Asian Journal of Geological Research

3(3): 35-41, 2020; Article no.AJOGER.59916

Physical and Chemical Water Quality of Cirata Reservoir in Cianjur Regency Area

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Ahmed Abdelraheem Frghaly, Sohag University, Egypt.
Reviewers:
(1) Ashish Kumar, Agra College, India.
(2) Joanna Maria da Cunha de Oliveira Santos Neves, Federal University of Southern Bahia, Brazil.
Complete Peer review History: http://www.sdiarticle4.com/review-history/59916

Original Research Article

Received 10 July 2020
Accepted 17 August 2020
Published 03 October 2020

ABSTRACT

Cirata Reservoir is one of three reservoirs drained by the Citarum River. Cirata Reservoir is included in the category of multipurpose reservoir, where in addition to being used as hydropower, this reservoir is also used as a means of fisheries and tourism activities. Fish cultivation in Cirata Reservoir uses the floating net cage system (KJA). The amount currently exceeds the capacity set by the government. The KJA provides organic material waste which causes a decrease in water quality in the Cirata Reservoir. This research aims to evaluate the physical and chemical parameters of river Cirata Reservoir in the Cianjur Regency. This research was carried out in the Cirata Reservoir in the Cianjur Regency area by taking three stations as a sampling area in November-December 2019. The method used was purposive sampling and quantitative descriptive analysis. Research results show fluctuations in the range of physical-chemical parameters of waters in Cirata Reservoir in Cianjur Regency as follows: Transparency 0.59 - 0.68 meters, Temperature 32.9 - 33.3°C, pH 7.2 - 7.5, Carbon dioxide (CO_2) 11.2 - 13.3 mg / L, Dissolved Oxygen (DO) 8 - 8.8 mg / L, Biochemical Oxygen Demand (BOD) 7.2 - 8.3 mg / L, Nitrates 0.192 - 0.204 mg / L Ammonia 0.003 - 0.004 mg / L, and Phosphate 0.162 - 0.171 mg / L.

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Keywords: Cirata reservoir; floating net cage system (KJA); water quality.

1. INTRODUCTION

Cirata Reservoir is included in the category of multipurpose reservoir, onceis used as hydropower plant, fisheries and tourism as an effort to improve the economic life of the community which is inundated by the Cirata Reservoir [1]. Reservoir flooded in 1987 is located at an altitude of 221 m above sea level, spacious Cirata is 7,111 Ha and extensive inundation of 6,200 ha, the average depth of 34.9 m and a volume of 2,165 x 106 m3. Geographically, Cirata Reservoir is located at 107° 14 '15 "- 107° 22'03" South Latitude and 06° 41 '30 "- 06° 48 '07" East. Cirata Reservoir was built by making a 125 m high dam with a length of 500 m [2].

Fish culture in the Cirata Reservoir is carried out using the floating net karamba (KJA) system. Cirata Reservoir Management Agency (BPWC) notes, currently the development of KJA population in the Cirata Reservoir has reached 98,397 plots (2018 census), this number exceeds the limit set by 12,000 plots according to the Decree of the Governor of West Java Number 14 of 2002 concerning Development Utilization of Public Water, Agricultural Land, and Cirata Reservoir Areas. The selection of research stations was based on the number of KJA scattered in the Cianjur area and then determined three regions representing the three Subdistricts namely Jangari (Mande District) of 3,584 plots, Maleber (Mande District bordering Cikalong kulon) as many as 2,075 plots and Patok beusi (Kec. Cikalong Kulon borders Purwakarta) as many as 2,268 plots [3]. KJA aquaculture activities are developing outside the control of environmental carrying capacity, allegedly has led to an increase in water fertility which is marked by a significant increase in nutrients such as N and P. These changes will reduce the condition of the waters, so that it can disrupt the life of biota and even further will reduce the diversity of biota such as fish and other organisms in the reservoir [4]. The development of KJA contributes much to the rest of the feed and the metabolism of fish which tends to increase nutrients in the waters thereby accelerating eutrophication [5].

Cirata Reservoir receives supplies of various pollutants or nutrients originating from the tributaries of the Citarum river which empties into the Cirata Reservoir and Saguling Reservoir. In addition to the input load, Cirata Reservoir obtains input of organic material from the KJA activities contained in the relevant water body. The input burden has the potential to increase fertility (increase the rate of eutrophication). Increased fertility is usually preceded by changes in physical and chemical quality of the waters which are often followed by various changes that tend to be detrimental to reservoir users, especially for the fisheries sector that wants good water quality for the growth of organisms that are maintained [6]. Based on this, research on water quality in the cirata reservoir is necessary.

