JATIGEDE RESERVOIR WATER QUALITY ANALYSIS BASED ON PHYSICAL AND CHEMICAL PARAMETERS

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ABSTRACT

Jatigede Reservoir was built by damming the Cimanuk River for various purposes to irrigate irrigation, agriculture and fisheries areas. The condition of the Cimanuk River watershed which is already polluted will of course affect the water quality of the Jatigede Reservoir itself. The purpose of this study was to determine the water quality condition of Jatigede Reservoir based on physical and chemical parameters as the basis for sustainable fisheries management. Based on the results of the study, it was shown that the physical and chemical parameters observed in the Jatigede Reservoir were still within the normal limits of the class II water quality standard in accordance with the applicable regulations, namely PP No 22 of 2021 concerning Environmental Implementation and Management and could be utilized for fishery activities.

Keyword : *Cimanuk River, watershed, fisheries management*

1. INTRODUCTION

Reservoir is water that is formed or modified by human activities for a specific purpose, to provide a reliable and controlled resource (Thompton *et al.* 1992). West Java Province has several reservoirs, one of which is Jatigede Reservoir which has been inundated with water since 31 August 2015 located in Sumedang Regency. According to Afifah et al. (2015), the purpose of the construction of the Jatigede Reservoir is to irrigate an irrigation area of 90,000 ha, to meet the water needs of the Jatigede PLTA 67.83 m3/sec to generate 110 MW of electricity, and 3.5 m3/sec as a source of water needs for Cirebon City, Cirebon Regency, Indramayu, and Majalengka. The increase in population settlements, industrial activities, and agricultural activities around the watershed can affect the conditions in these waters (Subarma et al. 2014). Changes in water conditions can occur due to the dynamics of the ecosystem which is influenced by several ecological aspects of the waters. According to Pratiwi et al. (2015), ecological aspects include morphology, water physico-chemical parameters, community structure of biota, and trophic status.

Water pollution can be caused by the entry of elements that are not in accordance with the characteristics of the water, both in terms of biology, physics or chemistry, the amount of which exceeds the tolerable threshold so that water quality decreases and cannot be utilized properly (Regulation of the Government of the Republic of Indonesia, 2001). According to Naslimuna et al, 2018 Water pollution is a threat that many people worry about because water is a source of life. The emergence of pollution in the watershed and groundwater due to industrial progress will affect the carrying capacity of the environment for living things. The Cimanuk River as the main dammed river in the Jatigede Reservoir has experienced a high level of pollution. This study aims to determine the water quality of Jatigede Reservoir based on physical and chemical parameters for further management in order to reduce the impact of pollution that occurs.

2. MATERIALS AND METHOD

Research was conducted in Jatigede Reservoir, Sumedang Regency, West Java Province, Indonesia in August – September 2019. Observation stations and sampling (Fig. 1) were carried out by purposive sampling method which was divided into four stations. The observation stations for sampling were selected based on the zone and input of river water flowing through the Jatigede Reservoir dam, including:

-Station 1 : Located at the reservoir inlet with a geographic location of 6°55'58.8"S 108°05'20.3"E which receives water input which is dominated by the Cimanuk River and is a riverine zone.

-Station 2 : Geographical location 6°54'40.1"S 108°05'46.4"E which is a transitional water body from the Cimanuk river water input to the middle of the water body.

-Station 3 : Located in the middle of the water body of the Jatigede Reservoir with a geographical location of 6°53'068"S 108°06'11.3"E which receives water input from the Cimanuk River and also other tributaries such as the Cinambo River, Cibayawak River, Sungai Cihonje, Cicacaban River, and Cimuja River.

-Station 4 : Located at the reservoir outlet with a geographic location of 6°51'32.6"S 108°05'49.0"E which is a lacustrine zone where there is an outflow of water from the Jatigede Reservoir from various water inputs at the previous station.

