The Impact of Floating Net Cages on the Water Quality of Riam Kanan Reservoir South Kalimantan

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Abstract. Reservoirs in Indonesia have been widely used as floating net cages, including in the Riam Kanan Reservoir. The use of the reservoir as a floating net cage has affected the quality of water in the reservoir. The purpose of this study was to analyze the physical and chemical quality of water in the Riam Kanan reservoir due to floating net cages cultivation activities. This study used a purposive random sampling method, with the sampling location determined based on the density of floating net cage cultivation with a total of 8 points and a depth of 2 m, 6 m, and 8 m, respectively. The physical value of water was obtained by direct measurement and the chemical value of water is obtained from the measurement results in the laboratory. The data analysis in this research was the descriptive analysis where the data were obtained from the tables and graphs. The results of the research on the physical-chemical quality of water in the Riam Kanan Reservoir show that the physical values of water such as temperature, smell, taste, and color in the waters of the Riam Kanan Reservoir were still within the normal condition. The value of pH has a value of about 7.18-7.76. The value of Dissolved Oxygen (DO) was about 3.76 mg/l-6.14 mg/l. Nitrate value is about 0.002 mg/l-0.4099 mg/l. The nitrite value was about 0.0012 mg/l-0.0034 mg/l. Ammonia content was about 0.1643 mg/l-0.5132 mg/l. The levels of pH, DO, nitrate, and nitrate were a normal category, but the ammonia level was in the dangerous category. The chemical content increased with the depth of the water, due to the influence of the used feed deposited.
Keywords: water quality, reservoir, floating net cages

1. Introduction

The utilization of fish culture technology in floating net cages in several reservoirs in Indonesia has long been known and applied by Indonesian farmers since the 1940s and was only applied intensively in the 1970s [1]. The cultivation of floating net cages is growing rapidly and has become one of the largest national freshwater fish producers [2, 3]. Freshwater cage cultivation is an important industry because it provides a source of protein and fulfills the high market demand for freshwater fish [4].

In general, floating net cage cultivation technology applies an intensive pattern so that it relies on artificial food as the main source of feed for fish. This makes fish feed in an efficiency ratio not fully utilized and will enter water bodies [1]. Coupled with metabolic waste such as feces and urine from fish, it causes various environmental problems in the waters [1, 5]. These activities trigger various problems with water quality [6–9]. The water quality degradation caused feed residue decomposes into nitrogen, phosphorus, sulfide, carbon. Poor water quality results in low fish quality and a risk to health [4]. Excessive feeding can also pose a threat to the aim, function, and benefits of the reservoir [10].

Riam Kanan Reservoir is one of the reservoirs located in Aranio District, Banjar Regency, South Kalimantan Province. This reservoir began operating in 1972. The water contained in this reservoir comes from the Riam Kanan River with a watershed area of 1043 km^2 [11–14]. This reservoir is used as a floating net cage. The floating net cages in this reservoir reach 600 units with 1 unit consisting of 9 ponds, and the size of 1 pond has an area of 7 m x 7 m [12].

Riam Kanan Reservoir function does not only a floating net cage but also a hydropower plant and a source of clean water for most people of South Kalimantan who live in Banjar Regency, Banjarbaru,

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and Banjarmasin. Pollution in reservoir water is a problem for clean water in the study area. Based on the background, the purpose of this study was to analyze the physical and chemical quality of water in the Riam Kanan reservoir due to floating net cages cultivation activities.

2. Methods

The type of research used was quantitative. The approach used in this research was descriptive because it was used to raise the facts, variables, and phenomena that occur today. The sampling method was carried out by random purposive sampling with a total sample size of 24 samples. The sampling location was determined based on the total density or density of floating net cages cultivation. Water samples that have been taken will be identified directly (in situ) and carried out in the laboratory (ex-situ). The consideration of determining the sample points taken was expected to represent the condition of the water quality of the area around the floating net cages so that it can be seen the level of pollution caused by floating net cages cultivation activities. Samples in the study were taken randomly as many as 8 sample points in the cultivation area with the highest density level. Each sample point was taken at a depth of 2 m, 6 m, and 8 m from the water surface. Data were taken by observation, laboratory, and secondary data collection. The parameters used in the data analysis were the physical and chemical parameters of water in the form of temperature, smell, taste, color, pH, dissolved oxygen (DO), nitrate (NO_3–N), nitrite (NO_2–N), and ammonia (NH_3–N).

