring pixels. At this pixel there is a possible edge of the pixel.

The image used is the Aqua MODIS satellite image with a spatial resolution of 4 km, a histogram window size of 32 x 32 pixels with a median filter 3, and determine the histogram window stride value. In this research, the value is adjusted to the area and data, especially the threshold value used. Recurring fronts at the same location are thermal fronts that are considered permanent (persistent thermal front). You will also see the thermal front comparison that occurs in the month that represents the division of seasons.

Spatial data processing in detecting thermal front uses Cayulla Cornillon 1992's Single Image Edge Detection Alogarithm and is divided into two categories, namely:

1. A strong front, formed by a difference in SPL> = 0.5 ° C
2. A weak front, formed due to a SPL difference between 0.3 ° C

RESULTS AND DISCUSSION

SST Variability

Sea Surface Temperature Variability (SPL) Pangandaran waters show differences according to seasonal changes. The temporal difference in the fluctuation of SST values in Pangandaran waters ranges from 27.1 - 31.03 ° C. The lowest SST value in 2016 occurred in August with a value of 28.96 ° C while the highest SST value occurred in March with a value of 31.03 ° C. The highest SST value occurred again in March 2017 with a value of 30.02 ° C and the lowest SST value with a value of 27.34 ° C occurred in August. Unlike

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the previous two years, the highest SST value in 2018 occurred in April with a value of 30.04 ° C while the lowest SST occurred in September with a value of 27.23 ° C. The average SPL value for 3 years in Pangandaran waters is 29.2 ° C.

Variable SPL values in 3 years in Pangandaran waters by monsoon movement patterns and wind speed. Monsoon winds cause Indonesia to recognize the West Season and East Season which influence on land and waters of Indonesia.

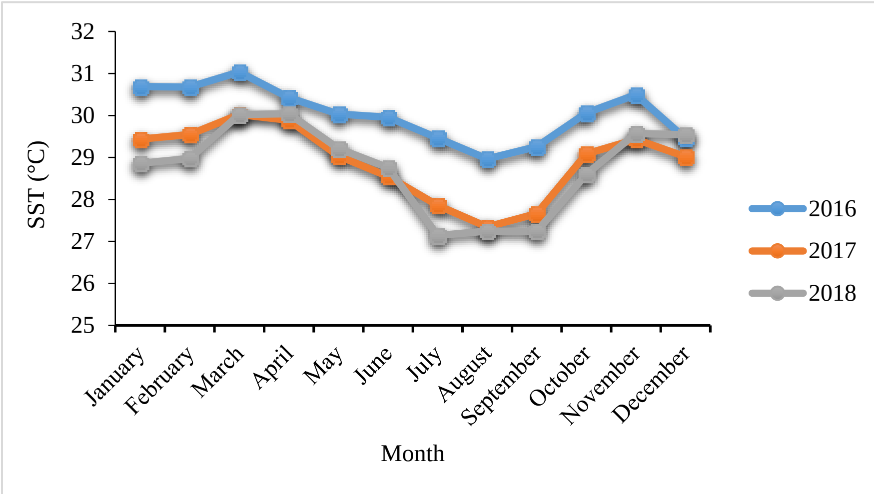

Figure 3. Sea Surface Temperature Variability in Pangandaran waters

Current Variability

The results of data processing of geostropic currents in Pangandaran waters in 2016-2018 have varying speeds (Figure 11). The average current speed ranges from 0.6 - 7.3 m / sec. The results of the time series analysis on the graph (Figure 11) show the current trend of rising velocity from year to year. The current with the lowest speed occurred in January 2016 while the highest speed occurred in July 2017. The current anomaly is suspected due to the influence of the season. The highest current speed in 2016 occurred in August with a value of 4.9 m / s and the lowest occurred in January with a value of 0.66 m / s. In July 2017 the highest current speed reached 7.31 m / s while the lowest speed was 1.72 m / s which occurred in March. In 2018 the highest current velocity occurred again in August with a value of 6.69 m / s and the lowest with a value of 1.37 m / s which occurred in March.

Based on the analysis between the SPL and the flow, it shows that the current affects the average SPL in Pangandaran waters. Where when surface surface velocity increases, the SPL decreases in temperature, and vice versa. The Pangandaran watershed watershed in general is influenced by seasonal fluctuations that occur along the southern coast of Java to Sumbawa.