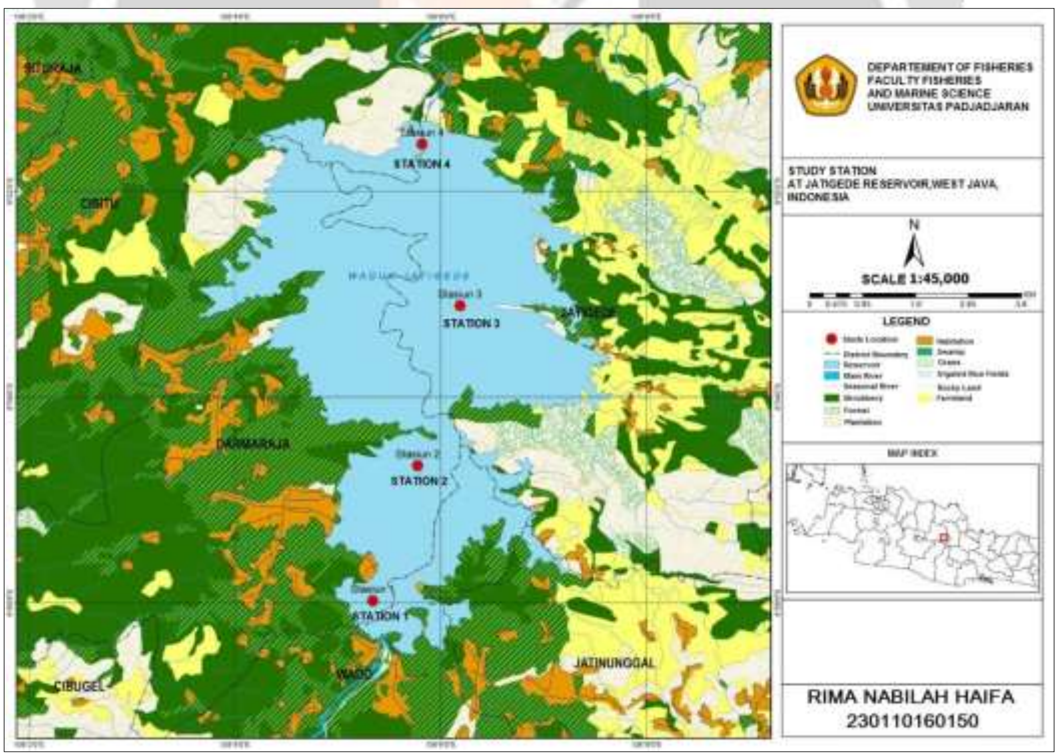

Fig 1. Map of Study Location

Water sampling was carried out horizontally using a dipper and vertically using *a Nansen water sampler* at the following depths.

a) 0 – 0.2 m : Surface water

b) 0.5 Compensation : Depth of half of compensation

c) Compensation : Depth approx. light intensity is only 1%.

The parameters taken include physical parameters (temperature, depth, current and brightness), chemical parameters (pH, Dissolved Oxygen, Biological Oxygen Demand, CO_2, Nitrate, Ammonia, Phosphate). Parameters were taken in situ, namely on-site measurements for parameters of temperature, brightness, CO_2, depth, current and DO (Dissolved Oxygen) while the parameters of nitrate, ammonia, BOD were observed in the laboratory. Water quality data analysis was carried out descriptively by presenting data in the form of tables and pictures.

3. RESULTS

Physical Parameters of Jatigede Reservoir Physical

Parameters in the waters can affect chemical and biological parameters. The physical parameters measured during the study were transparency, depth, temperature, and current. The results of the measurement of these physical parameters are in Table 1.

Table 1. Physical Parameters of Jatigede Reservoir Waters During Research

Parameter Unit	**Depth**		**Station**			
			1	**2**	**3**	**4**
Transparency (m)		k	0.20-0.39	0.25-0.79	0.63-1.17	0.72-1.13
		r	0.28±0.08	0.55±0.21	0.89±0, 19	0.93±0.18
Temperature (°c)	P	k	26.9-28.3	27-28.1	26.4-28.9	26.4-28.4
		r	27.48±0.54	27 ,46±0.5	27.02±1.06	27.26±0.73
	0.5 K	k	26.7-28	26.7-27.8	26.4-27.5	26.4-28
		r	27.38±0.53	27.32±0.45	27.02±0.53	27.04±0.59
	K	k	26.4-27.8	26.4-27.6	26.2-27, 1	26.3-27.6
		r	26.96±0.59	27.06±0.51	26.58±0.36	26.72±0.6
Current (m/s)		k	0.14-0.16	0.05-0.25	0.06-0.43	0.04-0.20
		r	0.152±0.008	0.136±0.092	0.216±0.148	0.142±0.069

Remarks: P= Surface; 0.5 K = Half Compensation; K = Compensation; k = Range; r = Average

Transparency and Depth of Waters

The average transparency of Jatigede Reservoir waters during the study is shown in Figure 2.

