

Evaluation of the Cibalabuan River's water quality and measures for reducing water pollution in the Sukabumi Regency

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ABSTRACT

The Cibalabuan River serves as an ecosystem that provides habitat for many species and as a source of water for industry, agriculture, and drinking. However, growing industrial and residential activity poses a threat to the amount and quality of river water. The river has recently contributed to both liquid and solid waste, which has lowered the quality of the river's water. The Cibalabuan River flows through the city center from upstream to downstream, collecting pollutants from the discharge of local activities along the river's course, including liquid and solid waste. By monitoring and computing the water's quality at a certain location and time, this study seeks to ascertain the current state of water quality. In order to create a sequential explanatory design, a mixed method approach was used, mixing quantitative and qualitative methodologies in parallel. Water quality in the Cibalabuan River is influenced by a number of factors, including the actions of those who use the river as a disposal site, public ignorance of the need to control pollution, competing interests in the management of water resources, and a lack of cooperation between authorized agencies in the management of natural resources and the control of water pollution.

ABSTRAK

Sungai Cibalabuan berfungsi sebagai ekosistem yang menyediakan habitat bagi banyak spesies dan sebagai sumber air untuk industri, pertanian, dan minum. Namun, meningkatnya aktivitas industri dan pemukiman menimbulkan ancaman terhadap kuantitas dan kualitas air sungai. Akhir-akhir ini sungai tersebut menghasilkan limbah cair dan padat sehingga menurunkan kualitas air sungai. Sungai Cibalabuan yang mengalir melalui pusat kota dari hulu ke hilir mengumpulkan zat-zat pencemar yang berasal dari buangan aktivitas masyarakat di sepanjang aliran sungai, termasuk limbah cair dan padat. Dengan memantau dan menghitung kualitas air pada lokasi dan waktu tertentu, penelitian ini berupaya mengetahui kondisi kualitas air saat ini. Untuk membuat desain penjelasan sekuensial, pendekatan metode campuran digunakan, yang memadukan metodologi kuantitatif dan kualitatif secara paralel. Kualitas air di Sungai Cibalabuan dipengaruhi oleh beberapa faktor, antara lain tindakan pihak yang memanfaatkan sungai sebagai tempat pembuangan sampah, ketidaktahuan masyarakat akan perlunya pengendalian pencemaran, persaingan kepentingan dalam pengelolaan sumber daya air, dan kurangnya sumber daya manusia. kerjasama antar instansi yang berwenang dalam pengelolaan sumber daya alam dan pengendalian pencemaran air.

Keywords: *AHP, Pollution Index, river quality, sequential explanatory, water pollution control, water quality*

INTRODUCTION

The growing population has an impact on the industrial sector and the rise in household activities (Wardhana, 2004; Zhou, 2009). Both significantly increased the demand for clean water. Thus, controlling water sources in order to meet the demand for clean water urgently needs to be done. The management of this water source should strike a balance between the environment's supply of clean water and human need for it. The river is a clean water source that humans use most frequently (Mulyanto, 2007).

In order to assess the degree of pollution in river water, the water quality must be assessed by measuring and computing the water's quality at a certain location and time using the prescribed methodology (Herlambang, 2006; Agustningsih, 2012). Measurement results can be used as a guide to determine which metrics go above the required level of quality.

Indonesia's Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management governs the protection and management of water quality. It defines water pollution as the presence of influent discharges or other components into water bodies originating from human activities that cause the Water Quality Standard to exceed the threshold (Rahayu et al., 2013).

Sukabumi Regency, the Cibalabuan River is a surface water source that traverses the city center. The Cibalabuan River flows through the city center as it moves from upstream to downstream, bringing with it solid and liquid waste that is discharged from nearby community activities and serves as a source of pollution (Said, 2006).

The Cibalabuan River needs to be treated properly because of its concerning quantity and quality conditions. Various interested parties must work together

to regulate river water quality to minimize the effects on the community and the environment (Effendi, 2003; Suripin, 2004; Campo et al., 2010).

