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Evaluation of total nitrogen In saguling reservoir during period 2007–2016 For sustainability of fish cultivation on floating net cage

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Abstract
This research aims to evaluate the content of organic matter in Saguling Reservoir within the period 2007-2016, comparing the organic matter conditions of the previous years with 2017, and describing the effect of organic matter for cultivation on floating net cage in Saguling Reservoir. The research was conducted in Saguling Reservoir, West Java in April-May 2017. This research used descriptive comparative methods. Sampling was done 3 times with 3 stations namely station 1 (Maroko), station 2 (Cijere), and station 3 (near intake structure) at a depth of 0,2 m, 5 m, and near the base. The analysis was done by comparing the value of Total Nitrogen (total-N) and water quality parameters (pH, DO, BOD, turbidity, and temperature) between stations with Government Regulation No. 82 year 2001 and other literature. The results showed that each station has been included in eutrophic waters due to nitrate value > 0,02 mg/L. During the period 2007-2016 station 2 tended to have higher nitrate values than other stations and reached its peak in the 3rd quarter of 2011, which was 4,91 mg/L. Starting from the 3rd quarter of 2014 the total-N value of station 1 is higher than the other stations, while in 2017 both values tend to rise in all stations especially near the base, but the total-N value and other water quality parameters can still support for fish cultivation on floating net cage.

Keywords: total nitrogen, water quality, floating net cage, saguling reservoir

1. Introduction

The Saguling Reservoir began construction in August 1981 and was inaugurated in 1986 [2]. Until now, the Saguling Reservoir is actively used for various community needs, including fisheries, tourism and others. Residents utilize the potential of reservoirs for fish farming businesses, especially the floating net cage system to improve the economy of the community around the reservoir [2]. Floating net cage was chosen because it is one of the fish cultivation technologies that is suitable for optimizing the use of aquatic resources, especially the lakes and reservoirs in Indonesia [11].

Data from the West Bandung Regency Fisheries Service show that in 2017, there was 7.261 units floating net cage in Saguling Reservoir, while the carrying capacity was only able to accommodate 2.425 units. Waste from various activities around reservoirs that accumulate at the bottom of reservoirs (sediments) including cultivation wastes such as leftover feed of fish faeces that rise to the surface (turn over) can cause mass death of fish [4].

In February 2017 there was a mass death of 1 ton of fish in Saguling Reservoir caused by changes in extreme seasons which caused a turn over and made the dissolved oxygen level in the water is thin [6]. The introduction of organic matter that occurs continuously in Saguling Reservoir resulting in increased biological and chemical oxidation of organic matter and can reduce the value of dissolved oxygen which is one of the important keys in aquaculture activities.

2. Material and Method

The research was conducted in April-May 2017 at 3 station points Maroko (Inlet), Cijere and near the intake structure (Outlet). Sampling and sample testing was carried out 3 times every 14 days with a depth of 0,2 m from the water surface, 5 m from the water surface and near the base. Ex situ measurements were carried out at Laboratory of Pusat Penelitian Sumber Daya Alam dan Lingkungan (PPSDAL) Universitas Padjadjaran. Water quality was tested based on physical and chemical parameters where the parameters, units, methods and place of analysis can be seen in Table 1 below.

Table 1: Parameters, Units, Methods, and Place of Analysis during the research

	Parameters	Units	Methods	Place of Analysis
A.	**Fisik**			
1	Temperature	°C	Termometer Hg	*In situ*
2	Transparency	cm	*Secchi disc*	*In situ*
3	Turbidity	NTU	Turbidimeter	Laboratory
B	**Kimia**			
1	pH	-	pH-meter	
2	DO	mg/L	DO-meter	*In situ*
3	TOM	mg/L	Titrimetri	Laboratory
4	Phosphate	mg/L	Spektrofotometri	Laboratory
5	Total-N	mg/L	Spektrofotometri	Laboratory
7	BOD	mg/L	Inkubasi	Laboratoty

The method used in this research was a descriptive comparative methods. The results will be compared with water quality for the past 10 years (2007-2016) and then compared with the Government Regulation No. 82 year 2001 concerning Management of Water Quality and Water Pollution Control and literature that has been obtained so that it can draw an outline and conclusions.