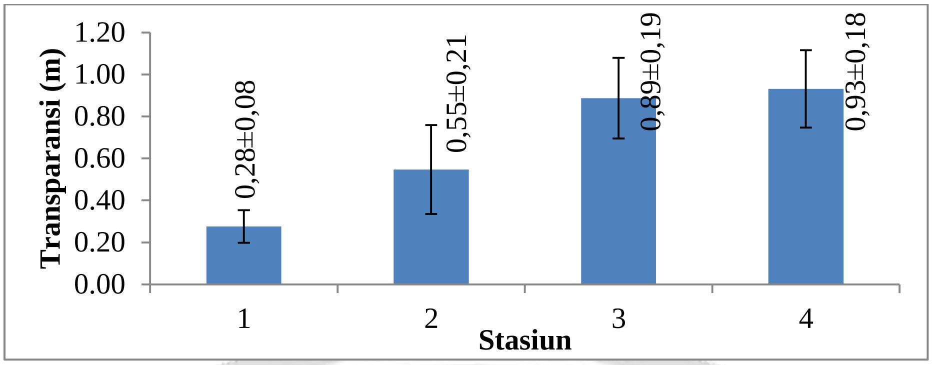

Figure 2. Average Transparency Graph of Jatigede Reservoir Waters

Transparency data obtained during the study show that the transparency of the waters of the Jatigede Reservoir varies. The lowest average transparency was obtained at station 1 with a value of 0.28±0.08 m. This is because station 1 is a reservoir inlet that has direct water input from the Cimanuk River and is still in the *riverine*, with less penetration of light entering the water column. The highest transparency is at station 4 of 0.93±0.18 m. The high value of transparency at station 4 is because station 4 is *outlet* of the Jatigede Reservoir and has entered the *lacustrine* which has clearer water conditions because mud and sediment particles have settled at the bottom of the water. The value of transparency is also influenced by several factors. According to Indaryanto and Saifullah (2015) the value of transparency is strongly influenced by weather conditions, measurement time, turbidity, and suspended solids.

According to PERMEN LH No. 28 of 2009, the transparency of waters 10 m is included in the status of oligotrophic waters, 4 m is included in the status of mesotrophic waters, 2.5 m is included in the status of eutrophic waters, and <2.5 m is included in the status of hypertrophic waters. Based on this statement, the waters of the Jatigede Reservoir during the study were included in the hypertrophic status at all observation stations.

The depth of the waters of the Jatigede Reservoir at each station is shown in Figure 3.

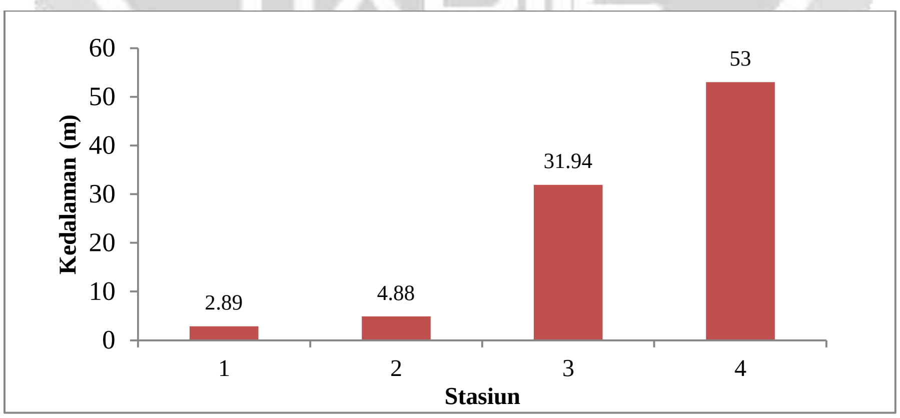

Figure 3. Graph of the Depth of the Jatigede Reservoir.

Based on the observation data, the lowest depth of the waters of the Jatigede Reservoir is at station 1 which is the *inlet* of 2.89 m, while the highest depth is at station 1 4 which is the *outlet* reservoirThe percentage of euphotic depth to the total depth of the Jatigede Reservoir during the study can be seen in Figure 4. Station 4 has the lowest percentage of euphotic depth of 1.76% of the total water depth of 53 m. This happens because the deeper a water is, the less intensity of light that enters. So the value of transparency which shows the euphotic depth will be smaller than the total depth. In accordance with the statement of Effendi (2003) that the intensity of light entering the water column decreases with increasing water depth. Light undergoes*extinction*or attenuation that increases with depth. In accordance with the statement of Effendi (2003) that one of the parameters that can affect the transparency of the waters is turbidity.

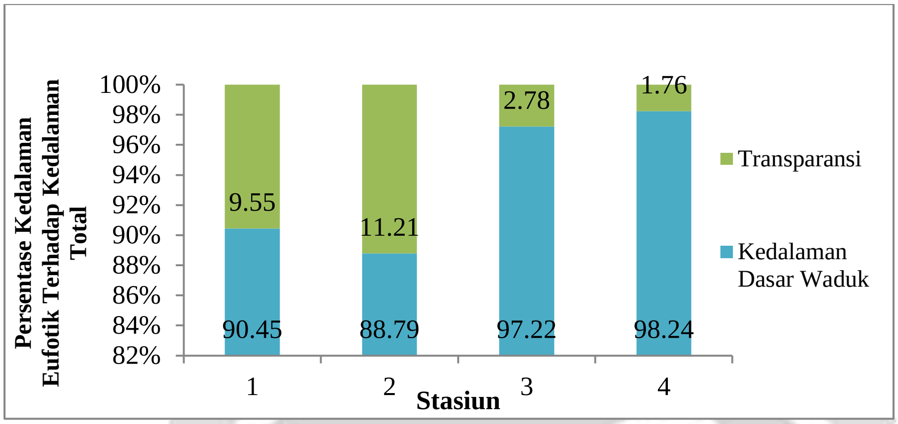

Figure 4. Percentage of Euphotic Depth to Total Water Depth of Jatigede Reservoir

Temperature

The water temperature of the Jatigede Reservoir at each station during the study is shown in Figure 5. The graph of the average water temperature of the Jatigede Reservoir in Figure 5 shows that the water temperature decreases with increasing depth. This is in accordance with Zahidah's (2017) statement which revealed that one of the factors that affect temperature is light transparency. This happens because light has a direct effect on temperature, which means that high light intensity will generate heat which will further increase the temperature.

