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[Research Article]

Hydrological Characteristics and Water Quality Assessment of Ci Jarian River in Bojonggaling Village, Cimandiri Sub-Watershed

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Abstract

Watersheds play a crucial role in the ecohydrological system. However, land use change has reduced the hydrological function and water quality in many rural areas. This study aims to analyze the hydrological characteristics and water quality of the Ci Jarian River. The river discharge measurement method at six locations using the velocity-area method was applied and accompanied by water quality analysis based on Total Dissolved Solids (TDS), pH, and Electrical Conductivity (EC) parameters. The Ci Jarian River has an influent-intermittent flow type with a dendritic pattern and variations in valley morphology from a V-shape in the upstream to a U-shape in the downstream. The flow rate ranges from 43-286 m^3/s at all observation points. TDS and EC values increase from upstream to downstream, indicating the accumulation of dissolved substances due to agricultural runoff and domestic waste. Meanwhile, the pH tends to be neutral to slightly alkaline (6.8-8.5), which is still within the category of suitable water according to the Minister of Health and WHO Regulations. This study emphasizes the importance of watershed management based on sustainable land use in rural areas.

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Abstrak

Daerah Aliran Sungai memiliki peran krusial dalam sistem ekohidrologi. Namun, perubahan penggunaan lahan telah menurunkan fungsi hidrologi dan kualitas air di banyak wilayah perdesaan. Penelitian ini bertujuan untuk menganalisis karakteristik hidrologi dan kualitas air Sungai Ci Jarian, Metode pengukuran debit sungai di enam lokasi dengan metode luas-kecepatan (velocity-area method) diterapkan dan disertai analisis kualitas air berdasarkan parameter Total Dissolved Solids (TDS), pH, dan Electrical Conductivity (EC). Sungai Ci Jarian memiliki tipe aliran influent-intermittent dengan pola dendritic dan variasi morfologi lembah dari V-shape di hulu hingga U-shape di hilir. Debit aliran berkisar antara 43-286 m^3/s diseluruh titik pengamatan. Nilai TDS dan EC meningkat dari hulu ke hilir, yang menunjukkan akumulasi zat terlarut akibat limpasan pertanian dan limbah domestik. Sedangkan pH cenderung netral hingga sedikit basa (6,8-8,5), yang masih berada dalam kategori air layak menurut Permenkes dan WHO. Penelitian ini menegaskan pentingnya pengelolaan DAS berbasis penggunaan lahan berkelanjutan di wilayah perdesaan.

INTRODUCTION

Watersheds play a crucial role in maintaining ecosystem balance and ensuring the availability of water resources for human needs as well as biodiversity (Zhang et al., 2025). River and watershed ecosystems function as natural ecological systems that regulate the hydrological cycle through the processes of rainfall absorption, storage, and distribution from upstream to downstream areas (Shaad et al., 2022). In addition, watersheds provide various essential ecosystem services, including the supply of clean water, agricultural irrigation, flood regulation, and the provision of habitats for a wide range of aquatic and terrestrial organisms (Khosrovyan, 2024).

In Indonesia, issues related to river water quality degradation have increasingly intensified along with land-use conversion and population growth, particularly in West Java, which serves as a major center for agricultural and industrial activities (Iqtashada & Febrita, 2023). Major rivers such as the Citarum and Cimandiri have experienced significant water quality deterioration due to pollution from domestic wastewater, agricultural runoff, and uncontrolled urbanization. This condition underscores the importance of watershed management efforts that balance human needs with long-term sustainability. Such water quality degradation is reflected in changes in key water quality parameters, including increased Total Dissolved Solids (TDS), fluctuations in pH, and elevated Electrical Conductivity (EC), which serve as the main indicators in this study.

With the increasing intensity of development and various human activities, pressure on the ecological functions of watersheds has also risen significantly. Land-use changes, urbanization, and anthropogenic activities have contributed to the degradation of water quality and the declining capacity of the environment to maintain hydrological balance (Siqueira et al., 2023). The degradation of river ecosystem functions directly affects water availability and environmental quality in downstream areas (Grizzetti et al., 2016). Therefore, understanding hydrological dynamics and water quality at the local scale is a crucial initial step in ensuring the sustainability of water resource management.

The Ci Jarian River, located in Bojonggaling Village, Bantargadung District, is part of the Cimandiri Sub-watershed in Sukabumi Regency, West Java Province. The Cimandiri Sub-watershed plays an essential role as a water source supporting agricultural activities, domestic use, and natural ecosystems in the surrounding area (Ridwansyah et al., 2019). Geomorphologically, the river flow pattern in areas with homogeneous sedimentary lithology generally exhibits a dendritic form, where water flows from multiple directions and converges into the main channel (Ridwansyah et al., 2019). The floodplains surrounding the river are often utilized for agricultural purposes due to their high soil fertility and abundant water availability (Rahma et al., 2023). However, increasing human activities near the river channel, such as agricultural expansion and settlement development, have the potential to elevate pollution levels and deteriorate water quality (Luo et al., 2020).

