

Physical and Chemical Parameters of Water in Cigunung River, Sukabumi, Indonesia

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ABSTRACT

This research aims to determine the water quality in the Cigunung River, Sukabumi, including TDS, TSS, pH, DO, BOD, and COD. Samples were taken at three points along the Cigunung River: station 1 (upstream), station 2 (middle), and station 3 (downstream). The results showed that the temperature at the three stations ranged from 23.21°C to 26.62°C; TDS ranged from 0.16 mg/l to 0.75 mg/l, pH ranged from 7.73 to 7.78, DO ranged from 6.4 mg/l to 71 mg/l, TSS value was 0.91 mg/l at station 1 and station 2, and 0.08 mg/l at station 3; and BOD values at stations 2 and 3 were 4 mg/l and 3 mg/l. Based on the analysis of water parameters using the water quality standards of PP No. 22 of 2021, it was found that the upstream of the Cigunung River, Sukabumi, is classified as class I, which can be used for drinking water, while the middle and downstream are classified as class II, which can be used for agricultural irrigation.

Introduction

Water is critical for human life and must be made accessible to all living things [1] but since the industrial transformation within the late eighteenth century, demand for clean freshwater has increased [2]. Water and water assets are fundamental for maintaining satisfactory nourishment supplies and a productive environment for all living life forms [3]. Water sources can be found in seas, lakes, oceans, air, and rivers. Although water sources vary from one to another according to their use, the water should not contain anything that could pose a health threat [4]. Streams are to be 0.0002% of the water on earth and as it were 0.46% of freshwater on the surface rivers have an imperative part since they are the flow of water when most other components of the hydrological cycle carry on more like a water storage area [5]. Rivers can be considered the mainstream that closes the hydrological cycle – returning most of the land's rain to the ocean [6].

One of the rivers in Sukabumi City is the Cigunung River. Cigunung River is known to be an important river in Sukabumi because it provides irrigation facilities to the areas around the river. Cigunung River has the lowest

pollution index compared to other rivers, which is categorized as moderately polluted. According to Sukabumi Central Statistics Agency, the population growth rate in Sukabumi, specifically in Kadudampit, where the Cigunung River is located, reached 1.57 in 2019, a large figure compared to other districts in Sukabumi. Population growth will indirectly affect people's need for clean water [7]. However, on the other hand, the existence of a new tourism area near Cigunung River could enable a decrease in water quality in the river which is in direct contact with the community [8].

Many types of pollutants can pollute aquatic systems, including sulphate, nitrogen, organic substances, copper, zinc, etc [9]. The length of time required for waste to decompose naturally is quite long, around 3 - 4 months, which can even be longer up to 1 - 2 years [10]. This situation will hurt the management of drinking water sources and social, economic, and health problems [11]. The dissolved and suspended components in this river are the result of physical and chemical weathering, which over time topographically dissolved the land down to ocean level. Assessment of river

water quality for the water system, health, household, and fishery purposes requires recognizable proof of critical physicochemical characteristics for each sector, and acceptable concentration levels [12]. Irrigation water quality is related to the impact on soil and plants and their management. This research focuses on an initial study regarding the quality of the Cigunung River by examining several chemical and physical parameters to find out whether pollution has occurred in the Cigunung River to support information regarding the condition and status based on water quality standards and to provide a general description of water quality. Three points of Cigunung River called upstream, middle, and downstream are evaluated by the physical and chemical parameters: pH, temperature, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), DO (Dissolved Oxygen), TSS (Total Suspended Solid) and TDS (Total Dissolved Solid).

Materials and Methods

This research was carried out in September-November 2023 at Cigunung River, Sukabumi. The sampling method in this study was purposive sampling at three points and was carried out once in the Cigunung River which was taken with about 6 km from one sample to another. Sampling was carried out following the procedure of SNI 6898.57:2008 concerning water and wastewater. Sample storage bottles are washed using detergent then rinsed with clean water. The bottles are then washed using 1: 1 HNO₃ acid and then rinsed with analyte-free water and dried. Sampling was carried out avoiding aeration as far as possible, after which the samples were stored and labeled. Samples are stored in a cool box at a temperature of 5 °C and tested immediately before 24 hours. The samples were then analyzed at the FITK Chemistry Laboratory of FITK UIN Syarif Hidayatullah Jakarta and Sucofindo Test Laboratory, Bekasi.