3. Results and Discussion

General Condition of Research Location

Saguling Reservoir has a hilly topography with high winding and cliff roads. High rainfall in the area also makes the cliffs and roads around the reservoir prone to landslides. The following are general conditions at the location of measurement and water sampling:

1. Station 1 (Maroko) is located in the Maroko area which is a meeting of water flow between Citarum trashboom Batujajar, Cihaur estuary and Cimerang estuary. At this station, in addition to fish farming activities with floating net cage there are also crossing activities using engine boats.
2. Station 2 (Cijere) is a meeting of water flow between the Cipatik estuary and the Ciminyak estuary. In this station more floating net cage were found abandoned or not used until overgrown with wild plants compared to station 1.
3. Station 3 (Outlet) is the gathering point of water flow from stations 1 and 2 and Cijambu estuary. The current and water waves in this station are smaller than the other 2 stations.

Total Organic Material (TOM)

Measurement of total organic material is needed to determine the amount of dissolved or suspended organic matter in waters. Factors that influence the high and low number of TOM are determined by primary productivity in these waters. The TOM value in each station can be seen in the following graph.

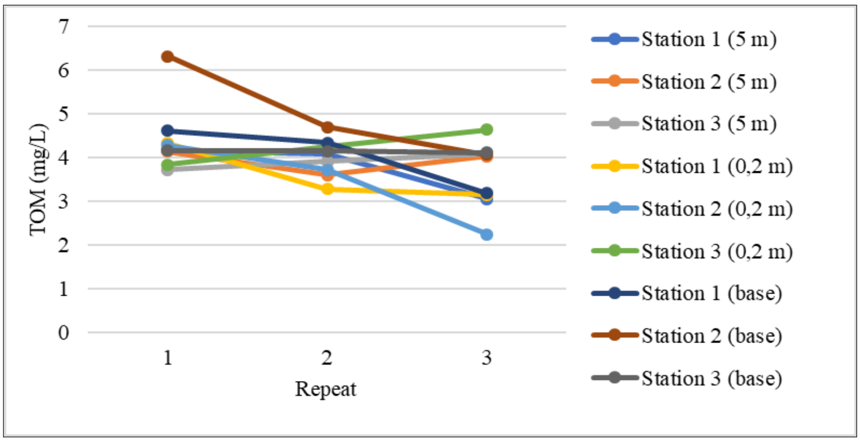

Fig 1: Graph of TOM in Each Depth

Based on the graph above, it can be seen that at a depth of 5 m from the water surface, the highest TOM value is at station 1 on 1st repetition of 4,16 mg/L and the lowest value in 3rd repetition at the same station is 3,06 mg/L. Overall, the TOM value at station 1 has continued to decrease in value during the research, inversely proportional to station 3, where TOM values continue to increase each repetition, while at station 2 TOM values are more volatile. The increasing value of TOM at station 3 is due to a quieter current than the other two stations, causing organic materials to accumulate longer before finally being flowed towards the Cirata Reservoir.

Horizontally viewed at a depth of 0,2 m from the surface, station 1 has the largest TOM value, this is because station 1 which is the inlet receiving upstream waste from Citarum larger than the other stations. The waste comes from domestic and industrial waste. The TOM value quality standard that supports a waters is < 12,5 mg/L [7], so it can be said that the TOM value in Saguling Reservoir is still below the quality standard.

Total Nitrogen

Total nitrogen (total-N) is one of the factors that affect the TOM value. The total nitrogen value that will be evaluated is based on the value of ammonia, nitrite and nitrate.

a) Ammonia

Measurement results at each station can be seen in Figure 2. The highest ammonia value is near the base of station 1 on the 3rd repetition of 2,681 mg/L and the lowest ammonia value is at station 2 in 0,2 m from the water surface of 0,01 mg/L.