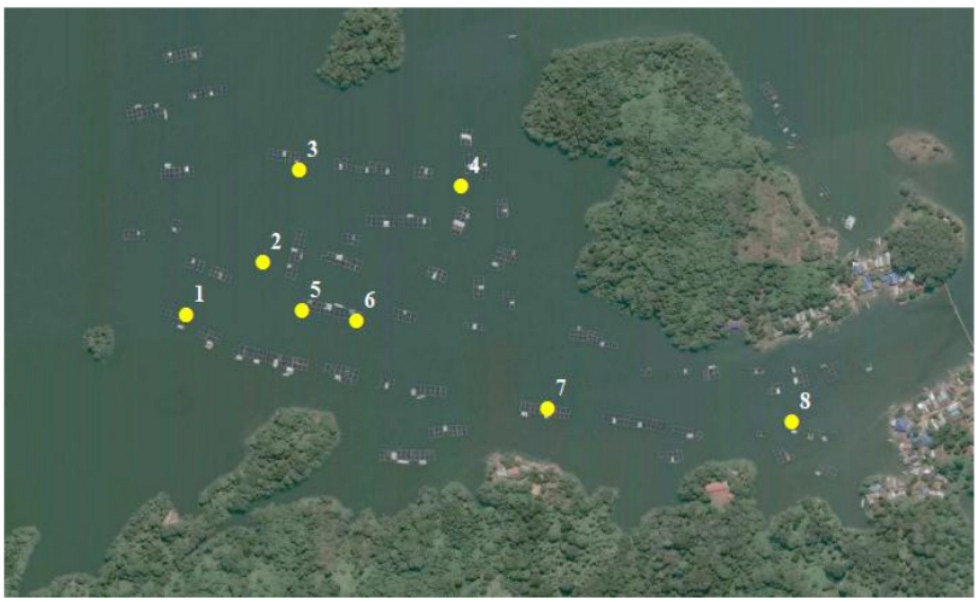

Figure 1. Research Sampling Points (Source: *Google Earth*)

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Figure 2. Research Locations

3. Results and Discussion

Physical parameters measured at the time of observation include temperature, smell, taste, and color, while chemical parameters include pH, Dissolved Oxygen (DO), nitrates, nitrites, and ammonia. For physical parameters, the measurement method was carried out directly (in situ) using the five senses and tools. As for chemical parameters, the measurement method was carried out indirectly (ex-situ) in the laboratory after the sample was previously handled specifically so that the value and quality of the sample did not change when the measurement was carried out in the laboratory.

3.1. Temperature

The temperature distribution at the measurement point with a depth of 2 m was known to have the lowest value at points 2 and 7 with a value of 30.6 ° C while the highest value was at point 1 with a value of 31.5 ° C. The temperature distribution at the measurement point with a depth of 6 m was known to have the lowest value at point 7 with a value of 30.4 ° C while the highest value was at point 1 with a value of 30.9 ° C. The temperature distribution at the measurement point with a depth of 8 m was known to have the lowest value at point 4 with a value of 30.2 ° C while the highest value was at point 6 with a value of 30.8 ° C.

