

# Physicochemical Divergence of River and a Former Quarry Waters in Jember: A Focus on Turbidity, pH, TDS, and ORP

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## ABSTRACT

This study evaluated physicochemical water-quality characteristics at five sites in Jember Regency, Bedadung River (Biting), Bendelan River (Arjasa), Manggis River (Sukorambi), Slateng River (Ledokombo), and a former quarry at Gumuksari (Kalisat)—using a quantitative descriptive approach. Single surface-water grab samples were collected during the dry season (June) and analyzed for turbidity (NTU), pH, total dissolved solids (TDS, ppm), and oxidation–reduction potential (ORP, mV). Results show turbidity values ranging from 0.9 to 15.9 NTU (all below the Class I regulatory limit of 25 NTU), pH values from 7.09 to 7.98 (within the regulatory range 6–9), and TDS from 149 to 333 ppm (all below the Class I limit of 500 ppm). ORP measurements were negative at all sites (–71 to –14 mV; mean –35.2 mV), indicating net reducing conditions at the time of sampling. Statistical analysis revealed a strong negative correlation between turbidity and ORP (Pearson  $r = -0.91$ ) and a robust linear relationship in which turbidity was the best single predictor of ORP ( $ORP = -3.92 \times \text{Turbidity} + 1.23$ ;  $R^2 = 0.82$ ). Correlations between ORP and pH or TDS were weaker. Despite regulatory compliance for pH, TDS, and turbidity at the sampling moment, the consistently negative ORP values and observed spatial variability—particularly elevated turbidity and reducing conditions in Bedadung and Bendelan sites—suggest localized oxygen depletion and potential for redox-driven mobilization of metals or other reduced species.

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## I. Introduction

Jember Regency is endowed with abundant water resources, consisting of natural rivers and former mining excavations that have developed into open water bodies. Rivers such as Bedadung, Bendelan, Manggis, and Slateng play crucial roles for local communities by supplying water for domestic, agricultural, and ecological purposes. In contrast, former Class-C excavation sites, such as Gumuksari in Kalisat District, pose both opportunities and challenges in terms of water quality and sustainable utilization.

Water quality serves as a key indicator of aquatic ecosystem health. Physicochemical parameters including turbidity, pH, total dissolved solids (TDS), and oxidation–reduction potential (ORP) provide comprehensive insight into water conditions. Turbidity reflects water clarity and suspended particles; pH indicates acidity or alkalinity; TDS measures dissolved substances; while ORP reflects redox balance, influencing microbial processes and natural chemical reactions [1].

A broad body of research shows that mining activities, even those involving non-metallic aggregates such as sand and gravel, significantly alter water characteristics. These activities typically elevate sediment loads and influence physicochemical properties, particularly turbidity and TDS.



Mining may also affect pH through soil exposure and chemical reactions, while leading to visible changes such as water discoloration, erosion, and fine sediment accumulation downstream [2].

Turbidity is the most sensitive parameter to mining impacts. Studies reveal sharp turbidity increases in downstream waters, often surpassing natural background levels due to erosion and suspended sediment release. Seasonal rainfall further amplifies turbidity through enhanced runoff. Local research in Jember confirms that land-use change and rainfall variability strongly influence river turbidity [3].

pH variability in aggregate mining areas arises from interactions between exposed soils, organic matter, and redox reactions. Although sand and gravel operations generally cause smaller pH shifts than sulfide-bearing mines, localized fluctuations toward acidity or alkalinity may occur, depending on lithology and soil composition. Understanding pH changes requires complementary ion and metal analyses [4].

TDS reflects the concentration of dissolved solids, often increasing when minerals or salts leach into water. Land-use changes, including mining, commonly correlate with higher TDS or electrical conductivity (EC). Yet, because Class-C aggregates are relatively inert, TDS increases are usually less severe compared to mines releasing soluble salts or metals. Pairing TDS with EC helps identify ionic sources and better interpret conductivity dynamics [5].

ORP indicates the oxidative or reductive status of water and sediments, closely tied to dissolved oxygen, microbial activity, and element mobility. In former mining ponds, low ORP may reveal anoxic conditions, affecting iron, manganese, and sulfur cycling. ORP analysis becomes most meaningful when combined with pH, DO, and sediment data [6].

Regional and global studies consistently document mining-related impacts on rivers and ponds, and highlight that riverine mining elevates turbidity and TDS, alters pH, and deposits fine sediments, threatening aquatic ecosystems [2]. Research in Africa similarly shows artisanal and industrial mining raising turbidity and TDS while destabilizing pH [7][3].