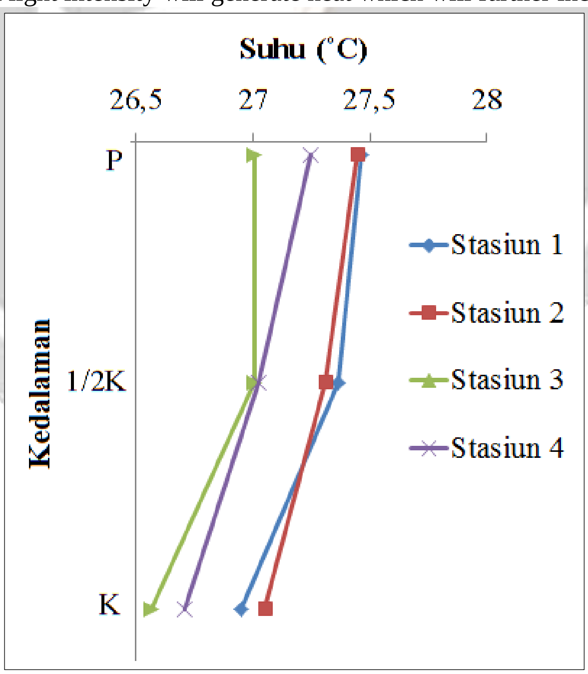

Figure 5. Graph of Average Water Temperature of Jatigede Reservoir

Station 1 has the highest average surface temperature of 27.48±0.54˚C, while the lowest average surface temperature is at station 3 of 26.72±1.06 C. The highest average temperature at a depth of 0.5 compensation is at station 1 of 27.38±0.53˚C, while station 3 has the lowest average temperature at a depth of 0.5 compensation. Station 2 has the highest average temperature at the compensation depth of 27.06±0.51˚C, while the lowest average temperature compensation depth is at station 3 of 26.58±0.36˚C. The temperature distribution in the water column is influenced by other factors besides light intensity. According to Brehm and Melfring (1990),the temperature pattern of aquatic ecosystems is influenced by various factors including the intensity of sunlight, heat exchange between water and the surrounding air, and geographic altitude.

Flow Current

velocity data in Figure 6 obtained during the study shows that the average current velocity at station 2 has the lowest value of 0.136±0.092 m/s, while the highest average current velocity is at station 3 of 0.216±0.148 m/s . Zahidah (2017) states that the reservoir ecosystem consists of a flowing type at the inlet, inundated at the outlet and an intermediate type (transition) which lies between these two main types. This causes a decrease in the current velocity at station 2 which is a transition zone.

An increase in current speed occurred at station 3 caused by strong winds when the observations were made. This is in accordance with the statement of Barus (2001) that in the lentic ecosystem the current is influenced by the strength of the wind, the stronger the wind, the stronger the current and the deeper it affects the water layer. The average current in the waters of the Jatigede Reservoir is still categorized as slow current. According to Welch and Lindell (1980), there are five categories of currents, namely very slow currents (less than 0.10 m/s), slow (0.10-0.25 m/s), moderate (0.25-0, 50 m/s), fast (0.50-1 m/s), and very fast (more than 1 m/s).

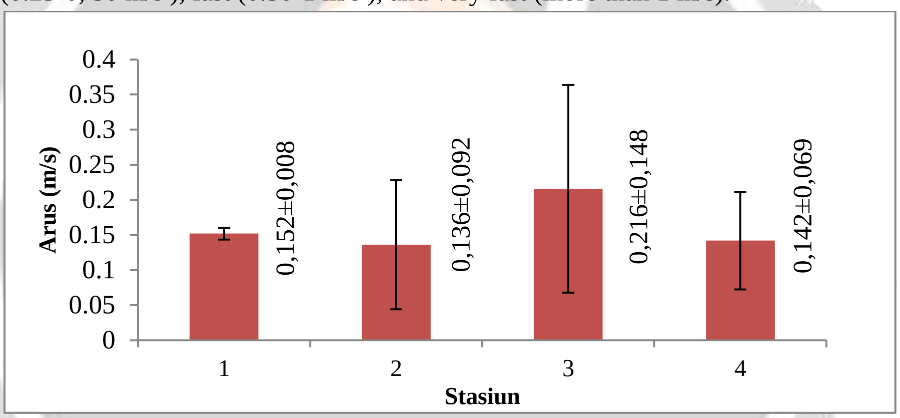

Figure 6. Graph of Average Flow Velocity of Jatigede Reservoir

Chemical Parameters of Jatigede Reservoir Waters Chemical

parameters in Jatigede Reservoir waters during the study are listed in Table 3.

