The 9th International and National Seminar on Fisheries and Marine Science
IOP Conf. Series: Earth and Environmental Science 695 (2021) 012020
IOP Publishing
doi:10.1088/1755-1315/695/1/012020

Application of Principal Component Analysis to Characterize The Effect of Fishing Ground of *Portunus pelagicus* in Lancang Island Based on Environmental Parameters

I. Rahimah*, E. S. Y. Siregar, T. Heriyanto, V. P. Siregar
1Matauli College of Fisheries and Marine, Indonesia
*E-mail: insaniarahimah@stpkmatauli.ac.id

Abstract. Crab is a high economic value fishery commodity that is third after tuna and shrimp. crab production depends on natural fishing. In the use of crab resources, it is necessary to understand several factors. Quantitative ecological analysis can be use Principal Component Analysis. This analysis divides the parameter matrix into several components, then compiles the diversity of components collected from the largest at the turn of the main component. Spatial distribution of physical and chemical parameters is obtained by following the findings of catching the crab. This paper tries to understand the suggested environmental parameters for the success of crab life. Water quality sampling was taken on June 2015 (representing the eastern season), with an average range according to the following: SST 27.89°C - 29.39°C, TDS 28.05 - 29.60 g / L, TSS 0.004 - 0.161 mg / l, brightness 1.37 - 5.45 m, DO 5.09 - 9.17 mg / L, salinity 29.8 - 31.70 psu, phosphate 0.013 - 0.09 mg / L, nitrate 0.0009 - 0.5 mg / L, bathymetry 2.3 - 30 m. The fishing ground of crab is in grid B, C and D. On-grid B there are grids B1, B3, and B4. Then on-grid C there is on grid C3 and C4. On-grid D on the D6 grid. The results of the analysis of the correlation matrix of aquatic biophysical parameters show that the variance in the main components of the five main axes is 85.7%. Thus, the four main components can explain 85.7% of all information available on all parameters. The parameters that have the highest contribution are salinity, TSS, DO, brightness, nitrate, and sediment. The highest contribution indicates the influence of these parameters on the presence of crabs in the waters of Lancang Island and its surroundings.

1. Introduction
The Lancang Island is one of the centers of crab production (*Portunus pelagicus*) in Kepulauan Seribu. For residents, crab is the main marine product where most of the fishermen in Lancang Island are crab fishermen. Referring to the DKI Jakarta regional regulation No. 4 of 2001, Lancang Besar island included an island of fisherman settlements located in the area of the South Kepulauan Seribu Village, with an area of 15.13 hectares [8].

As one of 111 islands in the Kepulauan Seribu, Lancang Island waters provide a significant contribution to the production of the Jakarta Province crab. Based on Indonesian Capture Fisheries Statistics data (2014), the potential of crab in Kepulauan Seribu Regency as a whole is 143,800 kg [8]. From secondary data recorded in the field, the crab catches in the same year were 17,196 kg. This figure shows that 12% of the potential of the crab comes from the waters of Lancang Island and its surroundings.

*P. pelagicus* is a high economic value fishery commodity that is third after tuna and shrimp. Nationally, data released by the KKP (Director General of Capture Fisheries) in 2014, the export
volume of crabs and crabs was 28,090 tons with a value of US $ 414.3 million or around Rp. 5 trillion. Until now, crab production depends on natural fishing, need to studies and solution that natural resources can be utilized sustainably.

According to Ihsan [5], in the use of crab resources, it is necessary to understand several factors, namely: internal factors, namely their life cycle and external factors such as oceanographic aspects, habitat, seasons and their relation to coastal and marine ecosystems.

There are no permanent catches for each crab fishing ground, always changing, shifting and moving following the movements and changes in environmental conditions, which the crab naturally chooses a more suitable habitat [6]. While these habitats are strongly influenced by oceanic conditions or oceanographic parameters such as sea surface temperature, salinity, oxygen, pH and depth [12].

The Data and information about the distribution of resources and the condition of the waters for the survival of crabs on Lancang Island and its surroundings are still limited. We need any information about good habitats for crab populations develop, various types to operation of fishing gear and any environmental factors that affect crab populations need to be studied further.

Principal Component Analysis until now has been widely used and is fundamentally considered important in the quantitative ecological analysis [14]. Based on some questions discussed above, this paper aims to determine what environmental factors have a direct effect on crab survival. This is important as a reference for maintaining the sustainability and sustainability of a sustainable habitat.