2. MATERIALS AND METHODS

This research was conducted in November - December 2019 with location analysis is conducted at the Laboratory of Aquatic Resources (SDP) FPIK Padjadjaran University. The method used in this study was purposive sampling on the water surface at each station with sampling locations carried out at three floating net cages stations (KJA) with different densities representing three subdistricts in Cianjur Regency in the Cirata Reservoir area.

The parameters measured were Transparency, Temperature, pH, Carbon dioxide (CO_2), Dissolved oxygen (DO), Biochemical Oxygen Demand (BOD), Nitrates, Ammonia, and Phosphates. Analysis of the data in this study uses quantitative descriptive methods.

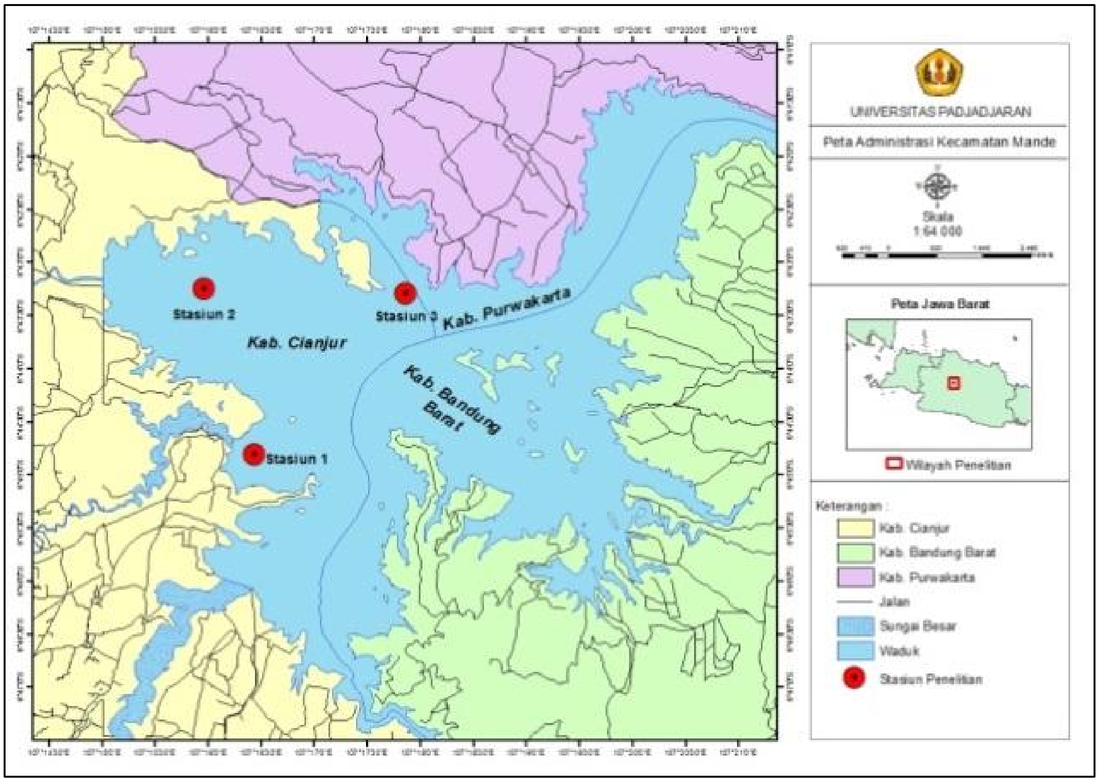
3. RESULTS AND DISCUSSION

Data on the water sample test results of these studies show a different value in each station. This means that the difference in the number of KJA at each station has an influence on water quality in these areas.

Based on Table 1, it can be concluded that the water parameters obtained are within the limits required in PP RI No. 82 of 2001 [7] concerning water quality. It is shown by chemistry parameters that are still included in the standard, except for one parameter which is still above the standard threshold.

3.1 Transparency

The average value obtained during the research transparency is 0.62 m (Stn.1), 0.68 m (Stn.2) and 0.59 m (Stn.3). In a previous study by Zahidah [8], the average transparency in the



Picture 1. Research station

Cirata Reservoir was 0.75 cm. Based on the statement can be concluded that the value of transparency in Cirata has decreased over time. Station 3 has the smallest value due to its position which is after the two previous stations, this causes a lot of organic materials from the two previous stations that have not been sedimentated and causes high turbidity.

Furthermore widdyastuti [9] states that the higher the transparency the deeper the penetration of light into water, which will determine the productive thickness.

3.2 Temperature

The temperatures obtained at the time of the study were 32.9°C (Stn.1), 33°C (Stn.2) and 33.3°C (Stn.3). Station 3 has the highest value while Station 1 has the lowest value. The temperature difference is influenced by the time of sampling, checking the temperature at station 3 is carried out in the morning while station 1 is carried out towards the afternoon.

