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THE RELATIONSHIP OF PRIMARY PRODUCTIVITY OF PHYTOPLANKTON WITH OCEANOGRAPHIC PARAMETERS IN THE WATERS OF LUBUK GAUNG SUB-DISTRICT, SUNGAI SENIN DISTRICT, DUMAI

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ABSTRACT

The waters of Lubuk Gaung Village, Sungai Sembilan District are areas that are widely used as transportation routes. Activities in these waters will cause environmental pollution, which affects the life of phytoplankton. The purpose of this study was to determine the relationship between the primary productivity of phytoplankton with oceanographic parameters in the waters of Lubuk Gaung Village, Sungai Sembilan District, Dumai. The method used is the survey method to determine the research station and the in situ method for measurement and sampling of oceanographic parameters. The results obtained are Oceanographic parameters from the three research stations, namely Brightness = 30 – 49 cm, Turbidity = 47.4 – 58.4 FTU, TSS = 124 – 209 mg/L, and BOD = 0.408 – 1.224 mg/L. The average value of primary productivity of the waters ranged from 48.07 to 79.69 mgC/m^3/day. The value of primary productivity at station II is categorized into Oligotrophic, namely low waters. Stations I and III are categorized into mesotrophic waters, namely medium waters. The relationship between brightness, turbidity, and TSS with primary productivity has a very strong and positive (unidirectional) correlation value. The relationship between BOD and primary productivity has a very strong and negative (opposite) correlation.

Keywords: Phytoplankton, Oceanographic Parameters, Primary Productivity

1. INTRODUCTION

The waters of Lubuk Gaung Village, Sungai Sembilan Sub-district are an area of harbors, fisheries, transport routes and agro-industry. The number of activities in these waters will directly or indirectly affect water quality and environmental pollution. Pollution of the aquatic environment will affect marine biota, one of which is phytoplankton. Phytoplankton acts as the main producer in the aquatic food chain. Phytoplankton's need the help of sunlight in carrying out the photosynthesis process.

Water pollution causes turbidity which affects phytoplankton activity in photosynthesis. The level of water turbidity can reduce the penetration of sunlight into the water. According to Irawati et al.[1], sunlight entering the water will experience dimming. Dimming is caused by suspended particulate matter, namely sedimentation. Sedimentation is caused by soil erosion from inland rivers. The sedimentation process causes siltation and degradation of water quality, the high concentration of sedimentation in the water will cause the water to become turbid.

Primary productivity values in waters are also caused by high levels of total suspended solid concentration. An increase in TSS will increase turbidity which will further inhibit the penetration of sunlight into the waters[2]. The value of sunlight intensity that is hampered by turbid water will inhibit the growth of phytoplankton in carrying out the photosynthesis process.

Total suspended solid, turbidity; brightness and biological oxygen demand

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are oceanographic parameters. Oceanographic parameters are important variables that must be measured in this study because these variables affect the life and growth of phytoplankton. Oceanographic parameters determine the value of phytoplankton primary productivity in a particular environment.

2. RESEARCH METHOD

Time and Place

This research was conducted in February - March 2022 in the waters of Lubuk Gaung Village, Sungai Sembilan District, Dumai.

Methods

The methods used were survey, in situ and laboratory analysis. There were three research stations determined by the purposive sampling method. Station I is a densely populated area and plantations, Station II is an industrial area and Station III is a mangrove forest area.

Oceanographic Parameters

Oceanographic parameters measured were water temperature, air temperature, brightness, total depth, turbidity, current speed, GPS, pH, salinity, TSS, Dissolved Oxygen (DO) and BOD.

Primary Productivity of Phytoplankton

According to Syafrizal et al.[3], the measurement of the primary productivity of phytoplankton is a commonly used way of measuring primary productivity in a water body, namely by using dark bottles and bright bottles. The initial bottle is measured as the initial DO level. Dark and light bottles containing water samples were incubated for 4 hours in the water. After incubation for 4 hours, the DO in the dark and light oxygen bottles was measured as the final DO level using the titration method.

