

Large pelagic potential fishing ground based on sea surface temperature and chlorophyll-*a* satellite image data in west season in Java Sea (case study: Indramayu Regency)

Mochamad D. Ghifary, Alexander M. A. Khan, Lantun P. Dewanti, Ibnu B. B. Suryadi

Department of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University, Bandung, West Java, Indonesia. Corresponding author: M. D. Ghifary, mochamad17020@mail.unpad.ac.id

Abstract. Potential fishing ground can be determined through remote sensing using satellite imagery. One of the satellite images that can detect the distribution of chlorophyll-*a* and sea surface temperature (SST) in the waters is an Aqua satellite image with a MODIS (Moderate Resolution Imaging Spectroradiometer) sensor. The purpose of this observation activity is to make an estimation analysis of potential areas for large pelagic fishing based on satellite images of SST and chlorophyll-*a* distribution in the eastern monsoon in the northern waters of Java Island, Indramayu Regency in the west season. The method used in this observation consisted in descriptive analysis and simple linear regression analysis. The results of the analysis of SST in the northern waters of Indramayu Regency during December 2019 to May 2020 ranged from 27 to 35°C. Chlorophyll-*a* concentration during the observation changes every month. The lowest chlorophyll-*a* concentration was 0.1 mg m⁻³ and the highest is 2.5 mg m⁻³. Estimation of large pelagic fishing ground in Java Sea, Indramayu in December 2019-May 2020 varies every month. This is due to changes in SST and chlorophyll-*a* concentration as well as changes in seasons that occur in Java Sea, Indramayu Regency from the west season (December-February) then to the transitional season (February-April) and also the transitional season to the eastern season (May).

Key Words: fishing area, Aqua satellite MODIS, chlorophyll-*a*, sea surface temperature.

Introduction. Indramayu Regency is one of the largest fish-producing districts in West Java (Syarif et al 2014). The contribution of the Gross Regional Domestic Product (GRDP) of the fisheries subsector in 2019 was Rp. 8,926 million or 20.12% of the total GRDP of Indramayu Regency (Indramayu BPS 2019). The total fishery production of Indramayu Regency in 2020 reached 535.729,36 tons, consisting of capture fisheries 157.320,60 tons (29.36%), aquaculture 327.045,99 tons (61.04%), 51.363,26 tons (9.5%) (Indramayu DISKANLA 2020). Capture fisheries production from Indramayu Regency provides the largest contribution to capture fisheries production in West Java (West Java Province RPJMD 2018).

According to Hernawati et al (2018) capture fisheries production in the Karangsong Fish Landing of Indramayu Regency shows that the composition of the fish caught is dominated by tuna (*Euthynnus affinis*) as much as 54% or 1,177 tons of the total catch of 2,166 tons. Tongkol (*Euthynnus* sp.) is one of the large pelagic fish that has a predictable movement and distribution pattern from various predictive indicators, one of which is sea surface temperature (SST) and chlorophyll-*a* (Shabrina et al 2017).

Temperature is one of the main environmental oceanographic parameters most often needed because it is useful in studying the physical and chemical processes that occur in the ocean (Bukhari et al 2017). Temperature affects metabolic and reproductive activities, because temperature is an important factor that helps life processes and the spread of organisms in the sea (Bukhari et al 2017). Meanwhile, chlorophyll-*a* is a pigment capable of photosynthesis and is present throughout Barnes's phytoplanktonic

organisms (Barnes & Hughes 1998). The number of phytoplankton in marine waters can generally be seen from the amount of chlorophyll-*a* in the waters. The distribution of water fertility can be determined by mapping the distribution of chlorophyll-*a* concentrations (Setyobudiandi 1996).

Geographical determination of fishery areas (fishing ground) can be determined based on physical and chemical parameters of oceanographic waters (Bukhari et al 2017). Fishing ground can be determined via remote sensing using satellite imagery. One of the satellite images that can help the distribution of chlorophyll-*a* and SST in the waters is the Aqua satellite image with the MODIS (Moderate Resolution Imaging Spectroradiometer) sensor. Aqua MODIS has a mission to gather information about the air cycle on earth that has more spectral wavelengths and a more accurate recording area (NASA 2014).

The purpose of this study was to estimate the potential for large pelagic fishing areas based on sea surface temperature (SST) satellite imagery and the distribution of chlorophyll-*a* in the east monsoon in the northern waters of Java Island, Indramayu Regency, West Java.

