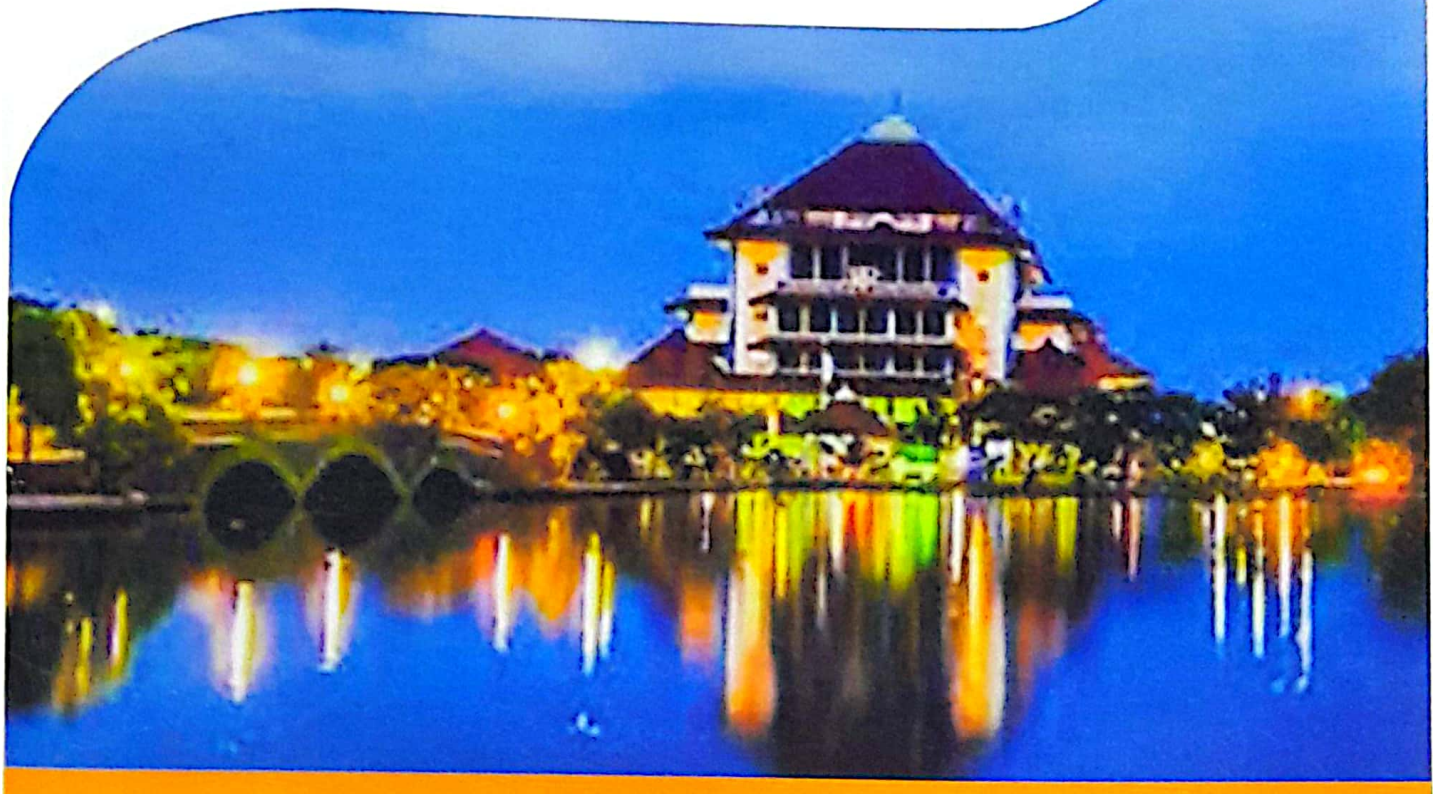
The 1st Seminar on Environment and Health

PROCEEDING

"Toward SDG's Achievement 2030"