One of the measures to prevent water pollution is the implementation of river water quality management, which ensures that the water's natural characteristics are maintained and that its designated quality is met. In an effort to avoid and manage water pollution and to restore water quality, it is also vital to control water pollution to make sure that the quality of the water conforms with the requirements (Pohan et al., 2016).

Thus, according to Yetty et al. (2011) by creating an effective water pollution control strategy, it is imperative to manage water quality and control water pollution to guarantee the availability of clean water sources and the quality of water that will be used for human activities both now and in the future.

METHODS

Sequential Explanatory

The research employed a mixed method approach or sequential explanatory design which is research by combining quantitative methods and qualitative methods in parallel (Sugiyono, 2012). Quantitative methods are used to analyze the results of river water quality measurements and weighting criteria for river water pollution control strategies (Hadi, 2007).

Location

The study was conducted in the Cipalabuan River basin, which encompasses the upstream, middle, and downstream monitoring points of the river, in the Palabuhanratu District of Sukabumi Regency. The location of the upstream monitoring point is at the Cipalabuan I Bridge at coordinate point 06°59'14.87" South and 106°32'41.09" East. The location of the middle monitoring point is at the Cipalabuan II Bridge, Pangsor Village, at the coordinate point 06°58'32.26" South and 106°33'19.61" East. The location of the downstream monitoring point is at the Ojolali Bridge at the coordinate point 06°59'20.8" South and 106°34'14.8 East.

The water quality requirements in Appendix VI of Government Regulation 22 of 2021 concerning the Implementation of Environmental Protection and Management are compared with the results of river water quality tests to analyze and interpret the measures. The Pollution Index calculation method, which makes reference to the Environmental Quality Index Regulation of the Minister of Environment and Forestry Number 27 of 2021, is used to determine the current state of water quality (Priyambada et al., 2008; Yuliasuti, 2011).

The formulation of a water pollution control strategy is prepared based on the results of field observations in

the study areas, discussions and in-depth interviews with experts who have the capacity and competence in the field of water pollution control (Rachmawati, 2011). The experts involved in this study consisted of 1). Head of West Java Province Water Resources Management Center, 2). Head of Pollution Control and Environmental Damage Division of DLH Sukabumi Regency, 3). Environmental Impact Controller Junior expert/Sub-coort for Prevention of Pollution and Environmental Damage, 4). Lecturer/researcher from LPPM Muhammadiyah University of Sukabumi.

The Analytical Hierarchy Process (AHP) method is then used to formulate strategic concerns in order to determine the criteria and strategies for controlling water pollution (Saaty, 2008).

RESULT AND DISCUSSION

Summary of laboratory test results

Table 1. Summary of laboratory test results for the quality of Cipalabuan River water in the dry season.

No.	Parameter	Unit	Quality Standard of River Water (PP 22/2021)				Test Results - 29 September 2022		
			Grade 1	Grade 2	Grade 3	Grade 4	Up Stream	Middle Stream	Down Stream
1	TSS	mg/L	40	50	100	400	54	56	58
2	pH		6-9	6-9	6-9	6-9	7.84	7.52	8.12
3	COD	mg/L	10	25	40	80	14	15	16
4	BOD	mg/L	2	3	6	12	6	6	6
5	DO	mg/L	6	4	3	1	3.11	2.97	2.67
6	NO ₃	mg/L	10	10	20	20	2.8	2.9	2.9
7	Total Phosphate	mg/L	0.2	0.2	0.2	0.5	0.44	0.47	0.48
8	Fecal Coliform	MPN/100L	100	1,000	2,000	2,000	550	550	600

Source: Analysis results, 2023

Table 2. Laboratory test results for the quality of Cipalabuan River water in the rainy season.