Previous studies have indicated that human activities, particularly those related to agricultural land use and domestic wastewater discharge, significantly increase the concentration of Total Dissolved Solids (TDS) and alter the pH levels in aquatic ecosystems (Widyarani et al., 2022). Elevated TDS values suggest an increase in dissolved substances in the water, commonly originating from surface runoff carrying detergent residues, household waste, or chemical fertilizers from surrounding areas (Muliyadi, 2020). Meanwhile, fluctuations in pH levels can affect the biological balance of aquatic ecosystems and lead to a decline in habitat quality for aquatic organisms (Shang et al., 2025).

Although several studies have been conducted on large watershed scales, such as the Citarum and Cisadane Rivers, research at smaller spatial scales, such as in Bojonggaling Village, remains limited. In fact, hydrological dynamics and water quality degradation processes at the micro-watershed level often exhibit distinct characteristics from larger basins, as they are directly influenced by human activities, land use patterns, and local geomorphological conditions (Rymbai et al., 2012). Small-scale studies play a crucial role in providing more detailed and context-specific empirical data to support the development of community-based water management policies. However, to date, no study has specifically examined the relationship between hydrological characteristics and water quality in the Ci Jarian

River within the Cimandiri Sub-Watershed, creating a research gap in understanding ecohydrological dynamics in rural environments.

In addition, small-scale studies play a vital role in understanding the relationship between hydrological characteristics and water quality within rural ecosystems (Kent et al., 2024). The Ci Jarian River was selected as the study site due to its strategic role as the primary water source supporting agricultural activities and domestic needs of the Bojonggaling Village community, as well as its location within an area experiencing ecological stress resulting from land use changes along the riparian zone. Therefore, this study aims to analyze the hydrological characteristics and assess the water quality of the Ci Jarian River in Bojonggaling Village as a scientific basis for sustainable water resource management within the Cimandiri Sub-watershed. Furthermore, the findings of this study are expected to enhance understanding of the interconnection between hydrological conditions and water quality in rural areas and to serve as a reference for developing community-based watershed management strategies.

METHOD

Research Design

This study employed a quantitative descriptive approach focusing on the analysis of hydrological characteristics and water quality. The hydrological analysis included measurements of river discharge and groundwater depth, while the water quality analysis included assessments of TDS, pH, and EC. These three parameters were selected because they broadly represent key indicators of water quality that are sensitive to environmental change and anthropogenic activities. TDS and EC reflect the degree of mineralization and the concentration of dissolved ions, respectively, while pH indicates the chemical stability of the water, which, in turn, influences the biological balance of the riverine ecosystem.

Study Area

This study was conducted on the Ci Jarian River, located in Bojonggaling Village, Bantargadung Sub-district, Sukabumi Regency, West Java Province. The site is part of the Cimandiri Sub-watershed. Geographically, Bojonggaling Village lies between 6°57’43” S - 7°01’19” S and 106°37’14” E - 106°39’40” E, covering approximately 1,393 hectares. The village has a population of 4,953 people (BPS, 2022).

The river channel within Bojonggaling exhibits both straight and meandering patterns, encompassing the upstream, middle, and downstream segments of the flow. Flat floodplain areas along the riverbanks are primarily utilized for rice cultivation, while the steeper sections are used for coconut plantations and other perennial crops. The research location can be seen in Figure 1.

Data Types

Data were obtained through field observations and in situ measurements conducted in 2024 at six sampling points representing the upstream, middle, and downstream segments of the river. The collected data were subsequently analyzed using quantitative and spatial approaches to characterize the hydrological conditions and water quality along the Ci Jarian River.

Hydrological Characteristics Analysis

River discharge was measured using the velocity-area method, which calculates discharge as the product of the cross-sectional area and the average flow velocity (Caissie, 2021). Each river cross-section was divided into several vertical segments according to the river’s width. The flow velocity in each segment was determined using the float method (USGS, 2023), following Equation 1:

$$V = \frac{L}{t} \quad (1)$$

where V is flow velocity (m/s), L is the distance traveled by the float (m), and t is the travel time of the float (s).

The total discharge (Q) was calculated by summing the product of the area and the average velocity for each segment, as expressed in Equation 2:

$$Q = \sum (A_i \times V_i) \quad (2)$$

where Q is the total river discharge (m^3/s), A_i is the cross-sectional area of the segment i (m^2), V_i is the average flow velocity of segment i (m/s).