The tools are UV-Vis spectrophotometer, 1000 ml bottle, ice box, Whatman 934-AH filter paper, porcelain glass, oven, analytical balance, Erlenmeyer, pH meter, burette, measuring flask, goblet glass, thermometer, goiter pipette, hot plate, spray flask, drop pipette and

magnetic stirrer. The materials used are Cigunung River water samples, pH buffers 4,7 and 10 for pH meter standardization. Determination of the sampling locations Details of sampling location area are described on Table 1. and Figure 1.

Table 1. Water sampling points in the Cigunung river

Station	Location	Coordinate
1 (upstream)	Cinumpang, Sukabumi	-6.8315391, 106.9322397
2 (middle)	Cipetir, Sukabumi	-6.8737484, 106.9104632
3 (downstream)	Kadudampit, Sukabumi	-6.9099512, 106.9013919

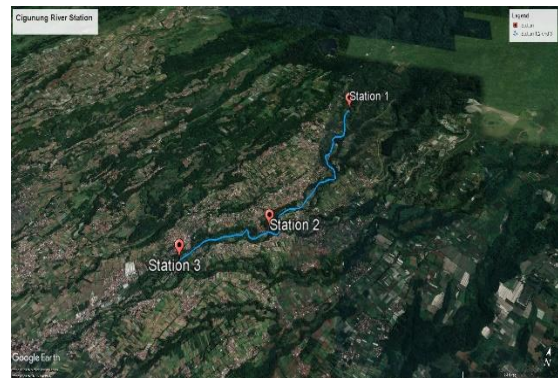


Figure 1. Map of sampling locations in Cigunung river (Source: google satellite)

The pH meter is standardized with distilled water and buffer solution. Then 50 ml of sample is put into a 100 ml beaker and its pH is measured using a pH meter for at least 5 minutes. Then the pH reading is taken from the pH meter and recorded. Before measuring other samples, the pH meter is soaked in distilled water or buffer solution. Meanwhile, temperature testing is carried out at the sampling site using a thermometer.

Total Suspended Solid (TSS) and Total Dissolved Solid (TDS) testing was carried out according to the gravimetric method of the SNI 6989.27:2019 procedure. The sample was stirred until homogeneous, and then 50 ml was taken and filtered using Whatman 934-AH glass-fiber filter paper. After that, the filter paper containing sediment was weighed at a temperature of 105 °C for 1 hour and weighed.

Weighing was carried out until a constant weight was obtained. Specifically, TSS and TDS testing began with prior preparation, namely weighing the filter paper to be used, heating the porcelain cup at a temperature of $180\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ then weighing it until a constant weight was obtained, and heating the gooch cup at a temperature of $105\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ then weighing it until a constant weight was obtained.

Dissolved Oxygen (DO) testing was carried out using the 4500 O-G method, Biochemical Oxygen Demand (BOD) testing was carried out using the 5210 B method, and Chemical Oxygen Demand (COD) testing was carried out using the 5220 B method at the Sucofindo Testing Laboratory, Bekasi.

Results of known data are analysed descriptively and then compared with water quality standards based on using PP No. 22 of 2021 concerning Environmental Management and Protection.