Table 3. Chemical Parameters of Jatigede Reservoir Waters

Parameter Unit	**Depth**		**Station**			
			1	**2**	**3**	**4**
Degree of acidity	P	k	7,04-8,77	7,94-8 ,74	7.88-8.57	7.79-8.46
		r	7.96±0.64	8.26±0.3	8.194±0.25	8.30±0.29
	0.5K	k	7.57 -8.7	7.73-8.65	7.9-9.38	7.81-8.76
		r	8.15±0.44	8.03±0.38	8.40±0.59	8.40 ±0.36

	K	k	7.04-8.62	6.5-8.67	8.18-8.44	7.78-8.51
		r	7.84±0.58	7.69±0.78	8 ,30±0.11	8.17±0.28
Carbon dioxide (mg/L)	P	k	4.19-12.57	4.19-4.19	4.19-8.38	4.19-4.19
		r	9.22±3.5	4.19±0	5.03±1.87	4.19±0
	0.5K	k	4.19-12.57	4.19-4.19	4.19-4.19	4 ,19-4.19
		r	7.54±3.5	4.19±0	4.19±0	4.19±0
	K	k	4.19-12.57	4.19-4.19	4.19-8 ,38	4.19-4.19
		r	7.54±3.5	4.19±0	5.03±1.87	4.19±0
BOD (mg/L)		k	4.86-21.08	6.48-24.32	6.48-17.84	3.24-17.84
		r	12.65±6.00	12±7.12	12.32±4.95	11 ,03±6.00
Dissolved Oxygen DO (mg/L)	P	k	6.2-7.9	5.4-8	5.8-7.9	6.1-7.3
		r	6.94±0.8	6.78±1.1	7.12±0.8	6.54±
	0.5K	6.5-7.9	4.8-7.9	6.2-7.5	6.5-	0.57.7
		r	7±0.6	6.38±1.2	6.76±0.5	7±0.5
	K	k	6-7.9	5.5-8.2	6-7.9	6.1 -8
		r	7±0.8	6.46±1	6.84±0.8	7±0.8
Nitrate (mg/L)	P	k	0.209-0.279	0.16-0.314	0.133-0.222	0.121-0.2
		r	0.238±0.028	0.232±0.066	0.187±0.034	0.168±0.037

	0.5K	k	0.148-0.357	0.126-0.286	0.116-0.259	0.13-0.237
		r	0.244±0.082	0.222±0.061	0.199±0.051	0.188±0.046
	K	k	0.15-0 ,37	0.162-0.321	0.159-0.251	0.152-0.221
		r	0.256±0.103	0.236±0.064	0.191±0.036	0.183±0.029
Ammonia (mg/L)	P	k	0.007-0.101	0.0047-0.042	0.004-0.02	0.003-0.016
		r	0.039 ±0.04	0.0139±0.016	0.011±0.006	0.0098±0.005
	0.5K	0.009-0.09	0.005-0.053 0.002-0.023	0.004-0.021	r	0.0184
		0.04	±0.031	±0.02	0, 0132±0.009	0.0103±0.008
	K	0.002-0.067	0.003-0.049	0.002-0.019	0.0023-0.013	0.0136
		r	0.027±0.026	±0.02	0.0113±0.008	0.0065±0.005
Phosphate (mg/L)	P	k	0.128-0.211	0.114-00.115-0.183	.169 0.127-0.182	r 0.161
		±	0.031	0.148±0.02	0.156±0.023	0.148±0.027
	0.5K	k	0.146-0.215	0.104-0.214	0.123-0.17	0.131-0.16
		r	0.174±0.026	0.152±0 ,04	0.139±0.019	0.141±0.012
	K	k	0.14-0.267	0.134-0.183	0.113-0.219	0.111-0.193
		r	0.185±0.049	0.152±0.019	0.15±0.041	0.142±0.033

Remarks: P= Surface; 0.5 K = Half Compensation; K = Compensation; k = Range; r = Average

Degree of Acidity (pH)

The value of the average degree of acidity at stations 1, 3, and 4 increased from the surface depth to a compensation depth of 0.5, then the acidity level decreased again at the compensation depth. The average degree of acidity observed during the study at each station and depth was within the appropriate range. The suitable pH range for the life of aquatic organisms is 6.5-9 (Boyd 1990).