2. Material & Methods
2.1. Tools and Materials
The tools used in this study are GPS, Multiparameter water quality checker, Vacuum pump and nalgene, cool box motorboats, Indonesian maps with scale 1: 50,000, a Windows operating laptop equipped with software such as ArcGIS 10.2.2 to determine the spatial distribution of parameters environment and make a map of the research location. Then the Minitab 15 software for analysis uses Principal Component Analysis (PCA). The materials used in this study include: environmental parameter data in the form of parameters of sea surface temperature (SST), Total Dissolved Solid (TDS), brightness, Total Suspended Solid (TSS), Dissolved Oxygen (DO), salinity, nutrient (Nitrate and Phosphate), sediment and bathymetry.

2.2. Collection of Aquatic Environment Quality Data
Water quality sampling was taken on June 2015 (representing the east season) with Bantuan Operasional Perguruan Tinggi Negeri (BOPTN) in Lancang Island waters which included Lancang Island, Laki Island and Bokor Island. Determination of sampling stations using Purposive Random Sampling with 15 station points. Geographically the study location is located at 5°54'0"-5°59'0" South latitude and 106°30'0"-106°39'0" East longitude (Figure 1).

[1] measurements and seawater samples were taken to determine the condition of physical and chemical parameters in Lancang Island waters. Physical factors observed were parameter; Sea Surface Temperature (SST), Total Dissolved Solid (TDS), Total Suspended Solid (TSS), brightness while the chemical factors observed included parameters, Dissolved Oxygen (DO), salinity, nutrients (Nitrate and Phosphates).

In addition to physical and chemical factors, this study also measured and extracted depth data (bathymetry) and also sediment types using sediment grab.
2.3. Collecting Data Fishing Ground of Crab
Data was collected by sampling the fishing ground in June 2015 (representing the east monsoon), from the fishermen. Collect data using a questionnaire sheet equipped with a map of the research location modified by dividing the grid system area. This grid aims to direct fishermen in determining crab fishing ground, grid dimensions are designed at 2.1 km x 2.1 km (Figure 1).

2.4. Principal Component Analysis (PCA)
To see the role of biophysical-chemical factors on fishing ground crabs, Principal Component Analysis (PCA) is also known as Principal Component Analysis. The main component analysis is an ordination technique that projects the dispersion of multidimensional data matrices in a flat field by reducing space so that new axes are presented which optimally represent the variability of dimensional matrix data, so that the relationship between variables and relationships between objects can be found [9]. Principal component analysis (PCA) is a technique used to emphasize variation and bring out strong patterns in a dataset. It is often used to make data easy to explore and visualize.

Multivariate, principal component analysis (PCA) allows the reduction of data dimensionality by transforming the original measured variables into new uncorrelated variables called principal components (PCs), retaining as much information as possible present in the original data [3].

This analysis divides the parameter correlation matrix into several components, then compiles the diversity of the relevant components from the largest on the axis of the main component so that the spatial distribution of physical and chemical parameters can be obtained on the station represented the fishing ground of crab.

3. Results and Discussion
3.1. Aquatic Environment Quality
From the results of measurements and water sampling to determine the condition of the physical and chemical parameters in the waters of Lancang Island, the SST range at the interval 27.89°C - 29.39°C was obtained. Spatially, the sea surface temperature in the waters of Lancang Island in the west is lower than the central part (between Lancang Island and Laki Island) and East Lancang Island. The high SST in the central part of the waters is influenced by river runoff from the Javanese mainland, which is generally warmer than those in the western part of the Laki island which is affected by the mass intake of water from deeper open waters. Likewise with islands in the eastern part of Lancang
Island and around Bokor Island, which are also affected by runoff of freshwater masses from rivers that empties into the Jakarta Bay.

Total Dissolved Solids (TDS) is a parameter that describes particles dissolved in water and cannot be filtered by filter paper. TDS is usually influenced by inorganic materials in the form of salt molecules that are commonly found in marine waters. Results of the observations obtained that TDS values are in the range 28.05-29.60 g/L. TDS values in marine waters are generally quite high, related to the number of dissolved compounds that affect high salinity values [4]. Spatially the TDS content in Lancang Island waters is not significantly different, but the conditions in the South of Lancang Island waters close to the mainland have a higher TDS value compared to other regions. This is because the southern part of the waters of Lancang Island is still influenced by activities originating from the land which directly affect the value of TDS.

