The correlation of the water quality and phytoplanktons in the Haruku waters

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Abstract. This study aims to analyze correlation of waters quality and phytoplacotn that it can be used as the basic for the utilization and management of the Haruku Village waters. This study was conducted in the Haruku Village waters in July to December 2017 at five sites. Water quality parameters analyzed are temperature, salinity, pH, DO, BOD₅, nutrient (nitrate, ammonia, phosphate, silicate), and phytoplankton. The correlation analyzed using Primary Component Analyzes (PCA). The results obtained are Water quality parameters of Haruku Village waters have a different correlation depending on the Musoon.

1. Introduction
Indonesia as an archipelago is located between the Pacific Ocean and the Indian Ocean and has a complicated geographic order seen from the topography of the seabed. The basis of Indonesian waters in several places, especially in the western region shows a simple or even form that is almost uniform, but in other places especially the eastern region shows more diverse, irregular and complex forms [1]. The form of the diverse seabed and the upper water environment gives the possibility of the emergence of high biodiversity of biota, with a wide distribution, both horizontally and vertically which causes the marine environment to change or dynamically.

The waters is a very important area for various needs and activities in the field of fisheries, tourism, industry and so on. An ocean waters can be said to be rich in aquatic resources if the waters have high fertility which can be seen from the productivity of their waters.

Phytoplankton is one of the parameters that determine primary productivity at sea, because phytoplankton capable of photosynthesis, namely the presence of chlorophyll pigments contained in it and with the help of sunlight, will change the mineral salts, water and carbon dioxide into organic compounds such as carbohydrates. This makes phytoplankton referred to as primary producers, because they are able to form organic substances from inorganic substances [2].

Geographically, Haruku Village is located in the Lease archipelago, precisely located on Haruku Island, Central Maluku Regency, and its location is exactly opposite to Ambon Island and is separated by the Haruku Strait in the west, with rivers and forests in the east, with Banda and Village seas Oma in the south, and with the land of Rohomoni in the north. The most interesting and most unique or typical of this village is the habitat of lompa fish (Trisina baelama; small sardines) because it is not found elsewhere in Maluku. This area has mangrove and seagrass ecosystems so that it becomes a place to find food and shelter for various marine biota including dugongs, turtles, and various types of pelagic fish.

Haruku also experienced a process of change to improve human living standards by utilizing natural resources. In a certain scale, any use of natural resources in coastal and marine areas can cause changes in coastal and marine ecosystems. These changes will certainly have an influence on environmental quality. The higher the rate of development in coastal and marine areas, the higher the
level of utilization of natural resources. Utilization by not considering ecological principles can reduce environmental quality and continue with the destruction of coastal area ecosystems [3]. Good coastal resource management can provide social and economic benefits, but its contribution to reducing long-term poverty and sustainable development is still a major issue of debate. Thus a study is needed to explain and analyze water quality and phytoplankton so that decision making can be made in coastal policies that are beneficial for efforts to improve environmental quality. This study aims to analyze correlation of waters quality and phytoplankton that it can be used as the basic for the utilization and management of the Haruku waters.

2. Method
This research was conducted in Haruku Village waters in July until December 2017. In this study five research locations were determined (Figure 1.).

Seawater samples were taken with Van Dorn Water Sampler to analyze phosphate, nitrate, nitrite, silicate, ammonia, dissolved oxygen, BOD$_5$ and COD. Measurement of oceanographic parameters in situ such as temperature and salinity using CTD. Phytoplankton samples were taken using Kitahara net cone with a diameter of 31 cm and 80 μm mesh. Samples of plankton obtained were stored in a sample bottle and given formalin solution. The results used in the form of contours and the relationship between quality parameters with the analysis of the main components in the form of quadrants.

