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Assessment and Community Outreach on the Impacts of Citarum River Water Pollution in Batujajar, West Bandung

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ABSTRACT

The Citarum River plays a critical role in supporting domestic, agricultural, and industrial needs in West Java. However, increasing anthropogenic activities have significantly degraded its water quality. This study aimed to assess water quality in the Batujajar area, analyze its environmental and health impacts, and promote community awareness through outreach programs. Water samples were collected from 12 observation points and analyzed using physical and chemical parameters, including pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), electrical conductivity (EC), and total dissolved solids (TDS). The results indicate that upstream locations exhibit acidic conditions (pH < 6) and low DO levels (< 4 mg/L), suggesting significant organic pollution. These conditions pose risks to aquatic ecosystems and public health. Community outreach activities were conducted through webinars to enhance public awareness of pollution mitigation strategies. The study highlights the importance of integrating scientific assessment with community engagement to support river restoration efforts.

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INTRODUCTION

As the human population grows, the demand for water increases. Water is a renewable resourcep; however, the availability of clean water continues to decline. According to Wahyuni et al. (2021), water is a primary need for living things and is used to support daily needs. In reality, the availability of clean water is very limited and decreasing. The decreasing availability of clean water on Earth is due to many factors arising from irresponsible human activities. According to Rosmeiliyana et al. (2021), water quality management and control measures to reduce water pollution must be addressed immediately to prevent further detrimental impacts on humans and the ecological balance of aquatic ecosystems.

The Citarum River is a national strategic river, serving a vital function as a source of raw water, agricultural irrigation, fisheries, and domestic needs. However, over the past two decades, the Citarum River has experienced water quality degradation due to increased industrial, agricultural, and residential activities, as well as domestic waste disposal. The Batujajar area, West Bandung Regency, is one of the areas directly impacted by this pollution. Communities in this area routinely use river water for daily needs, fish farming, and other economic activities.

Despite numerous studies on Citarum River pollution, limited research integrates field-based water quality analysis with community outreach initiatives in specific impacted areas such as Batujajar. Therefore, this study aims to combine scientific water quality assessment with community education to address pollution impacts at the local level. This activity was conducted to identify the level of river water pollution in the Batujajar area, assess the impact of pollution on public health and the environment, and provide community education and recommendations for environmental management.

METHOD

The wider community, including academics and the general public, needs to be aware of the impacts of water pollution in the Citarum River in the Batujajar area of West Bandung Regency. This is to raise awareness of the importance of good river water quality management to maintain environmental balance, as river water is a primary resource essential for daily life, both for drinking water and for clean water for agriculture, household needs, and other purposes.

The expected output target of this community service activity is a knowledge-sharing session in order to socialize with the community regarding the impact of water pollution of the Citarum River in the Batujajar area, West Bandung Regency.

This Community Service activity involves several stages, including the following:

- Literature Review

  This activity is conducted to determine the methods required for river water sampling and the testing that can be performed to meet the objectives of the Community Service activity.

- Research design

  This study employed a descriptive quantitative approach combined with community outreach activities.

- Sampling and laboratory testing

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This stage will involve sampling at the affected location, namely the Citarum River in the Batujajar area, West Bandung Regency. In-situ testing will be conducted, as well as testing at the Geochemistry and Environmental Laboratory of the Politeknik Energi dan Pertambangan Bandung. Water samples were collected using purposive sampling at 12 predetermined points representing upstream, midstream, and downstream conditions.

- Standards

  Water quality results were compared with Indonesian Government Regulation No. 82 of 2001 on water quality standards.

- Analysis

  Data were analyzed using descriptive statistical methods and comparative analysis against quality standards.

- Activity Implementation

  This stage will involve outreach activities on "The Impact of Water Pollution in the Citarum River in the Batujajar area, West Bandung Regency" and open-pit mining. This will be conducted online.

- Draft Report Preparation Stage

  The draft report will produce an output in the form of a report on the analysis of the Citarum River water in the Batujajar area, West Bandung Regency, aligned with river water quality standards, as well as an evaluation of the outreach activities that have been conducted.

