

The effect of upwelling on water productivity based on chlorophyll-a parameters in Sumatra and Java Waters (Edge of Jakarta Bay, South Lampung and South Coast of Central Java)

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Abstract: A natural phenomenon in the form of rising fish to land that has occurred recently has been occurring in several waters. Some of these waters are located in the Ujung Teluk Jakarta area to be precise at Mutiara Beach, then followed within a few consecutive days in South Lampung, and the coast of Central Java to be precise at Bopong Beach. Upwelling is the movement of seawater masses that contain higher nutrients to the surface due to pressure from the sea. This study aims to determine the effect of upwelling on water productivity. The observation method uses ENSO and IOD analysis and predictions in December which show Moderate La Nina conditions. The Meteorology, Climatology and Geophysics Agency explained that the flow of air masses is dominated by westerly winds, resulting in a meeting of winds in Lampung and Banten. Upwelling is an indicator of the large concentration of fish rising from the sea coast to the mainland, so that many fishermen get fish without having to go to sea. This indicator can be used to observe the linkage of potential fishing grounds to fishery production. The high primary productivity of the waters makes fish go ashore in large quantities. One of the factors influencing extreme climate change is the end of 2022 and is predicted to continue until 2023.

Keywords: Upwelling, Fish, Waters, Productivity.

Introduction

The high nutrient content on the surface of the waters due to the movement of water masses from within the sea is the main factor for fish to find food sources at sea level (Swara et al., 2022). The movement of rising water masses from the lower layers to the surface so that the surrounding waters become fertile and rich in nutrients is known as upwelling (Rahman and Kunarso, 2022). The nutrients available on the surface of the waters will be used by phytoplankton to grow more. Water productivity in aquatic ecosystems is mostly carried out by phytoplankton. One important factor in marine ecosystems is the primary productivity of waters, which play a role in the carbon cycle and food chains for heterotrophic organisms (Nuzappril et al., 2017).

Indonesia has diverse water characteristics and is divided into several Fisheries Management Areas of the Republic of Indonesia (WPP-NRI) in accordance with PERMEN-KP No. 18 of 2014. One of the water areas dominated by large pelagic fish is WPP 573, while other resources are demersal fish and shrimp in coastal waters (Nurhayati et al., 2018). The characteristics of WPP 573 waters are waters that have relatively narrow and steep oceanic basins with coral and sandy bottoms, especially in Java and Sumatra waters. The water currents on the south coast of Indonesia and the north coast of Australia are in a warm lane with low salinity, flowing from the Pacific Ocean westward to the Indian Ocean via the Indonesian Cross Current (Arlindo), this area is heavily

affected by the monsoon cycle and tropical storms (Jatisworo et al., 2020).

It turns out that oceanographic conditions are not only influenced by monsoon wind cycles and tropical storms, the influence of the Indian Ocean Dipole (IOD) and El Niño Southern Oscillation (ENSO) phenomena can also cause dynamics in Indonesian waters. According to Seprianto et al. (2016), ENSO and IOD are the variability of the global climate that can affect oceanographic conditions. ENSO is a pattern from which appears in the eastern Pacific Ocean. This condition is characterized by an anomaly in sea surface temperatures that cools (La Nina) or warms (El-Niño) from normal conditions. A similar phenomenon also occurs around the Indian Ocean equator which is also known as the IOD.

This event affected the climate in Indonesia and had an impact on other countries in the Indian Ocean basin area (Jatisworo et al., 2020). The ENSO and IOD phenomena can actually have an impact on the fisheries sector. Several studies have shown that this anomaly affects fisheries directly or indirectly through changes in chlorophyll-a concentrations as a food source, potential distribution areas, catch production and CPUE and changes in fishing seasons (Puspasari et al., 2021). The main sign that we can analyze from the influence of the monsoon cycle, ENSO, and IOD is Sea Surface Temperature (SST). The parameters used to measure the presence of upwelling are SST and chlorophyll-a (Swara et al., 2022). The relationship between chlorophyll-a and primary productivity is linear, so that if there is an increase in the concentration of chlorophyll-a in the waters it is directly proportional to the increase in the value of the primary productivity of the waters (Waas and Latumeten, 2019).