Total Suspended Solid (TSS) is a suspended material > 1 micrometer in diameter which is retained in the Millipore filter with a pore diameter of 0.45 micrometers. TSS consists of mud and fine sand and microorganisms which are mainly caused by soil erosion or soil erosion that is carried into the body of water. According to Effendi [4], TSS concentrations in waters greatly affect the lives of biota living in the waters. TSS concentrations in waters with a concentration value of <25 mg/L have no effect on aquatic biota life, TSS concentration values at intervals of 25-80 mg/L have little influence on aquatic biota life, TSS values at intervals of 80-400 mg/L are less good for aquatic life and TSS > 400 mg/L is not good for aquatic biota. Based on the TSS value obtained 9 station points that have little influence on aquatic biota life, 4 station points have TSS values that are not good for aquatic biota life and 2 station points have good TSS values.

Based on the spatial distribution of TSS values in the West of Lancang Island and around Pulau Laki has a higher value compared to the East of Lancang Island. The high TSS concentration in the West is thought to originate from waste inputs. Can be seen in the West there are settlements and mangrove ecosystems, thus causing higher TSS concentrations. The Laki Island region has sand substrates and there is a mangrove ecosystem that contributes to the higher TSS content around the area. Also, the Pulau Laki area which has a very close location from the mainland is thought to be a factor causing the TSS value to be quite high.

Water brightness is one parameter that measures the level of clarity of water. The brightness of the waters determines the thickness of the productive layer because the brighter the waters can increase the ability of aquatic plants such as plankton to photosynthesis [4]. Based on the data obtained shows that the brightness of the waters in Lancang Island waters is in the range of 1.37-5.45 m. The lowest brightness is at station 3, the low brightness at station 3 is thought to be due to the position of station 3 which is close to the mainland which has a high turbidity level due to runoff originating from the mainland. The average brightness value in Lancang Island waters is 2.25 m, the value is still below the standard brightness value set by KEPMENLH No. 51, 2004 [8] which is equal to 3 m for the life of marine life. The cause of the value of water brightness which is below the average is one of them due to the location of Lancang Island which is still close to the mainland area and the surrounding small islands. Spatially, it can be seen that the brightness conditions in the southern waters of Lancang Island and around Pulau Laki generally have low brightness values compared to the North.

The dissolved oxygen content (DO) is the most important limiting factor for all life in the sea. Based on the measurement results it is known that the distribution of DO content in Lancang Island waters is not significantly different at each station. The DO content on the sea surface of Lancang Island waters ranges from 5.09 - 9.17 mg/L. Stations that have the lowest DO levels are found at station 15, which is only 5.09 mg/L. While the highest DO content is at station 6 of 9.17 mg/L. According to Effendi [4], the value of DO content above 5 mg/L is highly favored by aquatic organisms. Spatial distribution of dissolved oxygen content has relatively small values around the land of Lancang Island and Laki Island. That is because around the land of Lancang Island there are settlements that contribute organic waste to the waters, as well as the island area of Laki which has a location not far from the mainland area, causing the contribution of organic material to the waters to be quite high. The high input of organic matter into marine waters has an impact on the low value of
DO content. The low DO material is due to the DO content in the waters used to decompose organic matter found in the waters.

The results of measurements of sea surface salinity in the waters of Lancang Island are not diverse or homogeneous. This salinity characteristic is caused by the waters of Lancang Island belonging to small islands that do not have rivers. Salinity in these waters is in the range of 29.8 - 31.70 psu. The lowest salinity value is at station 6. While the highest salinity value is at station 8. The salinity value obtained turns out to have a positive correlation with the TDS value, according to Effendi [3] that the higher the salinity of the TDS content the higher. This is because in waters that have high salinity there are many more dissolved ions and compounds than water that is not maternity

The spatial distribution of salinity values in Lancang Island waters can be seen that the salinity of waters in the area around Lancang Island and Laki Island has a lower salinity value compared to the southern region of Lancang Island. The difference in the value of salinity is in the range that is not too much different, so it is very possible. Also, the salinity data collection process in several locations was carried out during the rain so that it affected the low salinity at the station location far from the mainland.

