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WATER QUALITY ANALYSIS OF SITU CISANTI USING THE POLLUTION INDEX METHOD

Analisis Kualitas Air Situ Cisanti Menggunakan Metode Indeks Pencemaran

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ABSTRACT

Situ Cisanti plays a strategic role in maintaining the quantity and quality of water in the Citarum River watershed. Therefore, it is necessary to conduct a study on water quality analysis in Situ Cisanti. The purpose of this study was to determine the water quality status of Situ Cisanti using the Pollution Index method. The tested parameters include *total dissolved solid* (TDS), *total suspended solid* (TSS), pH, *dissolved oxygen* (DO), *biochemical oxygen demand* (BOD) dan amonia. This research uses a survey method with data collected at three station, each with four repetitions at 7-day intervals. The sampling was carried out from January to February 2025. Data analysis was conducted using a descriptive-comparative approach based on pollution index calculations in accordance with the Decree of the State Minister for the Environment Number 115 of 2003, following the water quality standards set by Government Regulation Number 22 of 2021. Based on the Pollution Index method, the overall water quality status of Situ Cisanti falls into the lightly polluted category with the pollution index 3,13 – 3,32.

Keywords: Citarum River Watershed, Water Pollution, Water Quality Status

ABSTRAK

Situ Cisanti memiliki peran strategis dalam menjaga kuantitas dan kualitas air di daerah aliran sungai (DAS) Citarum. Oleh sebab itu, perlu dilakukan penelitian mengenai analisis kualitas air di Situ Cisanti. Tujuan penelitian ini adalah untuk mengetahui status mutu air Situ Cisanti dengan menggunakan metode Indeks Pencemaran. Parameter yang diuji yaitu *total dissolved solid* (TDS), *total suspended solid* (TSS), pH, *dissolved oxygen* (DO), *biochemical oxygen demand* (BOD) dan amonia. Metode yang digunakan pada penelitian ini merupakan metode survei dengan pengambilan data yang dilakukan pada 3 stasiun sebanyak 4 kali pengulangan dengan interval waktu 7 hari sekali. Waktu pengambilan sampel pada penelitian ini dilaksanakan pada bulan Januari – Februari 2025. Analisis data dilakukan secara deskriptif komparatif berdasarkan hasil perhitungan indeks pencemaran menurut Keputusan Menteri Negara Lingkungan Hidup Nomor 115 Tahun 2003 sesuai kelas baku mutu air yang ditetapkan dalam Peraturan Pemerintah Nomor 22 Tahun 2021. Hasil penelitian menunjukan bahwa secara keseluruhan perairan Situ Cisanti termasuk ke dalam kategori tercemar ringan dengan nilai indeks pencemaran sebesar 3,13 – 3,32.

Kata Kunci: DAS Citarum, Pencemaran Air, Status Mutu Air

INTRODUCTION

Situ Cisanti is a body of water that accommodates seven main springs of the Citarum River. Known as Kilometer 0 of the Citarum River, it is the longest river in West Java and spans 12 regencies and cities. Situ Cisanti contributes to the Citarum River's water supply, which flows to the Saguling, Cirata, and Jatiluhur Reservoirs for irrigation, aquaculture, and hydroelectric power generation (PLTA) (Manalu & Rubiana, 2019).

Over time, increased community activity around Situ Cisanti can lead to a decline in water quality, potentially leading to water pollution. This is consistent with Fathurrohim (2022), who stated that the water in Situ Cisanti exhibits high levels of turbidity, an unpleasant odor, and the presence of puddles suspected to be pesticide residue. Furthermore, uncontrolled waste from tourist activities by the rangers impacts the ecosystem and pollutes Situ Cisanti's water quality (Oktavia et al., 2021).