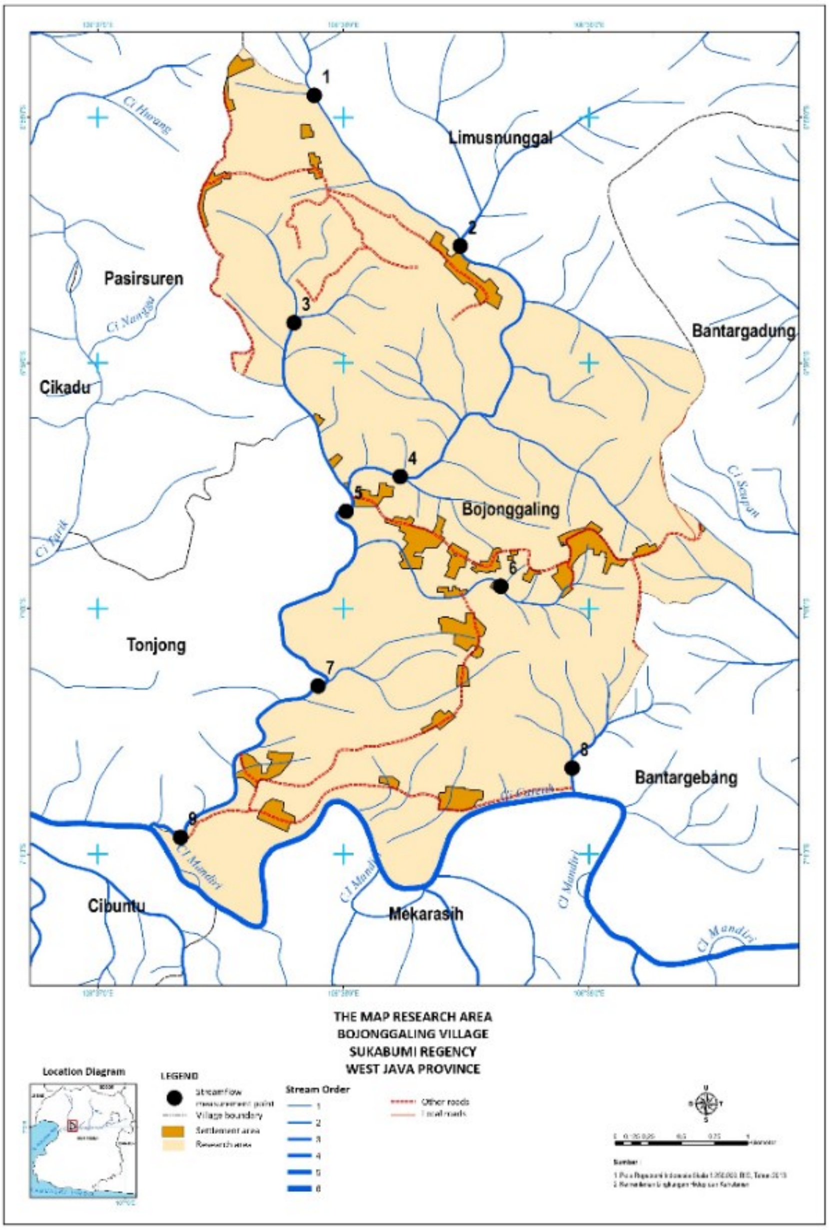

Figure 1. The Map of the Research Area of Bojonggaling Village

This approach allows for accurate estimation of streamflow variation across different segments, which is essential for understanding the hydrological behavior of the Ci Jarian River.

Groundwater level measurements were conducted at several household wells surrounding the study area using a roll meter. The measurement was taken from the top edge of the well down to the water surface to determine the groundwater depth. These data were utilized to examine the relationship between groundwater availability and river flow conditions within the surrounding area.

Water Quality Analysis

Water samples were collected from several points representing the upstream, middle, and downstream segments of the Ci Jarian River to capture the spatial variation in water quality along the river course. In addition, groundwater samples were obtained from local wells and natural springs to allow comparison between surface and groundwater conditions. All water samples were stored in 250 mL glass bottles that had been rinsed with distilled water (Aquadest) before sampling. The samples were then kept at a temperature of 4°C to preserve their chemical integrity until further analysis was conducted.

The concentration of TDS was measured in situ using a portable digital TDS meter (Hanna Instruments) to determine the level of dissolved substances in the water, consisting of inorganic ions and dissolved organic compounds. Before measurements, the probe was cleaned and calibrated using distilled water (Aquadest) to prevent cross-contamination between samples. The measurement was performed by immersing the electrode in the water sample until stable reading was obtained, and the results were recorded milligrams per liter (mg/L).

The pH values were measured in situ using a portable digital pH meter (Thermo Fisher Scientific) to determine the acidity or alkalinity levels of both river and groundwater samples. Before use, the instrument was calibrated with standard buffer solutions of pH 4.0, 7.0, and 10.0 in accordance with standard procedures (APHA, 2017). The pH meter electrode was rinsed with distilled water (Aquadest) before and after each measurement to prevent cross-sample contamination.