Material and Method

Time and place. This observation was carried out in December 2020. The location of the observation is the northern waters of Indramayu Regency and its surroundings. Chlorophyll-*a* and SST image data collection uses the results of the Aqua MODIS satellite detection which was carried out in the western season, namely December 2019 - May 2020.

Materials and tools. The equipment used in this observation is 1 unit of laptop to process data and the Windows XP Professional Operating System, Ermapper 7.1, Arcgis, SeaDAS 7.5.3, and Microsoft word 2013. While the materials used are satellite imagery oceancolor.gsfc.nasa.gov from December 2019 to May 2020 as well as a 1:1,000,000 topographic map of Indonesia (digital map) as a reference for geometric correction.

Method. The method used in this observation is the descriptive analysis and simple linear regression analysis. Descriptive analysis is a statistic that is used to analyze data by describing the collected data as is without the intention of making generalized conclusions or generalizations (Kusnadi & Mutoharoh 2016). Meanwhile, simple linear regression analysis is an analytical tool used to measure the effect of the independent variable (X) and the dependent variable (Y) (Romanti & Rohita 2020).

Observation procedure. The observation procedure carried out consisted on:

- 1). Literature survey, which studies deeply about the meaning and concept of GIS, remote sensing, especially its application to SST and chlorophyll distribution and its relationship with the distribution of large pelagic fish;
- 2). Download and collect data on SST and chlorophyll-*a* on oceancolor.gsfc.nasa.gov from December 2019 to May 2020;
- 3). Data processing:
 - a. Geometric correction is performed to eliminate image spatial errors caused by several factors when recording by satellite sensors;
 - b. Radiometric correction, namely (1) rectifying (correcting) or restoring (restoring) an image so that the image coordinates are in accordance with the geographic coordinates; (2) registering (matching) the position of the image with other images or transforming the coordinate system of multispectral images or multitemporal images; (3) image registration into a map or transformation of the image coordinate system into a map, which produces an image with a certain projection system;
 - c. Determine SST and chlorophyll-*a*;
 - d. Determine the prediction area for pelagic fishing according to the results of the analysis of SST and chlorophyll-*a* images and other supporting data;

- 4). Analysis of geometric errors and analysis of SST, chlorophyll-*a* and estimation of pelagic fishing grounds with statistical analysis of the data that has been obtained;
- 5). The results obtained from this study are prediction maps of large pelagic fish catchment areas for 6 months in the western season.

Results and Discussion

Distribution of sea surface temperature (SST). Temperature fluctuations and geographic changes act as important factors determining fish concentration and grouping. The high and low temperature also affects the productivity of the catch, because each type of fish has a certain temperature range for its survival (Zulkhasyni 2015).

The SST in northern waters of Indramayu Regency from December 2019 to May 2020 is presented in Figure 1. The values of SST ranged from 27 to 35°C.

Based on this research, it is proven that in the west season (December-April) the SST in the northern waters of Indramayu Regency ranges from 27 to 35°C with an average SST of 29-31°C, while in the east season in May the average SST is 28-30°C. This is very much proportional to the monthly average SST in the waters of the Java Sea in the west monsoon ranging from 29.06 to 30.63°C, and in the East monsoon ranging from 29.65 to 30.98°C (Kurniawati et al 2015).

The fluctuation of SST values in the northern waters of Indramayu Regency can be caused by several factors, including oceanographic conditions such as wind and currents and meteorological conditions. According to research of Laevastu & Hayes (1981), the factors that influence the SST are meteorological conditions which have an important role in this, namely rainfall, evaporation, humidity, air temperature, wind speed, sun intensity so that SST usually follows a pattern.