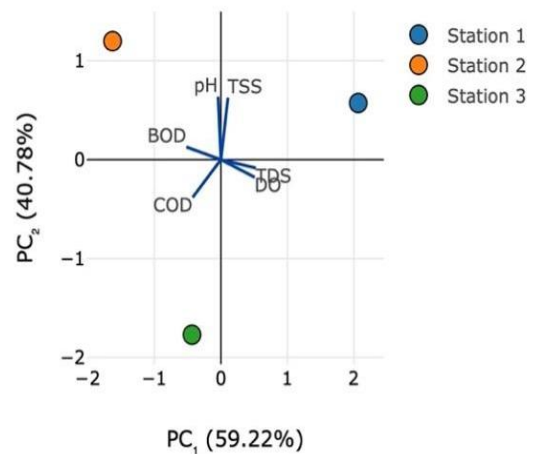
Results and Discussion

Whether water from a source can be utilized for a specific purpose depends primarily on its quality. Even in case, the water is accessible in adequate amounts from a source, on the off chance that the quality does not meet benchmarks, at that point, the water cannot be utilized or must be treated sometime recently its usage [13]. Water quality standards are legitimately enforceable criteria that decide parameters, such as temperature, concentration of different pollutants, etc. which make water appropriate for a particular purpose [14]. Passable limits depend on the intended use of a source, for case water from a particular source

may be good for irrigation but may not be appropriate for drinking [15].

Based on the results of the analysis of clean water quality parameters in Sukabumi, it can be said to be in the good category because all indicators for physical and chemical parameters tested meet the established quality standards in Table 2.

Table 2. show the details of Cigunung river water quality measurements. Based on Table 2. Cigunung River Station 1 (S1) to Station 3 (S3) generally has water quality standards that fall into the class I to IV categories. Temperature, pH, TDS, TSS, DO, BOD, and COD parameters enter class I which is intended for clean water. In accordance with PP No. 22 of 2021, these 7 parameters are included in the class I category, where the water is intended as drinking water. Below were discussed in detail the parameters analyzed in this research.



Gambar 2. Cigunung River Profile

Table 2. Results of Cigunung River Water Quality Measurements

Parameter	Quality Standard (Class 1)	Station 1		Station 2		Station 3		Average $\pm$ std	Unit
		Range	Class	Range	Class	Range	Class		
Temperature	Dev 3	23,21	K1	25,64	K1	26,62	K1	25.2 ± 1.76	$^{\circ}\text{C}$
TDS	1.000	0.75	K1	0.16	K1	0.42	K1	0.44 ± 0.3	mg. L ⁻¹
TSS	40	0.91	K1	0.91	K1	0.08	K1	0.63 ± 0.48	mg. L ⁻¹
pH	6-9	7.78	K1	7.8	K1	7.73	K1	7.77 ± 0.04	-
DO	6	7.1	K1	6.4	K1	6.8	K1	6.77 ± 0.35	mg. L ⁻¹
BOD	2	<2	K1	4	K3	3	K2	3 ± 1	mg. L ⁻¹
COD	10	3	K1	6.4	K1	8	K1	5.8 ± 2.55	mg. L ⁻¹

Figure 2. shows that each observation station has different characteristics. Station 1 has the highest TSS compared to other stations, station 2 has high BOD and pH value, while station 3 has high COD. Contamination can moreover be generally classified based on the time pattern of pollution release. A few sources ceaselessly release waste into water bodies, whereas others may do so immediately or intermittently [16]. A common illustration of a sustainable source is a municipal wastewater treatment plant. Although bulk stacking rates may vary over time, most of these treatment

plants ceaselessly release waste into water bodies [17].

1. Temperature

Temperature is defined as an intensive parameter only by measuring extensive quantity which is uniquely connected to it and refers to hotness or coldness [18]. The result shows that the temperature parameter values at the three stations ranged from 23,21 °C to 26,62°C. The temperature is still appropriate for the life of marine biota.