The EC parameter was measured in situ using a portable digital conductivity meter to determine the concentration of dissolved ions in the water. The instrument was calibrated with a standard conductivity solution before measurement. The probe was then immersed in the water sample until a stable reading was obtained. EC values were expressed in microsiemens per centimeter (µS/cm) and served as an indicator of the degree of mineralization or ionic content of the water, which is empirically correlated with TDS values (APHA, 2017). The EC analysis was utilized to support the interpretation of spatial variations in water quality and to identify the potential influence of anthropogenic activities on dissolved ion concentrations along the river channel.

Data Analysis

The data obtained from hydrological and water quality measurements were analyzed descriptively and spatially to illustrate the hydrological conditions and spatial variation of water quality along the Ci Jarian River. Descriptive analysis was applied to present the mean values, ranges, and variations among river segments (upstream, middle, and downstream) based on the measurements of discharge, groundwater depth, TDS, pH, and EC (Helsel et al., 2020).

Subsequently, spatial analysis was performed using ArcGIS 10.8 to visualize the spatial distribution of water quality parameters across the study area. The resulting maps were utilized to identify spatial patterns of water quality variation and hydrological characteristics influenced by land use around the river (Xiong et al., 2022). The measured water quality parameters were then compared with national clean water quality standard as specified in PERMENKES No. 492/MENKES/Per/IV/2010 and World Health Organization (WHO) guidelines, to evaluate the degree of compliance with acceptable water quality thresholds.

RESULT AND DISCUSSION

Hydrological Characteristics of the Ci Jarian River

The Ci Jarian River is a tributary within the Cimandiri Sub-watershed system, serving an essential role as a water source for agricultural activities and domestic needs of the Bojonggaling Village community. Based on field observations, the river exhibits a dendritic drainage pattern, which is typical of areas underlain by homogeneous sedimentary lithology, while the middle to downstream sections display a meandering pattern formed through long-term lateral erosion and sediment deposition processes (Ridwansyah et al., 2019). The transition from a dendritic to a meandering pattern plays an important role in shaping the hydrological dynamics of the river. River segments with a dendritic pattern tend to produce more stable discharge and concentrated flow, whereas meandering segments slow the flow, enhance sediment deposition, and increase the susceptibility of downstream areas to pollutant accumulation. These conditions lead to greater discharge fluctuations in the downstream section and a decline in water quality, primarily due to elevated sedimentation and the influx of agricultural runoff and domestic waste that is more easily trapped within meander bends. The locations of observation points for the hydrological characteristics of the Ci Jarian River are presented in Figure 2.

The valley morphology of the Ci Jarian River varies from a V-shaped profile in the upstream section to a broader U-shaped form in the downstream area. The V-shaped valley in the upper reach indicates the dominance of intense vertical erosion processes, whereas the U-shaped valleys in the middle to lower reaches