Primary productivity analysis was conducted directly in the field. Water samples were added to 2 ml of MnSO4 solution and 2 ml of NaOH+KI until a brown precipitate formed. Next, 4 ml of H_2SO_4 solution was added and stirred until the precipitate disappeared and turned a dark yellow color. Then transferred the solution to 50 ml Erlenmeyer and added 3 drops of amylum to form a dark blue color. Then titrated using a syringe that contained Na-thiosulfate ($Na_2S_2O_3$), 0.025 N until it turns clear.

Data Analysis

The data obtained will be presented in tables and graphs and then analyzed descriptively to describe Primary Productivity. Furthermore, linear regression tests were conducted using Microsoft Excel 2010 Software and Statistical Package for Social Science (SPSS) version 22.0 to see whether or not there is a relationship, what the direction of the relationship is and how strong the relationship is between the two variables.

Data collections using the Spectrophotometer tool and data measurement are carried out using a small glass bottle to enter a water sample. The sample bottle is filled with water with a predetermined limit, then insert the bottle into the Spectrophotometer tool and finally close the tool cover and press the enter button. The water turbidity value will appear on the digital screen. The size of the particles dissolved in the sample can affect the measurement results from the Spectrophotometer, where the shape and size of the particles will affect the intensity value of the transmitted and backscattered light read by the sensor.

TSS analysis was conducted in the laboratory using the gravimetric method according to SNI 06-6989.3-2004. The Whatman paper was soaked in distilled water for approximately 5 minutes, then in the oven for 15 minutes. The paper is put in a desiccator for 15 minutes, and then weigh the weight of the paper will be calculated as the weight of the empty filter paper. The water sample was shaken as much as 100 mL and filtered using a vacuum pump and Whatman paper size 0.45 μm. In the oven

for 15 minutes and put in a desiccator for 15 minutes to remove water on the paper. The filtering results were then weighed and the TSS concentration was calculated by the formula:

$$C_{si} = \frac{(G2 - G1) \times 1000}{V}$$

Description:

Csi = suspension sediment content mg/L
G2 = weight of filter paper and precipitate after heating (mg)
G1 = weight of blank filter paper (mg)
V = the volume of filtered water (mL)

Water samples for the BOD test were first incubated at room temperature for 5 days in the dark. Furthermore, the incubated samples were tested using a photometer filter that was treated. Calculation of BOD Value:

$$BOD_5 = A_1 - A_2$$

Description:

A = DO value of the test sample before incubation (0 days) (mg/L)
A2 = DO value of the test sample after incubation (5 days) (mg/L)

3. RESULT AND DISCUSSION

Observations of primary productivity values were made at 3 stations with 2 repetitions. It was found that the average primary productivity value was 48.07 - 79.69 mgC/m^2/hour. Based on the average value of the primary productivity of each station, different values were obtained. Station II is categorized into Oligotrophic waters, namely low water conditions. Stations I and III are categorized into mesotrophic waters, which are in moderate water conditions.

High and low primary productivity values are influenced by brightness. Brightness is an important factor in the rate of photosynthesis which is closely related to the primary productivity produced Phytoplankton will look for areas with optimum light to carry out photosynthesis

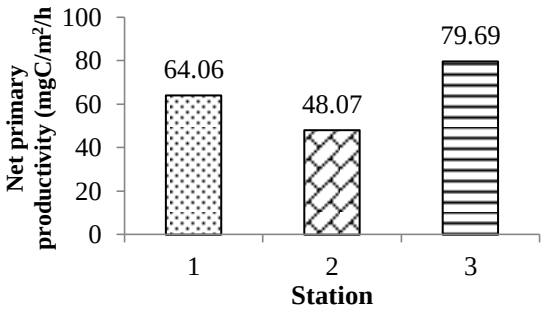

Figure 1. Diagram of average results of primary productivity level at each station

Relationship between Brightness and Primary Productivity

Brightness values with primary productivity have a very strong correlation. Measurements of brightness values at stations I, II and III ranged from 30 -49 cm and measurements of primary productivity at the same stations ranged from 48.07-79.69 mgC/m^2/h. Based on the linear regression equation, the mathematical result of the relationship between brightness and primary productivity is y = 1.5738x - 0.3225.