INTEGRATION SYSTEM
ON ENVIRONMENT AND HEALTH SUSTAINABILITY



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STUDY OF WATER QUALITY AND CARBON ABSORPTION BY PHYTOPLANKTON IN PENGASINAN LAKE DEPOK, WEST JAVA, INDONESIA

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ABSTRACT

Pengasinan Lake is located at Pengasinan Village, Sawangan District, Depok, West Java. The total area of Pengasinan Lake is ± 6 Ha. The functions of Pengasinan Lake are as a retention pond, water absorption area, recreation area, and irrigation for agriculture and fish pond. Phytoplankton is a parameter of water fertility and can be used to determine the rate of carbon absorption in the waters. The aims of the research are to analyze of water quality and compared with the water quality standard, analysis of abundance of phytoplankton, analysis the primary productivity and carbon absorption. This research was conducted from February until July 2016. The sampling of water and phytoplankton conducted on a 7 sampling point locations. Parameters BOD and COD were analyzed as indicators of water quality parameters. From the measurement results, shows that the BOD values ranged 3.12-17,. /l, COD from 23.59 to 82.59 mg/l that's means the values were exceeds the quality standards. The pollution in Pengasinan Lake comes from the activity around it. The pollution of water in Pengasinan Lake is caused by organic and inorganic wastes. The abundance of phytoplankton is 440,175 cel/l. The results of chlorophyll-a 4.12-7.04 mg C/m^3 and carbon which absorbed by phytoplankton are 1.37×10^9-2.35×10^9Ton/year or 210×10^3-359×10^3 Ton/m^3. Phytoplankton in lake plays an important role in absorbing of carbon. Abundance of phytoplankton are influenced by the quality of the water. Therefore, efforts to keep the situ from damage caused by pollution is needed. With the ability to absorb carbon by phytoplankton, the lake was very important to reduce global warming.

Keywords: water quality, abundance of phytoplankton, chlorophyll-a, carbon absorption

INTRODUCTION

Pangasinan lake is located in the Pengasinan Village, District of Sawangan Depok. Pangasinan Lake is one of the lake in Depok almost disappeared due to covering into housing by the developer. In 2003, Pangasinan Lake revitalized and spacious defined as an area of 6.5 hectares and there should not be any permanent buildings. Pengasinan Lake has a depth of 1-4 m. The Pengasinan Lake have a function as a water catchment area, irrigation for fish farmers and as a tourist destination. Pangasinan Lake managed by the lake working group to conservation and utilization. Lake working group consists of the communities around it and other stakeholders. This working group under the guidance of Depok City government especially the natural resources conservation bureau of the Environment Agency in Depok.

The activities around Pengasinan Lake can cause problems such as degradation of water quality and changes in the ecosystem balance. One way to monitor the water quality can be done by using of phytoplankton as an indicator.

In the context of global warming, the lake serves as a regulator of the micro-climate where ecological processes in the lake is very helpful in reducing air heating.

Phytoplankton are contained in the lake serves as a carbon sink in the air used in the process of photosynthesis and oxygen that is formed is released back into the air. In addition, the dynamic waters of the lake is quite efficient in the sinking of the organic carbon in the sediments. Based on the mass balance approach, it can be calculated Balance Carbon (Carbon Budget) in the waters of the lake. Thus, the existence of the Pengasinan Lake need to be considered and managed in a sustainable.

The research aims to analyze of water quality and compared with the water quality standard, analysis of abundance of phytoplankton, analysis the primary productivity and carbon absorption.

METHOD

This research was conducted from February until July 2016. Sampling was conducted 4 times that in April, May, June and July.

The sampling of water and phytoplankton conducted on a 7 sampling point locations. Determination of sampling points in terms of the Indonesian National Standard (SNI) 6989.57: 2008 regarding the method of sampling of surface water, are:

a) A natural water source, ie at the location that has not or a bit pollution.
b) Sources of contaminated water, are the location that has received the waste.
c) Water sources used, ie at the location where the intercepts of water resources.
d) Location entry of water into the reservoir or lake.

Determination of sampling sites in Pengasinan Lake based on the characteristics and surrounding activities. Sampling points shown in Table 1 and Figure 1 below.

