

Study of water quality and carbon absorbtion in West Sunter Lake using phytoplankton

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Abstract. The purposes of this research are to analyze the water quality and measure the carbon absorbtion in water of West Sunter Lake using the phytoplankton community. The sampling and analysis of water quality and phytoplankton using the APHA method. The result show that DO is 1.1-1.4 mg/L, BOD is 10.34 to 27.35 mg/L, COD is 23-130 mg/L, and phosphate is 0.38- 0.57 mg/L. The range of index values were at 0,128 to 2,516 for the Diversity Index (H'), 0.003 to 0.924 for the Evenness Index (E), that is waters this medium polluted. The study indicated that the water quality and productivity of West Sunter Lake is impacted by the activities around West Sunter Lake, especially the household activities. The value of chlorophyll-a in the Reservoir was ranging from 3.2-386.9 mg/m³ or 0.89 s/d 105.52 mg C/m³ and carbon which absorbed by phytoplankton are 2×10^9 to 14×10^9 ton/year or 9×10^3 to 50×10^3 ton/m³. The amount of carbon absorbtion by phytoplankton per year proves that phytoplankton have an important role in reducing CO₂ emissions.

Keywords: carbon absorbtion, phytoplankton, water quality, West Sunter Lake

1. Introduction

Changes of water quality depend on the physical and chemical conditions can also be reviewed from the abundance and composition of phytoplankton [1]. The presence of phytoplankton in the waters can provide information about the state of the water. As aquatic organisms, phytoplankton has many advantages as biological benchmarks that are able to show the level of ecological instability and evaluate various forms of pollution [2].

Phytoplankton is widespread in the waters, while sunlight can still penetrate the depth of the waters where phytoplankton are located. Therefore, the activity of photosynthesis is a photochemical reaction that becomes the basis of primary productivity by phytoplankton. The basic controlling factors of primary production are light and nutrients, varying their relative importance in the ecosystems according to their dynamics [3]. The monitoring of water quality using a biological approach is a relatively recent practice. The purposes of this research are to analyze the water quality, the structure of phytoplankton community such as the diversity, uniformity, also to investigate the relation between the distribution of phytoplankton with the abundance of nitrate and phosphate. These research involving phytoplankton organisms in reservoirs represent a significant advance in the determination of water quality in these aquatic systems.



2. Research Method

The research was conducted at West Sunter Lake located on Sunter Jaya Sub-district, North Jakarta. West Sunter Lake with an area of less than 19 Ha and a depth of 12 m. The sampling and analysis of water quality and phytoplankton using the APHA method [4]. The water sample was taken by using a water sampler, then inserted into a plastic jerry and then the sample bottle inserted into an ice box to preserve the sample unchanged due to the temperature effect. Other factors were measured, in the water column, such as temperature and dissolved oxygen, pH, conductivity at 25°C, water transparency (30 cm-white Secchi disk), alkalinity [5], and chlorophyll-*a* [6]. Dissolved N-NO₃⁻ [7], N-NH₄⁺ and P-PO₄³⁻ [8]. The carbon absorption rate was calculated as the ratio between primary productivity rate and chlorophyll-*a* concentration, in order to evaluate the photosynthetic efficiency.

Phytoplankton samples were taken with plankton net number 25 by filtering 100 liters of water. Composite water collection. Subsequently, the phytoplankton collected on a plankton net concentrate bottle (bucket) was transferred into a sample or sample bottle and preserved ± 10 drops of lugol.

2.1. Phytoplankton Abundance (N) [4].

$$N = z \times \frac{X}{Y} \times \frac{1}{V} \quad (1)$$

N = Abundance Phytoplankton (sel/L), X = The volume of water filtered (100 liter), Y = Volume 1 drops (0,05 ml), V = The volume of water filtered (250 liter), Z = The number of individual that found (cell)

2.2. Evenness Index (E)[3].

$$E = \frac{H'}{H'_{maks}} \quad (2)$$

E = Evenness Index, H' = Diversity Index, H' maks = The maximum value of diversity