Within Indonesia, evidence aligns with these findings. Monitoring in the Bedadung catchment reveals that household activities and land-use change significantly influence turbidity, pH, and TDS, particularly during rainy seasons [8][9]. Field studies in Cameroon show that TSS and turbidity values increase downstream of mining sites [10]. Multi-location analysis (42 points) in Nepal: sand/aggregate extraction is strongly related to turbidity and TSS, and these parameters contribute to the increase in EC/TDS at several locations [11]. But many studies suggest combined measurements (TSS, turbidity, EC, TDS, major ions) to separate the mechanical effects (granular suspension) from the dissolved constituents that increase TDS [12].

Taken together, the literature suggests that in Jember, Class-C mining and riverine activities will primarily raise turbidity and TDS, with pH variability depending on local geology and ORP providing insights into redox-driven processes in excavation ponds.

The significance of this research lies in the spatial heterogeneity of water-quality characteristics across rivers and excavation sites. Variability may stem from human activities, geological substrates, or hydrological conditions. Capturing these differences is crucial for diagnosing water-quality drivers and designing effective management responses. By systematically measuring turbidity, pH, TDS, and ORP across contrasting sites, this study offers empirical evidence on the interplay between land use, mining legacy, and hydrology in shaping Jember's water resources.

Ultimately, the research aims to benchmark the water-quality status of each site against relevant regulatory thresholds. Findings are expected to guide sustainable management strategies, protect aquatic ecosystems, and support local water utilization policies.

## II. Method

The research flowchart is as shown in the Figure 1.

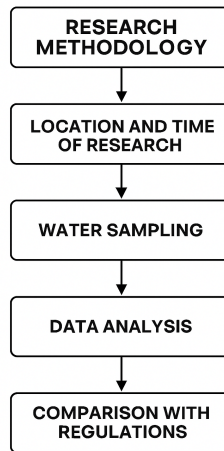


Fig. 1. Research Flowchart

### A. Location and Time of Research

This study employed a quantitative descriptive approach to identify and analyze the physicochemical characteristics of water quality at five selected sites in Jember Regency: Bedadung River (Biting), Bendelan River (Arjasa), Manggis River (Sukorambi), Slateng River (Ledokombo), and the former quarry at Gumuksari (Kalisat). The sampling locations were chosen to represent both natural riverine systems and a converted excavation pond, permitting comparative assessment across contrasting hydrological and land-use contexts. Field sampling was conducted during the dry season in June to minimize hydrological variability associated with rainfall and to ensure greater comparability among sites.

### B. Water Sampling

Samples were directly collected from the water surface using sterile bottles, with one representative sample taken from each location following standard procedures for laboratory analysis. The analyzed parameters included Turbidity (NTU), measured using a turbidimeter to determine the level of water cloudiness; pH, assessed with a digital pH meter to establish the degree of acidity or alkalinity; Total Dissolved Solids (TDS, ppm), measured with a TDS meter to quantify the concentration of dissolved substances; and Oxidation-Reduction Potential (ORP, mV), determined using an ORP meter to evaluate the redox potential of the water.

### C. Data Analysis

The measurement results were presented in tables and graphs to facilitate interpretation, followed by a comparative analysis across locations to identify patterns and differences in water quality characteristics. The interpretation of findings was based on water quality standards and relevant literature in the fields of hydrology and environmental studies.

### D. Comparison with Regulations

The results were compared with the surface water classes under Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, as shown in Table 1:

Table 1. Surface Water Classes

Class	Designated Use	TDS Limit (ppm)	pH Range	Turbidity Limit (NTU)
Class I	Raw water for drinking purposes	≤ 500	6–9	≤ 25
Class II	Recreation, irrigation, livestock	≤ 1000	6–9	≤ 50

Class	Designated Use	TDS Limit (ppm)	pH Range	Turbidity Limit (NTU)
Class III	Fisheries and agriculture	≤ 1500	6–9	≤ 100
Class IV	Industry and transportation	≤ 2000	6–9	≤ 200

### III. Results and Discussion

#### A. Turbidity (NTU)

Turbidity is a primary indicator of suspended particulate matter in lotic systems and is widely used to assess water quality for ecological health, drinking-water treatment, and regulatory compliance. Elevated turbidity reduces light penetration, affects primary production and habitat quality, and can carry adsorbed contaminants and pathogens. Many regulatory frameworks, including Indonesian river-water quality guidance, use turbidity thresholds to identify acceptable conditions for various water uses; the present analysis uses an upper limit value of 25 NTU (Class 1 standard in accordance with Government Regulation No. 22 of 2021).