Sampling point	Coordinat	Explanation
1	6° 25' 27.300" SL 106° 45' 0.640" EL	Southern part of the lake, there is a floating restaurant and pond fish farming
2	6° 25' 24.460" SL 106°44'55.370" EL	Influenced by the inlet from the the residential area of drainage channels
3	6° 25' 22.030" SL 106° 44' 53.260" EL	Influenced by the inlet from the Kali Angke
4	6° 25' 18.310" SL 106° 44' 53.890" EL	Influenced by the inlet from the housing residents, fish ponds, and stalls
5	6° 25' 16.094" SL 106° 44' 56.118" EL	Recreation zone
6	6° 25' 13.239" SL 106° 44' 58.345" ET	Waters towards the outlet which is end of area in Pengasinan Lake
7	6° 25' 12.350" SL 106° 44' 58.942" ET	*Outlet*

To determine of the water quality Pangasinan Lake, conducted some physical and chemical parameters are shown in Table 1. The data were compared and analyzed with the quality standard by the Indonesian Government Regulation No.82 of 2001 regarding Management of Water Quality and Water Pollution Control, Group III (water allocation can be used for freshwater fish farming, animal husbandry, water to irrigate crops, and or allotment another requires the same water with these purposes).

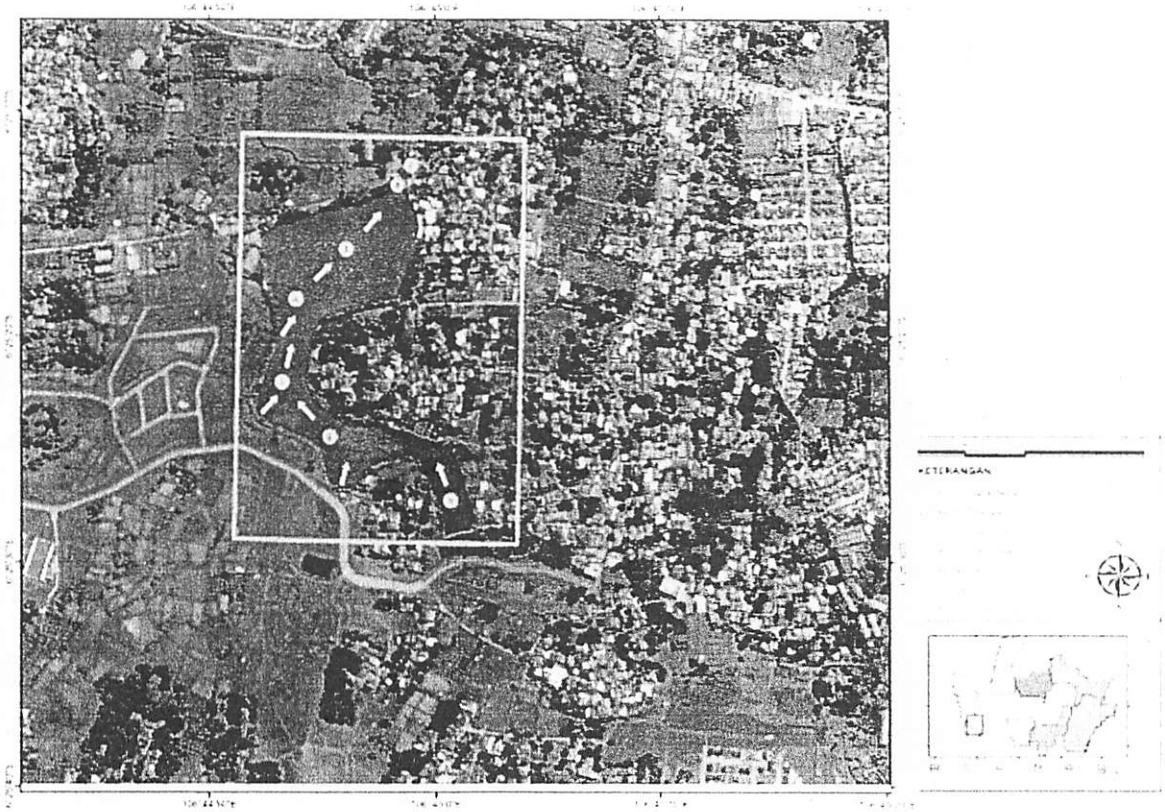

Figure 1 Sampling point at Pengasingan Lake

Table 2 The measured parameters, tools and method

Parameter	Unit	Tool/Methode
Temperatur	°C	Thermometer
Brightness	cm	Visual
Turbidity	NTU	Turbidimeter
pH	-	Elektrometric methode
DO	mg/l	Winkler
COD	mg/l	Titration
BOD	mg/l	Winkler
Nitrat	mg/l	Spectrophotometri
Phosphat	mg/l	Spectrophotometri

The determination of the abundance of phytoplankton carried out by the method wash over glass objects Sedgwick Rafter Counting Cell (American Public Health Assocition, 1983) with a set of cells per liter (cells/l) with the equation:

$$N = \frac{X}{Y} \times \frac{1}{V} \times Z \qquad \text{.....1}$$

Where:
N = abundance of phytoplankton (cells / l)
X = volume of filtered water (250 ml)
Y = Volume 1 drop (0.05 ml)
V = Volume of filtered water (100 liters)
Z = Number of individuals (cell)