Water pollution characterized by a decrease in water quality beyond the established threshold will result in the waters being unusable for their intended purpose. Mutmainah & Adnan (2017) stated that the utilization of aquatic resources can be carried out more optimally if it is based on the established water quality status. According to Hasan et al., (2013) based on the analysis of physical and chemical parameters and plankton abundance, the waters of Situ Cisanti are classified as waters with a mesotrophic to eutrophic trophic level and are still suitable for use in fisheries activities.

However, there is no updated information regarding the water quality conditions and status of Situ Cisanti, resulting in suboptimal water management. Based on the Decree of the Minister of State for the Environment Number 115 of 2003 concerning Guidelines for Determining Water Quality Status, water quality analysis to determine the water quality status of a body of water can be conducted using several methods, one of which is the Pollution Index method. Therefore, this study is necessary to analyze the water quality in Situ Cisanti using the Pollution Index method.

RESEARCH METHODS

Time and Place

The sampling time of this research was carried out in January - February 2025. This research was conducted in situ and ex situ. Water sampling and measurement of pH and DO parameters were carried out in situ at Situ Cisanti (Figure 1), while measurements of ammonia and BOD parameters were carried out ex situ at the Aquatic Resources Management Laboratory (MSP) of the Faculty of Fisheries and Marine Sciences, Padjadjaran University and TSS and TDS parameters were carried out ex situ at the Technical Implementation Unit (UPTD) of the West Java Environmental Laboratory.

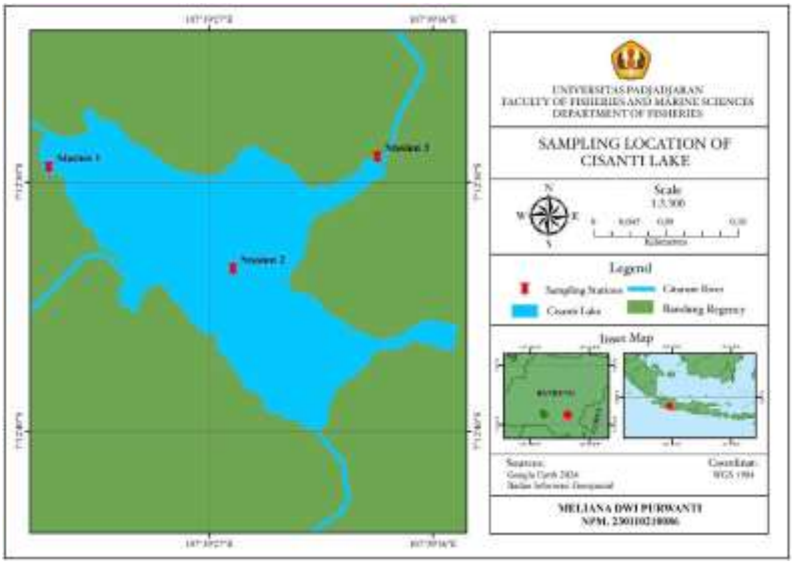

Figure 1. Research Station Location Map

Tools and materials

The tools used in this study consisted of a DO meter, pH meter, 1.5 L sample bottle, label paper, coolbox, spectrophotometer, and smartphone. The materials used in this study consisted of distilled water, 50% MnSO4 solution, H2SO4 solution, O2 reagent solution and sodium thiosulfate solution, signette solution, and Nessler solution.

Research procedures

Water sampling for this study was conducted at three locations: Station 1, the Cikahuripan spring, Station 2, the midstream, and Station 3, the outlet (Figure 1). The water sampling process involved rinsing the sample bottle three times with water from the sampling location to avoid contamination. Water samples were then taken directly from the water body by dipping the identified sample bottle until it was completely filled. The bottle containing the water sample was then placed in a coolbox filled with ice cubes and taken to the laboratory for testing. The parameters measured included TSS, TDS, pH, BOD, DO, and ammonia. TDS and TSS were measured using filter paper, pH using a pH meter, BOD using a titration tool, DO using a DO meter, and ammonia using a spectrophotometer.