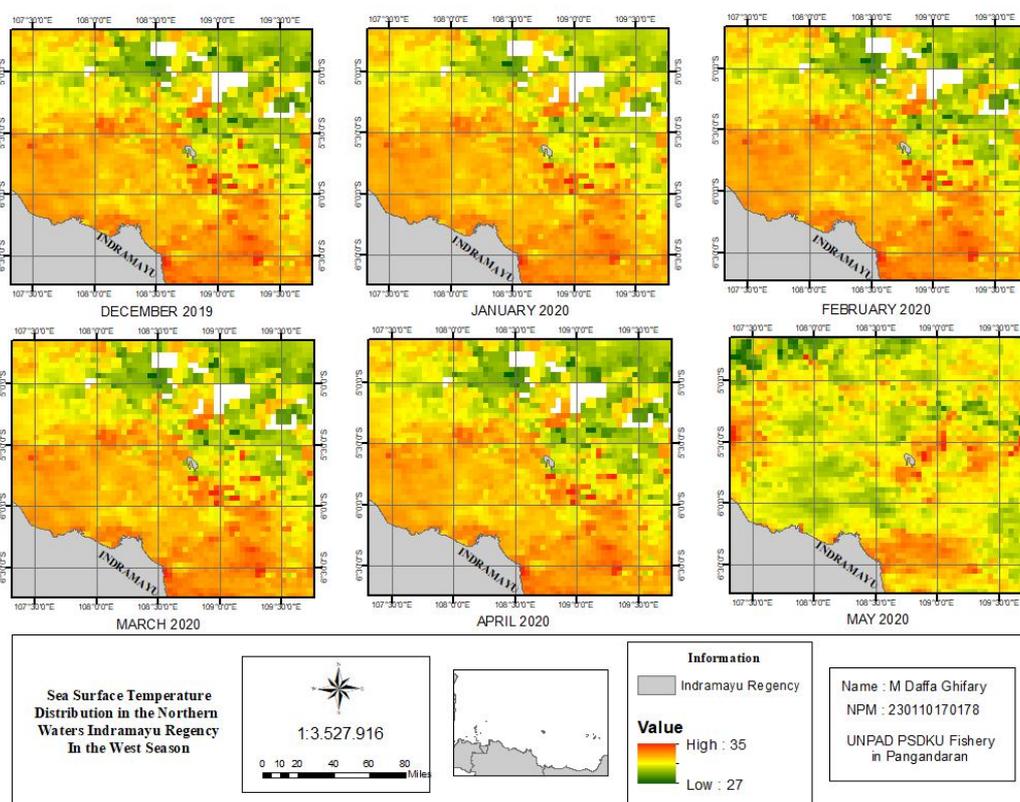


Figure 1. Map of SST distribution in northern waters of Indramayu Regency in December 2019 - May 2020.

Distribution of chlorophyll-a. Chlorophyll-a is closely related to the primary productivity of the waters as indicated by the amount of phytoplankton biomass which is the first chain of pelagic fish food. The distribution of chlorophyll-a during December 2019 to May 2020 can be seen in Figure 2. The value of chlorophyll-a concentration during the observation varied where the lowest concentration value was 0.1 mg m^{-3} , and the highest was 2.5 mg m^{-3} .