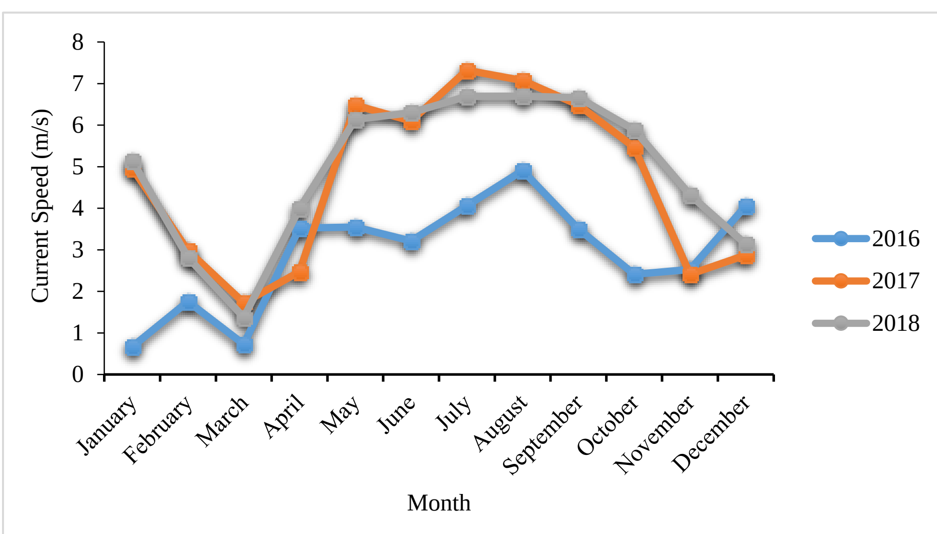

Figure 4. Flow Variability in Pangandaran waters

Spatial Thermal Front and Current Distribution

2016

The Thermal Front pattern formed in 2016 consists of a weak front (black line) and strong front (red line). Generally, the thermal front is formed in the southern region of Pangandaran and is temporary (temporary). Based on visual analysis, a strong-intensity thermal front is formed in the transition season 2 and the west season, with peaks forming in November marked with a red line. Whereas in transition season 1, the formed thermal front is a weak front. Entering October the intensity of the formation of the thermal front began to increase with the intensity of its weak front allegedly due to the effects of the transition from the east season to the transition season 2. The water temperature conditions in September showed 29.3 ° C and showed a fairly warm water mass until December (29.5 ° C). This is thought to be part of Arlindo. As it is known that the mass flow of water from the Pacific Ocean to the Indian Ocean passes through most of the seas in Indonesia that pass through waters in western Sumatra.

The current that formed in 2016 is quite varied, the east season is the current that reaches the highest speed with a value of 6.38 m / s, while for the lowest current velocity occurs in the transition season 1 with a value of 0.01 m / s.