Data analysis

Data analysis was conducted using a comparative descriptive method, describing the condition of each station based on the results of the pollution index calculation according to the Decree of the Minister of State for the Environment Number 115 of 2003 into good or polluted categories (Table 1), according to the water quality standard class stipulated in Government Regulation Number 22 of 2021, which is class II, which is then compared with literature references or previous research publications. The pollution index formula is as follows:

$$\text{IP } j = \sqrt{\frac{(\frac{Ci}{Lij})^2 M + (\frac{Ci}{Lij})^2 R}{2}}$$

Information :

IP j = Pollution Index for use (j)

Ci = Concentration of water quality parameters from the survey results
Lij = Concentration of water quality parameters stipulated in the water quality standards (j)
(Ci/Lij)M = Maximum Ci/Lij value
(Ci/Lij)R = Average Ci/Lij value

Table 1. Relationship between Pollution Index Value and Water Quality

IP Value	Water Quality
0 – 1,0	Good condition
1,1 – 5,0	Lightly contaminated
5,1 – 10,0	Moderately contaminated
> 10,0	Heavily polluted

Source: Decree of the Minister of Environment Number 115 of 2003

RESULTS

Water Quality Parameter Measurement

The results of measuring the water quality parameters of Situ Cisanti, consisting of TDS, TSS, pH, DO, BOD, and ammonia in this study are as follows.

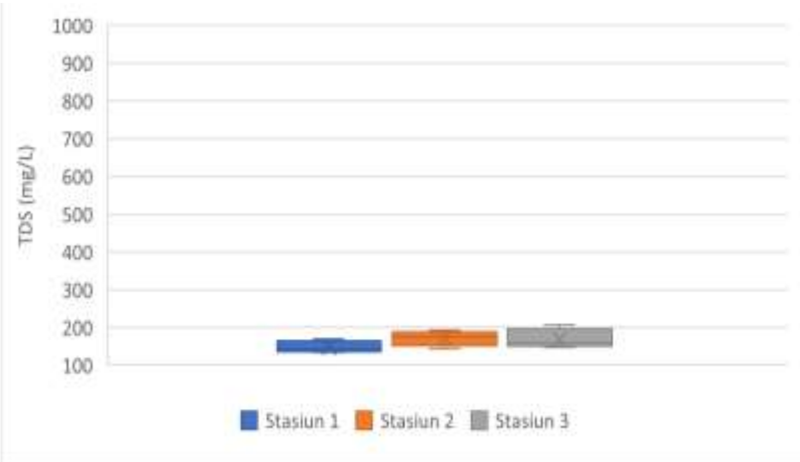

Figure 2. TDS Measurement Results During the Research

The TDS obtained ranged between 135 – 208 mg/L with the lowest average TDS value at station 1 of 148 ± 15.85 mg/L and the highest average TDS value at station 2 of 171.5 ± 20.31 mg/L (Figure 2).

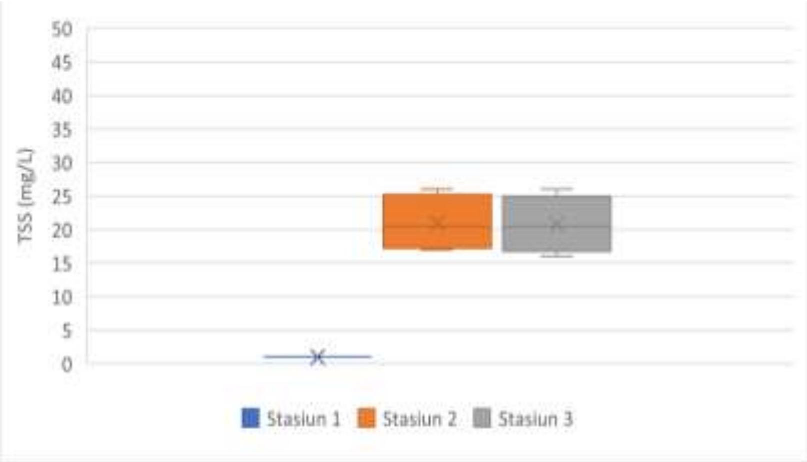

Figure 3. TSS Measurement Results During the Research

The TSS obtained ranged between 1 – 26 mg/L with the lowest average TSS value at station 1 of 1 ± 1 mg/L and the highest average TSS value at station 2 of 20.8 ± 4.27 mg/L (Figure 3).