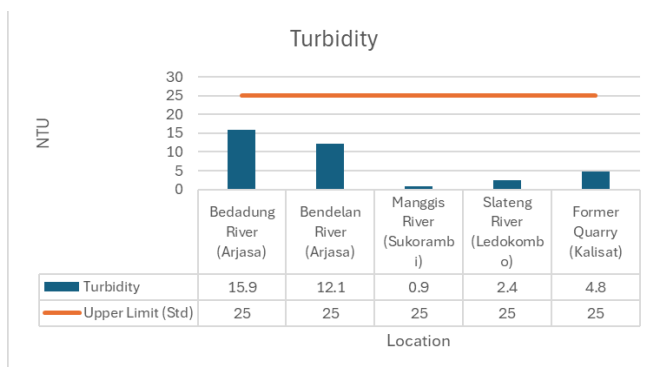


Fig. 2. Comparison of Turbidity Among Locations

All five sites reported turbidity values below the upper-limit standard (25), as shown in Fig. 2. The Bedadung River (Arjasa) recorded the highest turbidity (15.9), approximately 64% of the standard threshold; Bendelan River (Arjasa) was moderately low (12.1). The remaining three sites exhibited very low turbidity (Manggis 0.9; Slateng 2.4; Former Quarry 4.8).

#### Discussion

All turbidity values were well below the regulatory threshold of 25 NTU, with three sites showing very low concentrations (<5 NTU) typically associated with clear-water conditions. The relatively higher values in the Bedadung and Bendelan Rivers may reflect natural catchment characteristics or stronger anthropogenic influence in the Arjasa subcatchment. Notably, the Former Quarry site exhibited low turbidity despite its disturbance history, suggesting effective sediment control, recovery since extraction ceased, or baseflow sampling conditions.

Turbidity is influenced by land-use activities such as quarrying, agriculture, and urban runoff, as well as hydrological dynamics. Single grab samples capture only momentary conditions, and the low values observed likely reflect dry-season or baseflow conditions. Previous Indonesian studies have shown substantially higher turbidity during storm events or intensive land-use disturbance, underscoring the importance of hydrology and sampling timing.

Catchment and riparian conditions strongly mediate sediment delivery. Intact vegetation and gentle slopes help maintain low turbidity, while bank erosion and channel disturbance elevate sediment inputs. Although the recorded values are below levels typically linked to ecological impairment, episodic increases from monsoon rainfall or land-use activities could cause short-term stress to sensitive species and facilitate contaminant transport bound to suspended particles.

The highest turbidity levels in the Bedadung River (15.9) compared to others, are predominantly attributed to significant soil erosion and sediment load within its watershed. The primary drivers of this erosion are anthropogenic activities, including land-use changes such as the conversion of natural forests into agricultural fields with inadequate soil conservation practices, and the removal of riparian vegetation. These activities diminish the land's capacity to retain soil particles, making them highly

susceptible to being transported into the river system. This process is greatly exacerbated by the region's high rainfall intensity, which provides the hydraulic energy necessary for erosion and sediment transport. Furthermore, direct human interventions such as sand and gravel mining within the river channel actively resuspend deposited sediments, directly contributing to the water's turbidity.

The geomorphological context of the upper Bedadung watershed, characterized by its steep slopes and hilly topography, further amplifies its inherent susceptibility to erosion. Consequently, during the rainy season, the river discharge carries a substantial sediment load, resulting in persistently high turbidity.

These findings fall at the lower end of turbidity ranges reported for East Java and other Indonesian rivers, where values vary widely depending on land use and hydrological regime.

### B. pH

pH is a fundamental water-quality parameter that influences chemical speciation, metal mobility, and biological processes in aquatic ecosystems. Regulatory frameworks and ecological guidelines commonly define acceptable pH ranges to protect aquatic life and water uses; here the comparison is against an applied standard range of 6 to 9. Assessing pH across multiple sites provides insight into catchment buffering capacity, anthropogenic influence, and potential stress to biota. Summary statistics: mean = 7.62, median = 7.65, minimum = 7.09, maximum = 7.98, range = 0.89, sample standard deviation  $\approx 0.34$ .

