Primary Productivity of Blanakan Fishpond at Subang, West Java

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Abstract. Subang regency is one of the largest fisheries area in West Java, so it is important to maintain the quality of fishpond area in Blanakan, Subang. Primary productivity can be defined as the production rate of organic carbon per unit time which is the result of solar energy by green plants to be converted into chemical energy through photosynthesis. Primary productivity can be used to define the quality of an ecosystem including fishpond. The aim of this research was to measure the value of primary productivity in mangrove fishpond, determine the correlation between the primary productivity and the content of nitrate, phosphate, and chlorophyll-a, and to analyse the significance primary productivity differences among three sampling stations. The samples were collected from three sampling stations, where all of those consist of mangrove Avicennia marina vegetation. Each station was divided into two points based on different depth i.e. 0 and 1.5 meters. The measurement of primary productivity was done by light-dark bottle method, meanwhile the nitrate, phosphate and chlorophyll-a concentration by spectrophotometer method. The result showed that the value of primary productivity ranged from 39.0625 to 101.5625 mgC/m3/day with the highest value obtained at station I and the lowest value at station III. According to statistical test, there were a significant differences of primary productivity value among three sampling stations with the value is 0.003 (p < 0.05). Correlation analysis showed that primary productivity was correlated positively with chloropyll-a and negatively with nitrate and phosphate contain water.

1. Introduction

Subang is one of the regencies in West Java Province which located in the north coast of Java. Subang Regency has 189,400 ha area and was divided into 22 Districts or 243 Villages and 8 Sub-districts. Only 4 sub-districts located near the coastal area, namely Blanakan sub-district (7 coastal villages), Pamanukan (1 coastal village), Legonkulon (5 coastal villages), and Pusakegara (1 coastal village).

The Blanakan area has been a center for milkfish production in West Java with silvofishery type. Silvofishery is a traditional farming technology system that combines fisheries business with mangrove planting, which is followed by the concept of introducing a management system by minimizing input and reducing the impact to the environment [1]. The main commodities that are cultivated in the pond area are tiger shrimp and milkfish because the market demand for both commodities is still quite high, both for domestic and foreign markets [2].

Therefore, it is necessary to conduct a research that examines primary productivity in the waters of the Blanakan pond, especially in the area of fishpond owned by local farmers. In addition, further research is needed to see the differences of nitrate (NO3), phosphate (PO4), and chlorophyll-a
concentrations in each research station in the Blanakan pond area. The aims of this research was to determine the concentration of nitrate (NO₃), phosphate (PO₄), and chlorophyll-a at each station in the Blanakan pond area, Subang, West Java and to measure the value of primary productivity at each station. Then, the results of this study are expected to prove that there are differences in the value of primary productivity which is influenced by differences in nitrate, phosphate, chlorophyll-a content at each research station.

Fish cultivation is an activity to maintain, raise, and / or breed fish and harvest the results in a controlled environment [3]. In Indonesia, aquaculture is carried out through various means. The most common cultivation activities are in ponds, tanks, karamba, and floating cages. Definition of ponds according to [4] is a water body measuring 1 m² to 2 ha which is formed naturally or man-made.

Primary productivity is the production rate of organic carbon per unit time which is the result of capture of solar energy by green plants to be converted into chemical energy through photosynthesis [5]. Gross primary productivity is the total amount of photosynthesis carried out by plants within a certain period. While the primary primary productivity is the amount of synthesis of organic carbon compounds during photosynthesis reduced the amount of total respiration activity in light and dark in a certain period [6].

A common method which used to measure the primary productivity of an aquatic environment is dark bottle and a light bottle. The light bottle is used to measure the rate of photosynthesis which is also called gross primary productivity (the total amount of organic material produced in the presence of light), while dark bottles are used to measure respiration rate. The value of primary productivity is generally the same value of net primary productivity [5].

The presence of nitrate and phosphate compounds in the waters comes from the decomposition of weathering or decomposition of plants, the remains of dead organisms and waste from both land waste such as domestic, industry, agriculture, waste from ponds and farm waste or leftovers that bacteria will break down into nutria. This will affect the chlorophyll-a concentration in the waters [7].