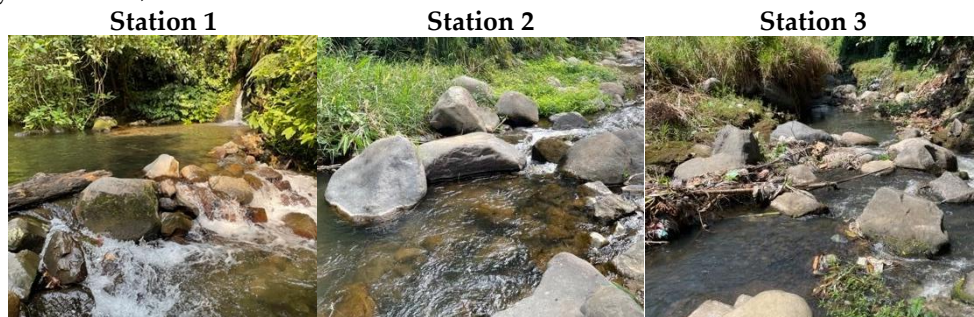


Figure 2. Physical profile of sampling locations at each observation station

Agreeing to Souhoka [19], the temperature for marine biota is within the range of 28 °C to 32 °C which is still reasonable for the life of marine biota (fish, plankton, etc). Be that as it may, the temperature in Cigunung River still must be observed, since extreme temperature changes can hurt oceanic live form. Temperature is associated with the rate of chemical reaction where the rising temperature to a higher degree shows a higher rate of chemical reaction [15]. Besides, temperature governs the type of living thing that are able to survive in rivers thus it influences biological activity and growth [20].

2. Total Dissolved Solid (TDS)

Total Dissolved Solids (TDS) is a measurement of inorganic salt, organic matter, and other dissolved materials in water [21]. Normally every water contains solid materials in the form of dissolved or suspended water. Whether a source of water meets the standard of TDS or not defines the quality of it and defines if the ecosystem is damaged or not [22]. Based on laboratory tests it ranges from 0.16 mg/l to 0.75 mg/l. This value range still shows compliance with water quality standards

because it has not passed the threshold value determined on PP No. 22 of 2021. The high TDS value at station 1 is possibly caused by human tourism activities around the river, causing more dissolved solids to occur. Weber-Scannell specified that higher concentrations of TDS come about diminished bring-forth rates and postponed bring-forth in living organism species particularly coho salmon (*O. kisutch*) when they were exposed to fertilization [21]. TDS and saltness levels are much-related concepts as the first broken-up solids customarily comprise inorganic particles, which are the components of salts; hence, the reason for expanding saltness is comparative to expanding TDS of the surface water body [23]. Topography of the drainage, atmospheric precipitation, and the water balance impact the composition and concentration of TDS [21]. Suspended objects inside the water come from numerous sources, organics such as takes off, mud, tiny fish, as well as mechanical squandering and sewage. It moreover might come from family squander, pesticides, and numerous others [24].

3. Total Suspended Solid (TSS)

Total Suspended Solids is one of the physical parameters tested in this research and shows values ranging from 0.91 mg/l in the upstream and middle areas and 0.08 mg/l in the downstream section. This value range still shows compliance with water quality standards because it has not passed the threshold value determined on PP No. 22 of 2021. The high TSS values at stations 1 and station 2 are due to the existence of open land around the river and the function of the river as a source of irrigation causing sediment pollution in the form of sand or fertilizer runoff that is not absorbed by plants will be carried away by rainwater and enter water bodies. Generally, TSS consists of mud and fine sand and microorganisms consist of soil erosion and soil erosion carried into water bodies [25].

Sedimentation in waters can have a direct or indirect effect on marine biota, the deposited sediments will directly cover the surface of coral polyps, which can cause coral polyps to suffocate, get buried, and increase the metabolic energy to restore them [26]. Meanwhile, suspended sediment can indirectly cause turbidity in the waters, thus preventing the entry of sunlight into the water column which is needed for the process of photosynthesis by phytoplankton [27]. This photosynthesis process will also result in the presence of dissolved oxygen in the water. If the dissolved oxygen in the water is low, it can kill aerobic microorganisms, or even if the oxygen level is very low it can kill aquatic animals in the water.

4. Degree of Acidity (pH)

The pH values at the three stations ranged from 7.73 to 7.78. This range of values still shows compliance with water quality standards because it has not passed the threshold value determined on PP No. 82 of 2001. The high pH at station 2 is caused by the photosynthesis process by aquatic plants such as phytoplankton which utilize sunlight as energy and CO₂ is absorbed to continue photosynthesis, such as breaking down water molecules, reducing NADP to NADPH, and forming oxygen gas. The CO₂ levels in the water decrease while the O₂ levels in the water increase. This is in accordance with Sa'adah and Widyaningsih's statement in [28], the pH of the

water will increase if the CO₂ in the water decreases, and the pH will decrease as the CO₂ content increases. The existence of places around rivers also supports the process of photosynthesis by phytoplankton, where the source of nutrients used in the photosynthesis process mostly comes from food waste, urea, and feces. This is under the statement by Latuconsina [7], phytoplankton need nutrients and carbon dioxide (CO₂) to carry out the photosynthesis process.