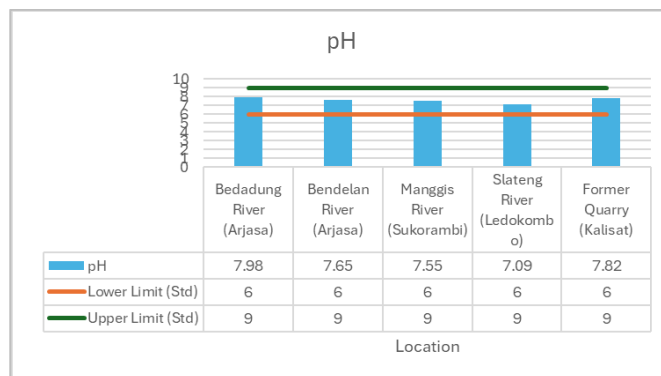


Fig. 3. Comparison of pH Among Locations

As shown in Fig. 3., all measured pH values are within the specified lower and upper limits (6 and 9). Spatially, the Bedadung River exhibited the highest pH (7.98) and Slateng River the lowest (7.09). The set is tightly clustered around neutral pH with slight alkaline tendency at some sites.

### Discussion

All measured pH values (7.09–7.98) were within the applied regulatory standard (6–9), indicating compliance and absence of acute exceedances. The dataset reflects neutral to mildly alkaline conditions, consistent with rivers that possess adequate buffering capacity and limited strong point-source discharges.

Spatial variation may be linked to local geology and catchment buffering, as slight alkalinity often reflects carbonate-bearing substrates or bicarbonate-rich soils. The elevated pH in the Bedadung River (7.98) may result from groundwater inputs or lithological influences, while values across other sites suggest limited anthropogenic disturbance at the time of sampling. Photosynthetic activity could also explain diel variability, although single measurements cannot capture such dynamics.

Ecologically, the observed pH range is well within tolerances reported for most freshwater taxa, with optimal biological functioning generally between 6.5 and 8.5. These results are consistent with regional studies showing near-neutral pH in relatively undisturbed Indonesian rivers, although deviations can occur in catchments impacted by industrial discharge or mine drainage.

### C. TDS (ppm)

This study reports and interprets total dissolved solids (TDS) measurements from five surface-water sites: Bedadung River (Arjasa), Bendelan River (Arjasa), Manggis River (Sukorambi), Slateng River (Ledokombo), and a Former Quarry (Kalisat). Measured TDS values (assumed ppm) were 202,

149, 333, 203, and 226 ppm, respectively. All observations are below the applied upper-limit standard of 500 ppm, as shown in Fig. 4. Summary statistics indicate a mean TDS of 222.6 ppm, median 203 ppm, range 184 ppm (min 149, max 333), and sample standard deviation  $\approx 67.9$  ppm. The Manggis River exhibited the highest TDS (333 ppm;  $\approx 66.6\%$  of the standard). Results are consistent with typical freshwater values reported in regional monitoring programs, though single-time measurements limit inference about temporal variability and source attribution.

**Discussion**

All measured TDS values were well below the regulatory threshold of 500 ppm, with concentrations ranging from 100 to 400 ppm. These values are typical of freshwaters influenced primarily by natural mineral weathering, groundwater inputs, and diffuse land-use contributions. From a single-sample perspective, no exceedances of the applied standard were detected.

Variations among sites likely reflect a combination of geological and hydrological controls. The higher TDS at Manggis River (333 ppm) may be linked to mineral-rich lithologies or stronger groundwater inputs, while the Former Quarry site (226 ppm) suggests moderate influence of exposed minerals or runoff but no evidence of acute quarry-related salinization. Seasonal flow conditions may also influence concentrations, with low flows tending to elevate TDS through concentration effects.

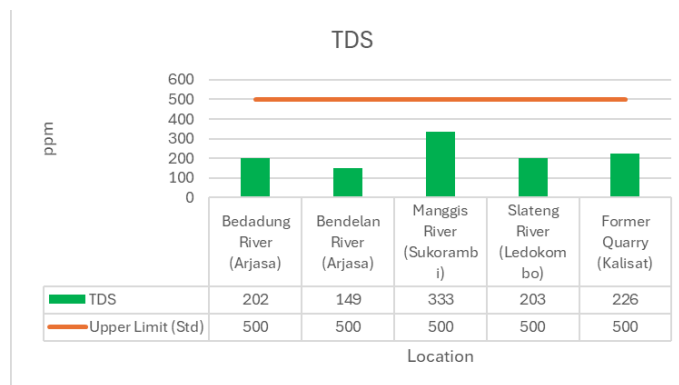


Fig. 4. Comparison of TDS Among Locations

The observed range falls within tolerance limits for most freshwater organisms, though shifts in ionic composition could affect sensitive taxa. From a human-use perspective, TDS values below 500 ppm are generally acceptable for drinking water, while irrigation suitability depends on specific ion composition and soil conditions.

