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# The structure of phytoplankton community to estimated trophic level in jatigede reservoirs

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**Abstract**
This research aims to estimate the trophic level status of the waters of the Jatigede Reservoir in terms of the phytoplankton community structure. This is an effort to support the sustainable management of Jatigede Reservoir. The method used is purposive sampling was conducted in June - September 2018. Sampling was conducted at 4 stations with 6 replications. The parameters measured include temperature, light transparency, TSS, pH, DO, BOD, Nitrate, Phosphate and phytoplankton. The results of the research show that the quality of the Jatigede Reservoir waters falls into the class II and III categories according to PP 82 of 2001 which supports the life of aquatic organisms including phytoplankton. There are 53 species of phytoplankton with abundance ranging from 15.945 – 644.300 individuals / L. The diversity index (H') is at 1,01 and the index evenness is 0,09 which is categorized as low evenness. Based on phytoplankton abundance, Jatigede Reservoir is in trophic status, eutrophic.

**Keywords:** phytoplankton, trophic status, jatigede reservoir

## 1. Introduction
Jatigede Reservoir was built by damming the Cimanuk River with a capacity of 979.5 million m3 of water. One function of this reservoir is as a source of irrigation for 90,000 hectares of rice fields in Indramayu, Majalengka, and Cirebon [4]. Utilization of the Jatigede Reservoir after the inundation period is an intensive fishing activity. To be able to support the catch in the Jatigede Reservoir there are many introduction and restocking activities for various types of fish, both native fish of the Cimanuk River and other fish. The use of reservoirs both for capture fisheries and aquaculture activities must be supported by a wealth of information about the potential of these reservoirs so that their utilization and management can be optimized and maximized. One of the potential reservoir waters which is an important factor that must be known is the structure of the phytoplankton community, because the presence of phytoplankton in a waters can affect the life of other organisms contained in the waters. Phytoplankton become the first energy source in the waters which will be the source of life for the next organism which is said to be the primary producer in the food chain. Besides phytoplankton can also be used as an indicator of the fertility of water.
Changing water conditions in the Jatigede Reservoir can be caused by the entry of various inputs from the Cimanuk River which will increase the nutrient elements in the reservoir waters so that it can result in changes in the community structure of phytoplankton. The presence of phytoplankton in a waters is strongly influenced by oxygen, nitrogen and phosphate which are essential nutrients needed for phytoplankton growth. These nutrient elements come from wastewater discharges from residential areas carried by rivers [7]. Phytoplankton are used as indicators of water quality because of their short life cycle, rapid response to environmental changes [7]. The abundance of phytoplankton in a body of water is very important because plankton functions as a primary producer of aquatic biota, on the other hand the abundance of phytoplankton can also be used as an indicator to estimate the trophic status of a waters. Phytoplankton community structure to estimate trophic status in the Jatigede Reservoir so that it can be known water conditions and as an effort to conduct appropriate management activities.

## 2. Material and Method
The study was conducted in June-September 2018, with 4 stations covering all waters of the Jatigede Reservoir. The characteristics of each station chosen by purposive sampling based on water input into the Jatigede Reservoir are (Figure 1):

1. Station 1, an inlet of the Jatigede Reservoir located in Desa Sukamenak, receives water from five rivers namely Cimanuk River, Cimuja River, Cibelah River, Cialing River, and Cijajaway River.
2. Station 2, a catch fisheries activity area, is located in Leuwihideung Village, receiving water from the Cihonje River.
3. Station 3, located in Jemah Village, receives water from the Cinambo River, an area that has the deepest depth of the Jatigede Reservoir
4. Station 4, a DAM of Jatigede Reservoir is located in Cipaku Village