2.3. Chlorophyll-*a* [6].

$$\text{Chlorophyll} - \text{mg} / \text{m}^3 = \frac{\{(11,85(E_{664}) - 1,54(E_{647}) - 0,08(E_{630})) \times \text{Volume Extraksi L}\}}{\text{Volume Sampel } \text{m}^3} \quad (3)$$

E₆₆₄ = absorbance 664 – absorbance 750 nm, E₆₄₇ = absorbance 647 - absorbance 750 nm, E₆₃₀= absorbance 630 – absorbance 750 nm, V_e = The volume of extract acetone (ml), V_s = The volume sampel of strain that filtrered (250 m)

2.4. Carbon Absorbtion [8]

$$\begin{aligned} \text{Chlorophyll} - a \text{ value (mg/m}^3) \times \text{mol CO}_2 &= \text{mg CO}_2/\text{m}^3 \\ \text{mg CO}_2/\text{m}^3 \times 12/44 (\text{Ar C / CO}_2) &\rightarrow \text{mg C/m}^3 * \end{aligned} \quad (4)$$

*Conversion C/m³ as ton/ m³ and ton/year to determine the ability of carbon uptake in a body of water and the amount of carbon uptake in a certain period of time.

3. Results and Discussion

3.1. Water Quality

The result of physical water measurement are temperature, turbidity and brightness. Water temperature ranges from 28–30°C. This high difference in low temperatures occurs at the time of sampling. Turbidity ranges from 24.3 to 2337 mg/L. The high turbidity due to the runoff water carried from open land and other factors that incoming wastewater contains many suspended solids. The results of

brightness measurements were 0.10 to 0.22 m. In general, very shallow brightness measured less than 1 m is affected by the water condition which is very turbid as seen from the turbidity data all sampling points obtained high results. This low brightness is caused by high suspended particles in the water (indicated by turbidity) as the turbidity has highest value of 237 NTU. The relationship between brightness and turbidity is inversely proportional. The high turbidity is caused by the presence of suspended organic matter and causing less sunlight to enter the waters, so that the brightness value in these waters is also quite shallow and the brightness value is low.

The pH values range from 7.15-8.1. The DO values were 0.22-1.9 mg/L. The low concentration of DO due to the level of oxygen consumption to decomposition of organic materials is higher than the level of oxygen production. The more organic content in the wastewater, the more the dissolved oxygen required for decomposition activities as well. BOD concentration were 2.18-65.60 mg/L, where it is decreased at the next point up to the outlet showing the relationship with the value of DO which shows the increase to the outlet. COD concentration were 13.76-247.68 mg/L, while the highest concentration is at the inlet point coming from the elite housing and surrounding mosques, which contain lots of organic and organic waste persistently causing high COD values.

The highest concentration of Nitrate at the inlet point. According to [5] the concentration of nitrate will increase as it gets closer from the point of disposal, but will decrease further from the point of discharge caused by the activity of microorganisms that will oxidize ammonium to nitrite which eventually becomes nitrate. Presumably this is in accordance with the natural rule that the tendency of high nitrate value is to occur in waters close to the land.

The highest concentration of Phosphate is at the point of inlet, the water entering the inlet is derived from the slums so that much of the organic waste is residual human activity and which affects the high concentration of phosphate from detergent. High phosphate values can be utilized by phytoplankton as a nutritional requirement. As it is known that phosphorus is a form of phosphorus that can be utilized by plants [5].

3.2. *Phytoplankton Abundance*

The composition and abundance of phytoplankton will change at various levels in response to changes in environmental conditions physically, chemically and biologically. The abundance of phytoplankton in West Sunter Lake were 500 – 1,202,850 cells/L, which is in the dominance type of phytoplankton *Oscillatoria* sp 1. The abundance of phytoplankton is related to the enrichment of a waters. The results of this trophic status of the waters according to [2] included in the category of eutrophic waters that have rich nutrients and high productivity. Associated with the level of water fertility, this condition is influenced by nutrients inside the water.

Nutrient content that affects the presence of phytoplankton in waters is nitrate and phosphate [3], [5]. Nutrients in waters do not describe momentary conditions but are a process of overhauling of incoming nutrients into compounds absorbed by phytoplankton, therefore conditions in the West Sunter Lake where relatively has low nitrate, while phosphates was in high abundance indicate that N in the form of nitrate has been absorbed by phytoplankton.