No.	Parameter	Unit	Quality Standard of River Water (PP 22/2021)				Test Results - 29 September 2022		
			Grade 1	Grade 2	Grade 3	Grade 4	Up Stream	Middle Stream	Down Stream
1	TSS	mg/L	40	50	100	400	51	53	56
2	pH		6-9	6-9	6-9	6-9	7.74	7.15	7.26
3	COD	mg/L	10	25	40	80	14	14	15
4	BOD	mg/L	2	3	6	12	6	7	6
5	DO	mg/L	6	4	3	1	2.87	02.45	2.49
6	NO ₃	mg/L	10	10	20	20	2.9	3.4	3.7
7	Total Phosphate	mg/L	0.2	0.2	0.2	0.5	0.45	0.5	0.54
8	Fecal Coliform	MPN/100L	100	1,000	2,000	2,000	550	550	600

Source: Analysis results, 2023

Four of the eight parameters tested—TSS, BOD, DO, and total phosphate—did not meet the necessary quality standards (Harson, 2010) in the results of the Cipalabuan River water quality test, which was conducted during both the dry and rainy seasons (Tables 1 and 2).

The results of tests conducted in the dry season and the rainy season are not much different. However, the pollutant parameter concentration values tend to be higher in the dry season test results compared to the rainy season test results. This can happen because during the rainy season there is dilution of the rainwater flow so

that it affects turbidity. Based on monitoring points, the value of pollutant concentrations is getting higher downstream, as illustrated in the following graph (Figure 1 and Figure 2).

Calculation of the water quality Pollution Index in the Cipalabuan River is obtained by calculating based on the equation in the calculation example. The results obtained for the 3 (three) location points tested during the dry season are presented in the following figures below (Figure 3 and Figure 4).

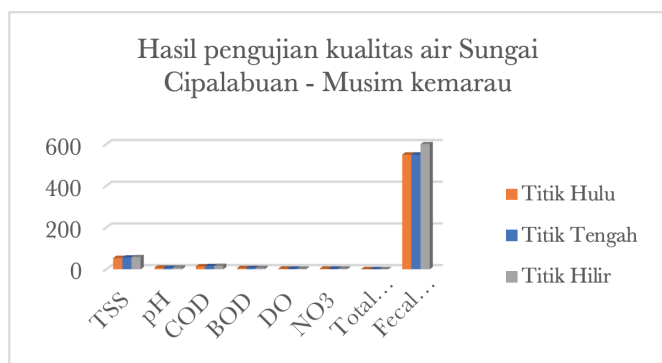


Figure 1. Results of testing the quality of Cipalabuan River water in the dry season.

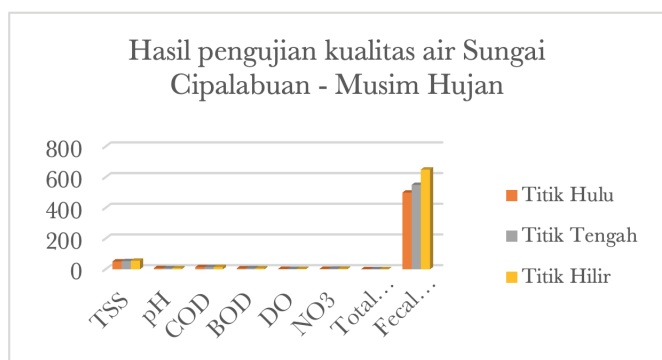


Figure 2. Results of testing the quality of Cipalabuan River water in the rainy season.

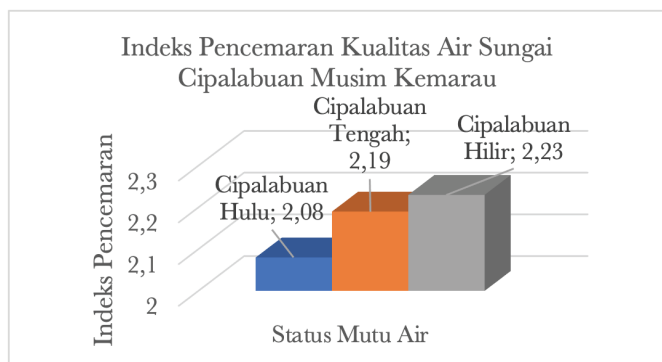


Figure 3. Results of testing the quality of Cipalabuan River water in the rainy season.