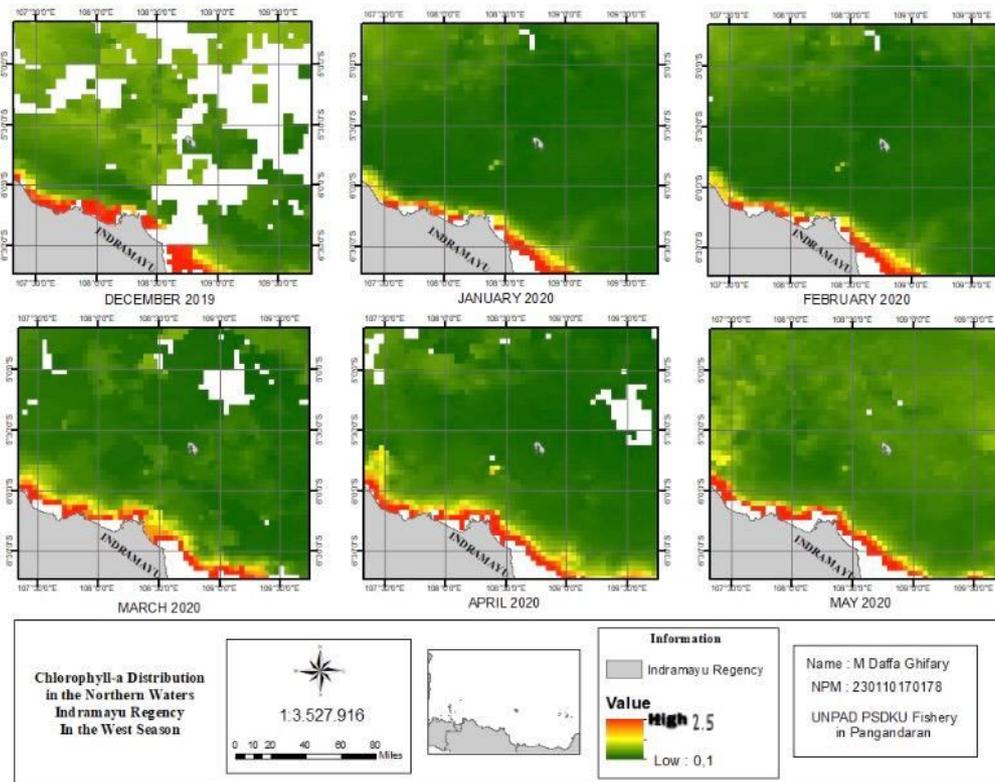


Figure 2. Map of chlorophyll-a distribution in Indramayu Regency in December 2019 - May 2020.

The chlorophyll-a concentration in December 2019 was dominated by values of $0.1\text{-}1.2 \text{ mg m}^{-3}$, January to April was dominated by values of $0.1\text{-}0.5 \text{ mg m}^{-3}$, while in May it was dominated by values of $0.1\text{-}1.2 \text{ mg m}^{-3}$, as in December.

The fluctuations in the values that occurred in the chlorophyll-a concentration during December 2019 to May 2020 were due to changes in monsoons which caused the circulation pattern of sea water masses that passed through the Java Sea. Besides that the season factor also affected the chlorophyll-a concentration where December 2019 tended to be higher than January to April 2020, this is due to the western season where the water tends to be bumpy accompanied by strong winds, allowing an increase in the concentration of chlorophyll-a.

According to Yoga et al (2014) the monsoon wind system affects the rate of primary productivity in Indonesian waters, while according to Kurniawati et al (2015) this variation is caused by differences in sunlight intensity and nutrient concentrations contained in the waters. The concentrations of chlorophyll-a is higher in coastal waters, and lower in offshore waters. This is very much related to the current observation.

Estimation of large pelagic fishing areas. Oceanographic parameter conditions such as SST and chlorophyll-a concentration in several studies have played a major role in determining the variability of fish catches, especially pelagic fish, so that in estimating fishing areas it is very important to pay attention to these two oceanographic factors (Tangke 2014).

According to the research of Setyaningsih et al (2014) the estimation of fishing area zones, especially pelagic fish, is based on SST, namely low temperatures ranging

from 26 to 29°C, and concentrations of chlorophyll-*a* ranging from 0.5 to 2.5 mg m⁻³. Meanwhile, according to research of Tangke (2014) large pelagic fish are more influenced by the SST so that their distribution is in offshore waters, this prediction is in accordance with the observations made, that the waters of Indramayu Regency are still a potential place as a large pelagic fishing area.

It can be seen in Figure 3 that the estimation of large pelagic fishing areas in the northern waters of Indramayu Regency in December 2019 - May 2020 varies every month and the location of the large pelagic fishing area in northern waters of Indramayu Regency is in offshore waters.

