Jurnal Sains dan Teknologi Lingkungan Volume 18, Number 1, January 2026 Hal. **1-10**
p-ISSN:2085-1227 dan e-ISSN:2502-6119

ANALYSIS OF WATER QUALITY AROUND THE FISHPOND AREA, CITARUM WATERSHEDS, KARAWANG REGENCY

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Abstract

This research was conducted to provide data on water quality based on physical and chemical parameters around the fishpond area, Citarum Watersheds, in Karawang Regency. Water quality is a primary requirement for the sustainability of local economic activities. However, with the increasing pollution load, there is concern that water quality around the fishpond area will decline, impacting fishpond productivity, public health, and the environment. Water samples were collected at 10 points along the Citarum Watersheds using a water quality test pen. The measured physico-chemical parameters included temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). The results indicate that several physico-chemical parameters still do not meet the quality standards established by Government Regulation (PP) Number 22 of 2021. These include BOD and DO, where concentrations at all observation points exceeded the quality standards, while the COD values exceeded the standard at most points, except at stations 1-5. This exception is due to their considerable distance from agricultural activities or other community practices. The high COD concentration indicates a significant load of organic pollutants, which are suspected to originate from agricultural runoff and domestic waste. Conversely, the low DO concentration is caused by microorganisms in the water body utilizing the oxygen. These microorganisms require DO as an electron acceptor in their metabolic processes, leading to a decrease in DO levels in the water and a corresponding increase in BOD. The BOD/COD ratio at the study site ranged from 0.46 to 0.5, meaning the pollutants are categorized as biodegradable. Therefore, it can be concluded that the waters in the downstream region of the Citarum River are still suitable for use in freshwater aquaculture activities.

Keywords: *BOD/COD ratio, citarum watersheds, water quality; physical-chemical parameters*

1. INTRODUCTION

Water quality plays a crucial role in maintaining the balance of aquatic ecosystems and is a key factor in the success of fish farming activities (Rochyani, 2018). Pond areas rely heavily on the condition of the surrounding aquatic environment. As a water-based production system, ponds require a stable environment that meets certain quality standards to support the optimal growth and development of cultivated organisms (Utojo, 2015). Unfortunately, pressure from various human activities such as industrial activities, intensive agriculture, and settlements has contributed to the decline in water quality in a number of coastal areas and watersheds (DAS), including in Indonesia (Izzati et al., 2019).

The Citarum Watersheds is one of the largest and most vital watersheds in Indonesia, flowing from upstream in Bandung to downstream in Karawang and Bekasi before emptying into the Java Sea (Putro et al., 2019). This watershed plays a vital role in providing water for most people in West Java and is used for irrigation, hydroelectric power generation, industrial activities, and the fisheries sector (Adam et al., 2018). However, the Citarum Watersheds has long been listed as one of the most polluted rivers in the world (Agustine, 2021). Various studies indicate that the high levels of pollution in this area originate from domestic waste, industrial waste, especially textiles, and agricultural residues such as pesticides and chemical fertilizers, plus sedimentation triggered by erosion processes in the upstream areas.

Water pollution in the Citarum Watershed originates from various sources, including industrial wastewater containing heavy metals such as lead (Pb), cadmium (Cd), and mercury (Hg); household waste rich in organic compounds, nitrogen, and phosphorus; and pesticide residues from agricultural activities (Komarawidjaja, 2017). The presence of these contaminants has the potential to degrade pond water quality, characterized by decreased dissolved oxygen (DO) levels, increased biochemical oxygen demand (BOD) and chemical oxygen demand (COD), eutrophication, and the accumulation of toxic substances in aquatic biota. The launch of the Citarum Harum program in 2018 by the government in 2018 was a strategic step in efforts to rehabilitate and improve environmental quality along the Citarum Watershed (Setiaman, 2023). Citarum Harum is a largescale program to rehabilitate the Citarum Watershed, widely known as one of the most polluted rivers in the world. The program was initiated through Presidential Regulation (Perpres) No. 15/2018, which established a 7-year strategic plan to restore water quality, strengthen watershed management for communities living along the river (Purnomo et al., 2017).