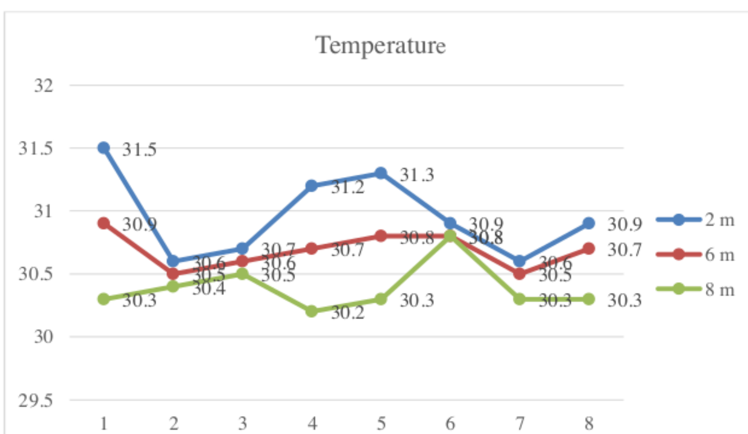

Figure 3. Temperature distribution at the measuring point

3.2. Smell of Water
Based on tests carried out by direct experimentation on water samples at the measurement point, it was known that the smell of water at a depth of 2, 6, and 8 m shows uniformity where there was no odor from pollutants in the samples taken.

3.3. Taste
Based on tests carried out by experimenting directly on water samples at the measurement point. The taste of water at a depth of 2, 6, and 8 m showed uniformity where there was no taste originating from pollutants in the samples taken.

3.4. Color
Based on tests carried out by observing water samples at the measurement point. The color of the water at a depth of 2, 6, and 8 m showed uniformity where there was no color originating from pollutants in the samples taken.

3.5. pH
The Distribution at the measurement point with a depth of 2 m was known to have the lowest value at point 2 with a value of 7.18 while the highest value was at point 8 with a value of 7.76. The pH distribution at the measurement point with a depth of 6 m was known to have the lowest value at point 2 with a value of 7.30 while the highest value was at point 8 with a value of 7.61. The pH distribution at the measurement point with a depth of 8 m was known to have the lowest value at point 7 with a value of 7.25 while the highest value was at point 5 with a value of 7.72.

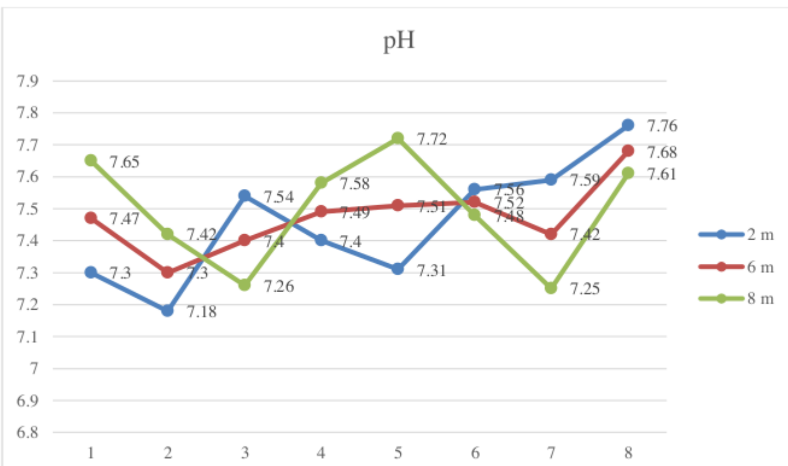

Figure 4. pH distribution at the point of measurement

3.6. Dissolved Oxygen (DO)
Distribution at the measurement point with a depth of 2 m was known to have the lowest value at 3 points, namely point 1, point 5, and point 8 with the same value of 4.16 mg/l while the highest value was at point 2 and point 3 with a value of 5.75 mg/l. The dissolved oxygen distribution at the measurement point with a depth of 6 m was known to have the lowest value at points 1 and 8 with a value of 4.36 mg/l while the highest value was at point 2 with a value of 5.94 mg/l. The dissolved oxygen distribution at the measurement point with a depth of 8 m was known to have the lowest value at point 5 with a value of 3.76 mg/l while the highest value was at point 2 with a value of 6.14 mg/l.