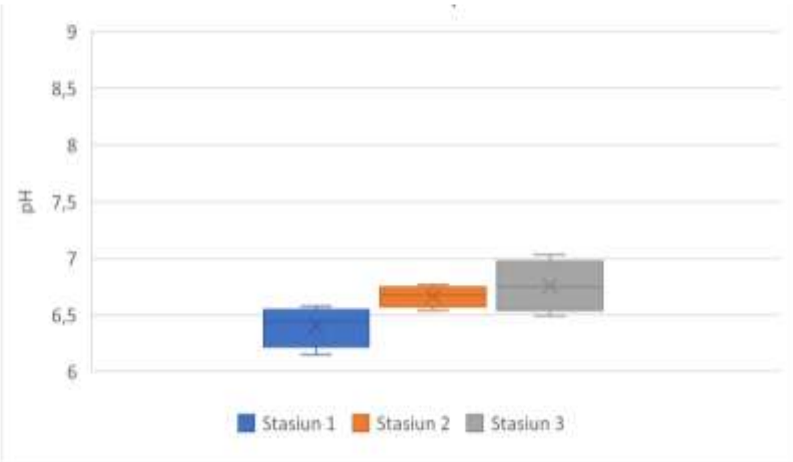

Figure 4. Results of pH Measurements During the Research

The degree of acidity (pH) obtained ranged from 6.15 – 7.03 with the lowest average pH value at station 1 of 6.4 ± 0.18 and the highest average pH value at station 3 of 6.8 ± 0.23 (Figure 4).

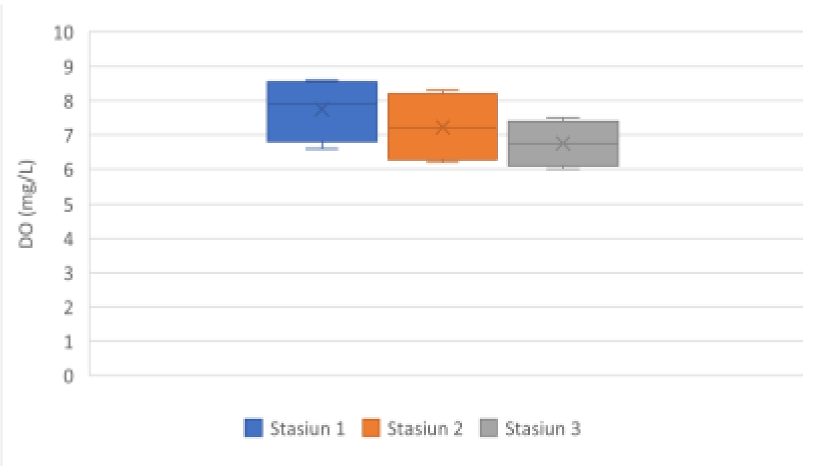

Figure 5. DO Measurement Results During the Research

The DO obtained ranged between 6 – 8.6 mg/L with the lowest average DO value at station 3 at 6.8 ± 0.68 mg/L and the highest average DO value at station 1 at 7.8 ± 0.93 mg/L (Figure 5).