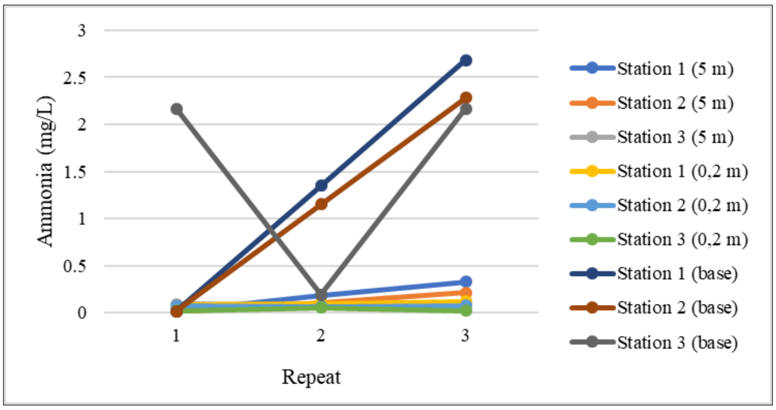

Fig 2: Graph of Ammonia Value in Each Depth

Based on the graph it is known that stations 1 and 2 have an average ammonia value greater than station 3, this is because there is a greater amount of floating net cage at stations 1 and 2 so that one source of ammonia which is fish feed has a greater contribution. According to the water quality standard Government Regulation No. 82 year 2001 (class II), the maximum limit of ammonia for fisheries activities for sensitive fishes is ≤ 0,02 mg/L. The results showed that ammonia value at each station had exceeded the maximum quality standard.

Compared with ammonia values in 2007-2016 at the same depth of 5 m, the results of ammonia measurements in 2017 can be said to worsen. Between 2007-2016, the highest ammonia value was at station 3 in the 2nd quarter of 2010, which was 0,169 mg/L. Station 1 reached its peak in the 4th quarter of 2012, which was 0,134 mg/L, while station 2 reached its peak in the 4th quarter of 2008 which was 0,1 mg/L. The poor ammonia value at the time of the research can be attributed to the increasing ammonia in line with the number of floating net cage.

b) Nitrite

Nitrite is a transitional form between ammonia and nitrate (nitrification) and between nitrate and nitrogen gas (denitrification) [8]. The measurement results of nitrite at a depth of 0,2 m, 5 m, and near the base can be seen in Figure 3.