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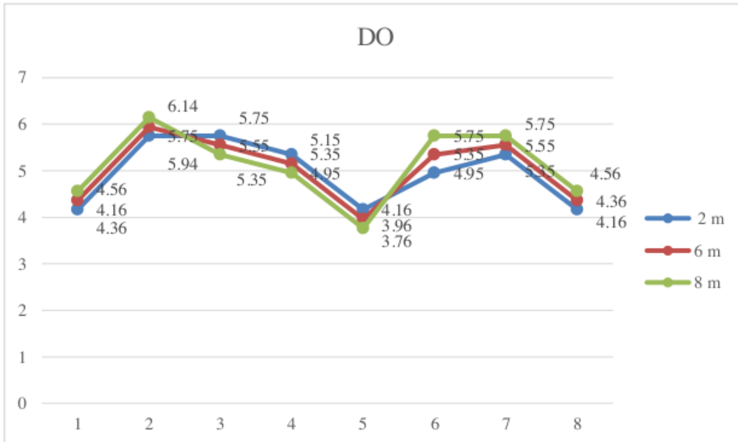

Figure 5. DO Distribution at Measurement Points

3.7. Nitrate (NO3 − N)

The distribution of nitrate at the measurement point with a depth of 2 m was known to have the lowest value at 3 points, namely point 2, point 3, and point 7 with the results of the examination below the limit of the method detection limit (MDL), which means that it was <0.002 mg/l. The highest value was at point 6 with a value of 0.4099 mg/l. The nitrate distribution at the measurement point with a depth of 6 m is known to have the lowest value at points 3 and 7 with the results of the examination below the limit of the MDL which means that the smallest readable value was 0.002 mg/l, so it can be said that the nitrate value at three this point was <0.002 mg/l while the highest value was at point 2 with a value of 0.2211 mg/l. The nitrate distribution at the measurement point with a depth of 8 m was known to have the lowest value at 3 points, namely point 3, point 4, and point 7 with the results of the examination being below the MDL, which means that the smallest value that can be read was 0.002 mg/l, so it can be said that the nitrate value at the three points was <0.002 mg/l, while the highest value was at point 2 with a value of 0.2032 mg/l.

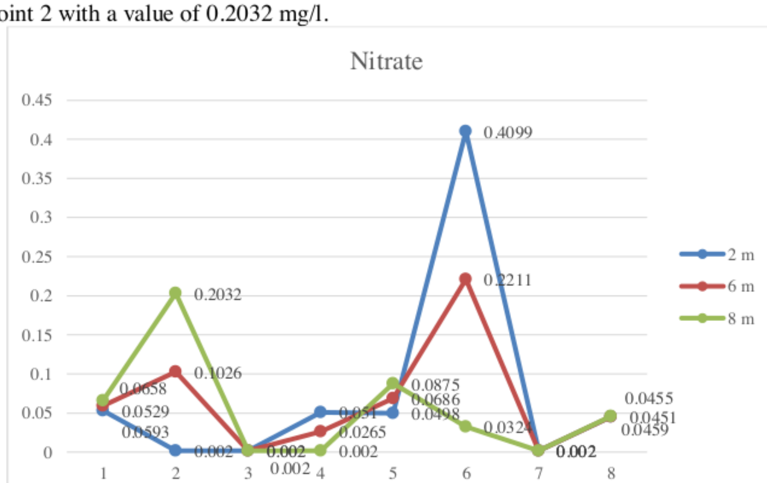

Figure 6. Nitrate Distribution at the Measurement Point

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3.8. Nitrite (NO_2 −N)

The distribution of nitrite at the measurement point with a depth of 2 m was known to have the lowest value at point 7 with the same value of 0.0012 mg/l while the highest value was at point 1 with a value of 0.0031 mg/l. The nitrite distribution at the measurement point with a depth of 6 m was known to have the lowest value at points 2 and 7 with a value of 0.0013 mg/l while the highest value was at points 1, 4, and 6 with a value of 0.0026 mg/l. The nitrite distribution at the measurement point with a depth of 8 m was known to have the lowest value at point 2 with a value of 0.0013 mg/l while the highest value was at point 4 with a value of 0.0034 mg/l.