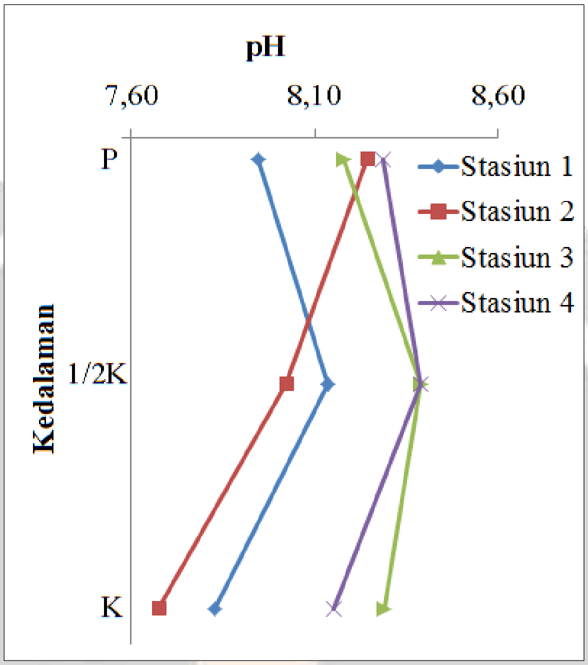

Figure 7. Graph of the Average Degree of Acidity (pH) of Jatigede Reservoir Waters

Overall, the value of the degree of acidity measured during the study tends to decrease at the compensation depth. According to Barus (2004),the high or low pH value of water depends on several factors, including the condition of gases in the water such as CO_2, as well as the decomposition process of organic matter.

Carbon dioxide (CO_2)

Concentration of carbon dioxide (CO_2average

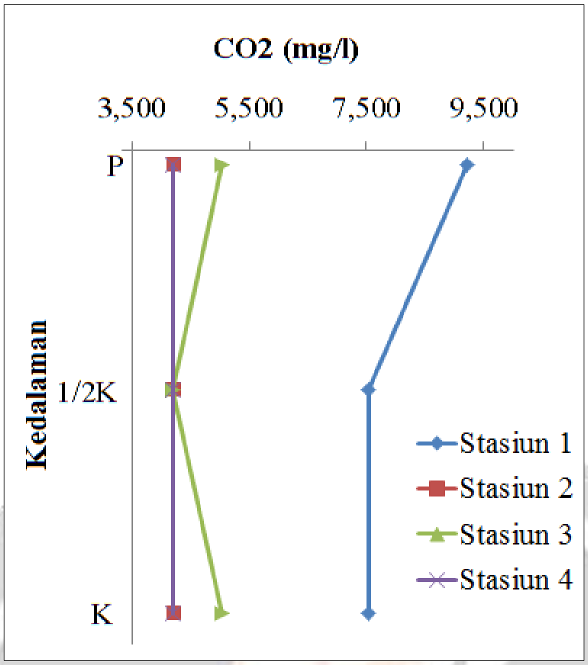

Figure 8. Graph of Carbon Dioxide (CO_2) Concentration in Jatigede Reservoir Waters

Data for measuring the average carbon dioxide concentration obtained during the study (Figure 8) shows that station 1 has the highest average surface carbon dioxide concentration of 9.12±3.506 mg/L which then decreases at a compensation depth of 0.5 to 7.543±3.506 mg/L and stagnates at that number at a compensation depth. The high average carbon dioxide concentration at station 1 is caused by the water station which is the *inlet* reservoirThis station contains pollutants from the Cimanuk River which carries carbon dioxide in the waters leading to the Jatigede Reservoir inlet.

Carbon dioxide in water can come from direct binding of free air and through the respiration process of organisms. Carbon dioxide in water is needed mainly by aquatic plants including algae for photosynthesis (Indrayanto and Saifullah 2015). Phytoplankton at a depth of 0.5 compensation has utilized carbon dioxide for the photosynthesis process, and the increase that occurs at the compensation depth is due to the respiration of organisms at that depth so that the value is lower than the surface.

***Biochemical Oxygen Demand* (BOD_5)**

Data$_5$ average.±The lowest$_{6.00}$ average BOD 5 concentration was at station 4 of 11.03mg/L, while the highest concentration of BOD_5 was at station 1 of 12.65±6.00 mg/L. The high concentration of BOD_5 at station 1 indicates that the content of dissolved organic matter in the waters is relatively high because this station is an *inlet* reservoir which is the input of Cimanuk River water which contains organic matter from industrial and residential activities. Syahbaniati and Sunardi (2019) revealed that organic materials in the waters can come from waste or garbage from settlements that are not decomposed by microbes that degrade organic matter in the waters.