The definition of primary productivity is the speed of carbon binding through the process of photosynthesis and the production of organic substances in the form of carbohydrates in units of volume and time (Nuzappril et al., 2017). Yogaswara (2020) added, a primary productivity value of waters that is too high indicates eutrophication, while conditions that are too low indicate that the waters are unproductive or nutrient-poor. Therefore, this study aims to

determine the effect of upwelling on water productivity in several waters in the bay of Jakarta, South Lampung and the South Coast around Central Java.

Materials and Methods

Study Area

The research location is in North Jakarta, to be precise, on the coast of Muara Angke Bay, the coast of South Lampung, the waters of the south coast of Central Java, to be precise, Bopong Beach. The three locations are a natural upwelling phenomenon in which large amounts of fish are stranded on land.



Figure 1. The fishermen do not go to sea because the fish are stranded on the coast in large quantities. (Capture by Rudi Bhatrix).

Procedures

Data from the ocean color database is data in the form of *.nc files and then processed using seadass. Data in the form of *.nc files are raw data which will then be analyzed for chlorophyll-a color gradations. In addition to using the Copernicus Marine Environment Service (CMES) online website to detect chlorophyll-a content. Latitude position that has been determined using the help of google earth.

Data analysis

The research data used is Sea Surface Temperature (SST) data in the form of El Niño-Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) from Meteorology, Climatology, and Geophysics Agency. Ocean color data uses MODIS level up 3 satellite for the month period August, September, October, November 2022. The chlorophyll-a content is compared to the locations where upwelling occurred.

Results and Discussion

Result

The distribution of chlorophyll-a in the oceans varies depending on geographical location and water depth. This is caused by differences in sunlight intensity and nutrient concentrations in the waters (Ratnawati et al., 2016). Chlorophyll-a data from CMES data for the Ujung Teluk Jakarta area at Mutiara Beach was 0.5802 mg/m³, while for

the Pesisir South Lampung area it was 0.47574 mg/m³. The South Coast of Central Java Island, precisely at Bopong Beach, contains 0.47152 mg/m³ of chlorophyll-a. According to the Seadass software, the reading for the highest content of chlorophyll-a is the more to the right, the more chlorophyll-a content. The green color is an ideal parameter for chlorophyll-a in several waters located in Indonesia.

Table 1. Chlorophyll-a content in several upwelling locations.

Date of Upwelling	Ujung Teluk Jakarta at Mutiara Beach (mg/m ³)	South Lampung (mg/m ³)	The coast of Central Java at Bopong Beach (mg/m ³)
November 29, 2022	0,5702	0,19791	0,38804
December 3, 2022	0,20398	0,47574	0,47152