Calculation of chlorophyll-a is done by using the following formula (APHA, 1992).

$$Klorofil - a\left({}^{mg}/_{m^3}\right) = \frac{\{(11{,}85 \times E_{664}) - (1{,}54 \times E_{647}) - (0{,}08 \times E_{630})\} \times V_e}{V_s} \quad \ldots\ldots\ldots\ldots\ldots 2$$

Where:
E664 = absorbance of 664 - 750 nm absorbance
E647 = absorbance of 647 - 750 nm absorbance
E630 = absorbance of 630 - 750 nm absorbance
Ve = acetone extract volume (ml)
Vs = volume of sample filtered (250 ml)

Having in mind the value of chlorophyll-a it can be seen fertility the water.

Table 3 Trophic Status of Water Classification

Parameter	Trophic Status			Source
	Eutrophic	Mesotrophic	Oligotrophic	
Brightness (m)	3 – 1,5	6-3	> 6	Wetzel (2001)
Nitrat (mg/l)	>0,2	0,1-0,2	<0,1	Golman and Horne (1983)
Phosphat (mg/l)	0,031 – 0,1	0,011 – 0,03	0,003-0,01	Vollenweider in Effendi (2003)
Klorofil-a (mg/m^{-3})	10-500	2-15	0,3-3	Jorgensen (1990)
Abundance of phtoplankton (ind/l)	> 15.000	2.000-15.000	< 2.000	Lander in Basmi (1999)

With the content of chlorophyll-a in phytoplankton are used to determine the amount of carbon that is absorbed by phytoplankton in the water. Brightness affects the viability of phytoplankton, so the depth measurement is based on the depth of the brightness measured using a Secchi disk. Carbon uptake can be calculated based on the volume. Total carbon absorption can be calculated by the following equation:

$$Value\ of\ clorophil - a\ (mg/m^3) \times mol\ CO_2 = mgCO_2/m^3$$

$$mgCO_2/m^3 \times \frac{12}{44}(Ar\ C/CO_2) \rightarrow mgC/m^{3*} \quad \ldots\ldots\ldots\ldots 3$$

* Converting mg/m^3 to ton/m^3 and ton/year to determine the ability of carbon absorption in the water and the amount carbon absorption in a certain time period.

RESULT AND DISCUSSION

Figure 2 below shows the water quality of Pengasinan Lake. From the pictures shows that BOD, COD and phosphate were exceed the quality standards. Activities around the lake such as gardens, stalls, garbage and settlements contribute to the pollution that goes into the lake.