This study aimed to evaluate water quality in the fishpond area, located in the downstream Citarum Watersheds, Karawang Regency. The evaluation was conducted based on several physical and chemical parameters, including water temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Power of Hydrogen (pH), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). The findings of this study are expected to provide a scientific basis useful for local governments, environmental managers, and fishpond businesses in formulating policies for sustainable water quality management. Furthermore, the results of this research support environmental conservation efforts and aquatic ecosystem improvement in the Citarum Watershed. Thus, sustainable and environmentally friendly pond cultivation in Karawang Regency can be further maximized as part of environmentally conscious fisheries sector development.

2. METHODS

2.1. Time and Research Location

This research was conducted from February to March 2025 within the downstream segment of the Citarum Watershed (DAS), specifically in the fishpond (aquaculture) area of Karawang, West Java (Figure 1). Sampling was carried out at aquaculture sites and adjacent river points to represent spatial variations in water quality influenced by aquaculture activities and surrounding land use.

A total of fifteen sampling locations were selected using a purposive sampling approach. Five points were situated directly within active aquaculture units, while ten additional points were positioned along the river channel and surrounding water pathways to capture upstream–downstream gradients and potential pollutant inflow to the pond area. The geographic coordinates of the sampling stations are presented in (Table 1).

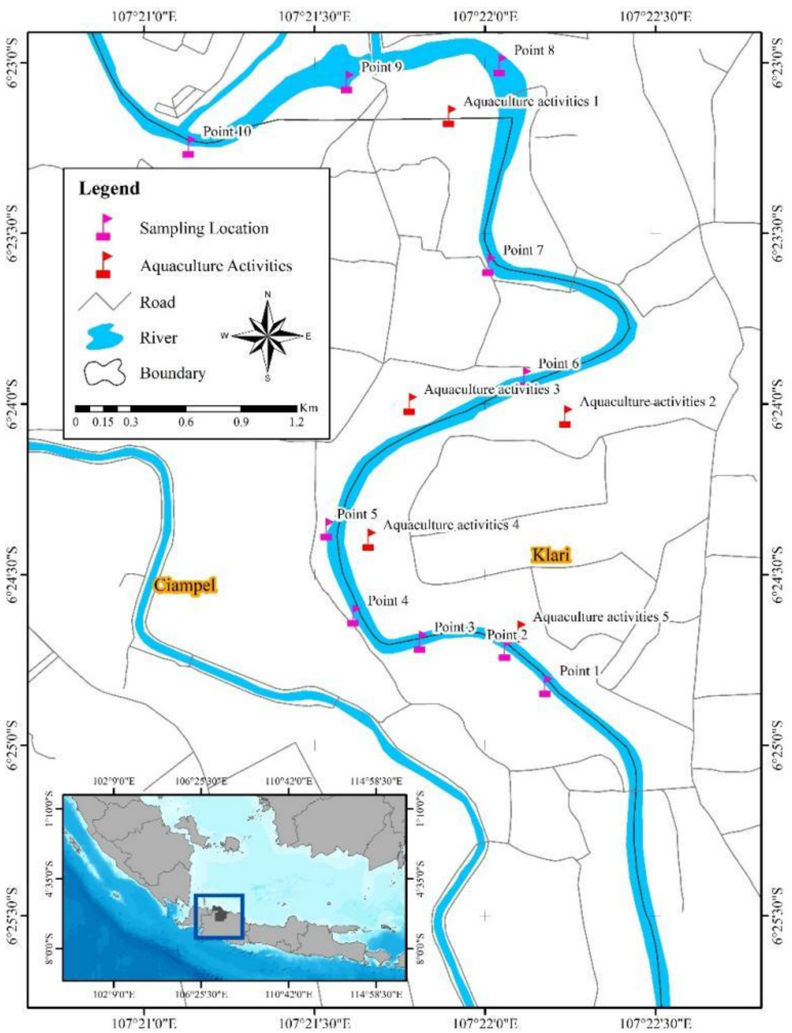

Figure 1. Research location (sampling location)