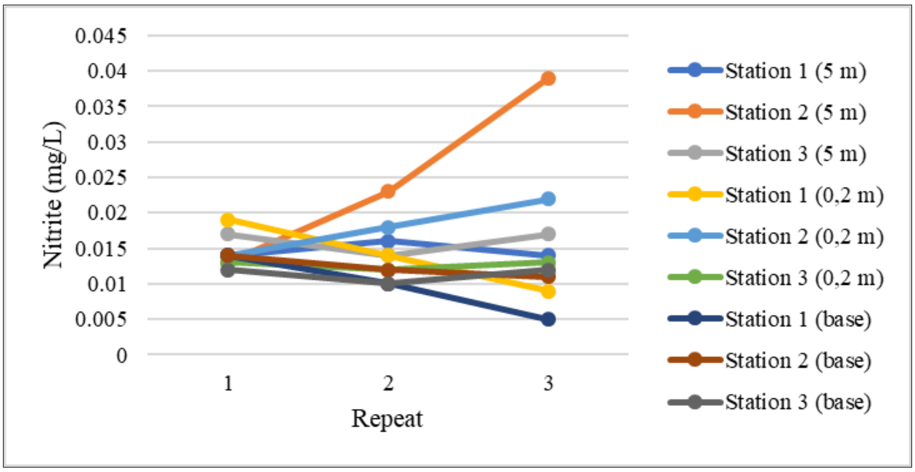

Fig 3: Graph of Nitrite Value in Each Depth

In general, station 1 tends to decrease while stations 2 and 3 increase. This can be caused by the inactivity of the nitrification and denitrification processes by microbes in the station 1. Quality standards for nitrite levels according to Government Regulation No. 82 year 2001 is 0,06 mg/L, thus it can be said that the amount of nitrite in Saguling Reservoir does not exceed the quality standard and still supports fish farming activities. When compared with the 2nd quarter of 2016, at the same depth of 5 m nitrite concentration during research at the three stations increased.

In 2007-2011, nitrite concentrations were higher than in the following years. Starting in the 1st quarter of 2012, nitrite concentrations began to improve with no exceeding quality standards. Even though in the 2nd quarter of 2012 the concentration had soared, starting in the next quarter until the 2nd quarter of 2016 the condition of nitrite concentrations could be said to be stable and could support cultivation activities.

c) Nitrate

Based on the research result at three stations, nitrate concentrations ranged from 0,011 mg/L – 0,66 mg/L (Figure 4). The lowest value is on station 3 in 1st and 3rd repetition at a depth of 0,2 m while the highest value is the part near the base at 1st repetition on station 1.

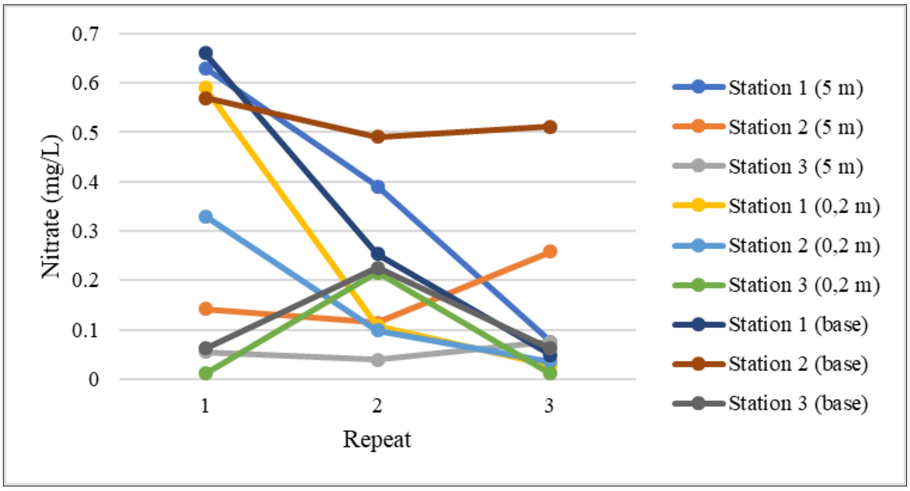

Fig 4: Graph of Nitrate Value in Each Depth

Based on Government Regulation No. 82 year 2001 for freshwater quality standards for nitrate is 10 mg/L. The concentration of nitrate at each station and its repetition is certainly still very far from the specified limit and can be said to still strongly support fish farming activities. However, nitrate concentrations of more than 0,2 mg/L can cause eutrophication of waters and blooming [9].

Nitrate concentration in 2007-2016 at a depth of 5 m also did not exceed the quality standard. The highest nitrate value occurred at station 2 in the 3rd quarter of 2011 which was 4,91 mg/L. This value does not include the criteria for the occurrence of pollution because a waters are said to be polluted if the nitrate concentration is 5 mg/L [9]. Changes in nitrate concentration in 2012-2016 between stations looked more stable compared to 2007-2011. In 2nd qwartal of 2016, nitrate concentrations of stations 1, 2, and 3 were successively decreased, which were 0,217 mg/L, 0,059 mg/L, and 0,035 mg/L. When compared with the results of 2017, at the same depth the value is not much different.

d) Total-N

The total-N concentration ranged from 0,048 – 2,806 mg/L (Figure 5). The lowest concentration is in 1st and 3rd repetition of station 3, while the highest concentration is in 3rd repetition of station 2. Total-N on the surface tends to be lower than the base, this is because at the base part a lot of N settles while the surface can flow or carry current.