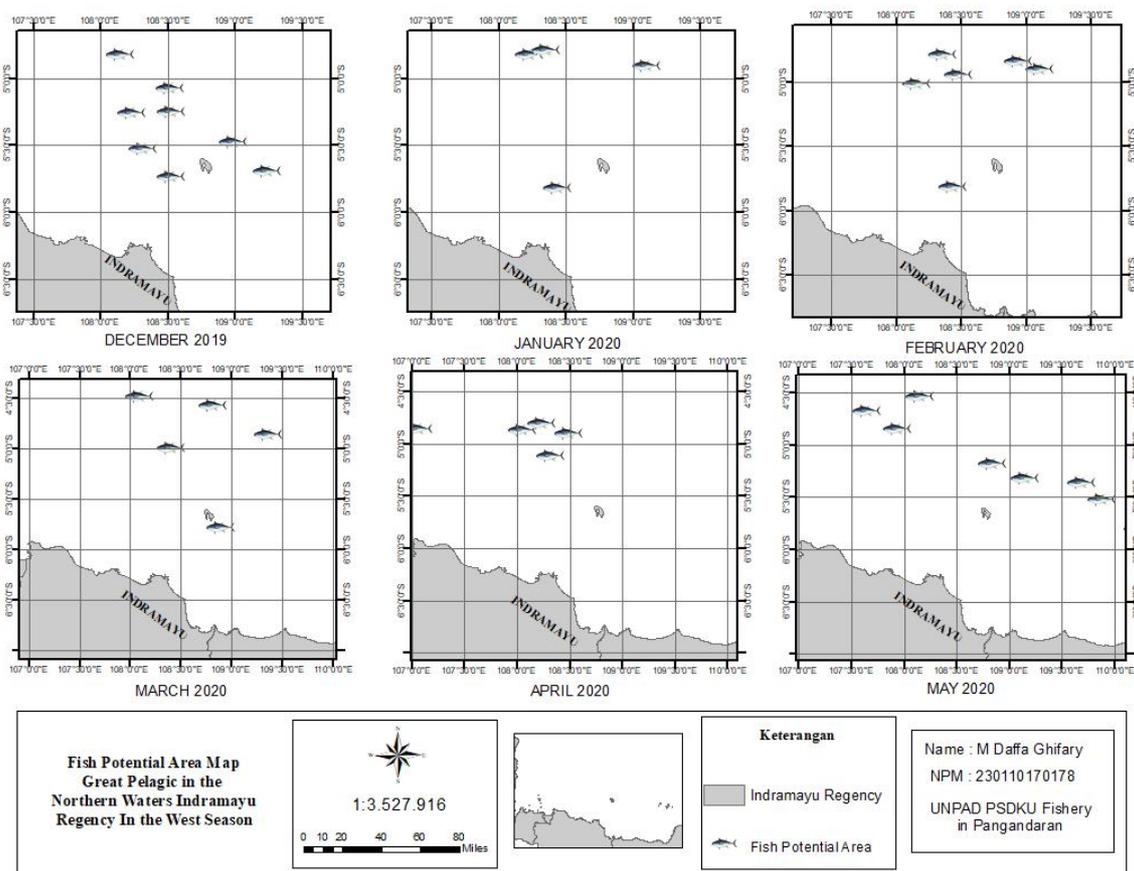


Figure 3. Map of large pelagic fishing areas in northern waters of Indramayu Regency in December 2019 - May 2020.

From the results of the observations that have been made, the authors suggest following up the observations that have been made to validate fishing areas in the northern waters of Indramayu Regency with large pelagic fish catches. If the data in the field are in accordance with this observation, the author suggests fishermen, especially to catch large pelagic fish in northern waters, Indramayu Regency, and to catch fish in December and May due to the changing seasons.

Conclusions. The values of the SST in Indramayu Regency during December 2019 to May 2020 ranged from 27 to 35°C. Chlorophyll-*a* concentration values were between 0.1 and 2.5 mg m⁻³. The waters of Indramayu Regency are potentially places for large pelagic fishing grounds.

Estimation of large pelagic fishing ground of Indramayu Regency in December 2019 - May 2020 varies every month, this is due to changes in seasons that occur in northern waters, Indramayu Regency from the western season (December-February) then to the transitional season (February-April) and the transition season to the eastern

monsoon (May) which causes changes in SST and chlorophyll-*a* concentration every month.

Conflict of interest. The authors declare that there is no conflict of interest.