3. Results and Discussion

3.1. Temperature
Temperature is an important factor in supporting photosynthesis in the sea. The size of the temperature in the sea can affect the enzymatic chemical reactions that occur in photosynthesis and can change the structure of the water column hydrology which can ultimately affect the distribution of phytoplankton. The temperature of Haruku Village waters at the time of the research was carried out ranging from 27.44 - 28.72°C. In tropical waters like Indonesia variations in sea water temperature throughout the year are not large, sea surface temperatures range from 27°C-35°C, where the temperature is the ideal temperature for life in the sea [4]. In the East Musoon the water temperature ranges from 27.45-27.55°C. Second Transition Musoon obtained temperature values ranging from 28.68-28.72°C. West Musoon obtained temperature values ranging from 28.68-28.71 °C (Figure. 2). Based on the Quality Standards, the temperature of the Haruku waters is still in the category of both marine life, marine tourism and ports.
From this study obtained the difference in the temperature value in the East Musoon is lower while in the Second Transition Musoon and West Musoon there is no significant temperature difference. This is because at the time of the study in the east musoon is the rainy.

3.2 Salinity
Salinity on Haruku Village waters has a value between 32.83 and 33.64 PSU (Figure 3). East musoon obtained salinity values ranging from 32.83 to 33.40 PSU. In the sampling period for Second Transition Musoon period, salinity values ranged from 33.59 - 33.64 PSU. While in the West Musoon sampling, salinity values ranged from 33.61 to 33.64 PSU. Thus there is no difference in salinity in different research periods.

3.3 pH
pH obtained during the study in the waters of Haruku Village has a range between 7.21 and 8.27 in the East Musoon, pH has a range between 7.32 - 8.23 p. In the Second Transition Musoon, pH has a range between 7.21 - 8, 27. Whereas in the Western Musoon the pH has a range between 7.59 - 8.23 (see figure 4). Based on the quality standard [5] the pH of the Haruku Village waters is still in the pH range of sea water.
Based on the results of research on the five research stations in all three musoons, the dissolved oxygen content in Haruku Village waters ranged from 5.54 to 6.69 mg/l on average. In the East Musoon, dissolved oxygen values between 5.54 - 6.07 mg/l, Second Transition Musoon, dissolved oxygen values between 5.82 - 6.69 mg/l, and in the West Musoon the dissolved oxygen value is between 5.81 - 6.26 mg/l. Dissolved oxygen during the study is shown in Figure 5.

3.4 Dissolved Oxygen (DO)

BOD$_5$ content in Haruku Village waters ranged from 0.36-16.0 mg/l. In East Musoon, BOD$_5$ values are between 1.75-4.10 mg/l, Second Transition Musoon BOD$_5$ values between 0.36-16.0 mg/l. While in the West Musoon, the BOD$_5$ value is between 1.69 - 6.45 mg/l (Figure 6). BOD$_5$ content according to Quality Standards [5] then BOD$_5$ in Haruku waters is still in the general range.
A = East Musoon; B = Second Transition Musoon; C = West Musoon

Figure 6. BOD₅ in Haruku Waters

3.6. COD
COD in Haruku Village waters ranged between 50.10-71.78 mg/l. In the East Musoon the COD value was between 53.36-71.78 mg/l. Transition Musoon II COD value between 50.10-62.95 mg/l. While in the West Musoon, the COD value is between 51.81-67.28 mg/l (Figure 7). As in BOD, waters with high COD values are not desirable for fisheries and agriculture. COD values in unpolluted waters are usually less than 20 mg/l, whereas in polluted waters can be more than 200 mg/l and in industrial waste can reach 60,000 mg/l [6]. The COD value is not included in the sea water quality standard [5].

A = East Musoon; B = Second Transition Musoon; C = West Musoon

Figure 7. COD in Haruku Waters

3.7. Nitrate
Nitrate is indispensable for phytoplankton growth and development. The measurement results of nitrate content in Haruku Village waters in the East Musoon ranged from 0.0323-0.0587 mg/l, in the Second Transition Musoon nitrate concentrations ranged from 0.0416-0.2154 mg/l and in the Western Musoon nitrate concentrations ranged between 0.0380-0.1345 mg/l (see Figure 8). That the nitrate content required by marine phytoplankton is 0.203 - 0.790 mg/l, if it is less than this value, it causes nitrate as the limiting factor of these waters [7]. In general, the nutrient content in the waters of the
Haruku Village shows a high value in the area near the estuary. This is understandable because the location close to the mainland allows the input of nutrients from the land.