Chlorophyll is the most important pigment of plants that carry out photosynthesis. Chlorophyll is a green carrier in plants, which plays the role for photosynthesis (absorbs and uses sunlight energy to synthesize oxygen and carbohydrates from CO₂ and H₂O) in plants. Therefore, the amount of chlorophyll content has a major effect in determining the rate of photosynthesis. The results of this study showed that chlorophyll a plays an important role in photosystem I and II [7].

2. Material & Method your paper
The sampling station of this research consist of 3 ponds locations as shown in Figure 1. Water sampling was carried out on the three ponds with two points according to depth, namely the first point at a depth of 0 meters and the second point at a depth of 1.5 meter.

Data retrieval of primary productivity was carried out using a dark-light oxygen bottle method. Work procedures for this method include: water sampling, sample incubation and calculation. Data retrieval of primary productivity is repeated three times at two sampling points at each station. The materials used for this research are dark bottles and light bottles that have been tied to bamboo, and Dissolved Oxygen meters to calculate the initial and final dissolved oxygen in each bottle.

The time required for incubation of dark-light bottles inside the pond was 6 hours. The incubation time started at 11.00 - 17.00 WIB. Before incubating each bottle, dissolved oxygen was measured as initial DO. After 6 hours, bamboo at each research station was lifted from the water. Then the dissolved oxygen was measured in each bottle as the final DO.

One liter water were collected for the measurement of Nitrate, phosphate and chlorophyll-a. Pearson correlation analysis was used to determine the relationship between the parameters nitrate, phosphate and chlorophyll-a as primary productivity [5]. Physic-chemical parameters were measured at 11.00 - 13.00 WIB at the location of water sampling. Parameters measured were temperature, dissolved oxygen (DO), degree of acidity (pH), salinity, and turbidity. To test the significance differences of primary productivity among three station, the data were measured by “One-Way ANOVA” with SPSS ver. 16 [5].
3. Result and Discussion
The water temperature in the Blanakan pond is normal for tropical mangrove areas, which is in the range of 27 - 34°C and is suitable for aquaculture ponds ranging from 28 - 32°C [8]. The degree of acidity (pH) in three ponds tends to be alkaline but is still relatively normal in the range of 6.5-9.2 and is still suitable for aquaculture ranging from 7.5-8.5. Salinity in these ponds ranges from 14 - 26.5 ppt. This value is still relatively normal for the mangrove area (7.40 - 25.80 ppt). Salinity value is optimal for aquaculture ponds which in the range of 10 - 35 ppt. Referring to [9], salinity of most of the local farmers’ ponds is indeed in those range because the three research stations are located very close to the sea.

Table 1. Physico-chemical parameter of water

| Station | Temperature | Salinity | pH  | Turbidity | Nitrate | Phosphate | Chlorophyll-a |
|---------|-------------|----------|-----|-----------|---------|-----------|---------------|
| I       | 29.30       | 15.5     | 6.50| 80.9      | 0.13    | 0.15      | 2064.210      |
| II      | 32.75       | 26.5     | 6.70| 38.2      | 0.12    | 0.05      | 589.834       |
| III     | 33.30       | 14.0     | 7.15| 186.0     | 0.16    | 0.17      | 549.226       |

a : oligotrophic; b : hypertrophic; c : mesotrophic

Turbidity in the Blanakan mangrove ponds ranges from 38.2 - 186 NTU. Turbidity at the second station is the lowest, while the highest value of turbidity is at station III due to the nitrate and phosphate concentration in it. Nutrients concentration plays an important role to block the light, causing the sunlight disable to penetrate up to the bottom of the waters so the water become more turbid. Based on the results obtained (Table 1), the highest nitrate concentration was found in station III due to the higher decomposition results of Avicennia leaf litter and the location is near to the river [9]. It also causes the high value of turbidity in station III (186 NTU). Chlorophyll-a ra

The value of primary productivity obtained can be seen in Table 2. The results of calculations using dark-light bottles showed that the highest average value of primary productivity was found in station I with the highest value of chlorophyll-a. This is because chlorophyll-a plays an important role in photosynthesis reaction which leads to a higher value of primary productivity. It can be concluded that
the concentration of chlorophyll-a was crucial for the primary productivity. The value of primary productivity ranges from 39,062.5 - 101,563 mgC/m²/day.