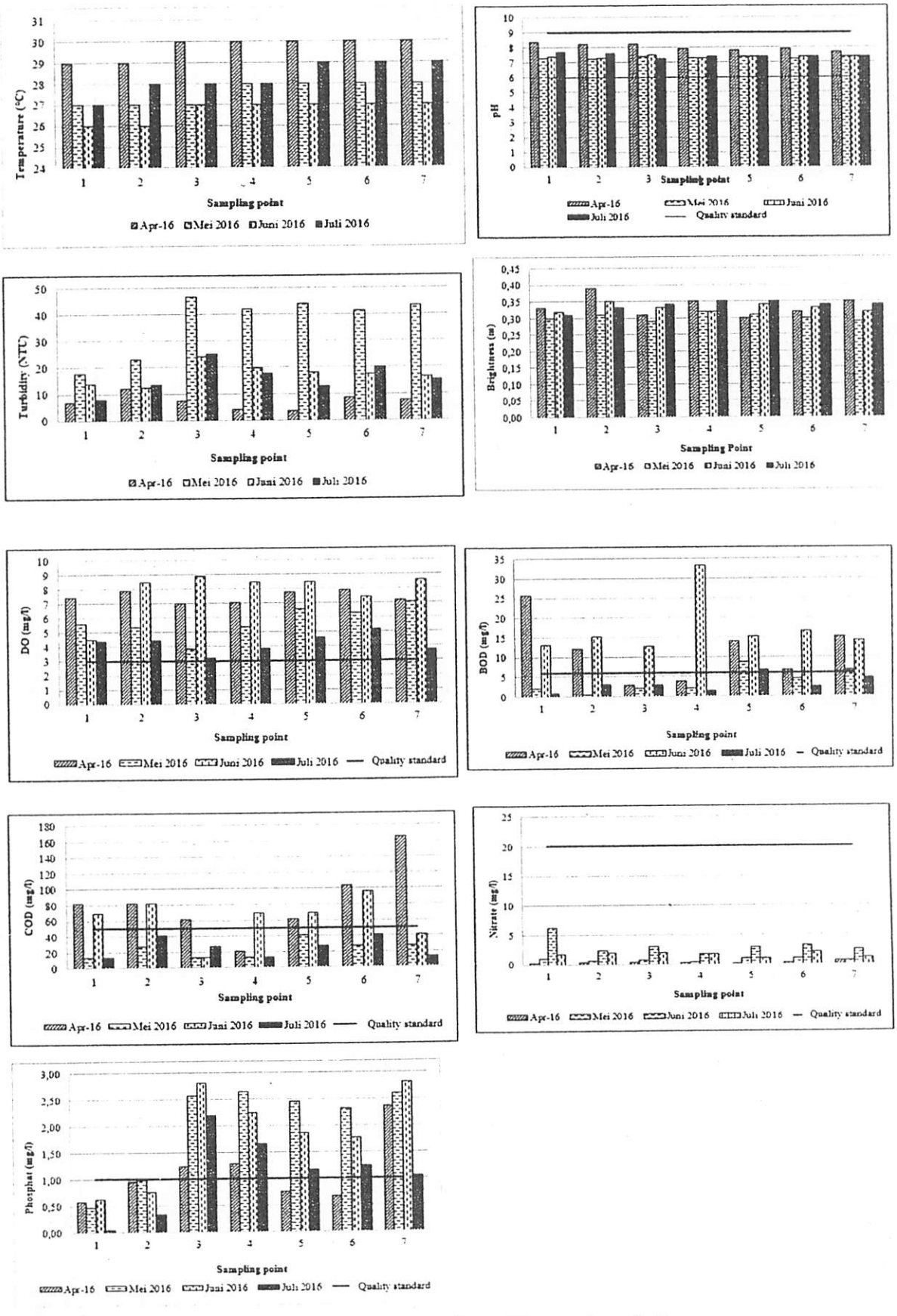

Figure 2 Water Quality of Pengasinan Lake

Waste water which enter into the lake in the form of gray water. Activities that surround the lake, has not made its waste water treatment. Phosphate exceeded the quality standard is estimated to come from detergents degraded. Organic materials that go into the water serves as a source of nutrients. Organic material is degraded by microorganisms become essential compounds like NO_3 and PO_4 which can be used by phytoplankton for growth. Phosphates which changes to orthophosphate would be absorbed by phytoplankton. The transformation process that occurred was influenced by a-biotic environmental factors such as sunlight, air, media and biotic factors such as microbes and phytoplankton. Degradation is supported by a sufficient oxygen content in the water. The oxygen content in Pengasinan Lake more than 3 mg/l. In addition to the brightness of 0.3 m, the process of photosynthesis performed by phytoplankton by using sunlight can take place optimally.