Table 1. Aquaculture activities and Sampling Point Coordinate

No	Location	Latitude	Longitude
1	Aquaculture 1	-6.385937°	107.364939°
2	Aquaculture 2	-6.400607°	107.364940°
3	Aquaculture 3	-6.399965°	107.364941°
4	Aquaculture 4	-6.406940°	107.364942°
5	Aquaculture 5	-6.415941°	107.364943°
6	Point 1	-6.415942°	107.364944°
7	Point 2	-6.415943°	107.364945°
8	Pont 3	-6.415944°	107.364946°
9	Point 4	-6.415945°	107.364947°
10	Point 5	-6.415946°	107.364948°
11	Point 6	-6.415947°	107.364949°
12	Point 7	-6.385948°	107.364950°
13	Point 8	-6.385949°	107.364951°
14	Point 9	-6.385950°	107.364952°
15	Point 10	-6.385951°	107.364953°

2.2. Tools and materials

The equipment used in this study includes sample bottles made of High Density Polyethylene (HDPE), dippers, gloves, masks, ice packs, thermoses, label paper, and a water quality test pen used to measure water quality parameters such as water temperature, Total Suspended Solid (TSS), Total Dissolved Solid (TDS), pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The materials used include river water samples, alcohol, and distilled water as solvents or cleaning agents.

2.3. Sampling Techniques

Water sampling was conducted from 7:00 to 11:30 a.m. Western Indonesian Time (WIB). Samples were collected using High-Density Polyethylene (HDPE) bottles at fifteen predetermined locations following a purposive sampling method. HDPE bottles were used for all laboratory analyses, including DO, BOD, and COD, to ensure chemical stability and prevent sample contamination. Each bottle was pre-cleaned, rinsed with sample water prior to collection, and clearly labeled with the station number, sample type, and sampling time and date.

2.4. Sampling Techniques

The physical and chemical parameters analyzed in this study included temperature, pH, total suspended solids (TSS), total dissolved solids (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), and chemical oxygen demand (COD). These parameters were selected because they represent key indicators of water quality related to oxygen availability, organic pollution, and overall environmental conditions. Sampling procedures for each parameter followed recognized national and international standard methods. Temperature, pH, TDS, TSS, and DO were measured in situ using a calibrated water quality meter in accordance with APHA Standard Methods (APHA, 2017) and SNI 6989 guidelines. Meanwhile, samples for BOD and COD analyses were collected using pre-cleaned High-Density Polyethylene (HDPE) bottles following SNI 6989.72:2009 for BOD and SNI 6989.2:2009 for COD. All bottles were rinsed with sample water before filling and were stored in a cold box prior to laboratory testing to preserve sample integrity. The collected data were analyzed using descriptive statistical methods and presented in tables and graphs. Interpretation was carried out by comparing the measured values with the water quality standards specified in Government Regulation (PP) No. 22 of 2021. This approach allowed for a comprehensive evaluation of water quality conditions in the fishpond area.

3. RESULTS AND DISCUSSION

Table 2 presents the measured water quality parameters at all sampling stations. Water temperature, TSS, TDS, and pH values were within the allowable limits established in Government Regulation No. 22 of 2021. In contrast, BOD and COD concentrations exceeded the quality standards at most stations, indicating a high level of organic pollution. Dissolved oxygen (DO) levels were consistently below the required threshold across all sampling points, reflecting limited oxygen availability and potential environmental stress in the aquatic system.

Table 2. Surface water quality at 10 points in the Citarum watersheds around the fishpond area

Parameter	Unit	Quality Standard	Station (Sample Point)									
			1	2	3	4	5	6	7	8	9	10
Temperature	°C	Dev 3	27.5	27	27	28	26.8	27.2	26.6	27.9	28.9	29.6
TDS	mg/L	1000	162	166	142	178	172	165	164	164	164	163
TSS	mg/L	50	11.3	11.3	12.3	13.7	11.4	11.2	11.3	11.4	12.8	12.6
pH	-	6-9	7.1	7.1	7.2	7.1	7.1	7.1	7.1	7.1	7.6	7.4
DO	mg/L	4	3.3	3.2	3.2	3.3	3.4	3.3	3.2	3.4	3.3	3.5
BOD	mg/L	3	11.3	11.6	12.9	11.9	13.5	13	12	13	13.4	13.2
COD	mg/L	25	24.5	23.5	24.5	22.6	23.7	25.6	25.8	26	26.6	26

Unlike other water quality parameters, dissolved oxygen (DO) is considered not to meet quality standards if its value is below the specified threshold. This is because DO represents the amount of oxygen available in a body of water that can be utilized by aquatic organisms for growth and reproduction (Sawyer et al., 2003). Thus, the lower the DO level in the body of water, the greater the indication of pollution in that water.