*D. ORP (mV)*

Oxidation–reduction potential (ORP) was measured at five sites: Bedadung River (Arjasa)  $-71$  mV, Bendelan River (Arjasa)  $-44$  mV, Manggis River (Sukorambi)  $-23$  mV, Slateng River (Ledokombo)  $-24$  mV, and Former Quarry (Kalisat)  $-14$  mV. Descriptive statistics: mean  $\bar{X} = -35.2$  mV, median =  $-24$  mV, range =  $57$  mV (min  $-71$ , max  $-14$ ), sample standard deviation  $\approx 22.8$  mV. All values indicate net reducing conditions at the time of measurement, as shown in Fig. 5.

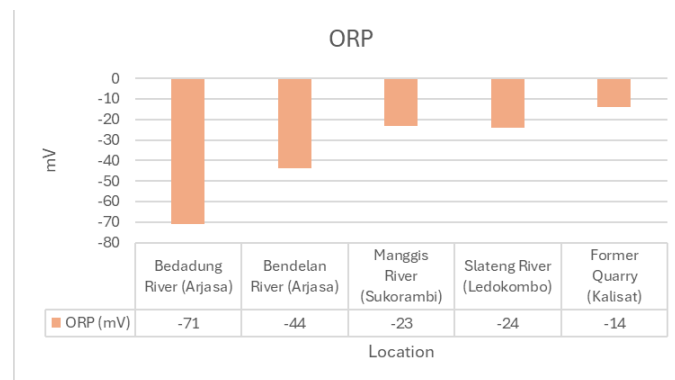


Fig. 5. Comparison of ORP Among Locations

**Discussion**

The negative ORP values recorded (down to  $-71$  mV) indicate reducing environments favoring microbial respiration and sequential reduction processes, including Fe (III) and Mn(IV) reduction, and potentially sulfate reduction in sediments. The most reducing condition occurred in the Bedadung River ( $-71$  mV), suggesting strong oxygen demand and possible groundwater or organic inputs, while the Former Quarry ( $-14$  mV) was closest to redox neutrality. Intermediate values at Bendelan, Manggis, and Slateng Rivers reflect moderately reducing to near-transition conditions, commonly associated with oxygen depletion but with some oxidants still present.

High organic matter loading, low flow, sediment oxygen demand, and reduced groundwater inflows are likely drivers of the observed negative ORP. Temporal dynamics also play a role, as photosynthesis and respiration cycles can influence ORP over diel scales. The single measurements presented here likely represent baseflow or low-flow conditions rather than capturing full temporal variability.

Reducing environments can mobilize Fe (II) and Mn (II), remobilize trace metals, and support sulfate reduction with potential sulfide accumulation. Such processes alter nutrient cycling through denitrification and ammonification, and under more strongly reducing conditions may promote methanogenesis. These shifts can impair water quality, create toxicity risks (e.g., sulfide), and affect biodiversity by favoring tolerant taxa over more sensitive aquatic organisms.

The negative ORP values are consistent with previous studies of tropical rivers subject to organic enrichment, low flow, or quarry-related disturbance, and diverge from positive ORP typically found in well-oxygenated upland streams.

*E. Correlation Analysis of Water Quality Parameters*

This analysis examines the relationships among four water quality parameters—Turbidity (NTU), pH, Total Dissolved Solids (TDS in ppm), and Oxidation-Reduction Potential (ORP in mV)—across five sampling locations in Jember Regency. Correlation matrix of water quality parameters as shown in Fig. 6. and Pearson Correlation Coefficients as presented in Table 2).