RESULTS AND DISCUSSION

Environmental Conditions of the River in Batujajar

The Citarum River is the largest in West Java, flowing through Bandung Regency, Sumedang Regency, Bandung City, Cimahi City, West Bandung Regency, Cianjur Regency, Bogor Regency, Purwakarta Regency, Karawang Regency, and Bekasi Regency. The Citarum River is divided into the Upper Citarum, Middle Citarum, and Lower Citarum based on a regional management system. The Citarum River Basin covers 1.132.334 square meters. The Citarum River Basin has been designated a National Strategic River Basin (Kemenpura, 2015) due to its role in supporting national economic activities, encompassing not only West Java but also the Jakarta Capital Region (Kusuma et al., 2011, and Kusuma et al., 2012).

The BBS (Babakan Sapan Bridge) area in Selacau Village, Batujajar District, is a key point through which the middle reaches of the Citarum River flow. Visually, the river conditions in this area exhibit the general characteristics of pollution that has been a major problem in the Citarum River Basin for the past several decades. At this point, the water tends to be cloudy and black, the water flow fluctuates rapidly during the rainy season, and there is an occasional unpleasant odor, indicating high levels of organic matter and domestic waste. Observations indicate the river's dimensions are presented in Table 1.

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TABLE 1. Results of river dimension observations

Parameter	Average Value	Note
River width	40 - 70 m	It can narrow to 25 - 35 m
Depth	3 - 6 m	Maximum 8 m at certain points
Flow rate	0.4 - 1.2 m/s	Influenced by Saguling
Riverbed elevation	650 - 650 meters above sea level	Relatively flat area

The minimum river width in the bridge area has narrowed to around 25–35 meters. The segment at the BBS (Babakan Sapan) Bridge is generally in the 40–60 meter range, depending on the season and flow rate. Depth can change rapidly during the rainy season due to high runoff from upstream. Flow velocity in Batujajar is influenced by the regulation of the Saguling Reservoir sluice gates upstream. The measurement locations for the observation area are presented in Table 2.

TABLE 2. Observation area measurement point data

No	Latitude	Longitude	Elevation (m)
1	06°56'00.16"	107°30'19.66"	651
2	06°55'59.44"	107°30'19.68"	651
3	06°55'58.28"	107°30'20.15"	670
4	06°55'56.97"	107°30'20.85"	657
5	06°56'10.31"	107°30'31.95"	659
6	06°56'09.71"	107°30'32.78"	662
7	06°56'08.21"	107°30'33.56"	665
8	06°56'06.98"	107°30'34.15"	663
9	06°55'51.72"	107°30'04.92"	664
10	06°55'52.77"	107°30'04.56"	662
11	06°55'55.74"	107°30'03.46"	663
12	06°56'01.50"	107°30'31.78"	659

In the river area around the BBS Bridge, community activities that still use river water for washing, fishing, and other daily needs also exacerbate the pollution. Furthermore, the presence of dense settlements along the riverbanks means that this area directly receives domestic wastewater, both through open drains and direct discharge into the river. This aligns with a 2019 report by the Ministry of Environment and Forestry (KLHK), which states that more than 60% of Citarum River pollution comes from untreated household waste.

Water Sample Test Results

Water quality measurements were conducted in Situ using a multiparameter test at 12 points on the right, left, and middle of the river. The results of the in situ river water measurements are shown in Table 3 and Figure 1.

