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Study of Water Quality Analysis in the Upper Cimanuk River, Sumedang Regency, West Java Province during the Dry Season

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Authors' contributions

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

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ABSTRACT

The Cimanuk River is the longest river in West Java after the Citarum River which passes through four districts namely Garut, Sumedang, Majalengka, and Indramayu districts. The headwaters of the Cimanuk River stretch from Garut to Sumedang Regency. The upper reaches of the Cimanuk river are crowded with various community activities that have the potential to cause a decrease in water quality. The decline in water quality that occurs will affect the existing resources in the upper reaches of the Cimanuk River. The purpose of this research is to gather information about water quality in the Upper Cimanuk River as seen from several measurement parameters. Water sampling was carried out during the dry season in September 2020. Water quality in the upper

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reaches of the Cimanuk River was obtained based on temperature parameters (27^{o}C to 29^{o}C), water brightness (30 cm to 36 cm), pH (6.54 to 6.67), DO (6.8 mgL^{-1} to 7.4 mgL^{-1}), COD (11 mgL^{-1} to 13 mgL^{-1}), TDS (206 mgL^{-1} to 244 mgL^{-1}), TSS (19 mgL^{-1} to 26 mgL^{-1}), ammonia (0.001 mgL^{-1} to 0.002 mgL^{-1}), and nitrite (0.017 mgL^{-1} to 0.019 mgL^{-1}) show that the water quality at each station in the upper reaches of the Cimanuk River is suitable for supporting the life of aquatic biota and fishing activities.

Keywords: Chemical quality; physical quality; upstream Cimanuk River; water quality.

1. INTRODUCTION

The Cimanuk River is one of the three largest rivers in West Java which empties into the north coast. The Cimanuk River flows for 180 km across several districts, namely Garut, Sumedang, Majalengka, and Indramayu Regencies (Rahman, 2016). The length of the Cimanuk River is 358 km [1] with a catchment area of 3600 km2 and its headwaters are in Cikajang District, Garut Regency, and empties into the Java Sea, Indramayu Regency. The Cimanuk Watershed covers 4 districts with 68 sub-districts, namely Garut Regency, Sumedang Regency, Majalengka Regency, and Indramayu Regency with an area of around 3409.17 km2 (West Java Provincial Environmental Management Agency, 2010). Most of the activities carried out along the Cimanuk river flow are used for various activities such as sand mining, water sources, power plants, industrial raw water, irrigation canals, livestock activities, and fisheries [2].

According to the results of research by the Garut Regency Mining and Water Resources Management Office (2010), the Cimanuk River Basin (DAS) has been damaged by years of sand mining. As well as dredging sand from the riverbed, miners also excavated gravel from the riverbanks, causing landslides in various places throughout the watershed.

Such drastic changes can naturally affect the decrease in water quality. The decline in water quality affects the aquatic biota within it, affecting biodiversity, growth, and fish populations. Changes in environmental conditions upstream of the Cimanuk River will affect the organisms in it. This phenomenon threatens the existence of fish and can cause extinction if no conservation efforts are made. This research aims to analyze water quality based on physical and chemical factors in the upper reaches of the Cimanuk River.

2. METHODS

This research is an observational type of research conducted by field measurements and laboratory tests to determine water quality. Sampling was carried out in situ and ex-situ at 3 stations upstream of the Cimanuk River during the dry season from September to November 2020.

Measurements of the upstream water quality of the Cimanuk River included temperature, water brightness, pH, DO, COD, TDS, TSS, ammonia, and nitrite concerning Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management as a comparison for the feasibility of river water quality parameters.

The materials used were samples of water upstream of the Cimanuk River while the tools used included sample bottles, dippers, DO meters, pH meters, *Secchi disks,* cameras *cell phones*, writing instruments, and label paper. The research procedure was as follows: Water samples were obtained directly from the Upper Cimanuk River using a dipper. The fish collection was carried out with three repetitions. The water sample is then put into a 1-liter bottle that has been previously labeled.