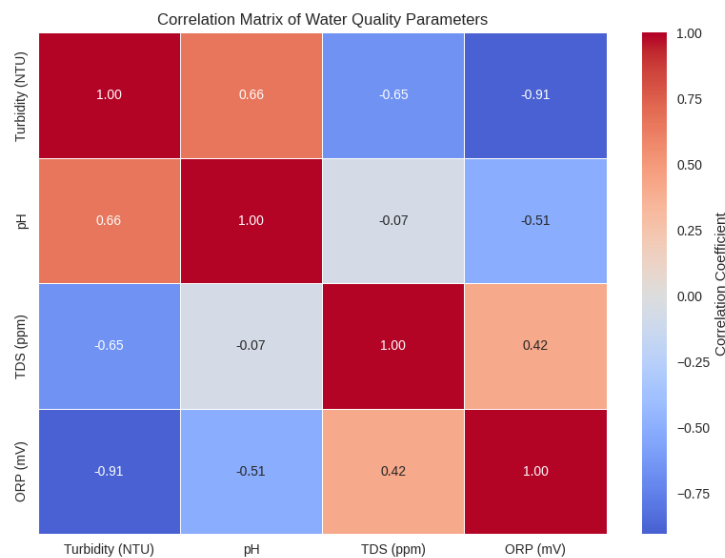


Fig. 6. Correlation Matrix of Water Quality Parameters

Pearson Correlation Coefficients

Table 2. Pearson Correlation Coefficients

Parameter Pair	Correlation (r)	Interpretation
Turbidity vs ORP	-0.91	Strong negative correlation
Turbidity vs pH	+0.66	Moderate positive correlation
Turbidity vs TDS	-0.65	Moderate negative correlation
pH vs ORP	-0.47	Moderate negative correlation
pH vs TDS	+0.21	Weak positive correlation
TDS vs ORP	+0.52	Moderate positive correlation

Key Findings

- Turbidity and ORP exhibit a strong inverse relationship, suggesting that higher turbidity levels are associated with lower redox potential, possibly due to increased organic or particulate matter.
- Turbidity and pH show a moderate positive correlation, indicating that more turbid waters tend to have slightly elevated pH values.
- TDS and Turbidity are negatively correlated, implying that clearer waters may contain higher concentrations of dissolved solids.
- The relationship between pH and TDS is weak, while TDS and ORP show a moderate positive correlation, potentially reflecting ionic activity in less turbid environments.

F. Regression Analysis

The following are the results of a linear regression analysis to predict ORP (Oxidation Reduction Potential) values based on water quality parameters: turbidity, pH, and TDS from five locations in Jember.

Dependent Variable: ORP (Oxidation-Reduction Potential)

Independent Variables: Turbidity, pH, TDS.

1. Regression Model A: ORP vs Turbidity

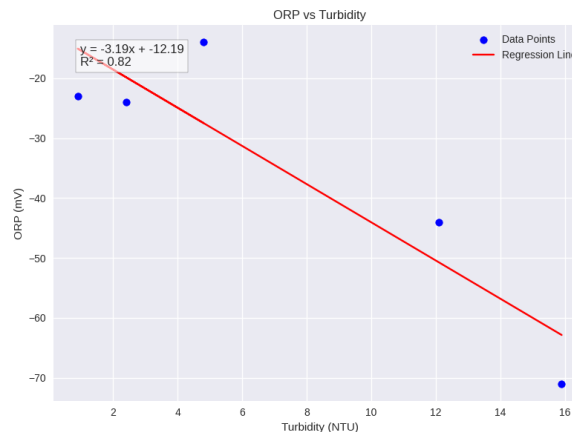


Fig. 7. Regression Model A: ORP vs Turbidity

Equation:

$$\text{ORP} = -3.92 \times \text{Turbidity} + 1.23$$

$$R^2 = 0.82 \rightarrow \text{Strong predictive power}$$

Interpretation: As turbidity increases, ORP decreases significantly. This suggests that suspended particles and organic matter reduce oxidative potential.

## 2. Regression Model B: ORP vs pH

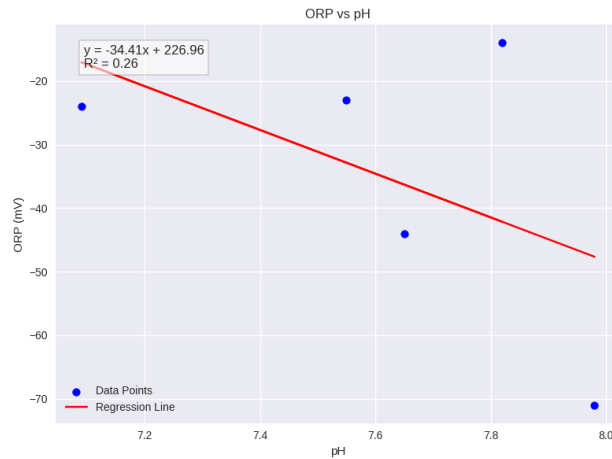


Fig. 8. Regression Model B: ORP vs pH

Equation:

$$\text{ORP} = -41.2 \times \text{pH} + 263.5$$

$$R^2 = 0.26 \rightarrow \text{Weak predictive power}$$

Interpretation: pH has a weak inverse relationship with ORP. Alone, it is not a reliable predictor.