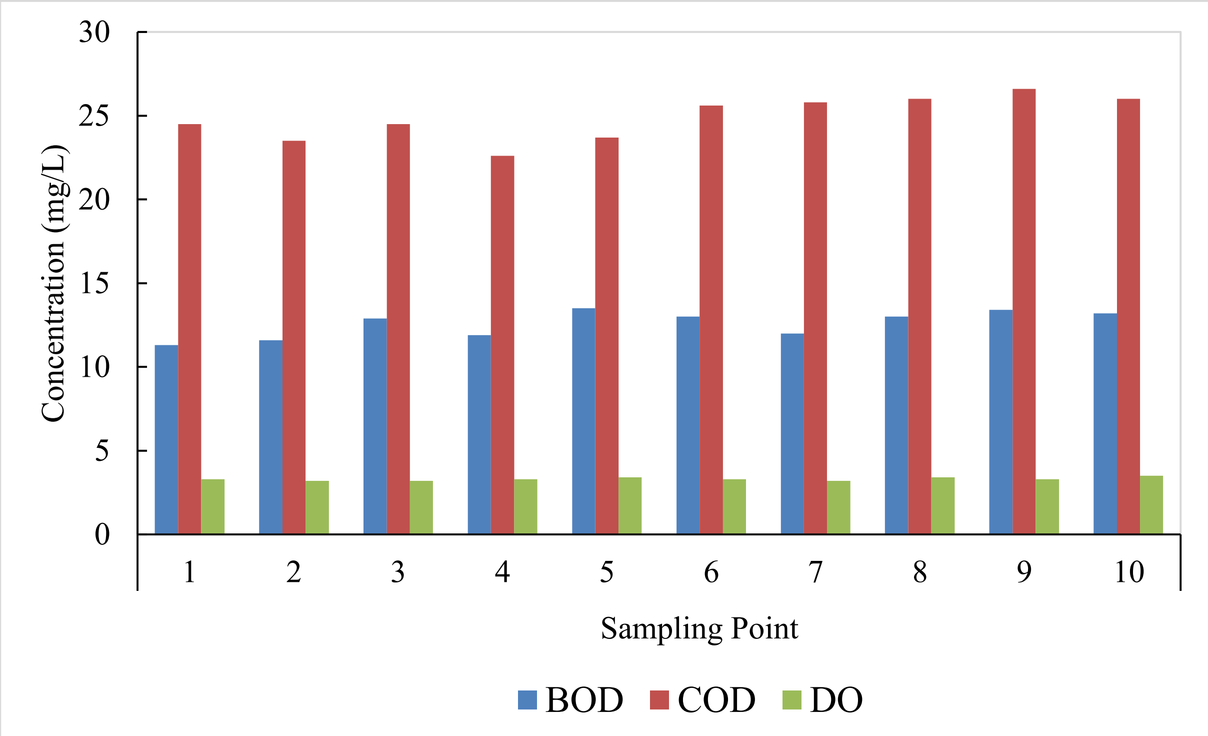

Figure 2. Concentrations of BOD, COD, and DO at 10 sampling points in the Citarum Watershed

Figure 2 shows the BOD, COD, and DO concentrations at ten sampling points in the Citarum Watershedin the Citrum watershed. The BOD and DO parameters at had concentration values that did not meet the quality standards required by Government Regulation No. 22 of 2021 concerning quality standards for freshwater aquaculture or pond activities, as did COD. However, the COD parameters at several observation stations still met the quality standards, namely at stations 1-5. BOD is the amount of organic content in water that can be biologically degraded with the presence of oxygen. According to Pitalokasari et al. (2021), the BOD parameter is also closely related to the DO concentration in water bodies. A decrease or low DO value in a water body is generally accompanied by high BOD concentrations. This condition occurs because dissolved oxygen in water is used by microorganisms, thereby reducing the availability of oxygen for fish and other aquatic organisms to survive in the water (Waziri et al., 2010).