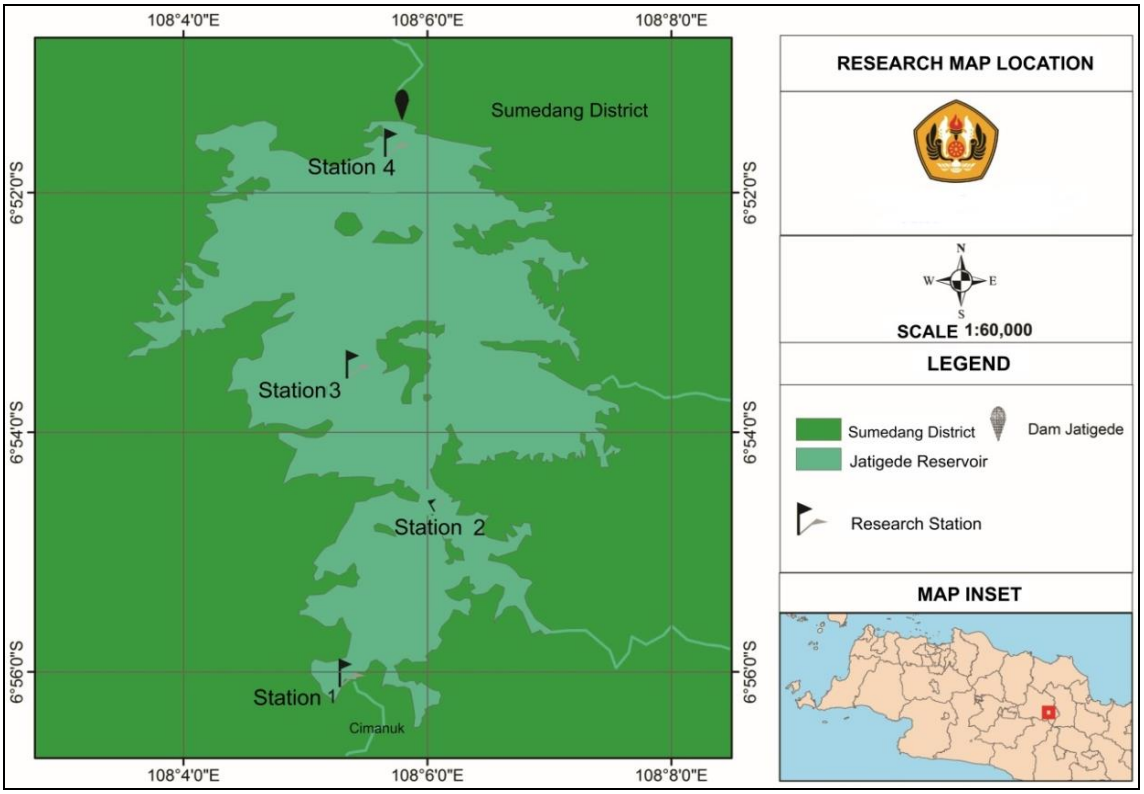


**Fig 1**

Water quality parameters measured are physical and chemical parameters including temperature, brightness, pH, DO, Nitrate and Phosphate, TSS. Measurement of all physical and chemical parameters refers to Rice at al (2012).

**Plankton abundance**

The determination of plankton abundance is based on the sweeping method on the glass of the segwick rafter object. Calculate the abundance of equations as follows [1]:

$$N = n \times \frac{Vr}{Vo} \times \frac{1}{Vs}$$

Information:
N = total of individual plankton.
n = number of observed plankton
Vr = Volume of filtered plankton
Vo = Volume of observed sample
Vs = Volume filtered water (L)

Diversity Index

The index of diversity is calculated using the Shanon-winner formula [1] as follows:

$$H' = -\Sigma(pi) \times (lnpi)$$

Information:
H' = Shanon-Winner Diversity Index
Pi = Proportion of individuals in one species divided by the total number of individuals

The diversity categories according to Whilm and Dorris (1968) are as follows:
H'<1 = Low species diversity
1<H'<3 = Medium species diversity
H'> 3 = High species diversity

**Evenness Index**

The evenness index is calculated by the Pielou formula (Heip *et al*. 1998), as follows:

$$E = \frac{H'}{Log\ S}$$

Information:
E = Phytoplankton / zooplankton uniformity index
H' = Diversity index
S = Number of species identified

Evennes index values are distinguished by categories:
E <0.4 = Low uniformity (depressed community)
0.4 ≤ E ≤ 0.6 = Medium uniformity (unstable community)
E> 0.6 = High uniformity (stable community)

**3. Results and Discussion**

Zhao *et al*. [12] stated that physical-chemical parameters of water that affect phytoplankton growth include temperature, nutrients (N and P), transparency of light, dissolved oxygen. The results of measurement of physical and chemical parameters of the quality of the Jatigede Reservoir waters in Table 1.