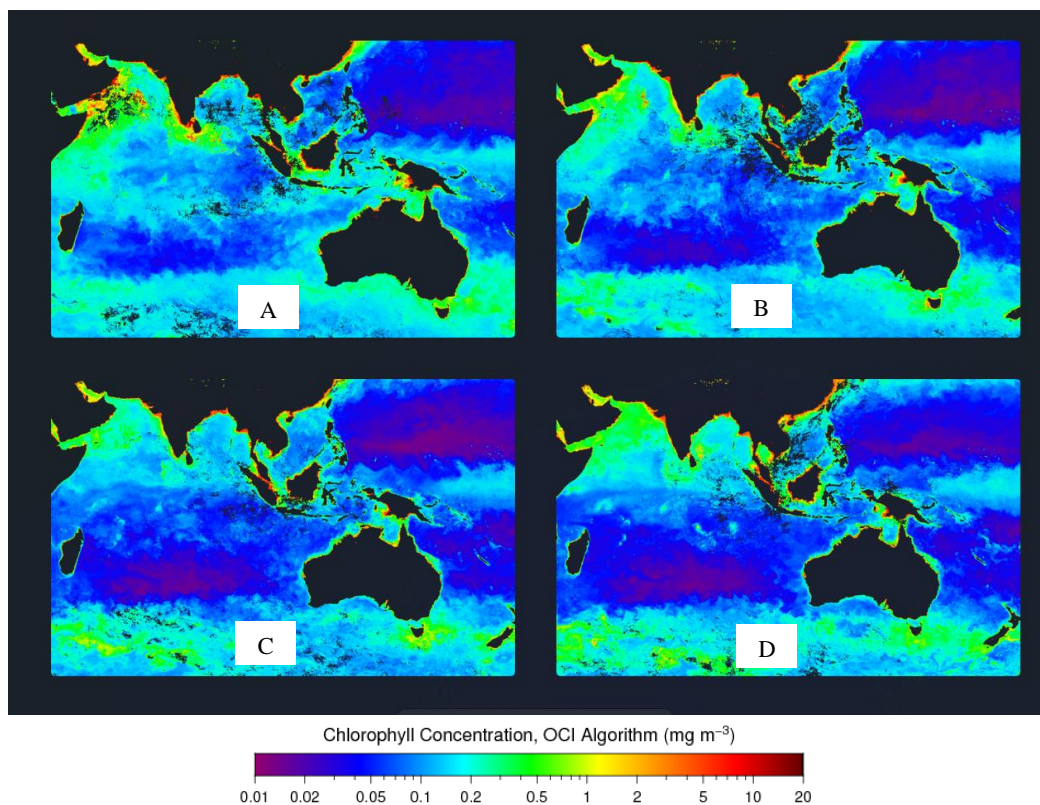


Figure 2. Distribution of Chlorophyll a Concentration in Indonesian Territory by Seadass.

Discussion

The upwelling phenomenon is located in the North Bay of Jakarta, to be precise, Mutiara Beach, South Lampung and the South Coast of Central Java, to be precise, at Bopong Beach. The time interval for upwelling to occur is not much different and there

has also been a lot of upwelling in Indonesian waters. Jakarta North Bay upwelling occurred at the end of November after which upwelling took place at the South Lampung and South Coast of Central Java Island. Upwelling is an increase in the mass of deep seawater towards the sea surface

which causes low sea surface temperatures (SST), high salinity, and high nutrient content for the needs of fish food to sea level (Hasyim, 2014). This upwelling causes fish to rise to land in large numbers due to the nutrient content of the waters being pushed by wind and currents.

Sukresno et al. (2018) explained that the southern waters of Java experience seasonal fluctuations, this causes a higher chlorophyll-a content of 0.40-0.55 mg/m³. This is when compared with the results of observations of chlorophyll-a content which is happening now because seasonal fluctuations also cause the chlorophyll-a content to increase. Chlorophyll-a and primary productivity have a correlation in the form of an increase in chlorophyll-a concentration directly proportional to an increase in primary productivity of waters (Waas et al., 2019). Phytoplankton are microscopic single cell plants that function as food chains for organisms and as fertility studies for the distribution of chlorophyll-a concentrations in waters (Putra, 2012).

The upwelling factor is generally caused by wind and the Coriolis force resulting in a movement of rising sea water within a certain period (Kämpf and Chapman, 2016). This may be due to climate change in the world that affects the movement of the wind. Local fishermen do not need to go out to sea to find fish because the fish have gone up to the mainland. Anggraini et al. (2017) stated that wind and currents are one of the factors that influence the occurrence of upwelling. The wind pattern is needed to determine the dominant and maximum wind direction and speed. The current pattern is needed to know the direction of the current that will be used to determine the Ekman transport pattern and is also needed to determine the maximum and dominant current speed. The fish that went up to the mainland included a large school of fish. The following picture is the documentation of fishermen who take fish that are stranded on land.

The Meteorology, Climatology and Geophysics Agency (2022) states that the sea surface temperature anomaly in the Central and East Pacific region is in Moderate La Nina conditions. The Indian Ocean Anomaly is in a Neutral Indian Ocean Dipole (IOD) condition. The Indian Ocean in

the west experiences cold sea surface temperatures. This is thought to be the cause of upwelling. La Nina is predicted to last until March 2023, until it reaches neutral.

Conclusions

An increase in chlorophyll-a content means an increase in the supply of food in Indonesian seas which of course increases the number of fish around Indonesian waters. One of the factors influencing extreme climate change is the end of 2022 and is predicted to continue until 2023.

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