The collection of water quality data that has been obtained is based on laboratory analysis conducted at the Aquatic Resources Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University, and the Laboratory of the Research and Development Center for Water Resources, Center for Water Resources Research and Development (PUSAIR) and then compared with the quality standard value of Government Regulation no. 21 of 2021 to determine the feasibility level of the upstream water quality of the Cimanuk River for the aquatic biota that inhabits it.

The sample used was in the form of water samples taken from the lower reaches of the

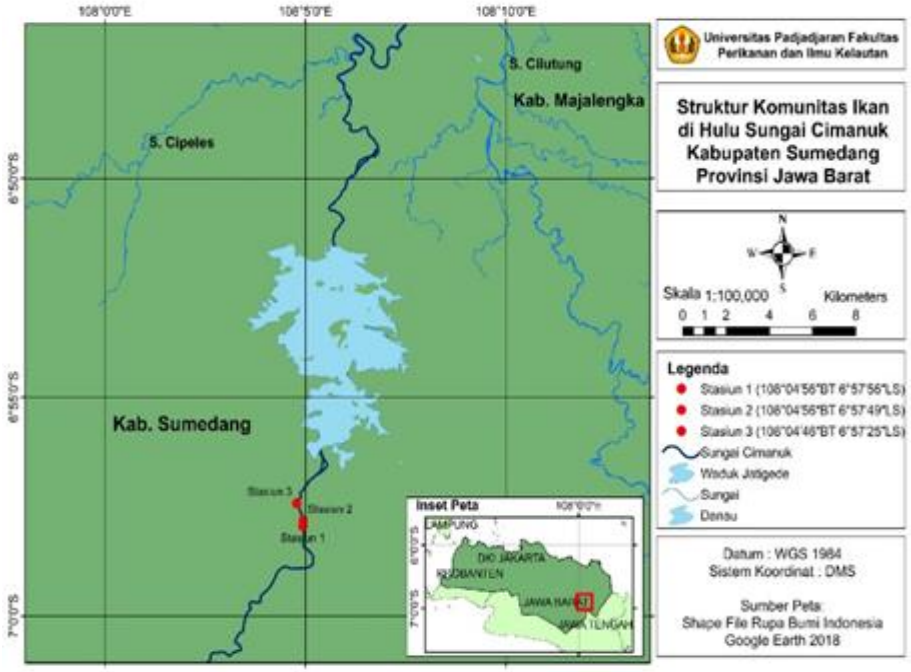

Fig. 1. Research Location

Table 1. Location Point

Location of coordinate points	Activities around the site
108°04′56.3" E and 6°57′56.9″ LS Sawah Pasir Block, Cipasang Village, Cibugel District, Sumedang Regency	Driftwood area, Citizen plantations
108°04′56.4″ E and 6°57′49.4″ LS Pasir Cangkudu Block, Cipasang Village, Cibugel District, Sumedang Regency	Residents' housing, rice field
108°04′46.8″ E and 6°57′25.6″ LS Cikareo Village, Wado District, Indramayu Regency.	Citizen plantations, close to Residents' housing

Cimanuk River. The sampling location is based on the activities of residents in the watershed. The sampling location points can be seen in Fig. 1 Table 1.

3. RESULTS AND DISCUSSION

The results of water quality measurements in the upper reaches of the Cimanuk River are presented in Table 1. The measured water quality parameters include physical parameters, namely temperature, light transparency, *total suspended solids* (TSS), and *total dissolved solids* (TDS) as well as chemical parameters including the degree of acidity, *dissolved oxygen* (DO), *chemical oxygen demand* (COD), ammonia, and nitrite. Temperature is an important physical parameter for aquatic biota, especially fish because the temperature is a factor affecting fish growth in tropical waters [3]. According to Iswanto et al. [4], water temperature is affected by season, weather, time of measurement, water depth, and brightness. The results of water temperature measurements in the upper reaches of the Cimanuk River ranged from 27.8^{o}C to 29.2^{o}C. This temperature is within the quality standards of Government Regulation no. 21 of 2021, namely at deviation 3. The condition of river water quality, seen from the temperature parameter, is still at the water quality standard limits according to its designation. The water temperature in this study was lower than the water temperature upstream of the Cimanuk River in 2016 reaching 29^{o}C to 33^{o}C [2]. This difference is influenced by several indicators such as time of measurement, geographical location, and river topography.