The presence of phosphate elements in the waters can determine the fertility of these waters. At the observation location, it was found that phosphate concentrations were in the range of 0.013-0.09 mg / L. According to Liaw 1969, the value of phosphate concentration in this range indicates that the level of water fertility is at a high level. The highest phosphate concentration is at station 1 and the lowest phosphate concentration is at stations 3,7,10 and 11. Excess phosphate concentrations can cause eutrophication. Spatially, it can be seen that phosphate content in the South of Lancang Island has a higher phosphate concentration compared to other regions. This happens because the southern waters of Lancang Island are still influenced by the input of organic materials from the mainland, namely the Jakarta and surrounding areas. Sources of phosphate in the waters can come from weathering rocks, household waste such as soap and detergents.

The content of surface sea nitrate in Lancang Island waters ranged from <0.0009-0.5 mg / L. The lowest nitrate concentration is at station 4, while the highest nitrate concentration is at station 7. Nitrate can be known spatially in the south of Lancang Island has a higher concentration of phosphate compared to other regions. This happened because the southern part of Lancang Island waters still had the influence of input from organic matter originating from the mainland, namely the Jakarta and surrounding areas, which had an impact on the high concentration of nitrate in the South of Lancang Island [12]. Sources of nitrate in the waters can come from household waste and agricultural fertilizers which are dissolved into the water.

Nutrients or nutrients play a very important role in maintaining the fertility of water, especially related to the primary productivity of the waters. The main nutrients contained in marine waters come from freshwater inputs through river runoff carrying organic materials. Besides that it also comes from the results of the process of secretion and degradation of marine organisms.

The richness of nutrient content in water can have a beneficial effect and vice versa is detrimental to marine organisms. The condition of nutrient that is detrimental to the organism is if the presence of nutrients is too abundant which results in certain species experiencing a growth spurt or blooming and dominating the region causing very strong space and food competition among species of organisms living in it.

3.2. **Fishing Ground of Crab**

[11] revealed that shrimp and crabs generally roam at night to look for food. This organism comes out of its hiding places and moves towards places that contain a lot of food. Important behavior of the crab is also the development of its life cycle that occurs in several places. In the larval and spawning phases, the crab is in the open sea and the juvenile phase to adulthood is in coastal waters near the islands, river estuaries and estuaries [7]. Such a complex crab life cycle causes the distribution of crab populations to be dynamic and vulnerable to local extinction in certain waters.

Based on data from interviews with crab fishermen in June (representing East Season), the fishing ground of crab is on-grid B, C and D. On-grid B there are grids B1, B3, and B4. Then on-grid C there are C3 and C4 grids. While on-grid D there is a grid D6 (Figure 2).
From the sampling results, it can be seen that Lancang Island fishermen tend to focus their fishing efforts on the west side of Lancang island to the waters around Laki island. This can also be attributed to the condition of the waters behind the wind (leeward) so that waves and surface currents are more damped due to the effects of the island and its vegetation.

Grid B3, B4, and D3, D4 are the most dominant areas used as fishing grounds for fishermen, so fishing pressure or environmental stress due to capture fisheries activities on crab resources are among the highest in the area.

Based on the capture grid, Laki island and Bokor Island are classified as not said to be crab fishing areas. Then the catchment area for the crabs is in the western part of Lancang Island. The statement above is information obtained from the fishermen who caught the crabs on Lancang Island.

![Figure 2. Spatial distribution of fishing ground of crab on June (2015).](image)

3.3. Spatial Distribution and Correlation of Aquatic-chemic Biopysical Parameters

From the 15 observation stations of aquatic biophysical-chemical parameters, the spatial distribution of correlations was obtained between the parameters of the capture location. The results of the Principal Component Analysis (PCA) chemical biophysical parameters of the waters of Lancang Island and its surroundings can be seen in Figure 2. Bengen [2], states that PCA can be used to obtain a relationship between biophysical-chemical parameters while determining station groupings.
Figure 3. Graph analysis of the main components of aquatic biophysical-chemical parameters between the Main Components First (F1) and Second Main Component (F2).

Figure 3 describes the spread of stations divided into several zones, where each zone characterizes different parameters according to the results of the correlation between parameters. From the zone division, stations 8, 11 and 12 have correlations with TSS, nitrate, and sediment. Stations 2, 13 and 14 correlate with TSS parameters, salinity, and brightness.