5. Dissolved Oxygen (DO)

Based on laboratory test results for chemical parameters, DO values at the three stations ranged from 6.4 mg/l to 7.1 mg/l. Based on water quality standards PP No. 22 of 2021, the DO parameter is included in the class I category. The three DO values at stations 1, 2, and 3 are above the established threshold for oxygen requirements in waters. The DO quality of a river can be polluted by community activities around the river such as bathing and washing. The foam produced by the reaction of detergent with water also inhibits the process of free oxygen diffusion into water. This is caused by a nonpolar group in the surfactant which cannot interact with water and prefers to interact with air so that foam forms on the water surface. According to Larasati *et.al* [29], certain amounts of surfactant in detergent can cause the foam to cover the surface of the water, causing a slow diffusion process of oxygen into the water. The decomposition process of decomposing bacteria will require more oxygen than normal respiration so that oxygen decreases while CO₂ in the water increases.

6. Biological Oxygen Demand (BOD)

Biochemical Oxygen Biochemical Oxygen Demand (BOD₅) is a term often used to indicate the amount of oxygen required to decompose organic matter aerobically or the decomposition of organic matter present in water within 5 days [30]. BOD is an indicator of organic pollution present in freshwater bodies and is associated with microbiological contamination [31]. Based on the results of laboratory tests on chemical parameters, the BOD₅ values at stations 2 and 3 are 4 mg/l and 3 mg/l. The BOD value at station 1 is below 2 and the value cannot be determined

because the resulting BOD value is below the test threshold using the method used. This shows that the BOD value in this river is very small. This value range still indicates conformity to water quality standards because it has not passed the threshold value determined on PP No. 22 of 2021. The high BOD₅ value at station 2 indicates the presence of organic pollutants that decomposed by biological bacteria. The existence of residential areas around rivers is thought to provide a burden of organic pollution such as food waste, urine, washing water and so on which are thrown into the river. BOD in waters comes from organic materials which are composed aerobically by microorganisms.

7. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand is a term to describe the total amount of dissolved oxygen needed to chemically oxidize organic materials that are either easily decomposed or non-biodegradable [32]. Based on the results of laboratory tests on chemical parameters, the COD values from the three stations ranged from 3 mg/l – 8 mg/l. The three COD values at each station do not exceed the water quality standards set on PP No. 22 of 2021 for the class I water category. The high COD value at station 3 is thought to be due to community activities around the river such as bathing and washing. There are chemicals contained in detergents and soaps such as surfactants, sodium, sulfonates and so on which are difficult to degrade by bacteria and cannot be degraded biologically so the decomposition process is through a chemical process, this chemical process requires more oxygen than usual [33]. COD analysis is usually used to measure organic matter concentration in aquatic systems such as rivers or surface water [34]. Natural materials that enter the waterway body and amass within the waterway will influence the natural framework that takes put in these waters which come about in changes in broken-up oxygen substances in these waters which tend to diminish [35].

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Conclusion

Water quality in the Cigunung river, Sukabumi at the upstream, middle and downstream points has different characteristics. Based on a comparison between the results of water parameter analysis, namely temperature, pH, TSS (Total Suspended Solid), TDS (Total Dissolved Solid), DO (Dissolved Oxygen), COD (Chemical Oxygen Demand) and BOD (Biochemical Oxygen Demand) with water quality standards PP No. 22 of 2021 found that the upstream of the Cigunung River, Sukabumi Regency is included in class I which can be used for drinking water, while the middle and downstream of the Cigunung River, Sukabumi Regency are included in class II and III categories which can be used for cultivating freshwater fish, animal husbandry and water to irrigate landscaping.

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