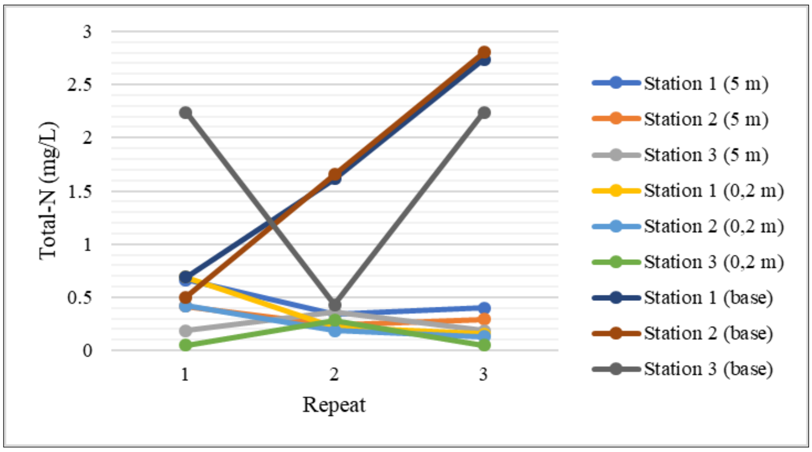

Fig 5: Graph of N-Total Values in Each Depth

In the 0,2 m from the water surface, the total-N value is higher at station 1 compared to stations 2 and 3. This is because station 1 receives more Citarum watershed waste compared to other stations both from industrial, agricultural, domestic and from the fishing activity itself. N predictions that enter upstream Citarum range from 6.400 – 187.852 tons N/year [5].

If the results of 2017 are compared with the 2nd quarter of 2016, the value of total-N can be said to deteriorate because of its higher value. This happens because the amount of floating net cage increases so that is more total-N input load especially from the feed. Increasingly densely populated residents also contribute more waste to reservoirs [8]. The total-N surge in 2011 caused fish production to reach only 2.051,38 tons. Overall total-N conditions in 2012 can be said to improve. This is evidenced by fish production which rose to 5.471,38 tons. The number of fish production in 2013 exceeded the previous year at 5.716,70 tons. A more stable total-N concentration allows this to happen even though in 4th quarter station 2 experienced an increase in total-N concentration. Fish production in 2014 was 5.034,52 tons, a decrease compared to 2013. This was due to an increase in the average total-N concentration in the 4th quarter, especially stations 1 and 3.

Temperature

Temperature does not directly affect organic matter, but directly affects the solubility of oxygen needed in the process of decomposition of organic matter [1]. The measurement results obtained ranged from 25,4 – 30,5 °C. The lowest temperature is near the base of station 3 on 1st repetition while the highest temperature is at 0,2 m station 2 on 1st and 2nd repetitions.