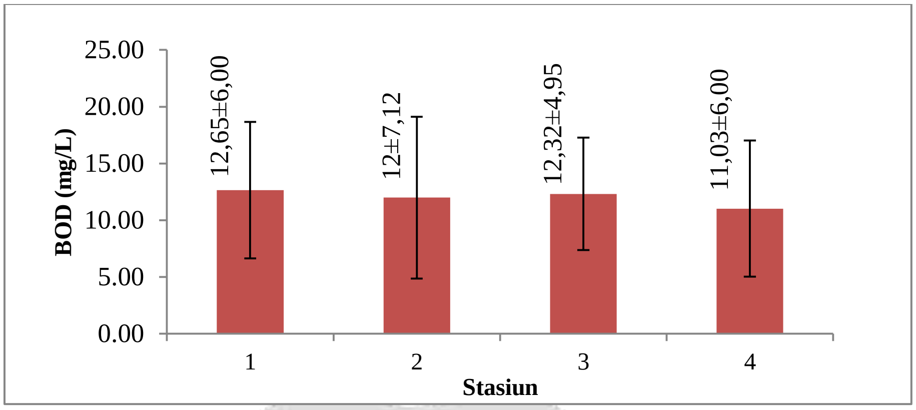

Figure 9. Graph of Concentration of *Biochemical Oxygen Demand* (BOD_5) in Jatigede Reservoir Waters

According to PP No.high concentration of BOD_5 a not in accordance with class II and class III water quality standards, which are more than 3 mg/L and 6 mg/L, respectively. The concentration of BOD_5 which was almost evenly distributed at all stations was thought to be derived from organic matter originating from tree decay due to inundation of the Jatigede Reservoir.

Dissolved Oxygen (DO)

The averageThe graph in Figure 10 shows that the dissolved oxygen concentration at station 2 and station 3 tends to decrease with increasing depth. The vertical distribution of dissolved oxygen at these two stations is classified as a *clinograde type.* Dissolved oxygen in this type decreases with increasing depth, and this decrease is caused by the process of decomposition of organic matter by microorganisms (Goldman and Horne 1983). Salmin (2000) states that the main source of oxygen in waters comes from a diffusion process from free air and the results of photosynthesis of organisms that live in these waters. However, as the depth increases, the oxygen supply from photosynthesis and diffusion decreases.

The vertical distribution of dissolved oxygen at station 1 and station 4 is classified as an *orthograde type.* Based on Goldman and Horne (1983), the *orthograde* type is the type that occurs in unproductive (oligotrophic) lakes or lakes that are poor in nutrients and organic matter. The oxygen concentration increases with increasing water depth. Indrayanto and Saifullah (2015) stated that the role of oxygen in addition to being used for metabolic activities is that it is also used by decomposer organisms in the process of decomposition of organic matter in waters. Overall, the dissolved oxygen concentration in the Jatigede Reservoir is still in a good range with a minimum of 4 mg/L for the class II category and 3 mg/L for the class III category according to Government Regulation No 82 of 2001.

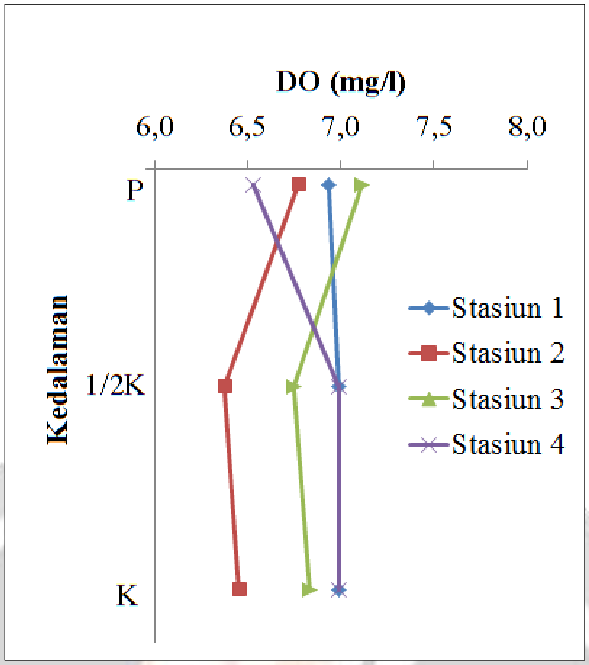

Figure 10. Graph of Dissolved Oxygen Concentration (DO) Average Waters of Jatigede Reservoir

Nitrate (NO_3) and Ammonia (NH_3)

The graph of measuring the concentration of nitrate and ammonia concentration in the Jatigede Reservoir during the study is shown in Figure 11. Overall, the nitrate concentration in the waters of the Jatigede Reservoir has met the requirements of class II water quality standards of no more than 10 mg/L and class III not more than 20 mg/L. The overall ammonia concentration in the waters of the Jatigede Reservoir is still relatively good. Santhosh and Singh (2007) *in* Bhatnagar *et al.* (2013) stated that the maximum limit of ammonia concentration for aquatic organisms is 0.1 mg/L.