Based on the results of the calculation of the pollution index on the Cipalabuan River for the upstream, midpoint and downstream points with a total of three

monitoring points, and carried out as much two times the measurement period, which represents the dry season and the rainy season, it can be seen that the water quality status at each monitoring point is in the status of slightly polluted.

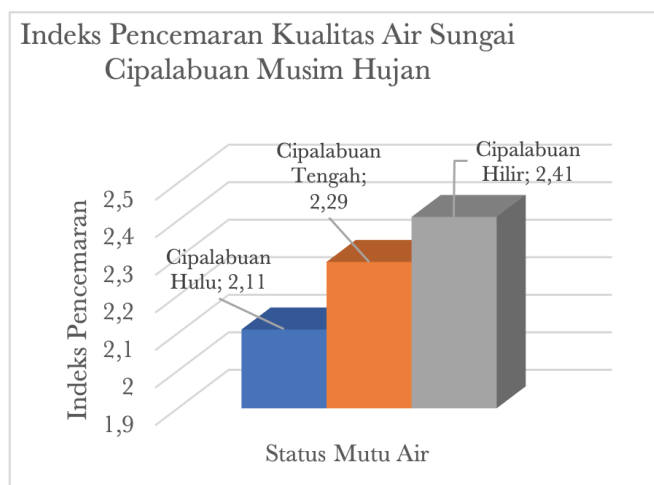


Figure 4. Pollution index of Cipalabuan River water quality in the rainy season.

Cipalabuan River water quality conditions at each monitoring point is in a lightly polluted status. And the value of the Cipalabuan Saungai Water quality index is 50. Based on the Water Quality Index category, it is known that the range $50 \leq x \leq 70$ is in the medium category. In addition, the classification of water use in the Cipalabuan River is classified as class 3 for water that can be used for fresh water fish, livestock, irrigation and/or other similar purposes.

Table 3. Criteria and strategy for controlling Cipalabuan River water pollution.

Criteria	Strategy
Economy	A1 Determination of water class
	A2 Providing data and information about river water quality
	A3 Integration of watershed management into spatial planning
Social	A4 The synergy between authorized agencies
	A5 Public education regarding controlling water pollution
	A6 Increased public participation
Environment	A7 Conservation of upstream river areas
	A8 Development of community sanitation infrastructure
	A9 Water quality monitoring and supervision

Source: Analysis results, 2023

Determination of alternatives and criteria in the Cipalabuan River Water Pollution Control Strategy is carried out based on the formulation of data from field observations, results of discussions and in-depth interviews, as well as grouping criteria, which are then synthesized and formulated into several strategic issues as follows (Table 3).

The hierarchical weighting framework in the Cipalabuan River water pollution control strategy is as follows (Figure 5).

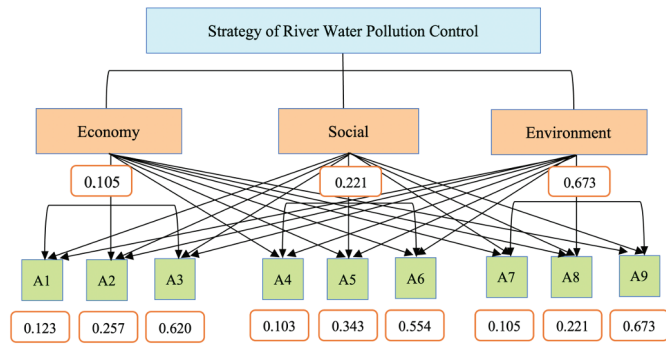


Figure 5. Hierarchical weight of the Cipalabuan River water pollution control strategy.