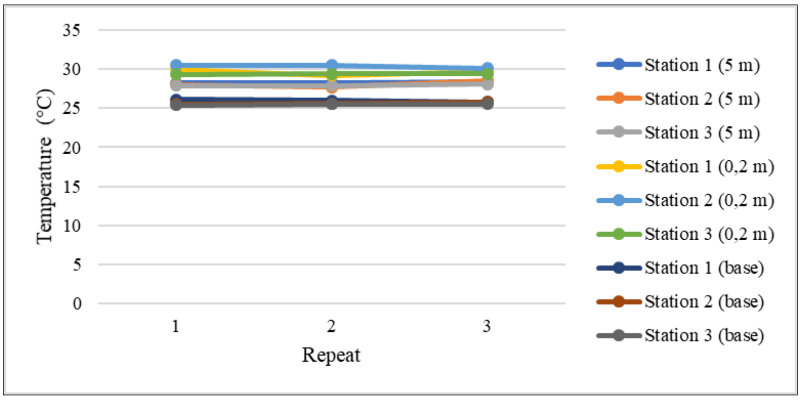

Fig 7: Graph of Temperature Values in Each Depth

Saguling Reservoir has a depth of more than 10 m so it has a fairly clear temperature stratification as in the graph. It can be seen that the more towards the base the temperature gets lower. This temperature stratification occurs because the entry of heat from sunlight into the water column results in a vertical temperature gradient. At a depth of 5 m, the temperature values for each station during 2007-2016 ranged from 25,3 – 30,9 °C. The lowest temperature is at station 3 in the 4th quarter of 2011 while the highest temperature is at station 1 in the 4th quarter of 2012. If the results of 2017 are compared with data in 2nd quarter of 2016, at the same depth the temperature value increases at each station.

According to Government Regulation No. 82 year 2001 the temperature range for freshwater fish cultivation was deviation 3 while the range of water temperature needed for fish to growth in tropical waters could take place between 25 - 32 °C, so that it could be said that the temperature of each station still supports the ongoing fish farming activities. Nevertheless, the response of fish to feed will be optimal at a temperature range between 28 - 30 °C [3].

Transparency

Brightness in a waters is influenced by the amount of sunlight entering the waters. Sunlight mainly functions for the assimilation of phytoplankton in water. The results of brightness measurements during research can be seen in Figure 8.

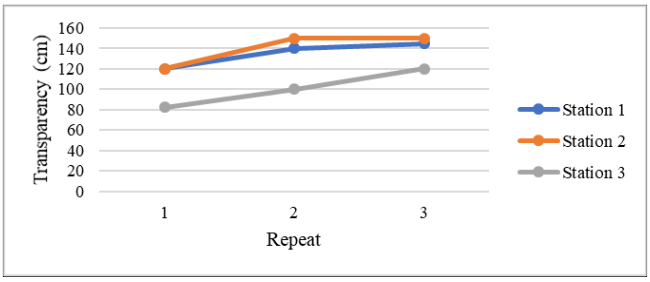

Fig 8: Value of Graphs for Each Station's Brightness

Overall, each station has an increase in the brightness level of each test, but the best transparency level for the location of fish farming is 2 m or 200 cm [9]. Transparency values are influenced by time, weather, turbidity and suspended solids. When researching, the weather is always bright and the time of measurement is done during the day so the measurement results are clearly visible. Compared to the 2nd quarter of 2016, the transparency value has increased or can be said to be better. This is because the elevation when researching is higher, which is around 641 m above sea level while in 2016 it is lower by 10 m, which is 631 m above sea level.

Turbidity

Turbidity is the number of substances suspended in a waters. This causes scattering of light absorption to come so that turbidity causes obstruction of the light that penetrates the water. The results of turbidity measurements during the research ranged from 0,97 – 15,4 NTU. The lowest turbidity is at station 2 on 3rd repetition at a depth of 0.2 m while the highest is at station 1 on 1st repetition near the base.

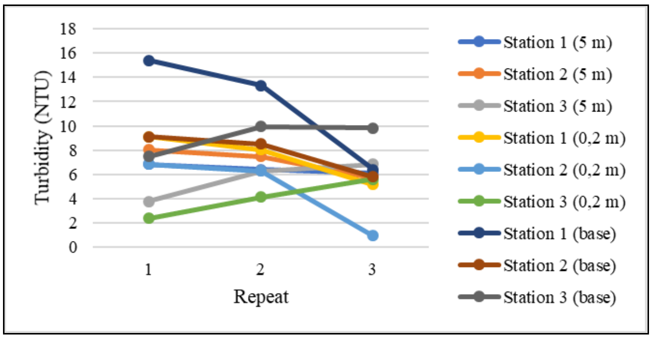

Fig 9: Graph of Turbidity Values in Each Depth

Stations 1 and 2 have decreased turbidity values for each repetition while station 3 has increased during repetition. A decrease in turbidity can be caused by an increase in the elevation of each repetition. Turbidity near the base is greater than the other depths, this is because the load of water settles on the bottom of the water.