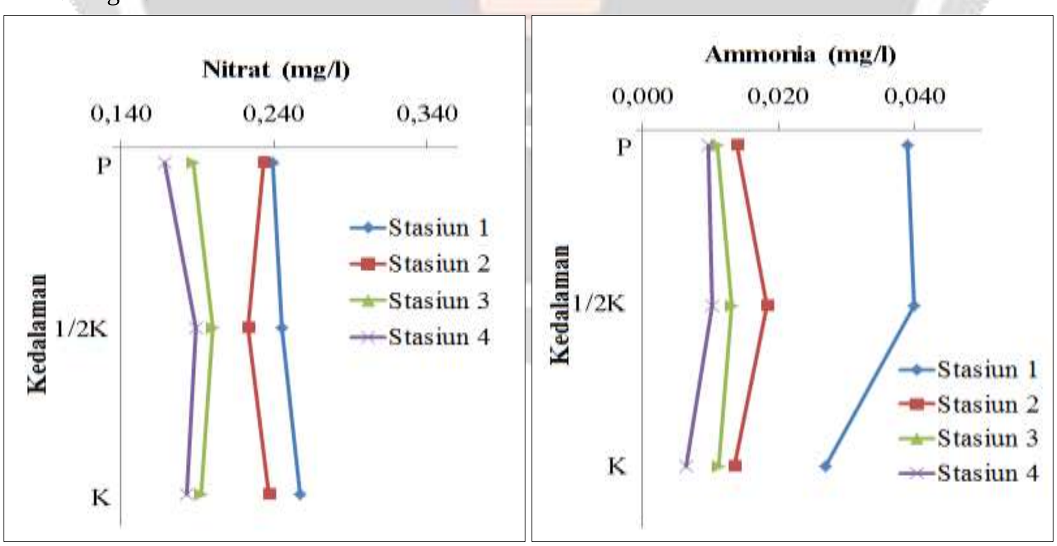

Figure 11. Graph$_3$) and Ammonia (NH$_3$of Average

Figure 11 shows that nitrate concentration increased at 0.5 compensation depth and tends to decrease at compensation depth at station 3 and station 4. Station 1 has the highest nitrate concentration and increases with increasing depth. Meanwhile, the nitrate concentration at station 2 decreased at a compensation depth of 0.5 and increased again at a compensation depth. The concentration of nitrate at station 1 and station 2 is inversely proportional to the concentration of ammonia. This indicates that the nitrification process has occurred. Nitrification involves *Nitrosomonas* which oxidize ammonia to nitrite and *Nitrobacter* oxidize nitrite to nitrate (Wibowo 2009).

Phosphate (PO_4^{3-})

Figure 12 shows that the phosphate concentration at station 1 during the study was the station with the highest phosphate concentration, besides that the phosphate concentration at station 1 increased with increasing depth. The high concentration of phosphate at station 1 is due to station 1 being the reservoir inlet which is the direct water input from the Cimanuk River. According to Patty et al (2015), the main source of phosphate and nitrate nutrients comes from the waters themselves, namely through weathering decomposition processes or the decomposition of plants and the remains of dead organisms. In addition, it also depends on the surrounding conditions, including donations from the mainland through rivers which consist of various industrial wastes containing organic compounds.

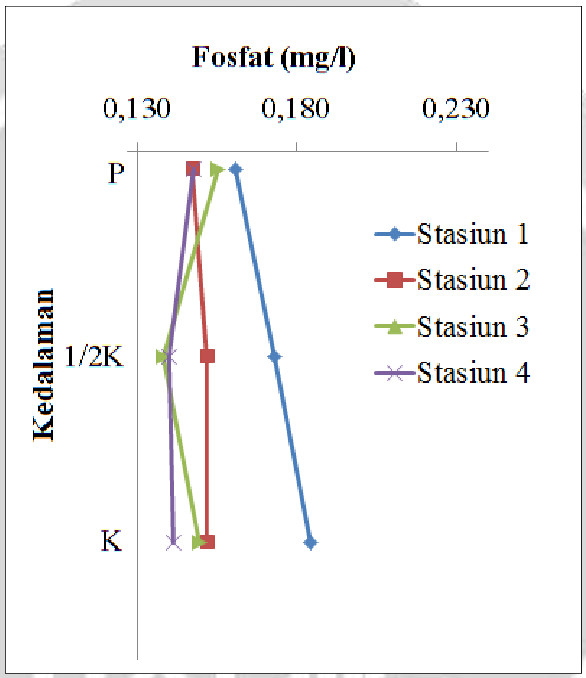

Figure 12. Graph$_4$of Average

Based on PP No. 82 of 2001, the concentration of phosphate in the waters of the Jatigede Reservoir is still in a good range, which is still in the class II category with a maximum threshold of 0.2 mg/L and class III with a maximum threshold of 1 mg/L.

4. CONCLUSIONS

Based on the results of the study, it can be concluded that based on the physical and chemical parameters observed the Jatigede Reservoir is still within normal limits of the class II water quality standard in accordance with applicable regulations, namely PP No 22 of 2021 concerning Environmental Management and Implementation andcan be used for fishery activities.

5. REFERENCES

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