Lobster aquaculture location selection based on oceanographic conditions using remote sensing (Case study: Ciletuh Bay, Sukabumi, Indonesia)

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Abstract. Lobster (Panulirus spp.) is one of the marine resources that has high economic value, both locally and internationally. Ciletuh Bay has potential as a lobster cultivation location. The growth of lobsters is influenced by the conditions of the aquatic environment, especially the salinity and sea surface temperature. Remote sensing method can identify and analyse salinity and sea surface temperature. Salinity value obtained using Cilamaya algorithm, and sea surface temperature obtained using Syariz algorithm. This study aims to select a suitable location for lobster cultivation in Ciletuh Bay using a remote sensing approach. Map of salinity distribution and sea surface temperature is obtained from Landsat-8 imagery. The condition of water quality parameters in the Ciletuh Bay was quite suitable to be used as a lobster cultivation location. The distribution of salinity shows a dominance value 28.0–32.0, the distribution of sea surface temperature shows a dominance value 25.0–29.0, and the distribution of pH shows a dominance value 7.0–14.0. Based on the analysis of sea water quality parameters in Ciletuh Bay, most of the waters of Ciletuh Bay have a high suitability for lobster cultivation, covering an area of 253.01 ha.

Keywords: Lobster, location selection, remote sensing, Ciletuh Bay

1. Introduction
One of the water areas with active utilization of marine resources is Ciletuh Bay. Pelabuhan Ratu Bay and Ciletuh have abundant marine resources [1-3]. Lobster (Panulirus spp.) is one of the marine resources that has high economic value, both locally and internationally. The good price makes lobster fishing the main choice for fishing communities [4]. The price of lobster at the fishermen level is around Rp.200.000–Rp.800.000/kg, while the price of lobster at the local consumer level can reach Rp.1.200.000/kg and can be higher at certain moments such as Christmas, New Year and Chinese New Year [5]. Ciletuh Bay in the southern waters of Sukabumi is astronomically located at 106 ° 26'00”–106 ° 29'00” East Longitude and 7 ° 9'00”–7 ° 11'0” South Latitude, which is included in the Fisheries Management Area of the Republic of Indonesia (WPPNRI 573). WPPNRI 573 have big contributed to the supply of national lobsters, especially the southern waters of Java which contributed 10.4 % of the total lobster production in Indonesia in the period 1997–2007 [5].

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Lobster growth is influenced by the conditions of the aquatic environment. Oceanographic environmental parameters that play a role in the distribution of lobsters include salinity, temperature, and pH [6]. Suitable water conditions will accelerate the growth of lobsters. Lobster will grow well and get bigger.

Conventional measurement salinity and sea surface temperature will require time, effort and money. Salinity and sea surface temperature can be determined based on the calculation of oceanographic parameters generated by remote sensing satellite image data processing. This study aims to produce a map of the lobster cultivation location in Ciletuh Bay. The map is expected to be useful for the community and local government as a reference and consideration in develop Lobster cultivation activities in Ciletuh Bay.

2. Materials and method

The research location is in Ciletuh Bay, Sukabumi Regency, West Java Province. The map of the location is displayed in figure 1.

This research processed the Landsat 8 which were recorded on September 13 2020 and in situ pH. ArcGIS software is used for data processing.

National Aeronautics and Space Administration (NASA) and the United States Geological Survey (USGS) launch Landsat 8 satellite and has 11 spectral bands. Band 1–Band 6 ensures continuity with the Landsat 7 mission. Band 10 Band 11 is used for temperature and humidity mapping [7]. The determination of salinity was obtained using the Cilamaya algorithm [8].

\[ Y = 139.566970 + 86.213184 \ln(B2) - 24.625188 \ln(B4) \]  
(1)

where \( Y \) is salinity (ppt), \( B2 \) is a blue sensor, and \( B4 \) is a red sensor on Landsat-8.

Sea surface temperature can be obtained from the brightness temperature value (\( T \)).

\[ T = \frac{K2}{\ln \left( \frac{K1}{L_A} + 1 \right)} \]  
(2)

where \( T \) is brightness temperature (°K), \( K1 \) is calibration constant 1 (774.89 °K), \( K2 \) is calibration constant 2, and \( L_A \) is sensor radiant.

Syariz algorithm is used to change the brightness temperature (\( T \)) value to sea surface temperature [6].

\[ y = -0.0835x + 31.192 \]  
(3)

where \( y \) is sea surface temperature and \( x \) is brightness temperature on band 10. Inverse Distance Weighted (IDW) interpolation was applied to determine the distribution of pH concentrations.