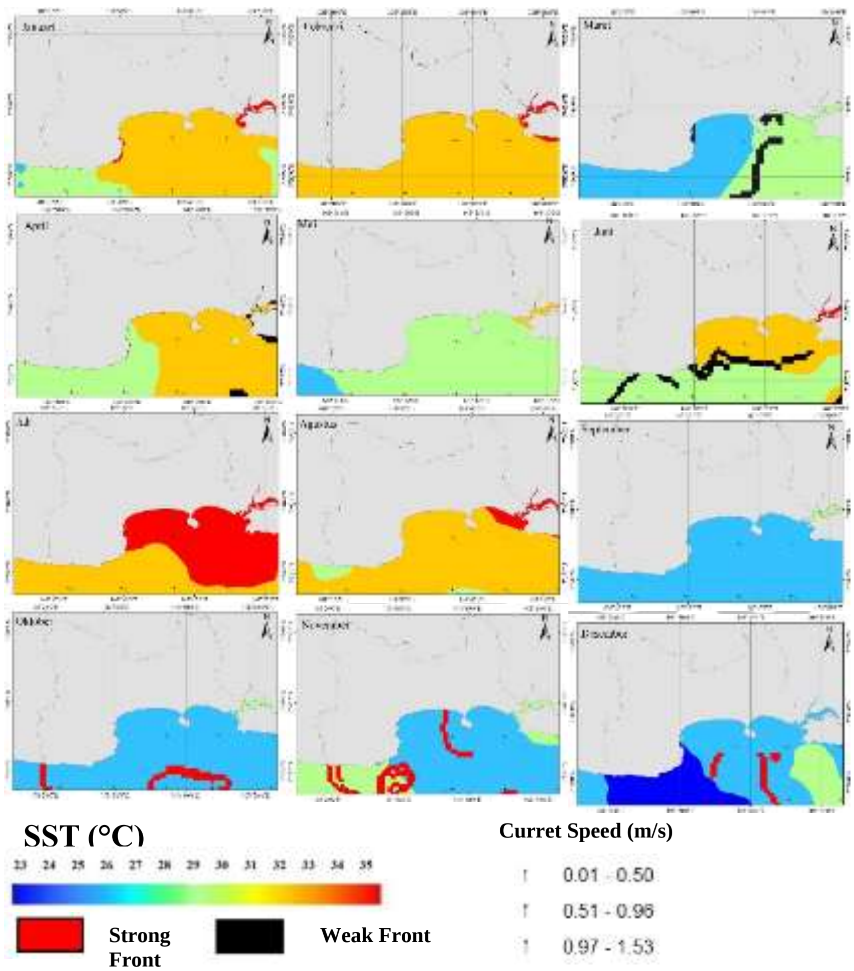

Figure 5. Thermal fronts formed in 2016

2017

SPL moves spatially, warm water masses tend to move from the Indian Ocean. Transition season (east-west) shows the difference between the SPL movement and the west season. In this season, the distribution of SPL shows that it has been mixed with warm water and cold water masses. Recurring fronts in the same region occurred in December, but the formed thermal front is a weak front. The maximum current velocity that occurs in 2017 constant occurs in the east season reaching 9.88 m / s, while the minimum current occurs again in the transition season 1 with a value of 0.25 m / s.

Hanintyo et al. (2015) suggested that the number of thermal front events in the waters of the Banda Sea, the Maluku Sea, and Sulawesi tends to be more prevalent in coastal waters. That is because the front formed is caused by water slap from the mainland with different temperature characteristics compared to the SPL. While the results of this research indicate that the waters of

Pangandaran approaching the bay have more thermal front events than those in the western region. This may be due to the rivers in the western area of Pangandaran are small rivers. So that it causes the possibility of forming a relatively small thermal front.

Daulay (2019) examined the formation of thermal fronts in the Tropical Waters of the Eastern Indian Ocean with the temperature gradient used was 0.5 ° C and thermal front temperatures ranging from 26.4-32 ° C occurred in coastal waters and waters off the Indian Ocean with The lowest temperature thermal front occurs in September. Slightly different from previous studies the temperature gradient used was 0.5 ° C and the temperature of the thermal front ranged from 25.8 to 34 ° C with the lowest temperature the thermal front occurred in May.