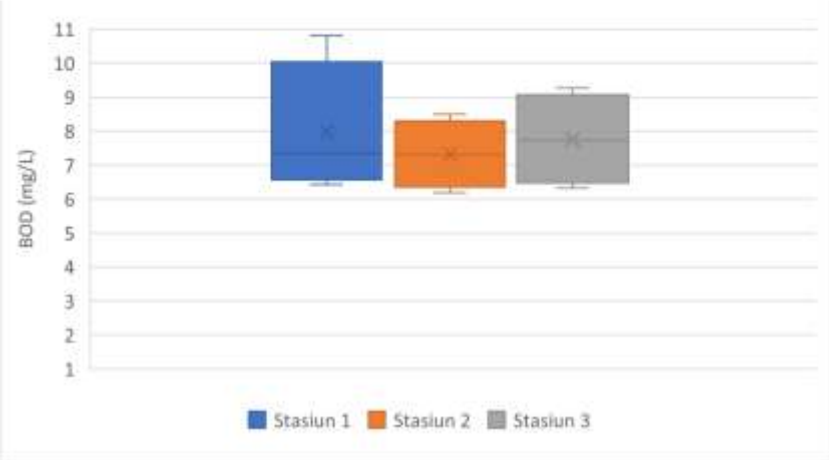

Figure 6. BOD Measurement Results During the Research

The BOD obtained ranged between 6.18 – 10.81 mg/L with the lowest average BOD value at station 2 at 7.3 ± 1.00 mg/L and the highest average BOD value at station 1 at 8 ± 1.96 mg/L (Figure 6).

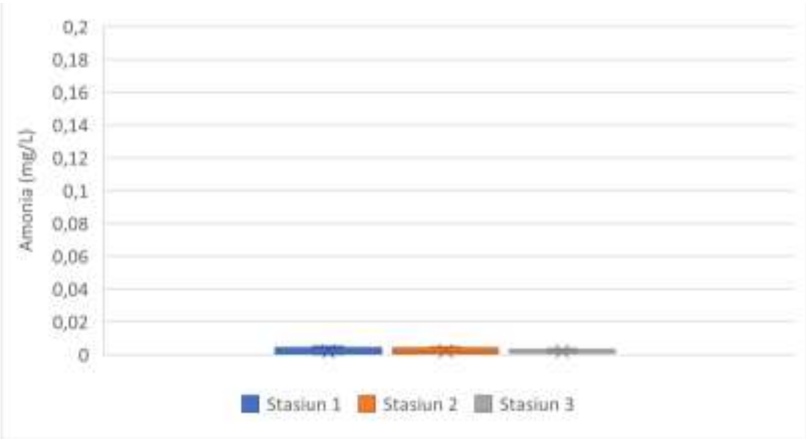

Figure 7. Results of Ammonia Measurements During the Research

The ammonia obtained ranged between 0.0003 – 0.0051 mg/L with the lowest average ammonia value at station 1 of 0.0016 ± 0.0023 mg/L and the highest average ammonia value at station 2 of 0.0022 ± 0.0019 mg/L (Figure 7).

Pollution Index Calculation

The results of the calculation of the pollution index and water quality status of Situ Cisanti in this study are as follows (Table 2).

Table 2. Results of the Pollution Index Calculation for Situ Cisanti

Station	IP Value	Water Quality Status
1	3,32	Lightly contaminated
2	3,13	Lightly contaminated
3	3,26	Lightly contaminated

DISCUSSION

Water Quality Parameters of Situ Cisanti

Total Dissolved Solid (TDS)

The highest TDS value at station 3 is thought to be due to its location near a closed sluice gate, which allowed leaf litter to collect and settle. This allows decomposition or decay to occur, which can increase TDS. TDS, an organic compound, generally originates from various sources, such as decomposing leaves, plankton, mud sediment particles, organic matter from feces, pesticide residues, and household and industrial waste (Nurhajawarsi & Haryanti, 2023). Organic waste in the form of leaves, twigs, and tree trunks entering the water body will trigger a decomposition process that can increase TDS levels (Putri et al., 2025).

High TDS concentrations in water can disrupt and hinder the balance of aquatic biota. High TDS in water can affect the composition of other water parameters, causing them to become toxic. This condition has the potential to cause imbalance in aquatic ecosystems, reduce biodiversity, threaten the survival of species with low tolerance to environmental changes, and increase toxicity levels, which can negatively impact various aquatic organisms (Triwulandari & Hendriyanto, 2023). Furthermore, high TDS levels in water have a negative impact on human health if the water is consumed (Putri et al., 2025).