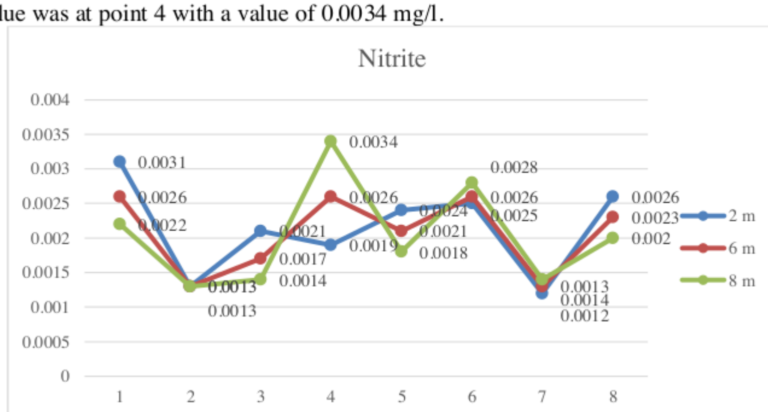

Figure 7. Nitrite Distribution at the Point of Measurement

3.9. Ammonia (NH_3−N)

The distribution of ammonia at the measurement point with a depth of 2 m was known to have the lowest value at point 4 with the same value of 0.1643 mg/l while the highest value was at point 7 with a value of 0.4244 mg/l. The ammonia distribution at the measurement point with a depth of 6 m was known to have the lowest value at point 5 with a value of 0.2351 mg/l while the highest value was at point 7 with a value of 0.4688 mg/l. The ammonia distribution at the measurement point with a depth of 8 m was known to have the lowest value at point 5 with a value of 0.2225 mg/l while the highest value was at point 7 with a value of 0.5132 mg/l.

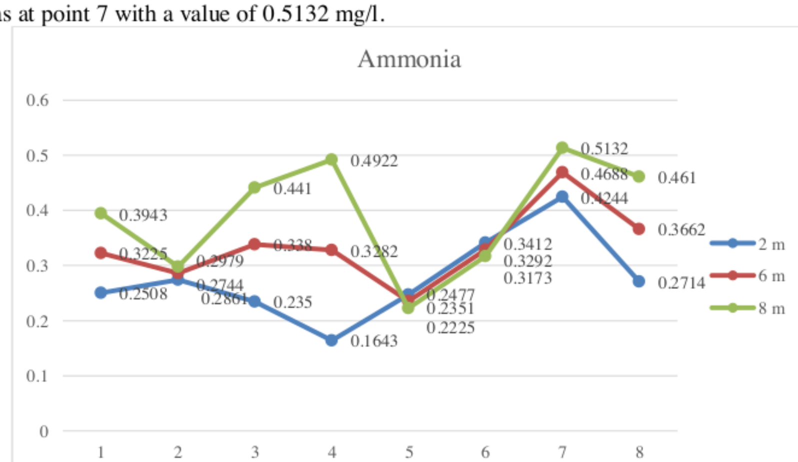

Figure 8. Distribution of Ammonia at Measurement Points

Based on several chemical indicators tested, namely pH, DO, nitrate, nitrite, and ammonia, it is known that the water quality of 8 points with 3 depths in the waters around the floating net cage cultivation activity is still finding the requirements of class II water quality standards, although some chemical indicators have exceeded the tolerance limit. The quality standard of water chemical parameters for water quality of Riam Kanan reservoir based on South Kalimantan Governor Regulation No. 05/2007[15]. Based on South Kalimantan Governor Regulation No. 05/2007, pH, nitrate, and nitrite values at points 1-8 are good observations at a depth of 2 m, 6 m, and 8 m are in class I water quality standards except for DO and ammonia values.