3.8. Ammonium

The ammonia in Haruku waters is presented in Figure 8 ranged between 0.0851 - 0.1992 mg/l. In the East Musoon, the ammonia ranges from 0.1046 - 0.1992 mg/l. In Second Transition Musoon the concentration of ammonia ranged from 0.0851 to 0.1334 mg/l while in the Western Musoon the concentration of ammonia ranged from 0.1019 to 0.1663 mg/l. Ammonia concentration in sea water varies widely and can change rapidly. The vertical distribution of ammonia concentration is higher with the increase in sea depth and in line with the lower oxygen, while the horizontal distribution of ammonia concentration is higher towards the coastal waters or river estuaries.

3.9. Phosphate

Phosphate in Haruku waters in the East Musoon ranged between 0.0131 - 0.0262 mg/l. In Second Transition Musoon, phosphate concentrations ranged from 0.0026 to 0.0200 mg/l. In the West Musoon, phosphate concentrations ranged from 0.0079 - 0.0166 mg/l (Figure 10). The range of
phosphate concentrations is still feasible for phytoplankton life. Phosphate is needed by phytoplankton in the range of 0.029 - 0.587 mg/l [7].

A=East Musoon; B = Second Transition Muson; C= West Musoon

**Figure 10.** Phosphate in Haruku Waters

### 3.10 Silica

Silicate concentrations in Haruku Village waters is shown in Figure 11 were on average between 0.1071 - 0.6250 mg/l. In the East Musoon, silicate concentrations ranged from undetectable to 0.6250 mg/l. In the Second Transition musoon, silicate concentrations ranged from 0.01946 - 0.3554 mg/l. In the West Musoon the silicate concentration ranged from 0.1866 to 0.4455 mg/l on the surface of the waters and ranged from 0.0527 to 0.1687 mg/l.

A=East Musoon; B = Second Transition Muson; C= West Musoon

**Figure 11.** Silica in Haruku Waters
3.11 Phytoplankton
Phytoplankton found in Haruku Village waters consisted of 22 genera, which included in three classes, namely Bacillariophyceae/Diatom (16 genera), Dynophyceae / Dinoflagellata (5 genera), and Cyanobacteria (1 genera). Stations that are closer to the mainland and rivers have an abundance of phytoplankton which is relatively larger than other stations (Figure 12). This is due to the influence of the river that carries nutrients. Phytoplankton fertilizer are generally found in the waters around the river mouth caused by the enrichment process due to the entry of nutrients into the environment, both coming from the land and flowing by the river into the sea and from the deep and raised layers to the surface [8].

Environmental conditions in Haruku Village waters are suitable for growth and distribution of phytoplankton. Temperatures in Haruku waters is suitable for phytoplankton growth. Salinity is closely related to the distribution of phytoplankton, Each type of phytoplankton requires different levels of nutrients (phosphate, nitrate, silicate) for its growth. Ault et al. [9], in his research shows that enrichment of silicates can have a significant influence on the composition and abundance of phytoplankton.

3.12. Correlation Between Water Quality And Phytoplakton
Before the Principal Component Analysis is carried out, these data need to be normalized first through concentration and reduction because the data from these parameters do not have the same measurement unit and variety. Thus the results of the Principal Component Analysis are not calculated from the initial parameter values, but from the synthetic indexes obtained from linear combinations of initial parameter values [10]. To determine the relationship between the two parameters a correlation matrix approach was calculated from the synthetic index [11].