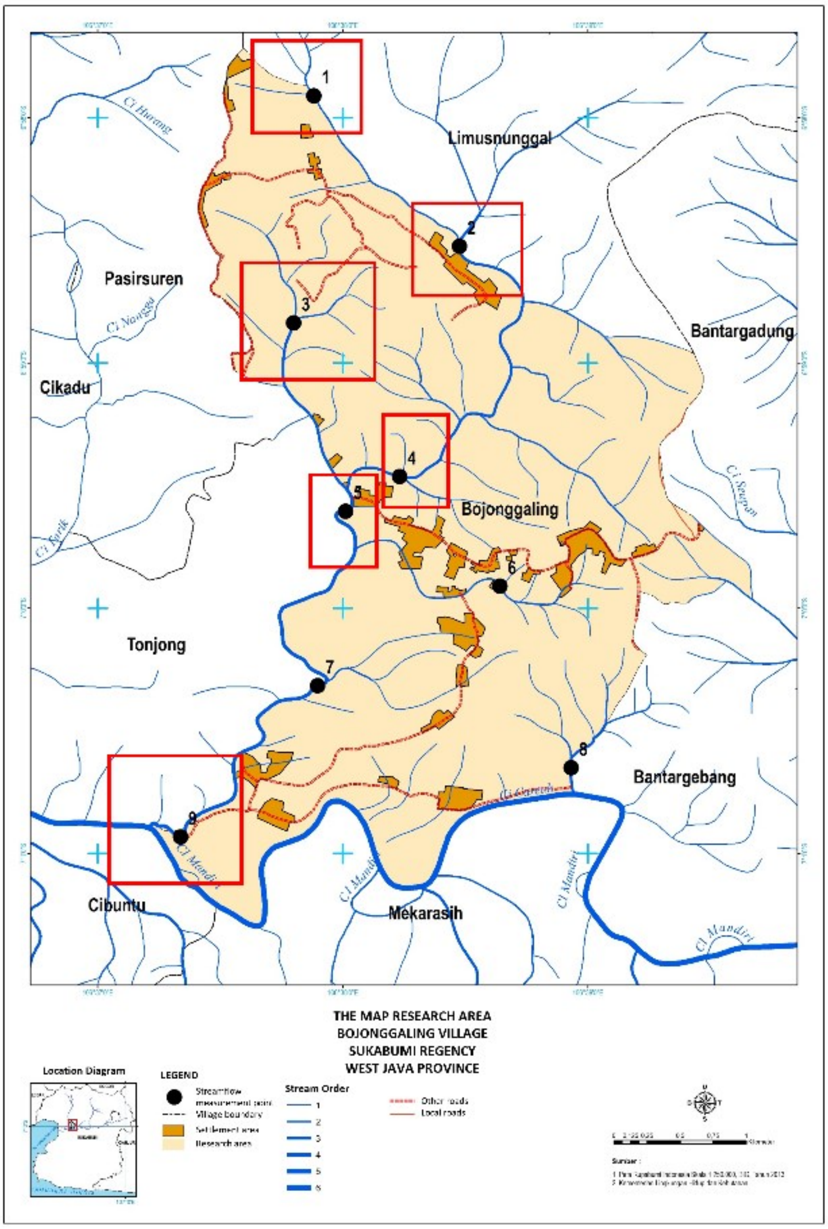

Figure 2. Observation Points of Ci Jarian River Characteristics in Bojonggaling Village

reflect enhanced sedimentation and weathering activities, typically occurring in lowland areas with gentle slopes (Zhang et al., 2023). The widening valley morphology in the downstream section reduces flow velocity, increases the potential for sediment deposition, and contributes to the higher discharge fluctuations observed in the field measurements. The riverbed materials, dominated by sedimentary rocks and sand, along with bank deposits formed through seasonal discharge variations, further reinforce the hydrodynamic characteristics of the middle and downstream segments. A summary of the physical characteristics of the Ci Jarian River at each observation point is presented in Table 1.

Hydrologically, the Ci Jarian River exhibits an influent-intermittent flow type across most segments, with perennial flow conditions observed at certain points. This pattern indicates a strong interaction between surface water and groundwater within a permeable sedimentary system (Grizzetti et al., 2019). The remaining riparian vegetation, such as coconut and bamboo trees, functions as a natural buffer that helps reduce bank erosion. However, the conversion of riparian zones into agricultural fields and residential areas has the

Table 1. Physical Characteristics of Ci Jarian River at Each Observation Point

ID	River Name	Stream Order	Coordinate		River Type	Valley Type	Channel Pattern	Riparian Vegetation	Rock Type	Sediment Deposit	Suspended Load
			X	Y							
1	Ci Jarian Upstream	2	106.63308	-6.96806	Interminttent	V	Straight	Rice field	Igneous	Sedimentary	Sedimentary
2	Ci Jarian Upstream	3	106.64554	-6.97931	Interminttent	U	Meandering	Rice field, Bamboo	Sedimentary	Sedimentary	Sedimentary
3	Ci Jarian Middle	4	106.63382	-6.99234	Interminttent	U	Straight	Bamboo, Coconut	Igneous	Sedimentary	-
4	Ci Jarian Middle	3	106.63302	-6.63302	Interminttent	U	Straight-Meandering	Bamboo, Coconut	Igneous	Sedimentary	Sedimentary
5	Ci Jarian Middle	4	106.63376	-6.99139	Interminttent	U	Meandering	Bamboo, Coconut, Grassland	Igneous	Sedimentary	Sedimentary
6	Ci Jarian Downstream	4	106.62654	-7.00980	Interminttent	U	Straight	Residential yard	Igneous	Sedimentary	Igneous

potential to disrupt the natural hydrological balance and increase sediment runoff into the river (Rodriguez-Romero et al., 2018).

Stream Discharge of the Ci Jarian River

The discharge measurements indicate that the Ci Jarian River exhibits considerable variability in flow rates across its different segments, reflecting the influence of morphological characteristics and land-use patterns along the river corridor. In the upstream section, discharge values range between 86-146 L/s, calculated using the velocity-area method with a float technique. These values were strongly influenced by the narrow channel geometry (1.5-3 meters), relatively greater local depth, and high flow velocity associated with the steeper channel gradient in the upstream section. This geomorphological setting concentrates the flow and produces a relatively substantial discharge despite the river's small spatial scale.

In the upstream segment, the rapid flow and rocky riverbed indicate active vertical erosion processes and substantial contributions from surface runoff. The increase in discharge from the upstream to the middle segment occurs due to additional inflow from tributaries and runoff originating from agricultural fields on the floodplain. Hydrologically, this increase in discharge demonstrates the role of the Ci Jarian River as the primary conduit for surface flow in Bojonggaling Village and reflects the sensitivity of its hydrological system to land use changes along the riparian zone.