Station 2 and 3 drastically increased and decreased turbidity in the final quarter of 2012 until the final quarter of 2014 while station 1 experienced a dramatic increase in turbidity values in 1st quarter of 2015 and 2nd quarter of 2016. According to [10] in 2015 the range of turbidity that good for fish farming business activities should be between 2-30 NTU. Overall, the turbidity values obtained during the research or in 2007-2016 were still in a suitable condition for cultivation.

pH (acidity degree)

PH value illustrates how much acidity or basicity of water. The pH value of the research results ranged from 7,21 – 9,9. Based on Government Regulation No. 82 year 2001, a good pH for freshwater fish farming activities ranged from 6-9.

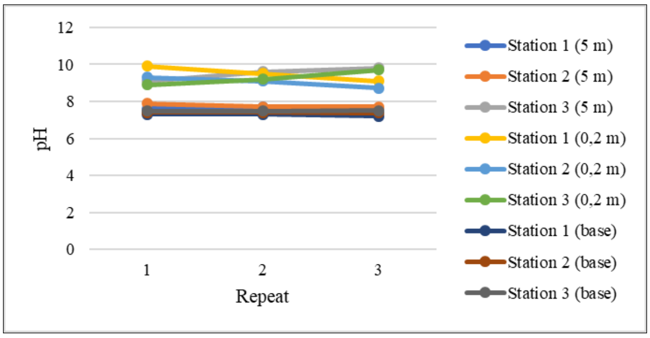

Fig 10: Graph of pH Values in Each Depth

When compared to the pH value of 2007-2016, at a depth of 5 m the pH value of previous years was far better because the three stations did not exceed the quality standard, while the results of the research at station 3 exceeded the quality standard or were too alkaline in the three repetitions but stations 1 and 2 still meet quality standards. pH values that are too alkaline make toxic ionized non-ionized ammonia in greater quantities so that they can be toxic to aquatic organisms.

The pH value that is classified as alkaline is due to the large number of limestone mountains around the Saguling Reservoir because of its location in the Rajamandala limestone hills. White limestone can be found round the reservoir both roadside cliffs and road material. The rainy season makes the water conditions of the reservoir more alkaline than the summer due to the carrying of chalk erosion towards the reservoir, moreover the conditions around the reservoir which are labile and prone to landslides make more matter goes into the reservoir.

Dissolved Oxygen (DO)
The results of DO measurements ranged from 1,3 – 5,9 mg/L. The lowest DO value is at station 1 on 1st repetition near the base while the highest value is at station 2 on 1st repetition at a depth of 0,2 m. Graph of DO values for each station during the research at a depth of 0,2 m, 5 m and near the base can be seen in Figure 11.