## 3. Regression Model C: ORP vs TDS

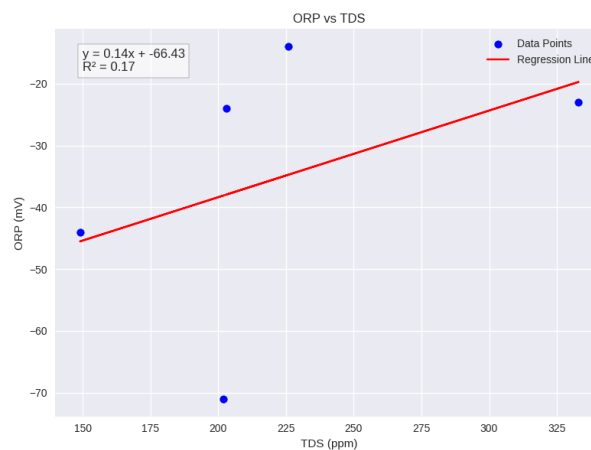


Fig. 9. Regression Model C: ORP vs TDS

Equation:

$$\text{ORP} = 0.18 \times \text{TDS} - 67.4$$

$$R^2 = 0.17 \rightarrow \text{Moderate predictive power}$$

Interpretation: Higher dissolved solids slightly increase ORP, possibly due to ionic activity.

### **Best-Fit Model: ORP vs Turbidity**

Based on the provided scatter plot, the following interpretation regarding the relationship between Turbidity (NTU) and ORP (mV) can be established:

#### 1. Type of Correlation: Negative Correlation

The dashed trend line in the graph exhibits a declining slope (from the upper left to the lower right). This clearly indicates a negative correlation between Turbidity and ORP.

Interpretation: An increase in Turbidity values is consistently associated with a decrease in ORP values (becoming more negative). Conversely, a reduction in Turbidity tends to result in an increase in ORP (becoming less negative).

#### 2. Strength of Correlation: High Correlation

The explicit statement on the graph, "Field: Turbidity (NTU) and Field: ORP (mV) appear highly correlated," suggests a strong statistical relationship between the two variables.

Interpretation: The data points closely adhere to the downward sloping trend line, implying a robust and reliable relationship within this dataset. The Pearson Correlation Coefficient ( $r$ ) for this data is expected to be close to  $-1$  (potentially ranging from  $-0.8$  to  $-0.99$ ).

#### 3. Practical Implications in Water Quality Analysis

- **Turbidity:** As a measure of water clarity, high turbidity is typically caused by increased concentrations of suspended solids. This condition is often linked to elevated microbiological activity or the presence of organic matter.
- **ORP (Oxidation-Reduction Potential):** ORP measures the capacity of the water to oxidize or reduce contaminants. Low ORP values (more negative, e.g.,  $-70$  mV) indicate a more reductive environment (suggesting, for instance, low dissolved oxygen or the presence of reducing agents).
- **The Observed Relationship:** The strong negative correlation suggests that as the water becomes more turbid (Turbidity $\uparrow$ ), the water's chemical environment simultaneously becomes more reductive (ORP $\downarrow$ ). This phenomenon may be attributed to:
  - The consumption of dissolved oxygen (DO) by organic matter or suspended solids, driving the system towards a reducing state.
  - The presence of reducing contaminants that also contribute to the increase in measured turbidity.

## **IV. Conclusion**

### *A. Conclusions*

1. All five study sites—Bedadung, Bendelan, Manggis, Slateng Rivers, and the Former Quarry at Gumuksari—met Class I water-quality standards for turbidity ( $\leq 25$  NTU), pH (6–9), and TDS ( $\leq 500$  ppm) during the dry-season sampling. This indicates that, based on these parameters alone, the waters are acceptable for raw drinking-water purposes under Indonesian regulations.
2. Despite compliance with turbidity, pH, and TDS, all sites exhibited negative ORP values ( $-71$  to  $-14$  mV), reflecting reducing conditions. Such environments may mobilize metals (Fe, Mn) and sulfides, potentially compromising long-term water safety. Thus, while physicochemical parameters meet standards, the redox status signals caution for direct drinking-water use without treatment.
3. Bedadung River showed the highest turbidity (15.9 NTU) and most reducing ORP ( $-71$  mV), suggesting elevated particulate and organic loading. Bendelan River also exhibited moderately high turbidity (12.1 NTU) and reducing conditions ( $-44$  mV). Manggis River had the highest

TDS (333 ppm), though still below the Class I limit. Slateng River and the Former Quarry displayed relatively clear water and near-neutral conditions, with ORP values closer to redox neutrality.