The range of pH values are ideal for the life of phytoplankton in the water is between 6.5 to 8.5 (Romimohtarto, 2004). Pengasinan Lake pH ranged from 7.31 to 8.01. Nitrate (NO_3) is the main form of nitrogen in natural waters and is a source of nutrition for the growth of phytoplankton. Nitrate (NO_3) levels exceeded 0.2 mg/liter can resulted of eutrophication (Effendi; 2003). NO_3 in Pengasinan Lake ranged from 0.27 to 3.13 mg/l. Yoshimoro in Wardoyo (1982) stated that the phosphorus content in waters> 0,201 extremely fertile. Phosphates in Pengasinan Lake ranged from 1.10 to 2.01 mg/l.

An abundance of phytoplankton community in waters highly related to biotic and abiotic factors. The nutrients can affect the abundance of phytoplankton and phytoplankton densities can otherwise degrade the nutrients in the water. Changes in the composition of phytoplankton may influence the composition of zooplankton and plankton community overall in an ecosystem (Pugesehan, 2010). Kocer (2014) says that the effect of temperature, pH, dissolved solids, nitrate, and silica on the abundance and distribution of phytoplankton. The generalized linear model revealed that high pH and high dissolved solids content seemed to affect the abundance of phytoplankton via limiting nutrient availability. Meteorological conditions play a major role in the dynamic of aquatic systems. The temporal cyclic patterns of phytoplankton composition are well-known in temperate regions, where temperature, stratification, light, and nutrients availability exhibit recurrent seasonal dynamics (Sommer et al. 1986; Grover and Chrzanowski 2006 in Figueredo and Giani, 2009).

Table 4 Phytoplankton abundance in Pengasinan Lake

Sampling point	Abundance (cell/l)			
	April	Mei	June	July
1	20,100	2,100	3,900	3,750
2	354,600	4,750	4,450	17,500
3	450,750	7,900	5,750	4,800
4	270,800	7,100	3,600	2,600
5	127,250	7,050	2,650	2,750
6	93,850	7,300	3,050	2,350
7	10,950	9,000	2,600	3,150
Total	1.328.300	45.200	26.000	36.900

Higher the abundance of phytoplankton in the area around the inlet than the other sampling points because in this area is a source of the inlet that brings a lot of nutrients. Nutrient source derived from agricultural activities and plantations that contain N and P, and therefore contributes to the growth of phytoplankton. In addition, supported by environmental conditions favorable for the growth of phytoplankton, where the water

temperature of 30 ° C. The temperature range is in accordance with the statement (Effendi, 2003) temperature range optimum for the growth of phytoplankton in waters ranging between 20 °C - 30 °C and by Boney (1982) that most of phytoplankton freshwater shall grow at temperatures between 25°C - 30°C. The brightness at the sampling point is 0.31 m and 7.64 NTU turbidity value. Turbidity greatly affect the abundance of phytoplankton, because it can affect the intensity of the light that enters the waters so that it will affect the photosynthesis of phytoplankton.

According Rimper in Yaserli, et al. (2013), the abundance of phytoplankton divided into 3 groups of phytoplankton, low, medium and high. Low abundance ranges <12,000 cells / l, was 12,500 cells / l and high phytoplankton abundance of> 17,000 cells / l. The number of species and abundance of varied influences diversity index. From these statements, it can be said that for 4 times the sampling Pengasinan Lake have high phytoplankton abundance, around 2100 cells/l – 450,750 cells/l. Meanwhile, based on the classification of trophic status Lander in Exterminate (1999), the value of the abundance of phytoplankton Pengasinan Lake > 15000 cells/l, classified as an eutrophic water or nutrient-rich water.