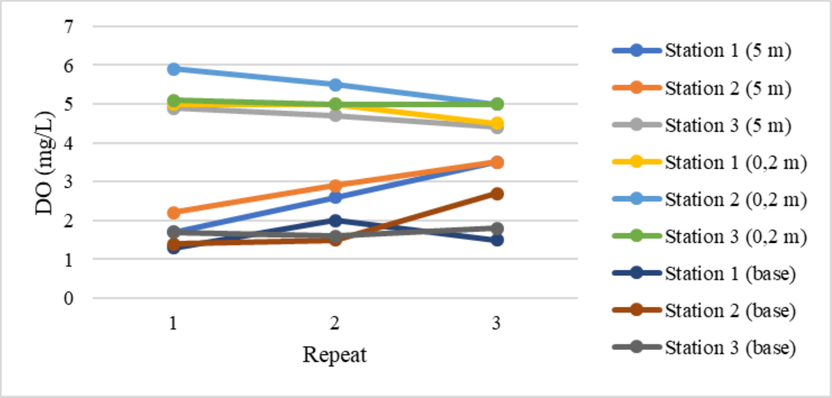

Fig 11: Graph of DO values in each depth

DO values are determined by water temperature, the higher the temperature the decomposition of organic matter increases which makes DO levels in the waters decreases. It is seen that the average results of the research show that DO values decrease when temperatures rise, for depths of 0,2 m and 5 m. A fairly good DO condition is also thought to be related to measurements taken during the day and the fertile conditions of the Saguling Reservoir so that the DO content is a phytoplankton metabolite that thrives.
At a depth of 5 m, compared to the 2nd quarter of 2016 the DO value on the results of the research has increased each station or it can be said that the condition is improving. The range of DO values between 2007-2016 was 0 – 6,1 mg/L. Based on Government Regulation No. 82 year 2001, the minimum DO value for fish farming activities is 4 mg/L and waters designated for fisheries purposes should have oxygen levels not less than 5 mg/L. DO values during the research at a depth of 5 m certainly did not meet the quality standards except at station 3, but DO levels at a depth of 0,2 m in the three stations met the standard standards.

Biological Oxygen Demand (BOD)
The BOD value during the research ranged from 2,08 – 5,71 mg/L. The lowest value is at station 3 on 1st repetition at a depth of 5 m while the highest value is at station 3 on 3rd repetition near the base. The results of BOD measurements at each station at a depth of 0,2 m, 5 m and near the base can be seen in Figure 12.

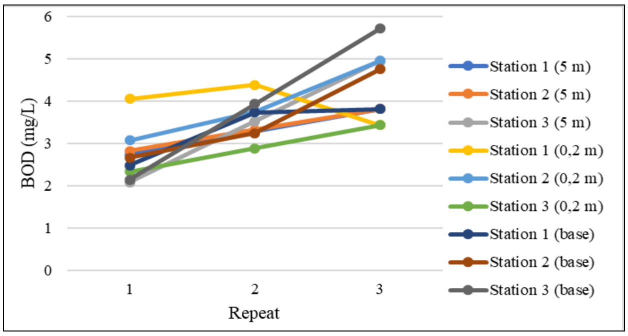

Fig 12: Graph of BOD Value in Each Depth

Based on Government Regulation No. 82 year 2001 the quality standard for BOD water quality for aquaculture activities was < 3 mg/L so that it can be said that the BOD conditions at each station passed the quality standard or did not meet the cultivation requirements. When compared with the 2nd quarter of 2016 the value of BOD during research experienced an increase except for station 1. The value of BOD in 2007-2016 at a depth of 5 m ranged from 2,35 – 35,57 mg/L with the lowest value in the 2nd quarter of 2016 at the station 2 while the highest value is at station 2 in the 2nd quarter of 2007.
Overall, the value of BOD starting in 2015 has been more stable than in 2007-2014, whose changes were drastic. This can be due to the considerable pollution of domestic waste entering the upstream Citarum watershed and industrial activities which caused an increase in BOD pollution in 2010 of 109.114 tons/day from 81.363 tons/day in 2000 [10] began to improve.

4. Conclusion
Based on the results of research conducted in the Saguling Reservoir, it can be concluded that:
1. The content of organic material in the Saguling Reservoir in the period 2007-2016 experienced quite extreme fluctuations with a tendency to become more stable starting in the 3rd quarter of 2012.
2. Compared with 2007-2016, the total-N value at the time of research tended to increase or it could be said that the condition of organic materials in the Saguling Reservoir deteriorated.
3. Organic material in the form of total-N affects the physical and chemical parameters of the water either directly or indirectly. Overall, the physical and chemical parameters of the waters still support the continued use of fish cultivation using floating net cage based on the quality standard of Government Regulation No. 82 year 2001.

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