According to Effendi [10] that the temperature is good for the life of aquatic organisms in the tropics is 25-32°C. Water temperature can affect the primary productivity of waters, with increasing temperatures that can still be tolerated by vegetable organisms, will be followed by an increase in the degree of metabolism and photosynthetic activity that is in it.

3.3 Acidity (pH)

The average pH obtained during the study was 7.2 (Stn.1 & Stn.2) and 7.5 (Stn.3). This value is included in the class II and III water quality standards according to PP RI No. 82 of 2001 [11]. The results are also not much different from those obtained in Zahidah research [6] which is 7.36. Station 3 has a higher value than the previous two stations. That is because the position of station 3 is after the previous station position, automatically getting organic material from the previous station. In line with Araoye's statement [12] it is said that organic matter will be processed by microbes with the help of oxygen to produce carbon dioxide, carbon dioxide will make the waters become acidic.

Each species of aquatic organism has a different tolerance range to pH. The ideal pH value for the life of aquatic organisms generally ranges from 7 - 8.5 [11].

3.4 Carbondioxide (CO_2)

The average value of CO_2 obtained was 11.2 mg / L (Stn.1), 13.3 mg / L (Stn.2) and 11.9 mg / L (Stn.3). The results of research in Cirata Reservoir by Zahidah [8] showed an average carbon dioxide value which was not much different at 12.21 mg / L. This value is also included in the class III water quality standards according to PP RI No. 82 of 2001 [7].

Station 2 has a higher value than the other two stations, this is because Station 2 receives the highest amount of organic material which is then processed by microbes to decompose organic matter into inorganic materials and carbon dioxide. Based on Effendi's opinion [10] which states that carbon dioxide in water can experience a reduction or even disappear due to photosynthesis. In addition, the different amount of KJA in each station affects the amount of different organic material for photosynthesis.

3.5 Dissolved Oxygen (DO)

Dissolved Oxygen is closely related to the transparency of light, the light that enters the waters used by phytoplankton for photosynthesis, photosynthesis produces oxygen. The average DO obtained during the study was 8.8 mg / L (Stn.1), 8.7 mg / L (Stn.2) and 8 mg / L (Stn.3). The value obtained is still included in the Class II and III water quality standards according to Peraturan Pemerintah Republik Indonesia No. 82 of 2001 [11]. Station 1 has the highest value while station 3 has the lowest value. Station 1 has the highest number of KJA and is located close to the main inlet of Cirata Reservoir, so it gets a lot of organic material. The organic material is broken down by microbes into inorganic material, then the inorganic material is used as a key to phytoplankton growth.

The maximum DO in the rainy season is slightly higher than in the dry season [6]. Decrease in oxygen levels in the rainy season other than due to the process of respiration is also caused by the decomposition process running smaller than the dry season so it requires little oxygen for the process of overhaul (decomposition) [1].

According to Basmi (1992), waters whose oxygen content is less than 3 mg / L will disturb the life of aquatic organisms, if the oxygen content between 5-7 mg / L means it is less productive, whereas if it is greater than 7 mg / L, including productive waters. According to Salmin [8], a high DO value is due to the presence of sunlight in the surface layer of water that is observed so that it helps the process of photosynthesis in supplying oxygen to the waters.

3.6 Biochemical Oxygen Demand (BOD)

The average BOD values obtained during the study were 7.2 mg / L (Stn.1), 8.3 mg / L (Stn.2) and 7.2 mg / L (Stn.3). Station 2 has the highest value compared to other stations. That is because station 2 gets its organic material intake from station 1 and has two river inlets that enter the reservoir water body which in one of the river streams is used as a cattle slaughterhouse waste disposal. According to the statement of Barus [13] BOD measurements are based on the ability of microorganisms to break down organic compounds, meaning that there are only substances that are easily broken down biologically like compounds that are generally found in household waste.

High BOD value is closely related to the low DO value, the higher the BOD value, the lower the value of the DO. Based on the results obtained above the water quality standard limits both class II and class III. The results which were not much different were also shown in Zahidah's study [14] which was 8.007 mg / L. According to Brower, et al. [15], the BOD concentration value indicates a water quality that is still relatively good if the consumption of O2 by microorganisms to break down organic compounds over a 5 day period ranges to 5 mg / L then the waters are classified as good and if O_2 consumption ranges between 10-20 mg / L will show a high level of pollution by organic matter and for wastewater the BOD value is generally greater than 100 mg / L.

3.7 Nitrate

The average values obtained during the research Nitrate is 0.197 mg / L (Stn.1), 0.204 mg / L (Stn.2) and 0.192 mg / L (Stn.3). The values obtained do not have significant differences from each other. Station 2 has the highest value while station 3 has the lowest value. Station 2 has the highest value because it is influenced by KJA activity although not as much as at Station 1 and also from the two inlets that enter Station 2 so that more organic material from Station 1. While Station 3 has the lowest value due to KJA activity and material accumulation organically affected by waterways in Cirata Reservoir starting from station 1 then station 2 then on station 3.