In the middle section, the discharge increases up to 275 L/s, with a channel width ranging from 3 to 5 meters. This rise in flow volume is influenced by inflows from tributaries and agricultural runoff originating from the surrounding floodplain areas. The meandering pattern observed in this segment indicates a transitional zone from erosion-dominated processes to sedimentation, corresponding to a decrease in channel slope gradient (Rutkowska et al., 2022). This meander configuration not only reduces flow velocity but also enhances the potential for fine-sediment deposition and the accumulation of dissolved materials. Such accumulation may influence downstream water quality, particularly through increased concentrations of TDS and EC in the midstream-downstream sections. The average discharge values for each observation segment are presented in Table 2.

Table 2. Stream Discharge of Ci Jarian River at Each Sampling Segment

ID	River Name	Flow Path Length (m)	V1 (m/s)	V2 (m/s)	V3 (m/s)	Q1 (m^3/s)	Q2 (m^3/s)	Q3 (m^3/s)	$\sum Q$ (m^3/s)	$\sum Q \times Vi$	$\sum Q$ (L/s)	Qi
1	Ci Jarian Upstream	2	0.56	-	-	0.10	-	-	0.10	0.06	60.75	0.09
2	Ci Jarian Upstream	2	0.50	0.21	0.12	0.12	0.04	0.01	0.17	0.10	103.18	0.15
3	Ci Jarian Middle	5	0.58	0.46	0.46	0.10	0.11	0.12	0.32	0.19	194.49	0.28
4	Ci Jarian Middle	4	0.49	0.53	-	0.06	0.06	-	0.12	0.07	71.18	0.10
5	Ci Jarian Middle	4	0.57	0.65	0.34	0.07	0.09	0.06	0.22	0.13	131.24	0.19
6	Ci Jarian Downstream	4	0.65	0.64	0.84	0.11	0.011	0.18	0.39	0.33	329.11	0.33

Meanwhile, the downstream section exhibits fluctuating discharge values, ranging from 43 to 286 L/s. This variability is primarily influenced by channel narrowing and increased sedimentation, resulting from agricultural and residential activities along the riparian corridor (Figure 3). Agricultural activities generate surface runoff that transports fine-sediments and dissolved particles into the river, thereby reducing channel cross-sectional capacity and causing variations in flow velocity and discharge. Meanwhile, the development of settlements within the riparian zone increases runoff volume through the expansion of impervious surfaces and reduces that soil's ability to absorb water. These discharge fluctuations indicate a significant anthropogenic influence on the stability of river flow, particularly due to the conversion of riparian zones into rice fields and settlement areas (Dunn et al., 2022).

The discharge pattern of the Ci Jarian River exhibits a gradual increase in flow from the upstream to the middle section, followed by greater fluctuations in the downstream reach. This pattern indicates that streamflow variability is influenced by the interaction between geomorphological factors, rainfall intensity, and land-use charges across the river's runoff catchment area.

Water Quality of the Ci Jarian River

The measurement results indicate that TDS values range between 70 and 820 mg/L, with the lowest concentrations observed in the upstream section and the highest in the downstream reach. The increase in TDS levels downstream is attributed to the accumulation of dissolved substances carried by agricultural runoff and domestic wastewater from nearby settlements. This pattern suggests that human activities significantly contribute to the enrichment of dissolved compounds, particularly in densely populated and agricultural areas (Rodriguez-Romero et al., 2018). According to Indonesian water quality standards (PERMENKES No. 492/MENKES/Per/IV/2010) and WHO guidelines, the upstream TDS values are still classified as clean water (<500 mg/L). whereas the downstream section indicates a decline in water quality. The whereas quality parameters of the Ci Jarian River are summarized in Table 3 below.