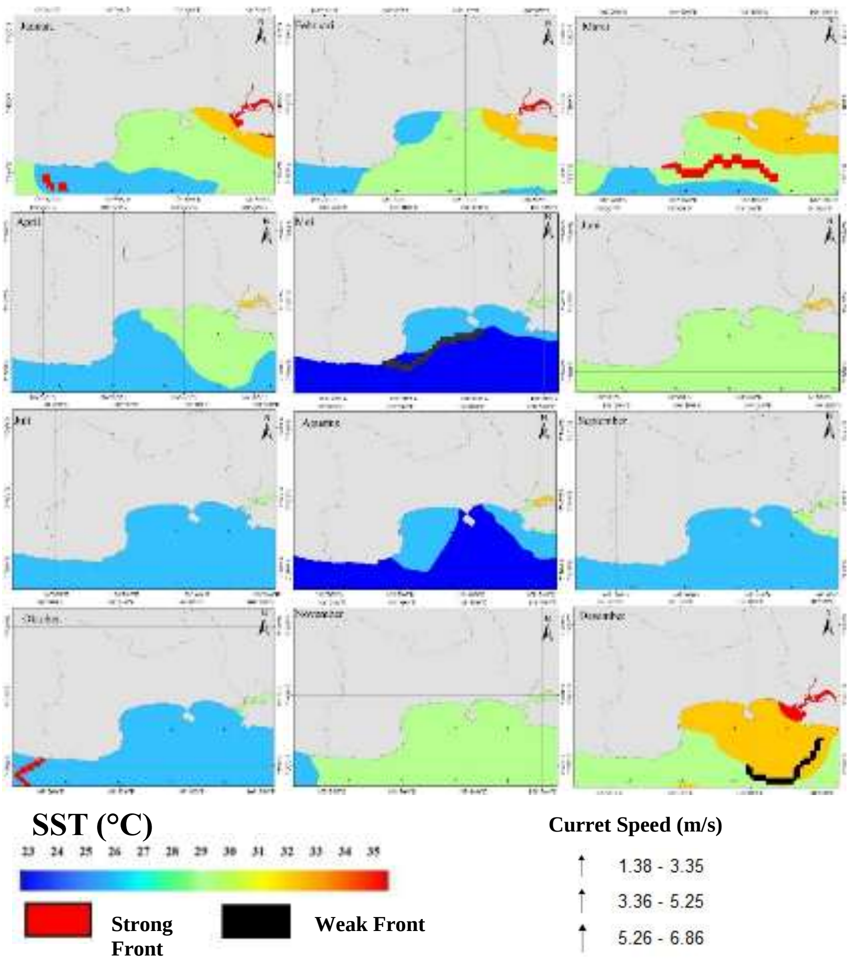

Figure 6. Thermal fronts formed in 2017

2018

The results of the analysis of the detection of the thermal front in 2018 show the existence of spatial and temporal thermal front fluctuations. The thermal front formed in the west season is due to the presence of water mass pockets formed based on differences in the surrounding SPL. The pockets of water mass that are warmer than the surrounding waters gather in the southern area of Pangandaran so that it can cause thermal fronts with relatively large temperature differences. The SPL movement in the west season (December, January, and February) visually shows hot temperatures (33.0 - 34.9 ° C) right in Pangandaran waters. This is due to the influence of SPL in the transition season 2 which tends to be warm.

This is consistent with the statement Wyrtki (1961) in Hanintyo et al ,. (2015) that during the west monsoon, the rainfall will increase and many river water will enter the sea, causing a dilution of sea water, and vice versa during the east monsoon. In the west season, the rainfall that occurs will be higher, so that the blows of water from the mainland will also have a temperature that is quite different from usual, so that the possibility of differences in temperature when reaching the ocean will result in the formation of a front, then in the west season the thermal front formed will be more compared to the east season.

Currents that occur in the west season in 2018 in Pangandaran waters have an average speed of 1.3 to 7.00 m / s flowing from west to east, these currents originate from western waters of Java to the east of Java waters. The direction of the dominant currents heading towards the east is thought to be the Java Coast Current (APJ), this is in accordance with the statement of Wyrtki (1961) in Safitri et al. (2012), APJ develops in the west season, the direction of the current flows from west to east. In 2018 the current with maximum speed occurs again in the east mecapau with 9.37 m / s. Transition season 1 has a minimum speed value of 0.36 m / s.