**Table 1:** Measurement of Jatigede Reservoir Water Quality

| Parameter | | Stasiun | | | | Quality Standars | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | PP 82 Th. 2001 | |
| | | | | | | Class II | Class III |
| Temperature ($^0$C) | k | 24,8-27,2 | 25,9-27,7 | 25 - 28,7 | 25 -26,7 | Deviasi 3* | Deviasi 3* |
| | r | 26,21±0,89 | 26,7±0,58 | 26,5±1,29 | 26,66±1,23 | | |
| Transparency (cm) | k | 22,5-85,5 | 57,3-158,5 | 114,2-224,3 | 92,8-185,6 | - | - |
| | r | 49,06±23,90 | 105,55±35,84 | 150,3±41,42 | 149,15±34,39 | | |
| *TSS* (mg/l) | k | 1,4 - 5 | 1, -10 | 2,2-7 | 1,8-8,3 | 50 | 50 |
| | r | 4,91±5,25 | 4,28±3,03 | 3,46±1,77 | 4,5±2,69 | | |
| pH | k | 6,67-7,54 | 6,84-8,04 | 6,94 - 8,11 | 6,78-8,4 | 6–9 | 6–9 |
| | r | 7,14±0,36 | 7,51±0,54 | 7,62±0,42 | 7,76±0,59 | | |
| DO (mg/l) | k | 2,3 - 4,4 | 3 - 6,7 | 4,4 - 5,5 | 4,2 - 6,5 | 4 | 3 |
| | r | 3,56±0,76 | 5,05±1,28 | 5,08±0,39 | 5,71±1,17 | | |
| $BOD_5$ (mg/l) | k | 2,9 - 3,25 | 2,1 - 2,61 | 2 - 2,55 | 2,1 - 2,65 | 3 | 6 |
| | r | 3,06±0,14 | 2,36±0,20 | 2,33±0,21 | 2,47±0,47 | | |
| $NO_3$ (mg/l) | k | 0,27-0,44 | 0,18-0,56 | 0,15-0,54 | 0,14-0,65 | 10 | 20 |
| | r | 0,37±0,08 | 0,34±0,13 | 0,31±0,13 | 0,33±0,18 | | |
| $PO_4$ (mg/l) | k | 0,17-0,20 | 0,16-0,18 | 0,14-0,17 | 0,150,19 | 0.2 | 1 |
| | r | 0,18±0,01 | 0,16±0,01 | 0,16±0,01 | 0,17±0,01 | | |
| Abundance | | 299.605 | 193.831 | 101.333 | 120.802 | | |
| (H') | | 0,87 | 1,21 | 0,99 | 0,94 | | |
| (E) | | 0,08 | 0,1 | 0,09 | 0,08 | | |

Based on observations of temperature at each station it is known that the Jatigede Reservoir temperature ranges between 24.8ºC-28.7ºC with an average of 26.5ºC. This temperature is still in the optimum range of phytoplankton life. Good temperatures for the growth of plankton from the phylum Chlorophyta and diatoms are in the range (30-35ºC) and (20-30ºC) while Cyanophyta can tolerate a higher temperature range [3]. One of the factors that influence temperature is the transparency of light. Transparency of measured light in the Jatigede Reservoir during research ranged from 22.5 to 224.3 cm with an average of 113.51 cm. The higher the transparency of light, the easier the light to enter the water, and vice versa the lower it will inhibit the process of photosynthesis by phytoplankton.