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TABLE 3. In-situ Measurement Point

Parameter	In-situ Measurement Point											
	ST 1	**ST 2**	**ST 3**	**ST 4**	**ST 5-1A**	**ST 6-2A**	**ST7 -3A**	**ST8 -4A**	**ST9 -1B**	**ST10-2B**	**ST11-3B**	**ST12-4B**
Temp.[°C]	27.02	26.58	26.88	27.04	27.02	26.58	27.48	28.16	27.87	27.75	27.90	28.88
pH	5.38	5.94	6.55	6.87	5.96	6.88	6.76	6.91	6.38	6.51	6.60	7.15
mV[pH]	91.01	62.69	32.07	16.15	61.63	15.45	21.21	13.91	40.58	33.96	29.42	2.70
ORP [mV]	102.48	90.68	89.89	91.15	86.35	88.51	92.00	90.52	94.77	90.13	96.15	86.11
EC [µS/cm]	303.54	291.71	302.19	326.90	270.67	294.81	317.86	319.43	277.68	291.71	290.05	198.48
EC Abs.[µS/cm]	315.29	300.48	312.48	340.38	281.19	306.67	332.91	338.57	292.64	307.10	305.95	213.14
RES[MOhm-cm]	0.01	0.00	0.00	0,00	0.00	0.03	0.00	0.00	0.09	0.00	0.00	0.02
TDS [ppm]	151.71	145.76	151.05	163.19	135.29	147.52	159.18	159.76	138.55	145.76	145.14	99.24
Sal.[psu]	0.14	0.14	0.14	0.15	0.13	0.14	0.15	0.15	0.13	0.14	0.14	0.09
Press.[psi]	13.71	13.72	13.72	13.73	13.82	13.83	13.84	13.83	13.88	13.88	13.87	13.87
D.O.[%]	39.70	53.92	55.82	56.77	52.78	57.80	56.26	56.33	58.39	53.63	60.48	57.94
D.O.[ppm]	2.94	4.05	4.16	4.22	4.28	4.38	4.18	4.13	4.31	3.89	4.47	4.20

FIGURE 1. The process of measuring water quality using multiparameters

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Physical parameters indicated no significant thermal or heavy inorganic pollution within the Batujajar segment. Water temperatures ranged from 26.58 to 28.88 °C, with the maximum recorded at ST12-4B, likely resulting from localized solar exposure and shallow runoff. Electrical Conductivity (198–340 µS/cm) and Total Dissolved Solids (99–163 ppm) remained well below the 1,000 mg/L regulatory maximum for raw water, reflecting normal freshwater salinity levels (<0.5 psu). However, visual observations of dark water coloration combined with elevated Total Suspended Solids (TSS) highlight a substantial influx of sediment and particulate runoff. This sediment load primarily originates from upstream agricultural activities, riverbank erosion, and residential waste disposal, a typical accumulation phenomenon in the middle segments of large watersheds (Asdak, 2010).

In contrast to the physical stability, chemical analyses revealed severe organic pollution localized predominantly in the upstream segment (ST1–ST2). Measurements of pH (5.38–5.94) and Dissolved Oxygen (DO) (2.94 ppm at ST1) in this area failed to meet the Class II Water Quality Standards (pH 6.0–9.0; DO $\geq$ 4 mg/L). This acidic and hypoxic condition is strongly corroborated by the highest Oxidation Reduction Potential (ORP) recorded at ST1 (102.48 mV) alongside elevated BOD and COD levels. Collectively, these parameters denote an excessive organic load—likely derived from domestic wastewater and decaying matter—that stimulates intense aerobic microbial activity (Effendi, 2003). As microorganisms rapidly deplete available oxygen to decompose organic waste, habitat viability for aquatic organisms severely deteriorates. These findings align with previous assessments of the Citarum River (Nugraha & Lestari, 2019; Kamila et al., 2024), confirming that upstream sites bear the highest organic pollution burden, whereas the downstream segment (ST9–ST12-4B) exhibits spatial recovery with DO levels approaching or meeting regulatory thresholds (up to 4.47 ppm).

Water Quality Zoning Analysis Based on Measurement Results

In-situ measurements yield several water quality parameters within specific value ranges. Based on these measurements, water quality zones are categorized as follows:

- Zone 1 Near Residential Areas (ST1–ST2)

  This zone is characterized by low pH (acidic), low DO, and high ORP (oxidative). This indicates the presence of influencing organic matter, potential domestic waste, and high bioactivity. This zone is categorized as moderately to heavily polluted by organics.