References

- Barnes R. S. K., Hughes R. N., 1998 An introduction to marine ecology. 2nd edition. Blackwell Scientific Publications, Oxford.
- Bukhari B., Adi W., Kurniawan, 2017 [Estimation of mackerel fishing area based on distribution of sea surface temperature and chlorophyll-*a* in Bangka waters]. *Jurnal Sumberdaya Perairan Akuatik* 11(1):26-47. [in Indonesian]
- Hernawati D., Chaidir D. M., Meylani V., Putra R. R., 2018 [Potential catch and abundance of fish resources in the Karangsong landings, Indramayu]. *Bioedusiana: Jurnal Pendidikan Biologi* 3(2):69-76. [in Indonesian]
- Indramayu BPS, 2019 [Distribution of percentage of GRDP in Indramayu Regency at current prices by business field (percent)]. Indramayu: Central Bureau of Statistics. Available at: <https://indramayukab.bps.go.id/indicator/52/95/1/distribusipersentasepdrbkabupaten-indramayu-atas-dasar-harga-berlaku-menurut-lapangan-usaha.html>. Accessed: May 2021. [in Indonesian]
- Indramayu DISKANLA, Indramayu District Marine and Fisheries Service, 2020 Government Agency Performance Accountability Report 2020. Available at: https://drive.google.com/file/d/1TEvylfF_AXf_Df90PdyO8ybc96IJ2yjT/view. Accessed: May 2021. [in Indonesian]
- Kurniawati F., Sanjoto B. T., Juhadi, 2015 [Estimation of potential catching of small pelagic fish in Java Sea waters in West and East seasons using Aqua Modis Image]. *Jurnal Geografi* 4(2):9-19. [in Indonesian]
- Kusnadi Y., Mutoharoh, 2016 [The effect of accepting online registration applications to the number of registration in state elementary school Jakarta]. *PARADIGMA: Jurnal Komputer dan Informatika* 18(2):89-101. [in Indonesian]
- Laevastu T., Hayes M. L., 1981 Fisheries oceanography and ecology. Fishing News Books, 199 pp.
- Romanti S., Rohita, 2020 [Teachers role in increasing children's ability in solving problems at the Center of Natural Materials]. *Jurnal Audhi* 3(1):1-9. [in Indonesian]
- Setyobudiandi, 1996 [Study of several ecobiological aspects (phytoplankton and benthos) and bio-optics of phytoplankton in relation to chlorophyll-*a* remote sensing in South and North Java waters]. Research report, Faculty of Fisheries and Marine Sciences, Bogor Agricultural Institute. [in Indonesian]
- Setyaningsih A. S., Sudaryatno S., Widyatmanti W., 2014 [The effect of changes in the distribution of sea surface temperature and chlorophyll concentration on the production of pelagic fish in the southern waters of Central Java and the Special Region of Yogyakarta]. *Jurnal Bumi Indonesia* 3(3):1-10. [in Indonesian]
- Shabrina N. N., Sunarto, Hamdani H., 2017 [Determination of tuna fishing areas based on the sea surface temperature distribution approach and fish catching products in the northern waters of Indramayu, West Java]. *Jurnal Perikanan dan Kelautan* 8(1):139-145. [in Indonesian]
- Syarief A., Rustiadi E., Hidayat A., 2014 Analysis of fisheries subsector in the regional development of Indramayu Regency. *TATALOKA* 16(2):84-93. [in Indonesian]
- Tangke U., 2014 [Population parameters and exploitation rate of tuna (*Euthynnus affinis*) in Morotai Island waters]. *Agrikan: Journal of Fisheries Agribusiness* 7(1):74-81. [in Indonesian]
- West Java RPJMD, West Java Province Medium Development Plan 2018-2023. Bandung, West Java Provincial Government 2018. [in Indonesian]
- Yoga R. B., Setyono H., Harsono G., 2014 [Upwelling dynamics based on variability of sea surface temperature and chlorophyll-*a* in Southern Java water]. *Jurnal Oseanografi* 3(1):57-66. [in Indonesian]

Zulkhasyni, 2015 [Effect of sea surface temperature on skipjack fish catch in Bengkulu city waters]. *Jurnal Agroqua: Media Informasi Agronomi dan Budidaya Perairan* 13(2):68-73. [in Indonesian]

Received: 21 April 2021. Accepted: 23 June 2021. Published online: 07 December 2021.

Authors:

Mochamad Daffa Ghifary, Department of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University, Campus UNPAD Cintaratu, Cikembulan-Sidamulih, Pangandaran Regency, West Java, Pangandaran, Indonesia, e-mail: mochamad17020@mail.unpad.ac.id

Alexander M. A. Khan, Department of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University, Campus UNPAD Cintaratu, Cikembulan-Sidamulih, Pangandaran Regency, West Java, Pangandaran, Indonesia, e-mail: alexander.khan@unpad.ac.id

Lantun Paradhita Dewanti, Department of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University, Campus UNPAD Cintaratu, Cikembulan-Sidamulih, Pangandaran Regency, West Java, Pangandaran, Indonesia, e-mail: lantun.paradhita@unpad.ac.id

Ibnu Bangkit Bioshina Suryadi, Department of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University, Campus UNPAD Cintaratu, Cikembulan-Sidamulih, Pangandaran Regency, West Java, Pangandaran, Indonesia, e-mail: ibnu.bangkit@unpad.ac.id

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

How to cite this article:

Ghifary M. D., Khan A. M. A., Dewanti L. P., Suryadi I. B. B., 2021 Large pelagic potential fishing ground based on sea surface temperature and chlorophyll-*a* satellite image data in west season in Java Sea (case study: Indramayu Regency). *AAFL Bioflux* 14(6): 3469-3475.