High or low transparency of light is related to the presence of suspended solids (TSS) in water. The range of TSS in Jatigede Reservoir is 1.4-15 mg/L. The station that has the largest average TSS is Station 1, which is 4.91 mg/L with a range of 1.4-15 mg/L, and the lowest is Station 3. The number of suspended solids is suspected because Station 1 is the inlet of the Jatigede Reservoir which gets a lot of waste input from the Cimanuk River. The large number of suspended substances also results in low transparency at Station 1, as well as at Station 3, the low TSS at Station 3 causes the transparency of light at Station 3 to be higher than other stations. A high suspended solid (TSS) shows a high level of pollution and inhibits the penetration of light into water so that it interferes with the photosynthetic process of aquatic organisms [8].

Dissolved oxygen (DO) is an important parameter in a waters. The station that has the highest DO average is station 4 and the lowest station 1. The DO level that can cause death in aquatic organisms is less than 2 mg/L [3]. The DO range of Jatigede Reservoir is 2.3 - 6.7 mg/L with an average of 4.85 mg/L. The lowest DO is found at Station 1 and the highest is Station 4. The low dissolved oxygen concentration at Station 1 is allegedly due to the large amount of organic material present at Station 1 so that the process of respiration and decomposition of materials requires a lot of oxygen in the process.

The acidity (pH) in the waters of the Jatigede Reservoir is between 6.72 - 8.21 with an average of 7.5. The pH at Station 1 is lower than the pH at the other stations. This indicates that the input load from the inlet (Cimanuk River) in the form of domestic, agricultural and industrial waste in the watershed greatly affects the pH at this station. Aquatic organisms are sensitive to changes in pH. Generally blue algae prefer a neutral to basic pH and a negative growth response to acidic pH (Wetzel 1980).

Biochemical Oxygen Demand (BOD) in the waters of Jatigede Reservoir ranges from 2.10 to 3.35 mg/L. The station that has the highest average BOD value is Station 1, which has an average of 3.06 mg/L and with a range of 2.90-3.25 mg/L. Station 1 is the station that receives the largest input load in the form of both organic and inorganic waste, because it is an inlet of the Jatigede Reservoir and there are also many community activities at this station that have the potential to increase the organic burden. The station with the lowest average BOD concentration is Station 3, which is 2.33 mg/L with a range of 2-2.55 mg/L. This result is in accordance with the characteristics of the water body at Station 3 which does not have as much organic material input as other stations. The BOD value of waters is influenced by temperature, plankton density, the presence of microbes, as well as the type and content of organic matter [3].

The average nitrate concentration of Jatigede Reservoir is 0.343 mg/L, and ranges from 0.14 - 0.65 m/L. The highest nitrate concentrations are in Station 1 and lowest Station 3. Nitrate is not toxic to aquatic organisms but, if the levels are too high, it can cause enrichment of aquatic nutrients so that the algae grows in excess or commonly called algae bloom [3]. Phosphate concentrations in the Jatigede Reservoir ranged from 0.14 to 0.20 mg/L. The highest phosphate concentration at Station 1 and the lowest at Station 3. The high NO3 and PO4 content at Station 1 is suspected due to the input load from the inlet and agricultural land around the Cimanuk River estuary through drainage and rainwater flow. The low $NO_3$ and $PO_4$ at Station 3, due to the lack of potential organic load input at Station 3.

**Phytoplankton abundance and composition**

Phytoplankton identified in the waters of the Jatigede Reservoir during the research took place 53 species of phytoplankton derived from six phyla, namely pyrrophyta, cyanophyta, chlorophyta, chrysophyta, euglenophyta, rhodophyta. The abundance of phytoplankton Jatigede Reservoir both between stations and between sampling times has relatively different abundances. Changes in the abundance and composition of phytoplankton in a waters can reflect changes in physical and chemical variables of the waters and biota interactions in them [2]. The abundance of phytoplankton in Jatigede Reservoir can be seen in Figure 2.