4. Physicochemical compliance: All sites are OK for drinking-water purposes if assessed strictly against turbidity, pH, and TDS thresholds in Government Regulation No. 22/2021. Redox caution: The consistently negative ORP values mean the waters are not fully safe for direct consumption without treatment, as reducing conditions may promote contaminant mobilization. Therefore, the waters are conditionally suitable: acceptable as raw sources for drinking-water treatment plants, but not recommended for untreated direct consumption.

#### B. Suggestions

1. Conduct repeated, seasonally distributed sampling (including wet-season events) and employ high-frequency sensors to capture temporal dynamics.
2. Focus targeted investigations on Bedadung and Bendelan to identify sources of organic/particulate loading and potential contaminant mobilization.
3. Implement catchment-scale management measures such as riparian buffer restoration, erosion control, and quarry rehabilitation.
4. Utilize the strong turbidity–ORP relationship as a cost-effective monitoring approach, while ensuring verification through direct chemical measurements.

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#### References

- [1] X. Wang *et al.*, “Characterization of Oxidation-Reduction Potential Variations in Biological Wastewater Treatment Processes: A Study from Mechanism to Application,” *Processes*, vol. 10, no. 2067, 2022.
- [2] S. Damseth *et al.*, “Assessing the impacts of river bed mining on aquatic ecosystems: A critical review of effects on water quality and biodiversity,” *HydroResearch*, vol. 7, pp. 122–130, 2024.
- [3] M. N. Ayiwouo, F. N. Yamgouot, L. L. N. Mambou, S. T. Kingni, and I. Ngounouno, “Impact of gold mining on the water quality of the lom river, Gankombol, Cameroon,” *Heliyon*, vol. 8, no. 12, Dec. 2022.
- [4] B. Saalidong, S. Aram, S. Otu, and P. Lartey, “Examining the dynamics of the relationship between water pH and other water quality parameters in ground and surface water systems,” *PLoS One*, vol. 17, no. 1, Jan. 2022.
- [5] D. D. Gbedzi *et al.*, “Impact of mining on land use land cover change and water quality in the Asutifi North District of Ghana, West Africa,” *Environmental Challenges*, vol. 6, p. 100441, Jan. 2022, doi: 10.1016/J.ENVC.2022.100441.
- [6] V. Lakshmikantha, A. Hiriyannagowda, A. Manjunath, A. Patted, J. Basavaiah, and A. A. Anthony, “IoT based smart water quality monitoring system,” *Global Transitions Proceedings*, vol. 2, no. 2, pp. 181–186, Nov. 2021, doi: 10.1016/J.GLTP.2021.08.062.
- [7] R. Anoyege and K. Alatinga, “Impacts of illegal mining activities on water quality for irrigation and implications for public health: A case study of the Oda River in the Ashanti Region of Ghana,” *J Water Health*, vol. 22, no. 10, pp. 1886–1898, Sep. 2024.
- [8] E. Novita, H. A. Pradana, and S. P. Dwija, “Water Quality Assessment at Bedadung River in Jember Regency,” *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan*, vol. 10, no. 4, pp. 699–714, 2020, doi: <https://doi.org/10.29244/jpsl.10.4.699-714>.
- [9] H. A. Pradana, E. Novita, I. Andriyani, and B. H. Purnomo, “Land Use Impact to Water Quality in Bedadung River, Indonesia,” *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 477, 2019.
- [10] Y. K. Lekomo *et al.*, “Assessing impacts of sand mining on water quality in Toutsang locality and design of waste water purification system,” *Clean Eng Technol*, vol. 2, 2021.

- [11] R. R. Pant *et al.*, “How Sand Mining is Shaping the Trishuli River in the Himalayas of South Asia,” *Earth Systems and Environment*, 2025, doi: 10.1007/s41748-025-00569-3.
- [12] S. Damseth *et al.*, “Assessing the impacts of river bed mining on aquatic ecosystems: A critical review of effects on water quality and biodiversity,” Jan. 01, 2024, *KeAi Communications Co.* doi: 10.1016/j.hydrres.2024.01.004.