- Transition Zone 2 (ST3–ST6)

  The transition zone is characterized by increasing DO values (>4 ppm), stabilizing pH (6.5 to 6.9), and moderate EC and TDS values. Zone 2 is moderately polluted.

- Zone 3 with a Faster Water Flow Area

  Zone 3, or the area with smoother water flow, shows relatively stable DO values (4.1 to 4.4 ppm), normal pH (6.5 to 7.15), and decreased conductivity values at ST 12, indicating mixing with cleaner water. Zone 3 is lightly polluted and tends to be stable.

Based on the results of the measurement data analysis, water quality values vary between location segments, reflecting the presence of local pollution sources. The most critical parameters are low pH and low DO at the upstream point (ST1–ST2). Physical parameters (TDS, EC, temperature) are in the safe category. Oxidative conditions (ORP) indicate no anaerobic conditions, but high ORP + low DO indicates a high organic load. Overall, the water is categorized as lightly to moderately polluted, with attention focused on organic pollution.

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Impact of Water Pollution

Ecologically, the BBS Bridge area acts as a recipient of the cumulative impacts of pollution that has occurred along the Citarum River. This area is located in a river segment that has passed through various industrial, residential, and agricultural areas, increasing the potential for the accumulation of pollutants such as heavy metals, organic matter, phosphates, and ammonia. According to the Citarum River Basin Management Agency (BBWS) report (2020), the Batujajar area is one of the segments with moderate to severe levels of pollution, particularly during the dry season when water flow decreases and pollutant concentrations increase.

From a socio-economic perspective, pollution in the BBS bridge area directly impacts the surrounding community. Many residents complain of declining fish populations, unpleasant odors, and health risks such as skin irritation or digestive problems. These conditions reflect the challenges faced by communities along the Citarum River, where changes in environmental quality affect their quality of life and livelihoods (Wijaya & Putri, 2020).

Thus, the condition of the Citarum River around the BBS Batujajar Bridge reflects not only a local problem but also an integral part of the overall pollution problem of the Citarum River. This area serves as a concrete example of a critical point demonstrating the scale and impact of pollution affecting West Java's longest and most important river.

The results of water quality measurements at twelve observation points (ST1–ST12-4B) in the surrounding area indicate that the Citarum River in this region is still experiencing significant pollution pressure. Physical and chemical parameters measured in situ indicate variations in water quality along the course, with a tendency for poorer quality at upstream points (ST1–ST2) and relative improvement at downstream points (ST9–ST12). These findings indicate the presence of local pollution sources affecting water conditions at the beginning of the course. The impacts of pollution are outlined in Table 4.

TABLE 4. The impact of river water pollution

Problematic Parameters	Environmental Impact	Health Impact	Socio-Economic Impact
Low pH (ST1-ST2)	Metal dissolution, vegetation damage	Skin irritation	Infrastructure damage
Low DO (ST1-ST2)	Dead fish, bad smell	Increased pathogenic microbes	Fishery losses
Increased TDS/EC (ST4-ST8)	Dissolved material increases	Bad taste in water	Household appliance maintenance increases
High ORP	Organic decay	Increased risk of harmful microorganisms	Aesthetic decline

The upstream segment (ST1–ST2) exhibits the most severe organic pollution, indicated by low pH and low DO. This pollution can lead to a decline in habitat quality, biota mortality, and river silting. Furthermore, this organic pollution condition not only impacts the river ecosystem but also directly impacts public health. Water with low DO and acidic pH tends to contain pathogenic microorganisms, so people who still use river water for washing or other activities are potentially experiencing health problems such as skin irritation, dermatitis, and digestive diseases. This is in line with reports from local residents who often complain of itching and unpleasant odors from the river water, especially during the