From the results of the assessment using the AHP method for the three criteria in efforts to control water pollution (Figure 6), it is known that environmental criteria have the highest ranking with a priority value weight of 0.673 and a consistency ratio of 0.06 which is less than the maximum limit of ten percent (10%) or 0.1, so that the results of the analysis of priority grouping criteria show that hierarchical consistency is acceptable.

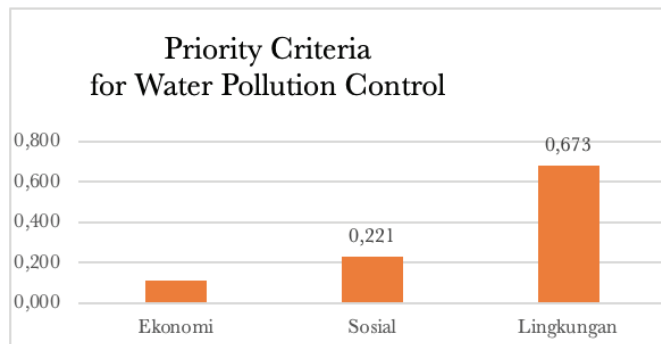


Figure 6. Priority criteria for water pollution control strategies.

Based on the results of the priority assessment analysis for each criterion (Table 7), it can be seen that from the economic criteria, the one with the highest priority value is A3 with a weight value of 0.620, namely the strategy for integrating watershed management into spatial planning (Asdak, 2010; Tchobanoglous, 2013; Pambudi, 2022). For social criteria, the value that gets the highest priority is A6 with a weight value of 0.554, with a strategy to increase community participation. And for

environmental criteria, A9 with a weight value of 0.673 is a priority criterion with a strategy for monitoring and supervising water quality (Purnomo, 2010).

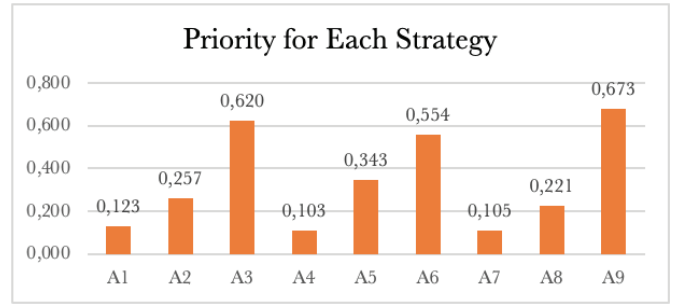


Figure 7. Priority of each strategy.

From the results of the assessment analysis using the AHP method, it shows that 3 (three) main priorities are alternatives in the water pollution control strategy as an effort to manage the water quality of the Cipalabuan River, including:

1. Integration of watershed management into spatial planning;
2. Increasing community participation;
3. Water quality monitoring and control.

CONCLUSION

At every monitoring location, the water quality of the Cipalabuan River is considered to be slightly contaminated. Cipalabuan Saungai Water has a quality index value of 50. It is known that the range $50 \leq x \leq 70$ falls into the medium group based on the Water Quality Index category (Purnomo, 2010). Additionally, water that can be utilized for irrigation, cattle, freshwater fish, and/or other comparable uses is categorized as class 3 water usage in the Cipalabuan River.

The following factors affect the water quality of the Cipalabuan River: 1. the actions of those who view the river as a disposal area; 2. a lack of public education regarding water pollution control; 3. divergent interests in the management of water resources; 4. a lack of cooperation between authorized agencies in the management of natural resources and the control of water pollution; and 5. the absence of a concerted effort by multiple parties to address pollution and environmental damage.

The main priorities that become alternatives in the Water Pollution Control Strategy as an effort to manage the water quality of the Cipalabuan River include: 1). Integration of watershed management into spatial planning; 2). Increased community participation; 3). Water quality monitoring and control.

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