Table 1. Physical and chemical quality of cirata reservoir in the cianjur regency area

Parameter	Unit	Station			Quality standars*
Physical		**1**	**2**	**3**	
Transparency	meter	0,62 (0,59-0,66)	0,68 (0,62-0,76)	0,59 (0,39-0,66)	-
Temperature	^oC	32,9 (32-34,5)	33 (33-33,3)	33,3 (31,9-35)	*Deviation 3**
Chemical					
Acidity (pH)	-	7,2 (6,9-7,5)	7,2 (6,9-7,8)	7,5 (7-8,7)	*6-9**
Carbondioxide (CO_2)	mg/L	11,2 (8,4-12,6)	13,3 (16,8-25,1)	11,9 (8,4-12,6)	*50**
Dissolved Oxygen (DO)	mg/L	8,8 (6,8-9,7)	8,7 (7,1-9,7)	8 (5,8-9,1)	*3-4**
Biochemical Oxygen Demand (BOD)	mg/L	7,2 (2,2-20,5)	8,3 (2,2-13,5)	7,2 (1,1-17,5)	*3-6**
Nitrates (NO3-N)	mg/L	0,197 (0,168-0,226)	0,204 (0,152-0,241)	0,192 (0,169-0,217)	*10-20**
Ammonia (NH3-N)	mg/L	0,003 (0,002-0,005)	0,004 (0,001-0,006)	0,004 (0,002-0,006)	*0,02**
Phosphate (PO4-P)	mg/L	0,171 (0,154-0,186)	0,162 (0,131-0,181)	0,167 (0,152-0,195)	*0,2-1**

**PP RI No. 82 Tahun 2001 (II & III) [11]*

Based on water quality standards, the value obtained is still included in the quality standards of class II and III according to Government Regulation No. 82 of 2001 [7]. According to Krismono & Krismono [16] high Nitrate concentrations can stimulate algal growth (algal blooming). The recommended concentration for fish growth is 10 mg / L [11].

3.8 Ammonia

Ammonia average values obtained during the research that is 0.003 mg / L (Stn.1) and 0,004 mg / L (Stn. 2 & 3). The highest ammonia value at Station 2 and 3 is assumed to be due to KJA activity, input of organic material from two inlets and from Station 1. For Station 3, it gets input from Station 2 and KJA activity whose amount is not different from Station 2. The value at each station does not have a significant difference. In PP RI No. 82 of 2001 [7] for fisheries, free ammonia content for sensitive fish ≤ 0.02 mg / L as NH3, the value obtained is still included in the standard. The concentration of free ammonia in the waters depends on the pH and temperature of the waters. Increasing pH and water temperature causes the percentage of free ammonia to increase total ammonia [13].

Ammonia concentrations in free form comes from fertilizers, fish excretion results and the breakdown of nitrogenous compounds by microbes. Ammonia can be produced from the nitrogen amonification process that occurs during the process of decomposition of organic matter with the help of bacteria and fungi [17].

3.9 Phosphate

The average grade phosphate obtained during the research that is 0.171 mg / L (Stn.1), 0.162 mg / L (Stn.2) and 0.167 mg / L (Stn.3). Station 1 has the highest value from the highest organic material input from KJA activities compared to other stations and the Citarum river inlet. Phosphate at Station 2 is thought to originate from KJA activity inputs, inputs from Station 1 and two river inlets, although the number of KJA is not as much as Station 1 but other sources are the two river inlets that contribute to household, agricultural and livestock waste. The phosphate source at Station 3 is thought to originate from KJA activity and input from the previous station. The number of KJA in this station is no different from Station 2 and there is no river inlet that enters this station.

The value obtained is still included in the quality standards for water quality classes II and III according to PP RI No. 82 of 2001 [7]. Phosphate is not toxic to fish, humans and animals. Excessive orthophosphate concentration can cause algae blooms and can inhibit light penetration into the waters [9]. In general, phosphate levels are directly proportional to BOD levels, which indicate high organic matter. High levels of phosphate indicate the low quality of the water.

4. CONCLUSION

From the results obtained wetting it can be concluded that the difference in the number KJA in three regions also showed differences in the value of the water quality. As for the parameters of nitrate, ammonia and phosphate there is no big difference, this means that the nutrient conditions both inlet, middle and outlet have an even distribution of nutrients. It is thought to be influenced by the amount of organic matter entering the Cirata Reservoir, the main source of which comes from waste enter through KJA activities, river inlets and household waste.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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