Linear regression results of the relationship between brightness and primary productivity showed a positive value. The value (+) indicates a unidirectional relationship between the value of brightness and primary productivity, meaning that the greater the value of brightness, the greater the value of productivity. Furthermore, the value of the correlation coefficient (r) is 0.98, which means 98% of the brightness variable affects the primary productivity variable. The analysis results show that the relationship between brightness and primary productivity shows a very close correlation. Based on the value of the coefficient of determination (R2) obtained a value of 0.95. This means that the brightness value has an influence of 95% on primary productivity, while 5% is influenced by other factors not tested in the study.

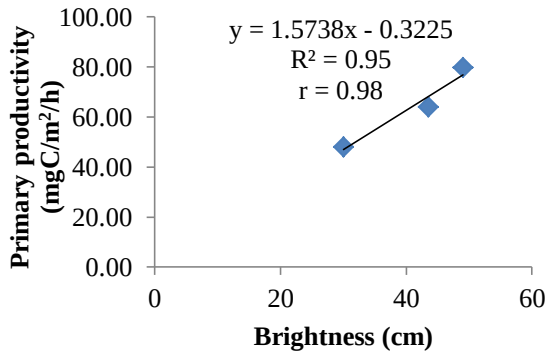

Figure 2. Linear regression graph of brightness relationship with primary productivity

Brightness values were positively correlated with primary productivity. The large concentration of suspended solids at each station reduces sunlight into the water, thus affecting photosynthesis. The more suspended particles, the higher the turbidity level, so that light penetration is reduced, which causes the spread of organisms into the waters to be limited[4].

Relationship between Turbidity and Primary Productivity

Turbidity value measurements at stations I, II and III ranged from 47.4 -58.4 FTU and primary productivity measurements at the same stations ranged from 48.07-79.69 mgC/m^2 /h. Based on the linear regression equation, the mathematical result of the turbidity relationship between primary productivity is y = 8456x - 32.526.

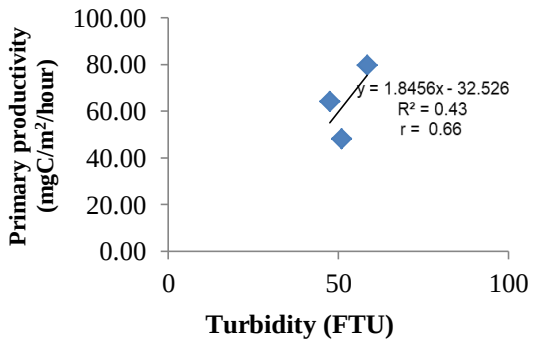

Figure 3. Linear regression graph of turbidity relationship with primary productivity

The linear regression results of the relationship between turbidity and primary productivity showed a positive value. The value (+) indicates a unidirectional relationship between the value of turbidity and primary productivity, meaning that the greater the turbidity value, the greater the productivity value. Furthermore, the value of the correlation coefficient (r) is 0.66, which means that 66% of the turbidity variable affects the primary productivity variable. The analysis results show that the relationship between turbidity and primary productivity shows a close correlation. Based on the coefficient of determination (R2) of 0.43. This shows that turbidity has an influence of 43% on primary productivity, while the remaining 57% is influenced by other factors not tested in the study. This means that turbidity explains the productivity variable quite limited. The figure above shows that any increase in turbidity value will always be followed by an increase in primary productivity value.

High turbidity values are thought to have various influencing factors such as soil erosion and factory discharge, which greatly impact the level of turbidity. The high value of turbidity in a water body for a long period will reduce the value of the primary productivity of water so it will affect the activity of phytoplankton in carrying out the photosynthesis process.

Relationship between TSS and Primary Productivity

TSS value measurements at stations I, II and III ranged from 124 - 209 mg/L and primary productivity measurements at the same stations ranged from 48.07 - 79.69 mgC/m^2/h. Based on the linear regression equation, the mathematical result is y = 0.255x + 25.688.

The linear regression results of the relationship between TSS and primary productivity showed a positive value. The value (+) indicates a unidirectional relationship between the TSS value and primary productivity, meaning that the greater the TSS value, the greater the

productivity value. Furthermore, the correlation coefficient (r) value is 0.83, which means 83% of the TSS variable affects the primary productivity variable. These results indicate a very strong relationship between TSS parameters and primary productivity. Based on the graph above, the coefficient of determination (R^2) is 0.69. This shows that TSS has a 69% influence on primary productivity, while the remaining 32% is influenced by other factors not tested in the study.