3.3. *Diversity Index*

The value of Diversity Index (H') average is 1.61 showing the stability of the high biodiversity of Phytoplankton community (Figure 1). Based on the criteria of water quality in [1], the quality of the water categorized medium polluted.

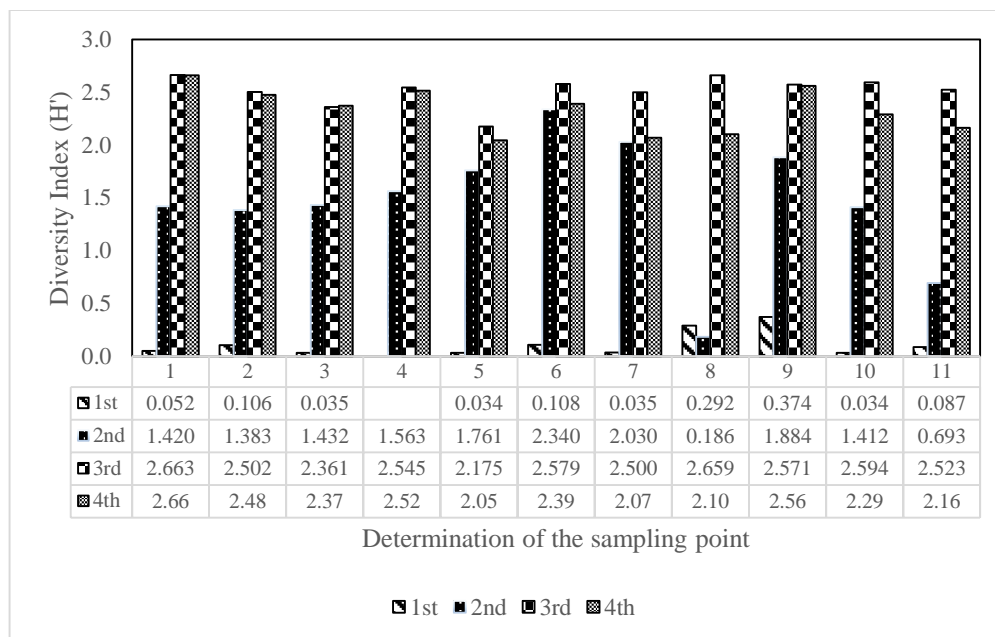


Figure 1. Diversity Index (H').

3.4. Evenness Index (E)

The highest Evenness Index is 0.924 shows in June (Figure 2). The Evenness Index (E) closes to 1 means that the species is relatively similar and the difference is not so striking, other words the distribution is evenly distributed. The value of this similarity is directly proportional to the value of diversity due to the highest value of diversity that occurs in June. Besides, it is also influenced by the quantity value of water based on physical and chemical, which at this time of June is at neutral pH, the optimum temperature, the average BOD value does not exceed the quality standard so it is suitable as biota habitat.