Total Suspended Solid (TSS)

The TSS value at station 1 differs significantly from stations 2 and 3. This is because station 1 is the natural Cikahuripan spring and is strictly guarded by the guards, preventing any waste input that could cause the water to become cloudy or polluted. TSS plays a role in increasing water turbidity because it consists of all solid components, such as mud, sand, and clay. It can also be caused by particles suspended in the water, such as bacteria, fungi, phytoplankton, and zooplankton. Furthermore, dead components such as detritus and inorganic particles can be sources of high TSS concentrations in the water (Triwulandari & Hendriyanto, 2023).

Dissolved substances in natural waters are generally non-toxic, but excessive amounts can degrade water quality. Insoluble substances tend to form colloidal or suspended particles, contributing to increased water turbidity, which inhibits sunlight penetration and reduces the rate of photosynthesis. Turbid waters inhibit phytoplankton photosynthesis, resulting in decreased primary water productivity and disrupting the overall food chain balance (Tanjung et al., 2016).

Degree of Acidity (pH)

The acidity (pH) of Situ Cisanti waters is stable between stations and tends to be acidic. The pH value depends on several factors, including physical factors such as turbidity and temperature, chemical factors such as CO2 levels and salinity, and biological factors such as the breakdown of organic matter and aquatic microorganisms (Scabra & Setyowati, 2019). Lower (acidic) water pH values are generally associated with a high accumulation of decomposing organic matter. The decomposition process occurs because microorganisms consume oxygen and release carbon dioxide. Therefore, when carbon dioxide levels are high, the water pH will become low (acidic) (Effendie, 2003).

The degree of acidity (pH) is an important parameter for organisms living in water. pH can affect the availability of nutrients in the water, which indirectly affects the growth and survival of fish. A low pH (acidic) in water can cause a decrease in the rate of fish oxygen consumption, while a high pH (alkaline) in water can cause an increase in the concentration of non-ionized ammonia (NH3), which is toxic to fish life (Scabra & Setyowati, 2019). A low pH value of less than 5 (acidic) and a high pH of more than 11 (alkaline) can cause fish to not reproduce or even die. The ideal pH value for freshwater fish is in the range of 6.8 – 8.5 (Kulla et al., 2020).

***Dissolved Oxygen* (DO)**

Dissolved oxygen values obtained during the study at each station indicate that the waters of Situ Cisanti are in good condition. Dissolved oxygen in water generally comes from two main sources: diffusion from the atmosphere and photosynthesis by aquatic plants and phytoplankton (Santoso, 2018). High dissolved oxygen levels can be influenced by the presence of riparian vegetation around the sampling location. This condition produces oxygen from the photosynthesis of organisms living in the water and diffusion from the surrounding air (Vikriansyah et al., 2024).

Ketersediaan oksigen terlarut yang cukup dalam perairan akan memberikan respon positive for fish so that fish can carry out the respiration process and produce energy for activities, such as swimming, developing, growing and reproducing (Arifin, 2016). Fish are one of the aquatic biota that require high oxygen levels. In general, each fish species has a different tolerance range for dissolved oxygen levels in water. Dissolved oxygen in water should be in the range above 5 mg/L because if it is below 3 mg/L it can cause a decrease in the fish growth rate (Sucipto and Prihartono (2007) in Arifin 2016).

***Biochemical Oxygen Demand* (BOD)**

BOD indicates the amount of oxygen required by aerobic microorganisms to oxidize organic matter. BOD values obtained at all stations exceeded the established water quality standards. BOD requires dissolved oxygen in water for the decomposition of organic pollutants present in the water. The higher the amount of dissolved oxygen required by microorganisms, as indicated by the lower remaining dissolved oxygen content in the water, the greater the presence of organic pollutants in the water, which require high amounts of oxygen for decomposition (Tamyiz, 2015). High BOD levels in water can indicate a high population of microorganisms living in the water. Organic matter that easily decays or decomposes will cause BOD values to increase (Ramadani et al., 2021).