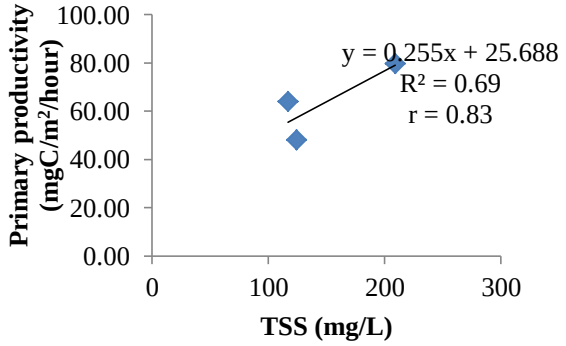

Figure 4. Linear regression graph of TSS relationship with primary productivity

The high TSS content is thought to be due to sea transport activities, industrial factory activities and fishermen activities such as fishing and others. Suspended particles are also influenced by waste from land and strong currents that will have an impact on increasing turbidity in a body of water. If the water is turbid, the photosynthesis process will be hampered. According to Sinaga et al.[5] high TSS particles can block the brightness of sunlight in the waters, thus affecting the value of primary productivity.

Relationship between BOD and primary productivity

BOD value measurements at stations I, II and III ranged from 0.408 - 0.612 Mg/L and primary productivity measurements at the same stations ranged from 48.07-79.69 mgC/m^2/hour. Based on the linear regression equation, the mathematical result is y = -35.835x + 90.744.

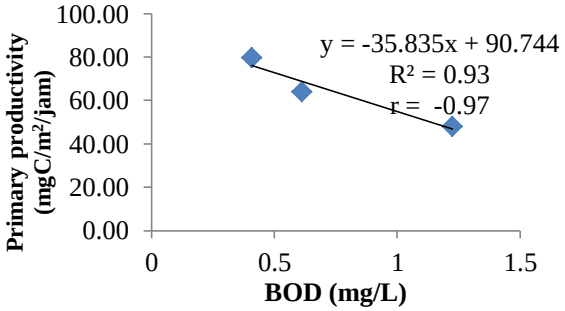

Figure 5. Linear regression graph of the relationship between brightness and primary productivity

The linear regression results of the relationship between TSS and primary productivity showed a negative value. The (-) value indicates an inversely proportional relationship between BOD value and primary productivity. The smaller the BOD value, the greater the productivity value. Furthermore, the correlation coefficient (r) value is 0.97, which means 97% of the BOD variable affects the primary productivity variable. These results indicate a very strong relationship between BOD parameters and primary productivity. Based on the graph above, the coefficient of determination (R2) is 0.93. This shows that BOD has an influence of 93% on primary productivity, while the remaining 7% is influenced by other factors not tested in the study. Figure 4.7 shows that any decrease in BOD value will always be followed by an increase in primary productivity.

BOD5 is the amount of oxygen required by aerobic microbes to oxidase organic matter into carbon dioxide and water. Organic matter can come from the decay of dead plants and animals or waste products from domestic and industrial waste. Hatta[6] stated that the BOD value will be higher with the increase of organic matter in the waters. Conversely, the lower the amount of organic matter in the waters, the BOD value will also decrease. The higher concentration of BOD5 indicates that the waters have been polluted, while the concentration of BOD_5 the level of

pollution is still low and can be categorized as good waters.

4. CONCLUSION

The average values of oceanographic parameters from the three research stations are brightness ranging from 30 - 49 cm, turbidity 47.4 - 58.4 FTU, TSS 124 - 209 mg/L and BOD 0.408 -1.224 mg/L. The average value of water primary productivity is 48.07 - 79.69 mgC/m^3/day. The value of primary productivity at station II is categorized into Oligotrophic (Low waters). Stations I and III are categorized into mesotrophic waters (medium waters).

The relationship between Turbidity and primary productivity has a strong and positive correlation (unidirectional). The relationship between Brightness and TSS with primary productivity has a very strong and positive (unidirectional) correlation value. The relationship between BOD and primary productivity has a very strong and negative (opposite) correlation.

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