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dry season when water discharge decreases. From an environmental perspective, water pollution in the Batujajar area leads to declining aquatic habitat quality, reduced biodiversity, and increased sedimentation caused by organic matter. Fish mortality and a decline in the population of sensitive organisms are common impacts found in rivers with low DO. In addition, low pH can damage riparian vegetation that functions to prevent erosion, thereby accelerating the process of river silting. The impact of this pollution is also felt in the socio-economic aspects of the community. The Batujajar area is home to several small-scale fisheries and communities that directly utilize river water. Poor water quality can reduce fish farming productivity, increase healthcare costs, and reduce the quality of life for residents living near the river. Infrastructure such as bridges and buildings near the riverbanks can even corrode more rapidly due to acidic water. Overall, the condition of the Citarum River around the Batujajar BBS Bridge reflects pollution patterns also occurring in other segments along the Citarum River. This emphasizes that pollution control efforts must be carried out not only at the macro scale through the Citarum Harum program, but also at the micro scale through public education, improving environmental sanitation, and managing household waste. This Community Service Program activity is an important step in raising public awareness and providing technical recommendations to reduce the pollution load entering the river.

ICPMS testing was conducted on water samples taken from ST1 to ST12-4B. The ICPMS test results showed the highest intensity recorded for the elements Fe, Mn, Zn, and Cu, in order of highest to lowest intensity. This indicates the presence of particle/sediment loads and dominant geochemical elements. Based on the results obtained, the elemental content is described as follows:

- High Fe and Mn levels can potentially cause sedimentation problems, oxidation-reduction problems on riverbed, water discoloration, and at acidic pH levels, can increase the mobilization of other metals. Potential impacts include habitat disruption, aesthetic problems, and infrastructure corrosion if the water is aggressive.
- High Zn and Cu levels can come from industrial inputs, scrap metal disposal, or orthophosphate fertilizer runoff. Both are potentially toxic to aquatic organisms at certain concentrations.
- Pb and Cr were detected, both of which pose a health risk. If concentrations are found to be above quality standards, immediate action is required, such as public notification, restrictions on raw water use, and source investigation.
- Cd, although its intensity is relatively smaller, remains a concern due to its high toxicity even at low concentrations.

The data raises an alert for significant metal loads (Fe, Mn, Zn, Cu) and the presence of potentially hazardous heavy metals (Pb, Cr, Cd). However, quantitative verification is needed before making policy/enforcement decisions.

Implementation of Socialization Activities

The socialization of the Community Service results was held as a step towards understanding the impact of water pollution in the Citarum River in the Batujajar area, West Bandung Regency. This activity was held online on Thursday, November 6, 2025, and invited speakers as speakers:

- Dr. Qomarudin Helmy, S.Si., M.T., a lecturer in the Environmental Engineering Study Program at the Bandung Institute of Technology.
- Ir. Rochsyid Anggara, S.T., M.T., IPM, a lecturer in the Mining Engineering Study Program at the UPN Veteran Yogyakarta and a member of the PEP Bandung Community Service team.

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The webinar activities were divided into two sessions, namely a presentation on the results of the Community Service activities that have been carried out and supplemented with an understanding of the material regarding the impact of river water pollution and how to overcome it as well as an overview of the Citarum River and the process of sampling and data collection from the Community Service activities that have been carried out at the BBS Citarum Bridge, West Bandung. The next session was an explanation of the outline of the impact of river water pollution to the methods of mitigation and the technology that has been used to overcome river water pollution. The rundown of the webinar activities is as follows in Table 5 and Figure 2.