### Table 2. Primary productivity

| Station | Depth | DO₀ | DO₆ | Light | Dark | GPP | Respiration | NPP | Mean of PP |
|---------|-------|-----|-----|-------|------|-----|-------------|-----|------------|
| I       | 1.5   | 7.5 | 9.5 | 6     | 182.292 | 78.125 | 104.167 | 101,563 |
|         | 0     | 7.4 | 9.3 | 5.4   | 203.125 | 104.167 | 98.958  |
| II      | 1.5   | 7.5 | 9.2 | 6.7   | 130.208 | 41.667 | 88.541  | 83,333  |
|         | 0     | 7   | 8.5 | 4.5   | 208.333 | 130.208 | 78.125  |
| III     | 1.5   | 8.1 | 8.9 | 3.3   | 291.667 | 250    | 41.667  | 39,062  |
|         | 0     | 8   | 8.7 | 3.1   | 297.667 | 255.208 | 36.458  |

DO₀: initial DO; DO₆: DO after 6 hours; GPP: gross primary productivity; NPP: net primary productivity

It is much lower compared to the primary productivity from the fishpond owned by Perhutani, which ranged from 152 – 260 mgC/m²/day due to its location was nearer with the river allowed the nutrient concentration to be increased. Furthermore, the different season occurring when the data taken from both location also affecting the primary productivity value both for Perhutani and local fishpond.

The results of Pearson correlation analysis (Table 3) show that the value of primary productivity is directly related to chlorophyll-a with the P value 0.74. This result also showed that chlorophyll-a strongly related with the value of primary productivity. Chlorophyll-a in the water comes from the phytoplankton, according to [10] the relationship with primary productivity is caused by phytoplankton which are producers of O₂ in water significantly influence photosynthesis products and respiration in the waters.

### Table 3. Correlation between primary productivity and chemical parameter using Pearson

| Nitrate | Phosphate | Chlorophyll-a |
|---------|-----------|---------------|
| -0.862  | -0.382    | 0.741         |

The Anova test results at the 95% confidence level showed the significance value of primary productivity is 0.003 (Table 4). From these results it is known that the average value of primary productivity among three stations is significantly different (p < 0.005).

### Table 4. Anova test on primary productivity

| Variation | Total Value | Degree | Average | F₀ | Sig. |
|-----------|-------------|--------|---------|----|------|
| Station   | 4132.307    | 2      | 2066.153|    |      |
| Error     | 81.38438    | 3      | 76.162 | 76.162 | 0.003 |
| Total     | 4213.691    | 5      |        |    |      |

This result caused by the differences of nutrient concentration which can affect indirectly to the photosynthesis reaction. Turbidity also affected the value of primary productivity by affecting the sunlight radiation to the water [11].
4. Conclusion
The results of the study about "Primary Productivity of Blanakan Pond waters in Subang Regency, West Java" can be concluded as follows:

a) The average value of primary productivity in the Blanakan pond area considered as very low with the value of 74.65 mgC/m²/day. The highest primary productivity value was found in station I. The Anova Test results show that there is a significant differences in the value of primary productivity among three stations.

b) The value of nitrate and phosphate nutrients in each research station is different, with the highest nitrate was found at station III at the value of 0.16 mg/L. Meanwhile, the highest value of phosphate also found at station III with the value 0.17 mg/L.

c) The highest chlorophyll-a value was found at station I which is 2064.21 (μg/L) while the lowest value goes to station III at 549.226 (μg/L).

d) According to Pearson correlation analysis, there is a strong correlation between the value of primary productivity and chlorophyll-a concentration, while it is negatively correlated with nitrate and phosphate concentration in the water.

e) Further research is needed to determine the effect of broad spatial vegetation of mangroves with the value of primary productivity. In addition, further research also expected to examine the linkages of primary productivity with the harvest production in Blanakan fishpond area.

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