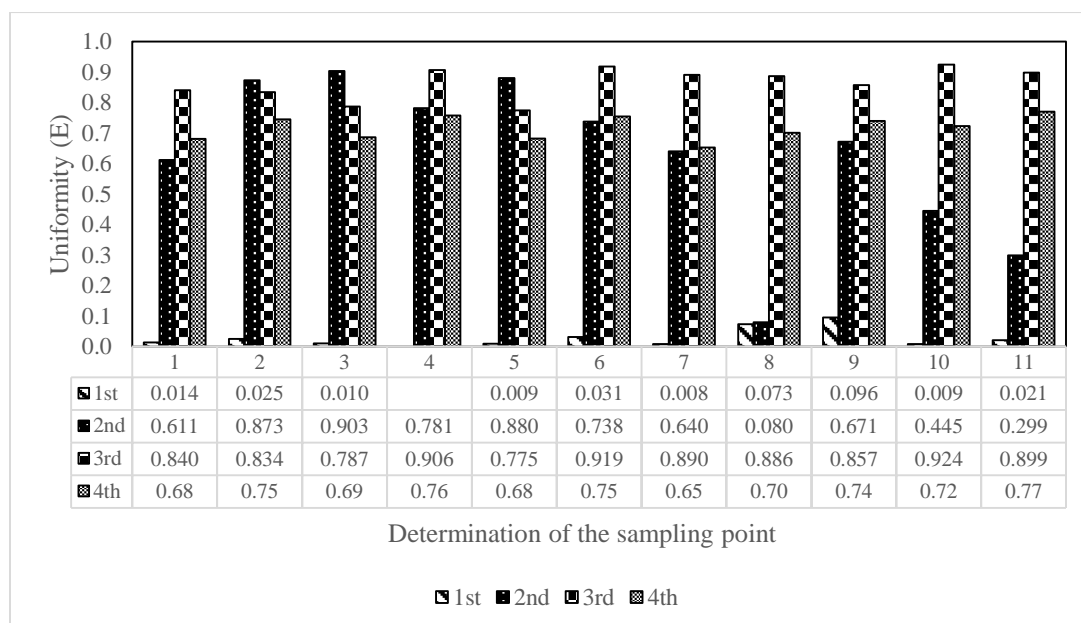


Figure 2. Evenness Index (E).

3.5. The Carbon Absorption

The value of chlorophyll-a were 32.2-386.9 mg/m³ as seen at Table 1. There is a lot of factors that influence one of the value of abundance. The trophic status, this West Sunter Lake belongs to the eutrophic category which according to [3], [7] this chlorophyll-a value on trophic status of eutrophic category are 10-500 mg/m³. The magnitude of this chlorophyll-a value will cause the waters to be highly productive and the growth of algae will increase which causes blooming algae.

Table 1. The value of chlorophyll-a and carbon absorption.

Sampling Points	Value chlorophyll -a		Carbon absorption	
	mg/m ³	mgC/m ³	Ton/Tahun (10 ⁹)	Ton/m ³
1	139.58	38.07	12	1652828.96
2	125.52	34.23	11	1486371.49
3	84.29	22.99	7.6	998157.45
4	114.02	31.10	10	1350175.26
5	42.44	11.58	3,8	503006.58
6	386.9	42.75	14	1856317.50
7	97.31	26.54	8.8	1152249.91
8	32.02	8.73	2.9	379194.30
9	36.94	10.07	3.3	437429.66
10	52.77	14.39	4.7	624869.74
11	27.16	7.41	2.4	321608.56

Carbon absorption capacity ranges from 2x10⁹ to 14x10⁹ ton/year (Table 1). The highest value is at the point of the inlet point of 14x10⁹ ton/year and the lowest at point 11 (the center near the outlet) of 2.4x10⁹ ton/year. That was happened because at point 1 the value of chlorophyll-a is high and influenced by the phytoplankton composition. The higher the value of chlorophyll-a, the higher the carbon absorption. The amount of carbon absorption by phytoplankton per year, proving that phytoplankton have an important role in reducing CO₂ emissions, therefore West Sunter Lake as an ecosystem that must be protected.

4. Conclusion

There are four parameters that not comply with the quality standard of the Governor Regulation Number 582 of 1995 on Water Quality Management and Pollution Control Class III, i.e DO (1.1-1.4 mg/L), BOD (10.34-27.35 mg/L), COD (23-130 mg/L), and phosphate (0.38-0.57 mg/L). The abundance relationship with the concentration of nitrate and phosphate is weak, where the nutrients in not depend on instantaneous condition, but on a whole process of nutrients entering into compounds absorbed by phytoplankton. The abundance of phytoplankton in West Sunter Lake were 500-1,202,850 cells/L, which is in the dominance type of phytoplankton *Oscillatoria* sp 1. The value of chlorophyll-a in the West Sunter Lake were 3.2-386.9 mg / m³ which categorized as eutrophic condition. The value of carbon uptake between 2 x10⁹ to 14 x 10⁹ Ton/year or 9x10³ to 50x10³ Ton/m³. The amount of carbon absorption by phytoplankton per year proves that phytoplankton have an important role in reducing CO₂ emissions. The source of contaminant in West Sunter Lake were from the organic and inorganic exiles produced by the activities around West Sunter Lake, especially the household activities.

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