According to Effendi [5], the temperature has an important role in determining the condition of aquatic ecosystems. Increased temperature can result in increased decomposition of organic matter by microbes. The temperature suitable for freshwater aquatic organisms is in the range of 20^{o}C to 30^{o}C and optimal in the range of 25^{o}C to 28^{o}C [6]. The optimum temperature can encourage digestive and metabolic enzymes to work effectively so that they will produce energy for growth [7].

The water brightness in the upper reaches of the Cimanuk River ranges from 30 cm – 36 cm. Stations 1 and 3 have lower brightness values compared to station 2. The high brightness at station 2 is caused by the calm and slow flow of water so that suspended organic matter and other materials will settle. Meanwhile, the low brightness at stations 1 and 3 is caused by fast currents and a rocky bottom which results in the movement of water by currents. This is by Tarigan et al. [8] who explained that the low brightness value in waters is caused by high human activity which produces waste and results in high dissolved and suspended particles which can disrupt the activity of aquatic biota. Based on Indonesian National Standard for fish farming activities the water brightness value for the Cyprinidae family *Cichlidae* ranges from 20 cm to 80 cm and *ranges* between 30 cm to 40 cm.

The measured pH values at each research station in the upper reaches of the Cimanuk River ranged from 6.54 to 6.67. These results prove that the upstream water of the Cimanuk River is weakly acidic and is still within the class 1 water quality limit, which is still between 6-9 according to Republic of Indonesia Government Regulation No. 22 of 2021. The degree of acidity is closely related to the heavy metal content in the river, the greater the number of contaminants in the water, the lower the pH value [9]. In addition, the pH value of water can be influenced by natural and human factors. The pH level in the upper reaches of the Cimanuk River is optimal to support the survival of fish, especially native fish that inhabit the upper reaches of the Cimanuk River.

Dissolved Oxygen is needed by all living organisms for breathing, metabolism, or exchange of substances which then produce energy for growth and reproduction [10]. DO is an indicator of water quality, productivity, ecological status, and health of a body of water [11]. Dissolved oxygen levels in the upper reaches of the Cimanuk River at each station ranged from 6.8 mgL^{-1} to 7.4 mgL^{-1}. This value indicates that the condition of the waters is still feasible to support the life of aquatic biota, especially fish. However, the optimum DO range for each type of fish differs depending on the fish's ability to tolerate dissolved oxygen levels. In general, fish can tolerate DO values between 4 mgL^{-1} to 12 mgL^{-1} [12]. Water areas can be categorized as good if they have low levels of pollution with oxygen levels greater than 5^{-1} [10].

Table 2. Water Quality Analysis Results

Parameters	Unit	Sampling Points			Quality Standards PP No. 22 of 2021	
		1st station	2nd station	3rd station	Class II*	Class III*
Temperature	°C	29 ^{o}C	27 ^{o}C	28.3 ^{o}C	Deviation ± 3	Deviation ± 3
Water Brightness	Cm	32 cm	36 cm	30 cm	-	-
pH	-	6.67	6.59	6.54	6 - 9	6 – 9
DO	mgL^{-1}	6.8	7.4	7.2	>4	>3
COD	mgL^{-1}	12	13	11	25	40
TSS	mgL^{-1}	19	24	26	50	100
TDS	mgL^{-1}	206	242	244	1,000	1,000
Nitrite	mgL^{-1}	0.019	0.018	0.017	0.06	0.06
Ammonia Total	mgL^{-1}	0.001	0.002	0.001	0.2	0.5

Source: (*) Water quality standard PP No. 22 of 2021 concerning Implementation of Environmental Protection and Management (Appendix VI regarding National Water Quality Standards)