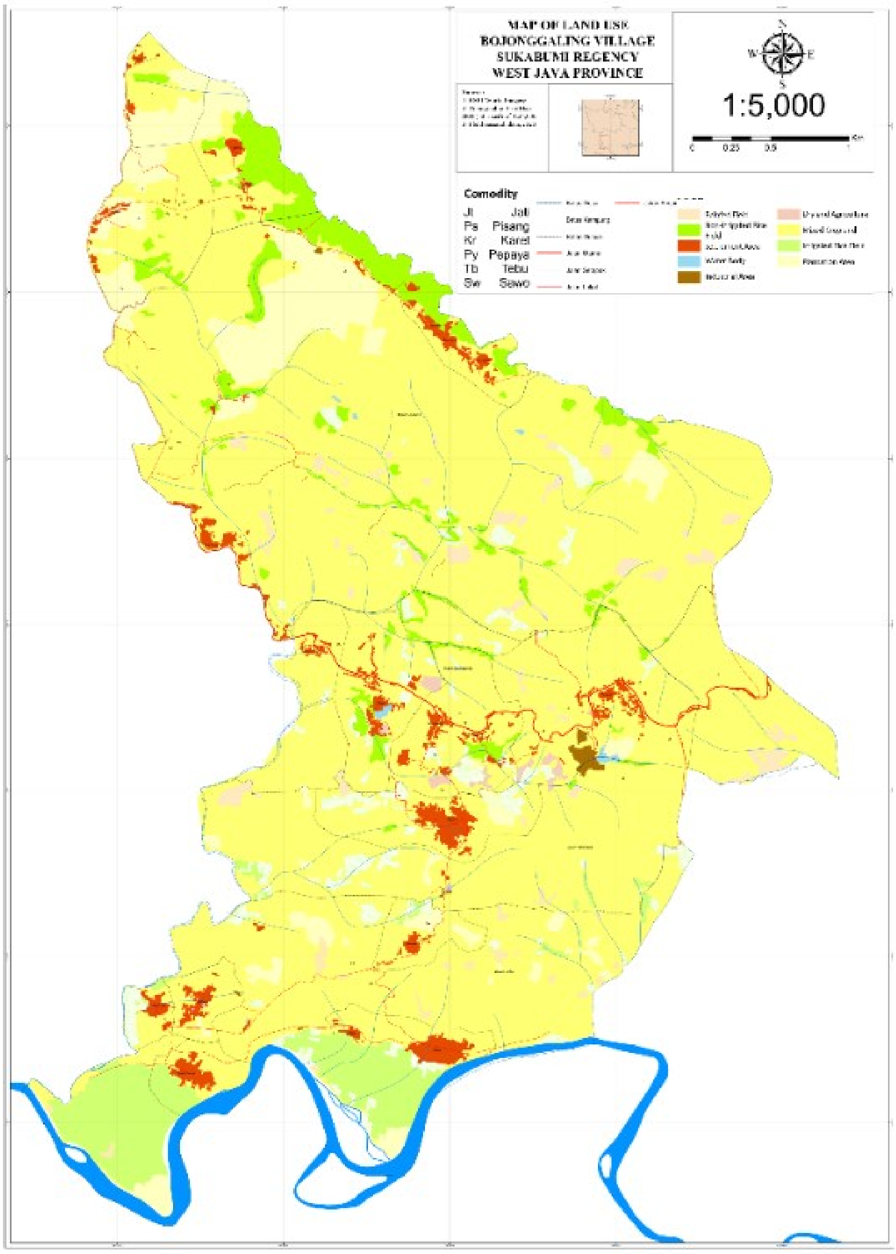

Figure 3. Land Use Map around Ci Jarian River, Bojonggaling Village

The pH values of the river water range from 6.8 to 8.5, indicating neutral to slightly alkaline conditions. The higher pH levels observed in the downstream section are likely influenced by the decomposition of organic matter, detergent residues, and the increase in bicarbonate ions resulting from household activities near the river. Nevertheless, the measured pH values remains within the acceptable range for clean water quality standards. Variations in pH can affect the biological stability of aquatic ecosystems, as extreme pH levels may disrupt the ecological balance by influencing species that are highly sensitive to acidity fluctuations, which in turn affect their respiratory processes, metabolism, and overall survival. Excessively high or low pH levels can reduce aquatic biodiversity and alter the community structure of riverine ecosystems (Lowe et al., 2019).

The EC parameter exhibits a pattern similar to that of TDS, showing an increasing trend from the upstream to downstream sections. The highest EC values were recorded in the downstream area, indicating a higher concentration of dissolved ions due to the accumulation of agricultural runoff and residential effluents. The strong correlation between TDS and EC suggests that Electrical Conductivity can serve as a reliable indicator of

Table 3. Water Quality of Ci Jarian River at Each Sampling Segment

ID	River Name	Temperature (°C)	TDS	pH	EC	Characteristics (Colour, Taste, Runoff, Utilization)
1	Ci Jarian Upstream	27.96	70	6.96	0.14	Clear, Unknown, Moderate, Agriculture
2	Ci Jarian Upstream	27.06	90	7.05	0.17	Clear, Unknown, Moderate, Agriculture
3	Ci Jarian Middle	27.10	170	7.69	0.33	Slightly brownish clear, Brackish, Moderate, Bathing & Washing
4	Ci Jarian Middle	27.70	210	7.30	0.41	Slightly brownish clear, Brackish, Moderate, Bathing & Washing
5	Ci Jarian Middle	27.50	160	7.67	0.33	Slightly brownish clear, Brackish, Moderate, Bathing & Washing
6	Ci Jarian Downstream	28.20	820	7.87	0.56	Turbid, Brackish, Moderate, Washing

water quality, particularly for detecting elevated mineralization levels and inorganic contamination (Rutkowska et al., 2022).