In the next zone, stations 3, 5 and 15 correlate with TDS parameters and depth. The last zone where stations 1, 4, 6, 7, 9 and 10 have correlations with phosphate and DO parameters. To be able to find out the parameters that correlate with the fishing ground in the study waters in June representing the east season, the next step is overlaying between the crab fishing ground (in the grid) and the observation station.

The PCA results (load plot and score plot) are shown in Figure 3. PCA crab samples were carried out at an average value of eleven quality parameters aimed at identifying the similarities and differences between these parameters. Figure 3 illustrates 41.59% of the initial variability, while each parameter accounts for less than 6% of the total variance. The correlation load from PC results shows a relatively high correlation.

Parameters that have the highest contribution based on correlation are salinity, TSS, DO, brightness, nitrate, and sediment. The highest contribution indicates the influence of these parameters on the presence of crabs in the waters of Lancang Island and its surroundings. Based on the correlation, which has a negative correlation is TDS and depth parameters. Depth parameter is one of the physical processes the affect of water quality [13]. Then the parameters that have a positive correlation are TSS parameters, salinity, brightness, DO, phosphate, temperature, nitrate, and sediment.

Based on the correlation loading plot, brightness, phosphate, SST, nitrate, sediment, TDS and depth parameters are influenced by TSS, salinity and DO. The magnitude of the influence of TSS,
salinity and DO indicates the magnitude of the influence of these parameters on the existence of crabs. The fishing ground of crab is at stations 1, 2, 4, 6, 7, 8, 9, 10, 11 and 12.

If based on the grid, of the 14 fishing ground fishing sampling grids represented by 5 grids located in 5 observation stations namely grid A6 at station 11, grid B3 at station 6, grid C5 at station 1, grid D4 at station 7 and grid D8 at station 9. The overlay results between grid and station are then read on the main component analysis graph (Figure 3), where stations 1, 6, 7 and 9 correlate with phosphate and DO, while station 11 correlates with SST, sediment, and nitrate.

The results of the analysis of the correlation matrix of aquatic biophysical parameters show that the variance in the main components of the five main axes is 85.7% (Table 1). Thus the four main components can explain 85.7% of all information contained in all parameters.

### Table 1. The Characteristics and percentage contributions of each factorial axis to total variance.

| Parameters | KU-1    | KU-2    | KU-3    | KU-4    | KU-5    |
|------------|---------|---------|---------|---------|---------|
| Eigenvalue | 2.3616  | 1.7967  | 1.6757  | 1.4403  | 1.2947  |
| Proportion | 0.236   | 0.180   | 0.168   | 0.144   | 0.129   |
| Cumulative % | 0.236 | 0.416   | 0.583   | 0.727   | **0.857** |

Based on the biophysical-chemical parameters of the waters, the observation stations are grouped according to proximity (similarity). The results obtained show that in general there are two groups of stations, namely the first group consisting of stations 1, 2, 12, 10, 11, 6, 8, 9, 4, 13, 5 and 7, and the second group consisted of stations 3, 14 and 15 (Figure 4).

Based on the results of the grouping, it can be concluded that the station grouping is the first group and the second group station location. The second group is on the outskirts of the island which is station 3 in the South of the island of Men, station 14 in the West of Lancang Island and station 15 in the East of Lancang Island, while the stations far from the island are grouped.

![Dendogram of Parameters](image)

**Figure 4.** Grouping of observation stations based on the similarity of the characteristics of biophysical parameters of the waters.
4. Conclusions

The PCA results of a crab sample against eleven quality parameters that aim to identify the similarities and differences between these parameters. The PCA results illustrate 41.59% of the initial variability, while each parameter accounts for less than 6% of the total variance. Parameters that have the highest contribution based on correlation are salinity, TSS, DO, brightness, nitrate, and sediment. The highest contribution indicates the influence of these parameters on the presence of crabs in the waters of Lancang Island and its surroundings. Based on the correlation, which has a negative correlation is TDS and depth parameters. Then the parameters that have a positive correlation are TSS, salinity, brightness, DO, phosphate, temperature, nitrate, and sediment.

Based on data from interviews with crab fishermen in June (representing East Season), the fishing ground of crab is on-grid B, C and D. On-grid B there are grids B1, B3, and B4. Then on-grid C there are C3 and C4 grids. Whereas on-grid D is on the D6 grid.

Acknowledgments

Thank you for Educational Fund Management Institution, Ministry of Finance - RI which has provided assistance in the implementation of this research. Thanks to The MATAULI Foundation for its assistance in the publication of this article.

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