DO values at points 1-8 observations at a depth of 2 m, 6 m, or 8 m on average are at class II and III quality standards. The DO value that can reach the minimum limit of class I quality standards is only at point 2 observations at a depth of 8 m. Conversely, at point 5 observation at a depth of 6 m and 8m, it is known that the DO value is not able to reach the Class II quality standard because the DO value is below 4 mg/liter. Point 5 is a point that has a low DO value.

Ammonia values at points 1-8 observations at a depth of 2 m, 6 m, 8 m are mostly still included in the class I quality standard (drinking water raw water). Only point 7 at a depth of 8 m the ammonia value exceeds 0.5 mg/l. For fisheries, the ammonia content must be ≤ 0.02 mg/l, so it can be said that the average ammonia value at points 1-8 at a depth of 2 m, 6 m, 8 m is not suitable for fisheries because it can be toxic to fish. Only point 4 2m depth, the ammonia value is below ≤ 0.2 mg/l. However, it can be said that all observation points have ammonia values above 0.2 mg/l.

The quality of water in water bodies is determined using the area [16, 17]. Excessive use of reservoirs can cause pollution in reservoir water [3, 6, 7]. Increasing the number and density of cages is a problem for the environment in the long term [18]. Water fertility in the reservoir and high levels of NH3 in the bottom part of the water is the accumulation of nutrients from human activities. These activities include agricultural activities and floating net cages [19, 20]. Changes in the color of reservoir water also indicate pollution in reservoir water [3]. Low oxygen levels also indicate pollution in the reservoir water. Low oxygen levels can cause anaerobic decomposition at the bottom of the reservoir [21].

Samples taken at the research location, especially at a depth of 8 m, have high ammonia values that have exceeded the threshold. The presence of fish feed deposited at the bottom of the reservoir causes high levels of ammonia in the waters high ammonia can be toxic in fish farming [6].

Pollution in reservoir water can cause fish mortality. The mass mortality of farmed fish such as that which occurs in cages in Lake Cirata is caused by low oxygen concentrations. The low oxygen concentration is the strength of mixing surface water with reductive water in a deeper layer [22]. Aquaculture has become one of the main causes of lake eutrophication due to the lack of direct and efficient technology for pollution control and remediation [23]. Several reservoirs in Indonesia have explored green technology to overcome the impact of floating net cages on Lake Maninjau. The purpose of this green technology exploration is to improve water quality and reduce the impact of floating net cages [24]. Regulating the number of cages is also needed to reduce the impact of fish farming on the environment [25].

4. Conclusion

The physical parameters become indicators of observation are temperature, smell, taste, and color. The value of water temperature at 8 (eight) observation points shows a range between 30.6 ° C - 31.5 ° C (normal) because it is still in the optimum temperature range for fish life in the waters (between 25 ° C - 32 ° C). Observation of the smell, taste, and color of water by visually organoleptic shows similarities because at 8 (eight) observation points the water has the properties of odorless, tasteless (fresh), and colorless (clear).

The chemical parameters used as observation indicators are pH, Dissolved Oxygen (DO), nitrate (NO_3–N), nitrite (NO_2–N), and ammonia (NH_3–N). Based on 8 (eight) observation points, the measured pH value shows a range between 7.18-7.76 which means that it is neutral (optimal water pH ranges from 7 - 8.5). The measured DO value shows a range between 3.76 - 6.14 mg/l which means normal (normal DO levels for fish are at least 3 mg/l). The measured nitrate value shows a range between 0.002-0.4099 mg/l, meaning it is normal for aquaculture activities (South Kalimantan Governor Regulation No.5 of 2007). The measured nitrite value shows a range between 0.0012-0.0034 mg/l, meaning it is normal for aquaculture activities (South Kalimantan Governor Regulation No.5 of 2007). The measured ammonia value shows a range of 0.1643 - 0.5132 mg/l, which means that it is not normal (the minimum limit for ammonia in water is 0.3 mg/l).

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