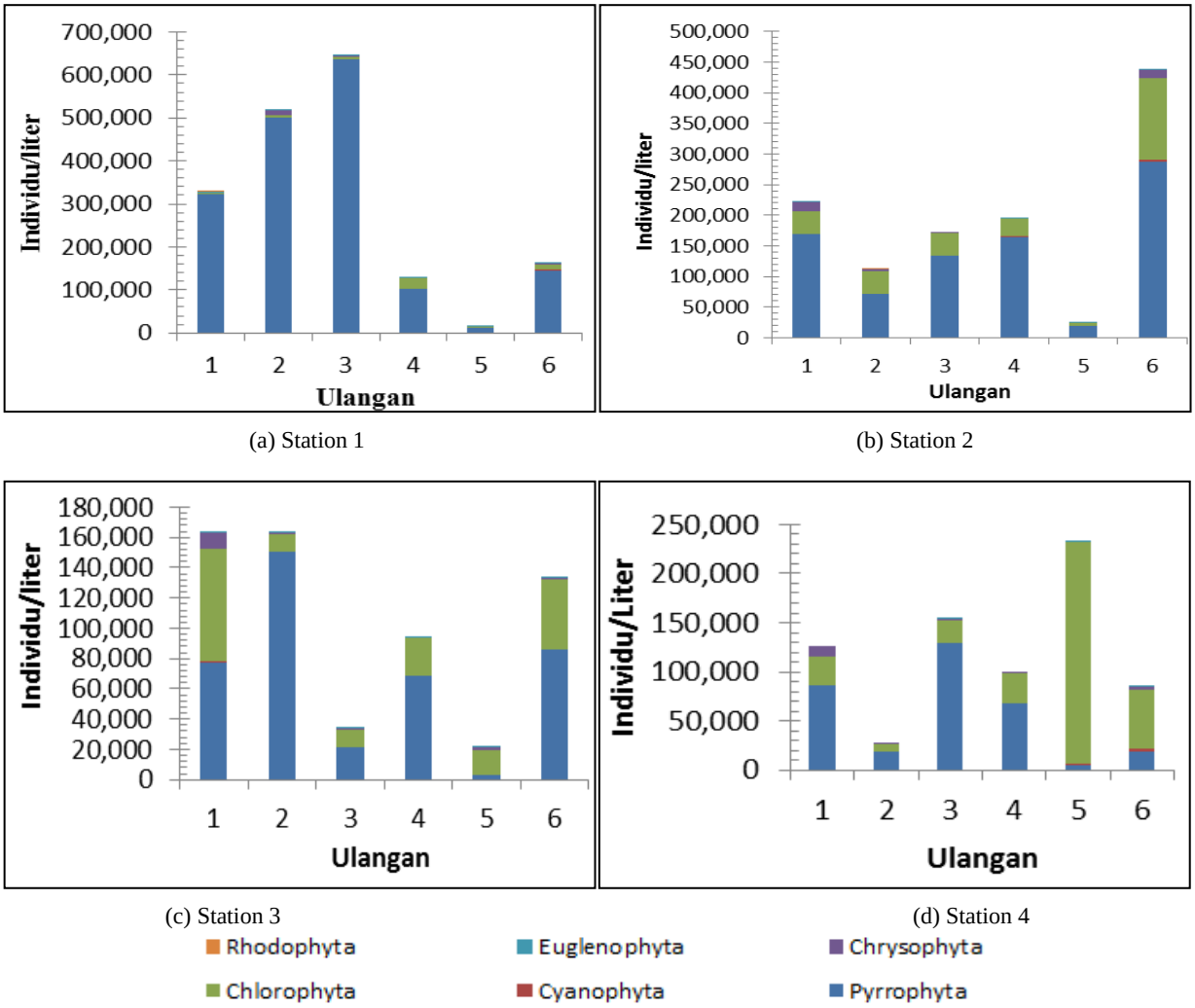


**Fig 2:** Abundance of Phytoplankton in Jatigede Reservoir

The highest abundance of phytoplankton is at station 1 with an average abundance of 299,605 individuals/L. The high abundance of phytoplankton at station 1 is related to $NO_3$ and PO4 concentrations which are also the highest compared to the other two stations. The average $NO_3$ concentration at station 1 was 0.37 mg/L and $PO_4$ was 0.18 mg/L. Nutrient concentration at Station 1 is also related to land use around the station which is the Jatigede Reservoir inlet. The inlet is the area that gets the most nutrient input. The higher the nutrients, the more nutrients phytoplankton can use for life.