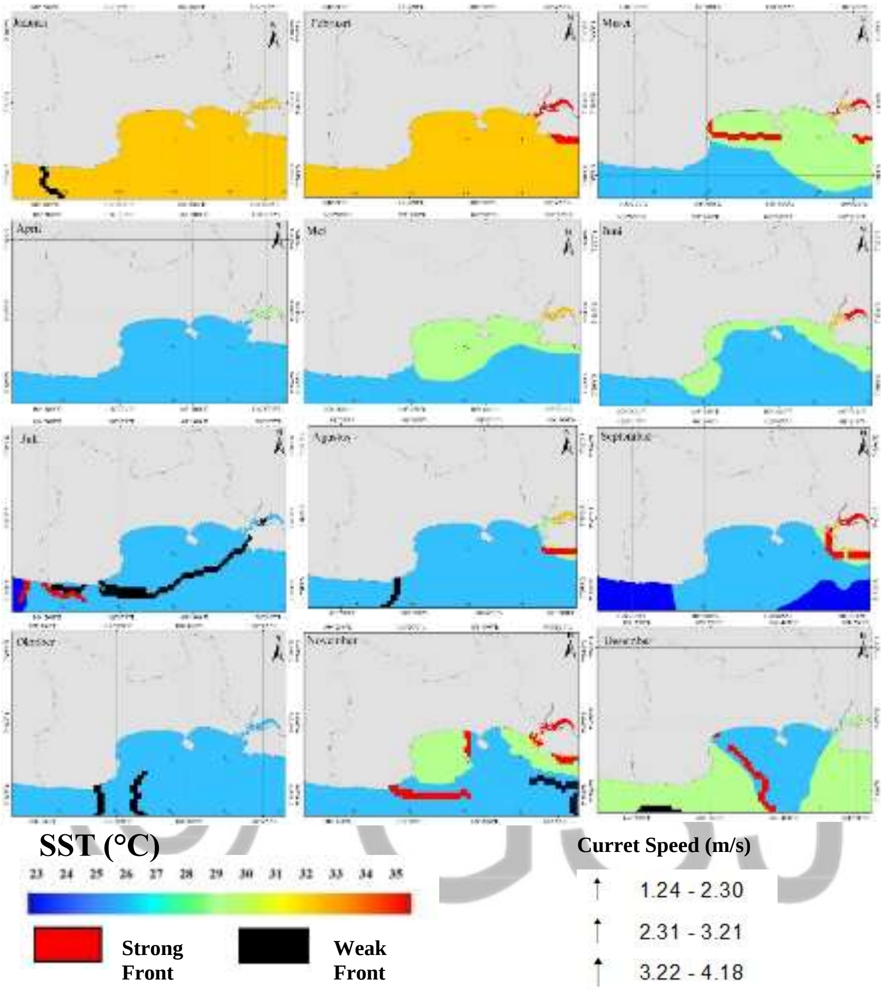

Figure 7. Thermal fronts formed in 2018

Conclusion

The results of sea surface temperature analysis show that in the west season and transition season 1 dominates the formation of thermal fronts. The highest number of front events in a waters is 9 times the occurrence of fronts from 3 months in 1 season, namely waters around Pangandaran Bay. It has the highest average monthly area in 3 years in October (transitional season 2) of 87.83 km2, patterned width east of Pangandaran waters during the west (rainy) season while for the eastern season the intensity of the front is rarely seen or even none was suspected because in the dry season so that there is no mixing of cold and warm water masses in the region. In general, the thermal front distribution follows the location of ocean mixing due to the pattern of movement of sea surface currents by monsoons.

References

[1] [1] Ahmad, A. L., Syamsuddin, M. L., & Purba, N. P. 2017. Thermal Front Conditions In terms of EL NINO and ARLINDO in the South Waters of East Java and Bali in East Muson. Journal of Fisheries and Maritime Affairs. (1) 186-191

[2] [2] Angraeni, I., R.N. Safruddin & M. Zainuddin. 2014. Spatial and temporal analysis of tuna catches (Katsuwonus Pelamis) and thermal fronts in the transitional season in the waters of Bone Bay. J. PSP IPTEKS. (1): 20-27

[3] [3] Cayulla, J.F. and P. Cornillon, "Edge Detection Algorithm for SST Images", Journal of Atmospheric and Oceanic Technology 9 (1): 67-80 (1992).

[4] [4] Cayulla, J.F. and P. Cornillon, "Multi Image Edge Detection for SST Images", Journal of Atmospheric and Oceanic Technology 12: 821-829 (1995).

[5] [5] Daulay S.R., Sari T.E.Y., Usman U., and Jhonnerrie R. 2019. Characteristics of Thermal Fronts in Tropical Waters of the Eastern Indian Ocean. Journal of Fisheries 21 (1): 25-29

[6] [6] Fadika Ulha, Aziz Rifai, Baskoro Rochaddi. 2014. The Direction and Seasonal Wind Speed and Its Relation to the Distribution of Sea Surface Temperature in the South of Pangandaran, West Java. Journal of Oceanography. 3: 429 - 437

[7] [7] Hamzah, R., T. Prayogo & W.K. Harsanugraha. 2014. Identification of the thermal front from Terra / Aqua MODIS satellite data using the single image edge detection method (Case Study: North and South Waters of Java Island). Proceedings. National Seminar on Remote Sensing.

[8] [8] Hanintyo, R., S. Hadianti., R.M.P. Mahardhik., J.S. Aldino & F. Islamy. 2015. Seasonal distribution of thermal front events based on Aqua-MODIS imagery in WPP-RI 714, 715 and 716. Proceedings. National Seminar on Remote Sensing.

[9] [9] Hendriati, N., Suwarso., Aldrian, E., Amri, K., Andiastuti, R., Sachoemar, S.I., Wahyono, I.B .. 2005. Seasonal Variation of Pelagic Fish Catch around Java. Oceanography 18 (4), Special Issue of The Indonesian Seas: 112 - 123.

[10] [10] Olson, D. B, Hitchcock, G.I., Mariano, A.J, et al. 1994. Life on the Edge: Marine Life and Fronts. Oceanography 7 (2): 52-50.

[11] [11] Podesta, G. P., J. A. Browder. 1993. Exploring the association between swordfish catch rates and thermal fronts on U.S. longline grounds in the western North Atlantic. Continental Shelf Research 13: 253-277.

[12] [12] Safitri et al. 2012. Arlindo Flow Variations and Oceanographic Parameters in the Timor Sea as an Indication of ENSO Events. Journal of Tropical Marine Science and Technology. 4 (2): 369-377.

[13] [13] Wyrtki, K. 1962. The Upwelling in The Region between Java and Australia during the South East Monsoon ", Australian Journal of Marine and Freshwater Research 13 (3): 217-225.