TABLE 5. Rundown of the Community Service webinar activities

Time	Description	PIC
10.00 - 10.10	Opening	Head of community service
10.10 - 11.00	Delivery of Session I Material	Ir. Rochsyid Anggara, S.T., M.T., IPM.
11.00 - 11.45	Delivery of Session I Material	Dr. Qomarudin Helmy, S.Si., M.T.
11.45 - 12.00	Conclusion and closing	Head of community service

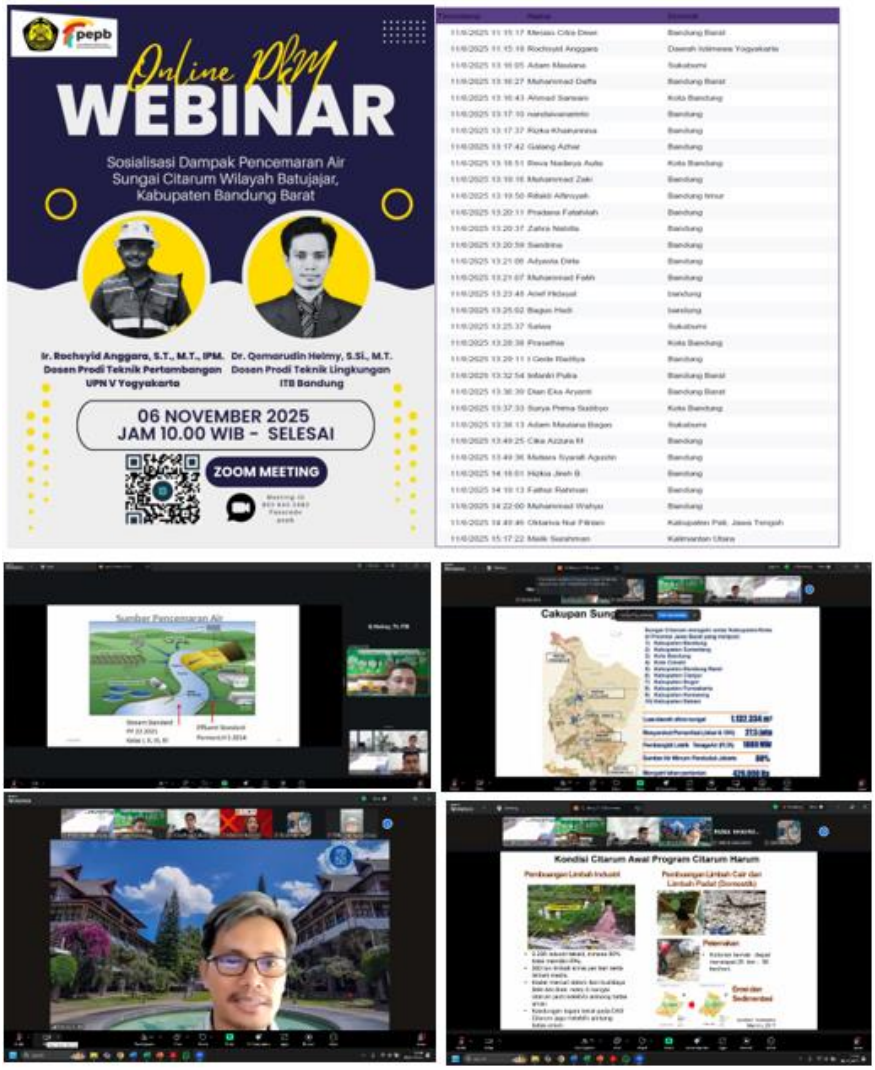

FIGURE 2. Webinar activities in the context of socializing the result of community service

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Schedule for Implementation of Community Service

The schedule for implementing community service activities is as follows in Table 6.

TABLE 6. Schedule for implementing community service activities

Activity Description	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Preparation of proposals												
Coordination with regional stakeholders												
Data collection												
Laboratory testing												
Activity socoalization												
Report preparation												

CONCLUSION

This community outreach and assessment study confirms that the Citarum River within the Batujajar region suffers from moderate to severe organic pollution, localized primarily in upstream segments. Critical parameters, notably low pH and DO levels, fail to meet established quality standards, posing substantial ecological, socio-economic, and public health risks to the surrounding communities. However, the integration of empirical water quality analysis with targeted community webinars effectively enhanced local awareness regarding the dangers of water pollution and the urgency of environmental sanitation. Future mitigation efforts must prioritize continuous monitoring, stricter localized pollution control, and sustainable, community-based waste management practices.

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