Chlorophyll-a is the most commonly pigment contained in phytoplankton that the concentration of phytoplankton is often expressed in the concentration of chlorophyll-a (Parsons et al., 1984). The concentration of chlorophyll-a in the waters is highly dependent on the availability of nutrients and sunlight intensity. According Tubalawony (2007), when the nutrients and the intensity of sunlight is available, then the concentration of chlorophyll-a will be high and conversely. The high content of chlorophyll-a phytoplankton in the waters not always as good conditions for water. The content of chlorophyll-a high in the waters indicated the occurrence of eutrophication. The influence of nutrients that are uncontrolled will disrupt aquatic ecosystems. From an average of 4 times the sampling, chlorophyll-a in Pengasinan Lake range from 3.19 mg/m^3 - 38.81 mg/m^3. According to the criteria of Jorgensen (1990), the value is included in eutrophic waters or waters with high fertility.

In the process of photosynthesis by phytoplankton, the absorption and decomposition of carbon dioxide occurs (Wong, 1982, in Darussalam et al., 2008). So phytoplankton can be utilized optimally to reduce CO_2 emissions. The rate of carbon in Pengasinan Lake can be seen in Table 5.

Carbon absorption in Pengasinan Lake ranges from 1.37×10^9 to 2.35×10^9 ton/year or 210×10^3-359×10^3Ton/m^3. The absorption of carbon is highest at the sampling point 3 that the around of inlet area and is directly proportional to the value of chlorophyll-a. The amount of chlorophyll-a in point 3 influenced by environmental conditions. Looking at the results of carbon absorption by phytoplankton hence the phytoplankton has an important role in reducing CO_2 emissions. Therefore lake as aquatic ecosystems must be managed properly. The Management measures must be conducted in Pengasinan Lake are reducing of sedimentation, reducing pollution and planting trees and ground cover plants around the lake area.

Table 5 The rate of carbon absorption in Pengasinan Lake

Sampling point	Value of chlorophyll-a		The rate of carbon absorption	
	mg/m^3	mgC/m^3	Ton/Year	Ton/m^3
1	15.10	4.12	1.37×10^9	210×10^3
2	12.12	6.16	2.05×10^9	314×10^3
3	25.24	7.04	2.35×10^9	359×10^3
4	18.58	5.91	1.97×10^9	301×10^3
5	16.59	4.49	1.50×10^9	229×10^3
6	14.83	6.87	2.29×10^9	350×10^3
7	21.52	5.87	1.96×10^9	299×10^3

CONCLUSION

1. BOD, COD and phosphate were exceed the quality standards. Organic materials that go into the water serves as a source of nutrients. Organic material is degraded by microorganisms become essential compounds like NO_3 and PO_4 which can be used by phytoplankton for growth. The oxygen content in Pengasinan Lake range 4.19-7.84 mg/l very supportive to degrade organic matter. Pengasinan Lake pH ranged from 7.31 to 8.01. The range of pH values are ideal for the life of phytoplankton. NO_3 in Pengasinan Lake ranged from 0.27 to 3.13 mg/l this condition describes of eutrophication. Phosphates in Pengasinan Lake ranged from 1.10 to 2.01 mg/l this condition describes of extremely fertile.
2. The abundance of phytoplankton in Pengasinan Lake ranges 2100 cells/l–450,750 cells/l. The value of the abundance of phytoplankton in Pengasinan Lake > 15000 cells/l, classified as eutrophic water or nutrient-rich water.
3. Chlorophyll-a in Pengasinan Lake range from 3.19 mg/m^3-38.81 mg/m^3. The value is included in eutrophic waters or waters with high fertility.
4. Carbon absorption in Pengasinan Lake ranges from 1.37×10^9 to 2.35×10^9 ton/year or 210×10^3-$359 \times 10^3 Ton/m^3$. Looking at the results of carbon absorption by phytoplankton hence the phytoplankton has an important role in absorption the CO_2. In the context of global warming, the lake is very helpful in reducing of CO_2 emissions.

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