3.12.1. East Musoon. The results of data analysis presented in Figure 13 show that important information is centered on the main axis (F1 and F2). Observation station distribution graph shows that the intersection of axes 1 and 2 (F1 x F2) in positive 1 axis and negative 2 axis, namely station 4. At station 4 which forms its own group, which is characterized by high temperature, high silicate and dissolved oxygen, this is due to the position of station 4 located near the river mouth so that silicate
and phosphate are high due to the influence of river water movement. While the temperature is influenced by the flow of hot water which also empties into the Learisa Kayeli River. At the intersection between the negative axis 1 and the negative 2 axis there is station 3 showing the tendency of ammonia, pH, salinity. At the intersection of positive 1 axis and 2 positive axes there are 2 clustered stations namely stations 1 and 2. Both of these stations are adjacent which show nitrite, COD, and high nitrate. While at the intersection of positive 1 axis and positive 2 axis there is station 5 which is characterized by BOD$_5$, phosphate, and high phytoplankton which can show that there is an increase in phytoplankton due to high phosphate. The high BOD$_5$ at station 5 indicates the high organic matter found in Haruku waters, which makes phytoplankton also high.

![Figure 13. Principal Component Analysis on East Muson, 2017](image)

In the eastern monsoon, a strong positive correlation is indicated by the relationship between nitrate and COD, ammonia and pH. Strong negative correlation is shown between temperature with COD and nitrate, pH and phosphate.

3.12.2. Second Transition Muson. In the second Transition Muson in the land of Haruku Village, important information is centered on the three main axes (F1, F2 and F3) with the characteristic root being 5.9028%: 4.9980% and 1.0992% which contributed 49.19%, 41.6498% and 9.1602% of the total variance of 90.84%. On axes 1 and 2 (F1x F2) of Figure 14 shows stations 4 and 5 which are characterized by BOD$_5$ variables, salinity and pH play a major role in forming a positive F1 axis. At the intersection of positive 1 axis and 2 negative axes there is station 2 which is characterized by high silicate, ammonia, nitrate, and DO. At the intersection of negative 1 axis and 2 negative axes there is station 1 which is characterized by phytoplankton, COD, and high temperatures this mussoon. At the intersection of negative axis 1 and positive 2 axis there is station 3 which is characterized by high phosphate. This causes the number of phytoplankton to decrease.

![Figure 14. Principal Component Analysis on Second Transition Muson, 2017.](image)
In this second Transition monsoon, a very strong positive correlation is indicated by the relationship between temperature and COD, ammonia, and silicates. While negative correlation is shown in the relationship between salinity and temperature and COD, phytoplankton with pH. This can be caused because it is the time to change the monsoon from the East Musoon to the West Musoon so that changes in currents and winds affect the distribution of phytoplankton and other water quality parameters.

3.12.3. West Musoon. In West Musoon in Haruku waters, important information is centered on the three main axes (F1, F2 and F3) with the characteristic roots being 6.2353%, 3.2464% and 2.5183% which contributed 51.96%, 27.05% and 20.98% of the total variance of 79.01%. At the intersection of positive 1 axis and negative 2 axis, shows station 4 and station 3 which are characterized by variables of temperature, DO, pH and phytoplanton which play a major role in forming a positive F1 axis. At the intersection of positive 1 and 2 positive axes there is station 2 which is characterized by high values of nitrate, nitrite, ammonia, and COD. At the intersection of negative 1 and 2 negative axes there are stations 4 and station 5 which are characterized by BOD5 values and high salinity. Whereas on negative axis 1 and positive 2 axis there is station 1 which is characterized by high silicate and phosphate (see Figure 15). Strong positive correlation is shown in the relationship between nitrite and ammonia. While a strong negative correlation is shown in the relationship between temperature and silicate, COD and BOD5.

4. Conclusion
The water quality of Haruku Village waters at the time the research was carried out was undergoing nutrient enrichment (phosphate and nitrate), while other water quality parameters were still within the required quality standard. The correlation between the quality parameters of the Haruku Village waters based on the main component analysis varies in each season.

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