BOD is a water quality parameter that can be used to determine the level of water pollution due to the entry of organic matter into the water. A high BOD value indicates that the water has been polluted, while a low BOD value can indicate good water conditions (Hamuna et al., 2018). The BOD values obtained at all stations have exceeded the established water quality standards. High BOD can have a negative impact on the life of aquatic biota because it can reduce the dissolved oxygen content in the water and can be a medium for disease distribution (Slamet 2000 in (Tamyiz 2015). High BOD values in a body of water will affect the life of aquatic biota because it affects the amount of dissolved oxygen intake in the water that will be absorbed by microorganisms to decompose organic matter in the water. High BOD values indicate that the dissolved oxygen content in the water is low, which will cause the death of aquatic organisms, especially fish that will experience anoxia due to lack of dissolved oxygen (Daroini & Arisandi, 2020).

Ammonia

The ammonia levels at each station indicate that the waters of Situ Cisanti are still in good condition. Ammonia is largely produced by human and animal waste. Naturally, ammonia in waters is formed through the metabolic processes of living organisms and the decomposition of organic matter by bacteria (Effendie, 2003). Ammonia levels at stations 1 and 2 were higher than those at station 3. The increase in ammonia levels at station 1 was caused by the high urea content from human activity and the ammonification process resulting from the decomposition of organic matter by microbes (Apriyanti et al., 2013). Meanwhile, the increase in ammonia levels at station 2, located in the middle of the waters, was caused by mixing processes or the influence of human activities (Akbar et al., 2024).

Ammonia is a toxic compound in water that can cause damage to fish gill tissue and can disrupt the blood's function to transport oxygen. High ammonia concentrations in water can cause ammonia removal from the body to be hampered so that it will accumulate in the blood and gills. This accumulation can result in decreased blood efficiency in transporting oxygen throughout the body (Boyd 1982 in (Scabra and Setyowati 2019). Effendie (2003) stated that the ammonia concentration in fresh water is recommended not to exceed 0.2 mg/L because if it is more than 0.2 mg/L it causes the water to be toxic to several fish species that can enter the body of aquatic organisms through the respiratory system or body surface, then circulate through the circulatory system. Gayosia et al. (2015) added that the limit of ammonia concentration in water does not exceed 1 ppm because it can inhibit the absorption of blood hemoglobin to oxygen so that it can kill fish due to asphyxiation.

Water Quality Status of Situ Cisanti

Based on the results of the pollution index calculation regarding the water quality status in Situ Cisanti (Table 2) with TDS, TSS, pH, DO, BOD and ammonia parameters, the pollution index value was obtained at 3.13 – 3.32, which indicates that the water quality status is included in the lightly polluted category. The station with the highest average IP value is at station 1 and the station with the lowest average IP value is at station 2. This is because station 1 has the highest BOD value compared to stations 2 and 3.

The BOD parameters at the three stations did not meet the established quality standards. This is in accordance with Yudo's (2010) statement, which states that the BOD parameter is an index number as a benchmark for pollution from waste in a body of water. A higher BOD concentration in a body of water indicates an increase in the concentration of organic matter in the water (Hamuna et al., 2018). According to Salmin (2005), if the BOD value in a body of water ranges from 0–10 mg/L, then the level of water pollution is low. However, if the BOD value ranges from 10–20 mg/L, then the level of water pollution is moderate. Thus, based on the results of BOD parameter measurements that have exceeded the water quality standards, it can be said that Situ Cisanti is classified as lightly polluted.

CONCLUSION

Based on the research that has been conducted, it was concluded that the water quality status of Situ Cisanti based on the overall pollution index method is included in the lightly polluted category, with a pollution index value of 3.13 – 3.32.

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