The station that has the lowest abundance is station 3. The average abundance of phytoplankton at station 3 is 101,333 individuals/L. The reason this station has the lowest abundance is that nutrients only come from natural decay in the reservoir without the contribution of organic material from the outside. This is consistent with the results of $NO_3$ and $PO_4$ concentration measurements at station 3 lower than other stations. The average $NO_3$ concentration at station 3 is 0.33 mg/L and $PO_4$ is 0.14 - 0.17 mg/L.

In addition to nutrients, temperature also influences the abundance of phytoplankton in waters. Simanjuntak (2009) states that the effect of temperature directly on plankton is to increase chemical reactions so that the rate of photosynthesis increases with temperature. The indirect effect of temperature is the reduction in plankton abundance due to the temperature decreases and the water density increases with increasing depth. Pyrrophyta phyla has the highest abundance compared to other phyla. The species that contribute to have the highest abundance are Peridinium sp. and Ceratium sp. This is due to peridinium sp. has the ability to adapt to a wide range of pH and light intentions, is able to defend itself from predators (zooplankton) and can store phosphorus used when phosphorus deficiency occurs in aquatic environments [5].

The highest abundance of station 1 occurred on the 3rd test. The highest abundance of phytoplankton at station 2 occurred at the 6th test. The highest abundance of station 3 occurs in the first test and the highest abundance of station 4 occurs in the fifth test. The difference in peak abundance at

each station is due to differences in the amount of macro and micro nutrients present in the body of water, and environmental factors in each repetition. This is confirmed by the statement of Reynolds *et al*. (1984) which states that the composition and abundance of plankton will change at various levels in response to changes in environmental conditions both physical, chemical, and biological.

**Phytoplankton Diversity and Evenness Index**

Diversity is a condition that shows the number of different species that inhabit an ecosystem compared to the total number of all species (Zahidah 2017). In addition to the diversity index there is a evenness index. Plankton uniformity analysis was conducted to see the new pattern of plankton distribution in a plankton community ecosystem (Basmi 2000). Based on Table 1. the average diversity index (H ') of phytoplankton is 1.01. Wilhm and Dorris (1986) stated that diversity index criteria are divided into 3 categories namely, H '<1 means low diversity, 1 <H' <3 means moderate diversity and if H '> 3 then species diversity is high. Based on this statement, the phytoplankton diversity index in the Jatigede Reservoir is classified as moderate.

The average uniformity index (E) of phytoplankton in the Jatigede Reservoir is 0.09. This value means that the uniformity of phytoplankton species in the Jatigede Reservoir is low because E <0.4. This shows that the distribution of phytoplankton types has not been well distributed so that it experiences pressures that can reduce its survival or vice versa can dominate the waters. This condition is expected to continue to change by monitoring the management to determine the factors that cause dominance in certain locations and minimize the occurrence of these factors.

**Estimating the status of Trophic Jatigede Reservoir**

In general, the abundance of phytoplankton in Jatigede Reservoir is around 15,945 - 644,300 individuals / liter with an average of 178,893 individuals/L. Based on the abundance of plankton, the waters of Jatigede Reservoir are included in the category of waters with eutrophic fertility. According to [6] fertility based on plankton abundance is divided into three, namely oligotrophic with plankton abundance levels of 0-200 individuals/L, mesotrophic with plankton abundance levels ranging from 2,000-15,000 individuals/L and eutrophic with plankton abundance levels of more than 15,000 individuals/L.

## 4. Conclusion

In general, the quality of Jatigede Reservoir waters falls into classes II and III according to PP 82 of 2001 so that it supports the life of aquatic organisms. The phytoplankton community in the Jatigede Reservoir in June-September 2018 consists of 53 species, which come from 6 phyla. The average abundance of phytoplankton ranges from 15,945 - 644,300 individuals/L, based on phytoplankton abundance, the waters of the Jatigede Reservoir are at the eutrophic fertility level. Jatigede Reservoir Phytoplankton has moderate diversity (H ') which is 1.01 and low evenness (E) is 0.09.

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