BOD can indirectly cause a reduction in oxygen in a water body or within a body of water. This is caused by the utilization of BOD by microorganisms living in the body of water, which require DO as an electron acceptor in their metabolic process, thereby reducing the DO in the body of water and causing fish to die. COD is the amount of dissolved oxidized organic matter, including non-biodegradable materials (Putri et al., 2021).

COD can be said to be the oxygen equivalent of organic matter in a water sample that is susceptible to oxidation by strong chemical oxidants such as dichromate. High BOD and COD concentrations generally originate from the accumulation of organic matter entering water bodies through various sources, such as surface runoff from agricultural land, domestic waste disposal, and waste from livestock, fishery, and industrial activities (Sofia, 2018). Given that the activity is located in a rice field and farmland area, runoff from agricultural activities and domestic waste from surrounding settlements are suspected to be the main contributors to the high BOD and COD values in the area.

The ratio between BOD and COD is often used as an indicator of water pollution levels, particularly those related to the presence of organic matter (Table 3). In addition, this ratio also serves as a reference in selecting the appropriate wastewater treatment technology (Putri et al., 2021). The BOD/COD ratio reflects the extent of the influence of organic matter on water quality, whether in wastewater, leachate, or compost material in the environment (Putri et al., 2021). Measurement results at the study site showed that the BOD/COD ratio was in the range of (0.46–0.57). This value indicates that the river water around the pond area has been exposed to organic matter, which most likely originates from domestic and agricultural activities in the surrounding area.

Table 3. BOD/COD ratio

Parameters	Station (sample point)									
	1	2	3	4	5	6	7	8	9	10
BOD	11.3	11.6	12.9	11.9	13.5	13	12	13	13.4	13.2
COD	24.5	23.5	24.5	22.6	23.7	25.6	25.8	26	26.6	26
BOD/COD	0.46	0.49	0.53	0.53	0.57	0.51	0.47	0.50	0.50	0.51

However, the BOD/COD ratio is still within the biodegradable range (0.2–0.5) (Tamyiz, 2015), which indicates that organic matter in the water can still be broken down through biological processes and the waters remain suitable for use in freshwater fish farming (ponds). However, it should be noted that in this ratio range, the decomposition process is slow, because decomposer microorganisms need time to adapt to the characteristics of the wastewater.

4. ACKNOWLEDGMENTS

The author would like to thank the UC Seed Fund for Collaborative Research Grant SEAMEO SEARCA contract number Ref. No. GBG24-977 for funding this research and the Karawang Regency Fisheries and Marine Service for assisting with the research survey.

5. CONCLUSION

Surface water quality in the downstream segment of the Citarum Watershed, specifically in the fishpond (aquaculture) area of Karawang, West Java, demonstrates varying levels of environmental pressure across sampling locations. Water temperature, TSS, TDS, and pH generally remain within the allowable limits set by Government Regulation (PP) No. 22 of 2021. However, three key parameters DO, BOD, and COD show notable deviations from the standards. Dissolved oxygen (DO) levels were consistently below the required threshold at all stations, indicating limited oxygen availability throughout the study area. This pattern is consistent with the elevated BOD concentrations observed at all points, suggesting that microorganisms are actively consuming oxygen to degrade organic matter, thereby suppressing DO levels. COD values also exceeded the quality standard at most downstream stations, although concentrations at Stations 1–5 remained within acceptable limits. A clear spatial pattern emerges when comparing sampling points. Stations 1–5, which are located closer to upstream areas and farther from dense aquaculture and settlement zones, exhibited lower COD values and slightly higher DO levels. In contrast, Stations 6–10, situated near aquaculture activities, residential areas, and agricultural runoff pathways, showed markedly higher BOD and COD concentrations. This indicates that organic pollutant loads intensify downstream, likely due to cumulative inputs from domestic wastewater, nutrient-rich runoff, and aquaculture-related discharge. The BOD/COD ratio across all stations ranged from 0.46 to 0.50, classifying the organic material as biodegradable. Although biodegradability remains relatively high, the process is slow, as microbial communities require time to adapt to the characteristics of the wastewater. This explains the persistent low DO levels despite the organic matter being degradable.

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