Chemical Oxygen Demand (COD) is the amount of oxygen needed to oxidize organic substances in water bodies. COD values in the upper reaches of the Cimanuk River ranged from 11 mgL^{-1} to 13 mgL^{-1}. Conditions at Station 1 had the lowest concentration, namely 11 mgL^{-1}, and the highest at station 2, namely 13 mgL^{-1}, the data from the analysis carried out at the three research stations showed that the quality of the waters upstream of the Cimanuk river was categorized into class II water quality standard. because it is still below 25 mgL^{-1}, according to the Republic of Indonesia Government Regulation No. 22 of 2021 concerning the management of water quality standards. The high concentration of COD in the waters is caused by community activities around the river which causes organic matter to overflow in the river. In addition, the existence of industries that dispose of waste into rivers without being treated beforehand can affect water quality and impact the survival of aquatic biota in river habitats. COD is closely related to dissolved oxygen, this can be seen if the COD value is high in water, the dissolved oxygen concentration in water is low and vice versa, if the COD value is in low water, the dissolved oxygen concentration is high [13].

The total dissolved solid (TDS) value in the upper reaches of the Cimanuk River ranges from 206 mgL^{-1} – 244 mgL^{-1}. TDS can determine the number of dissolved solids present in a body of water. These dissolved substances can cause color, taste, odor, toxic, and carcinogenic chemicals [14]. In addition, TDS is closely related to turbidity where the higher the suspended solids, the higher the turbidity value [15]. TDS values that experience an increase in water indicate that the organic matter derived from waste has not been completely degraded into gas. The maximum concentration of TDS that is allowed to be in waters of groups I, II, and III is not to exceed the threshold of 1000 mgL^{-1}.

Total Suspended Solid (TSS) is an indicator that can show the concentration of suspended matter present in a body of water. TSS values in the upper reaches of the Cimanuk River ranged from 19 mgL^{-1} to 26 mgL^{-1}. TSS consists of silt, fine sand, and microorganisms which can be caused by soil erosion which are carried into water bodies [3]. An increase in the TSS value can be caused by soil erosion, erosion of cliffs which is then carried away by rain until it finally reaches the waters, influenced by the bottom of the waters, and human activities (industry and household) [16,17]. Land use around stations 2 and 3 is used as an area of rice fields and plantations causing a higher TSS value compared to station 1. However, this value is still below the threshold so that it can support the survival of aquatic biota upstream of the Cimanuk River. The low TSS value upstream of the Cimanuk River is due to the low soil erosion that occurs.

Ammonia is a nitrogen derivative that is toxic at low concentrations, at a concentration of 0.2 mgL^{-1} in water it will be toxic [18]. The value of ammonia in the upper reaches of the Cimanuk River ranges from 0.001 mgL^{-1} to 0.002 mgL^{-1}. Based on Government Regulation no. 22 of 2021 the threshold value for ammonia content for fisheries is <0.2 mgL^{-1} as NH_3-N. The concentration of ammonia in the upper reaches of the Cimanuk River is relatively low, this is caused by microbes that break down ammonia which is then utilized by phytoplankton [19].

The content of nitrite in water bodies that exceed the recommended limit will be toxic to fish so it will inhibit the rate of growth and can even cause death [20,17]. Nitrite concentrations in the upper reaches of the Cimanuk River were lower, ranging from 0.017 mgL^{-1} to 0.019 mgL^{-1} compared to nitrite levels in the upper reaches of the Cisangkan River, namely 0.01 mgL^{-1} [21]. In general, the nitrite value upstream of the Cimanuk River, based on Government Regulation of the Republic of Indonesia Number 22 of 2021, is still below the water quality standard, which is less than 1 mgL^{-1} and is included in the class II water quality standard because it is less than 0.06 mgL^{-1}. The concentration of nitrite in the upper reaches of the Cimanuk River is still very low because nitrite will be oxidized quickly to become nitrite [3]. So that these water conditions can support the survival of aquatic biota and not interfere with fish breeding.

4. CONCLUSION

The study concluds that the quality of the water in the upper reaches of the Cimanuk River which is analyzed based on parameters meets quality standards, which means it is very good for the life of aquatic organisms. The physical and chemical quality of the lower reaches of the Cimanuk River is influenced by activities in the

river such as sand mining, water sources, power plants, industrial raw water, irrigation canals, livestock activities, and fisheries which will affect the value of water quality in the upper reaches of the Cimanuk River.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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