The measurement results indicate that the water quality of the Ci Jarian River remains within the acceptable range in the upstream and middle sections, but shows a decline in the downstream area due to anthropogenic pressures. This condition reflects a spatial gradient of water quality, transitioning from conservation areas to zones of intense human activity, a pattern commonly observed in rural tropical river systems (Uriarte et al., 2011).

Watershed Management Recommendation

Restoring the ecological function of the riparian buffer is a priority intervention to improve the hydrological condition and water quality of the Ci Jarian River. Restoration efforts can be implemented through the establishment of a 10-20 meters riparian setback on both sides of the channel, consistent with riparian management recommendations for rural catchments (Liu et al., 2023). The planting of characteristic riparian vegetation such as bamboo and fibrous-rooted species has been shown to effectively reduce bank erosion and enhance infiltration, thereby decreasing inputs of fine sediment and pollutants into the river (Pertiwi et al., 2021). This measure is particularly relevant given the study's findings of elevated sedimentation in the middle-downstream segments as a result of land use changes. Accordingly, riparian corridor restoration is expected to improve channel morphological stability and mitigate the downstream increases in TDS and EC identified in this study.

Agricultural level management is required to reduce nutrient and sediment runoff from paddy fields located on the floodplain, which contributes to declining river water quality. This can be achieved by restricting fertilizer application within 50 meters of the riverbank and implementing low-input fertilizer zones, in line with agricultural landscape management strategies aimed at reducing nutrient transport to water bodies (Juncal et al., 2023). The construction of infiltration trenches along the boundaries of agricultural fields also represents an important measure, as this technology has been shown to effectively intercept surface runoff and reduce dissolved ion concentrations before water enters the river (Jeon et al., 2022). These strategies are increasingly relevant given the observed downstream increases in TDS and EC, which result from agricultural runoff and fine sediments that tend to accumulate in meandering segments of the river.

At the domestic's level, the contribution of household wastewater to increased pH and EC in downstream segment must be addressed through rural-scale wastewater treatment systems. The construction of domestic infiltration wells offers a practical solution, as this approach has been demonstrated to reduce runoff volume and enhance groundwater infiltration (Li et al., 2019). Meanwhile, the implementation of small-scale constructed wetlands as communal treatment systems has proven effective in reducing organic and inorganic pollutant loads before wastewater reaches the river (Dominguez-Solis et al., 2025). Community education on reducing the use of phosphate-based detergents is also essential, as phosphates are known drivers of increased alkalinity and eutrophication in freshwater systems (Richards et al., 2015). Collectively, these interventions provide actionable pathways for Bojonggaling Village to mitigate anthropogenic pressures on the Ci Jarian River and promote long-term water quality sustainability.

CONCLUSION

This study reveals that the Ci Jarian River in Bojonggaling Village, which forms part of the Cimandiri Sub-Watershed, exhibits complex hydrological characteristics influenced by geomorphological conditions and land-use activities. The dendritic flow pattern and the valley morphology, which transition from a V-shape in the upstream to a broad U-shape in the downstream, indicate active erosion and sedimentation dynamics. The measured discharge values show an increase from the upstream to the middle section, followed by fluctuations in the downstream reach caused by anthropogenic influences, such as the conversion of riparian zones into rice fields and settlements. Furthermore, the interaction between surface water and groundwater demonstrates that the Ci Jarian River exhibits an influents-intermittent hydrological system, reflecting a dynamic water exchange process within its permeable sedimentary environment.

The analysis of TDS, pH, and EC parameters reveals a spatial gradient of water quality, ranging from the relatively conserved upstream areas to the downstream sections that are more affected by human activities. The increase in TDS and EC values in the downstream region indicates the accumulation of dissolved substances resulting from agricultural runoff and domestic wastewater discharge, while the slightly alkaline pH values remains within acceptable limits according to national (PERMENKES) and WHO standards. This study highlight that land-use changes along the river play a significant role in affecting hydrological stability and water quality degradation.

Therefore, an operational and field-applicable management strategy is required. This study recommends three levels of intervention: 1) riparian vegetation rehabilitation, aimed at reducing bank erosion, enhancing infiltration, and trapping sediment; 2) fertilizer input regulation and agricultural runoff management through the implementation of low-input fertilizer zones and infiltration trenches to reduce dissolved pollutant loads; and 3) community-based domestic wastewater management, including the construction of household infiltration wells, small-scale communal wetlands, and public education on reducing the use of phosphate-based detergents. These approaches provide practical contributions to strengthening the ecological resilience of the Ci Jarian River and support the sustainable integrated management of the Cimandiri Sub-Watershed to maintain the river's ecological function as a vital local water resource.

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