3. Results and discussion

The results of determining the distribution of salinity obtained using the Cilamaya algorithm [8] was showed on figure 2.

Based on the picture above, it can be seen that the salinity concentration in the waters of Ciletuh Bay varies considerably. Waters near land have a lower salinity concentration than in waters far from land. The low concentration of salinity in the waters near the mainland is caused by the presence of large rivers, namely the Ci Leutuh and Ci Marinjung rivers. The mixing of fresh river water with sea water causes low salinity concentrations [9].

Figure 3 show the results of determining the distribution of sea surface temperature using the Syariz algorithm [10].
Based on the picture below, it can be seen that the value of sea surface temperature in the waters of Ciletuh Bay is dominated by a value of 29.0–29.4 °C. This shows that the waters of Ciletuh Bay have the potential as a lobster cultivation location because the temperature value requirements for lobster cultivation locations are 25–29 °C.

Figure 4 show the results of determining the pH distribution obtained using Inverse Distance Weighted (IDW) Interpolation.

Based on the picture above, it can be seen that the value of pH in the waters of Ciletuh Bay is dominated by a value of 8. This shows that the waters of Ciletuh Bay have the potential as a lobster cultivation location because the pH value requirements for lobster cultivation locations is above 7.

The selection of lobster cultivation locations can be made based on the environmental suitability criteria for lobsters [6] which includes Salinity 28–32 ppt; Temperatures 25–29 °C; pH above 7; dissolved oxygen 5–8 ppm.

The location selection for lobster cultivation is obtained from the overlay of each of these oceanographic parameters.

The overlay results show that the suitability level of the lobster marine environment in this area is quite dominant, with an area of about 253.01 Ha (figure 5).
Figure 3. The sea surface temperature distribution map uses the Syariz algorithm.

Figure 4. The pH distribution map uses the IDW interpolation.

Figure 5. Map of suitability of lobster cultivation location in Ciletuh Bay waters.
4. Conclusion

The results of this study can be concluded that the Cilamaya algorithm [8] and the Syariz algorithm [10] can be applied in the waters of Ciletuh Bay. Referring to Prosedur Penanganan Lobster Laut, the results show that the distribution of salinity concentration, sea surface temperature and pH in Ciletuh Bay has a dominant value range of 28–32 ppt, 29.0–29.4 °C, and 8.0. After intersecting the values of salinity, sea surface temperature and pH according to the criteria, an area of 253.01 ha have a high suitability for lobster cultivation in Ciletuh Bay.

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References

[1] Takarina N D and Supriatna 2017 AIP Conf. Proc. 1862 030168
[2] Supriatna S, Tambunan M P, and Azzahra H F 2018 AIP Conf. Proc. 2023 02018
[3] Faqihuddin M, Supriatna S and Pin T G 2018 AIP Conf. Proc. 2023 020187
[4] Zulkarnain, Baskoro M S, Martasuganda S and Monintja D 2011 Bulletin PSP 19 45-7
[5] Triyono, Arifin T, Nugroho D, Novianto D, Rahmawati H I, Amri S N, Faizah R, Prihatiningsih, Nurfiarini A, Purnomo A H, Suryaningrum T D, Zulham A, Wardono B, Yusuf R, Jayawiguna M H 2019 Potensi Sumberdaya Kelautan dan Perikanan WPPNRI 573 (Jakarta: AMAFRAD Press - Badan Riset dan Sumber Daya Manusia Kelautan dan Perikanan) pp 157-78
[6] Ministry of Marine and Fisheries 2015 Prosedur Penanganan Lobster Laut (Panulirus spp.) di Instalasi Karantina Ikan UPT KIPM (Jakarta: Badan Karantina Ikan Pengendalian Mutu dan Kecamanan Hasil Perikanan, Kementerian Kelautan dan Perikanan) pp 3-4
[7] Ihlen V 2019 Landsat 8 (L8) Data Users Handbook (United States: Department of the Interior U.S. Geological Survey)
[8] Kaffah, S., Supriatna, Damayanti, A 2020 IOP Conf Ser Earth Environ. Sci. 481 012071
[9] Ditriyani E, Supriatna and Tambunan M P 2020 IOP Conf Ser Earth Environ. Sci. 481 012059
[10] Syariz M A, Jaclani L M, Subehi L, Pamungkas A, Koenhardono E S and Sulisetyono A 2015 ISPRS XL-2/W4 87-90