

RESEARCH ARTICLE

Groundwater Quality Evaluation Based on Geochemistry Analysis in Wates Area, Blitar Regency, East Java, Indonesia

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Received: December 20, 2026; Accepted: January 31, 2026

Abstract

Groundwater is the primary water resource for communities in the Wates area, Blitar Regency, East Java. This study aims to evaluate groundwater quality based on physical and geochemical characteristics and to assess its suitability for domestic use. The study area is underlain by limestone-dominated lithology with high calcium carbonate (CaCO_3) content, which strongly influences groundwater chemistry. Groundwater samples were collected from three locations—Tugurejo, Sumberoto, and Sukorejo—representing wells and springs. Physical parameters (color, odor, and taste) and geochemical parameters (pH, total dissolved solids (TDS), Fe, Mn, Cl^- , CaCO_3 , and SO_4^{2-}) were analyzed and compared with Indonesian clean water quality standards (Regulation of the Ministry of Health No. 416/MENKES/PER/IX/1990). The results indicate that groundwater quality in the study area is generally acceptable for clean water use, although elevated manganese concentration was detected at one sampling location. Overall, groundwater chemistry is primarily controlled by limestone dissolution and water-rock interaction processes.

Keywords: groundwater quality, geochemistry, limestone aquifer, Wates, Blitar

1. Introduction

Water is an essential resource for human life, and access to clean and safe water is a fundamental requirement for local communities. In the Wates area, Blitar Regency, groundwater is widely utilized for daily domestic needs, sourced from shallow wells and natural springs. Groundwater flow in the study area occurs through fractures and joints within the aquifer system, which is predominantly composed of limestone lithology with high CaCO_3 content.

Carbonate aquifers are known to significantly influence groundwater chemistry through dissolution processes, often resulting in high hardness and elevated concentrations of calcium and bicarbonate ions. Consequently, evaluating groundwater quality using a geochemical approach is essential to determine its suitability for domestic use and to understand the influence of lithology on groundwater characteristics. This study focuses on groundwater quality analysis in Tugurejo and

surrounding areas based on physical and chemical parameters, following national water quality standards

2. Study Area

Tugurejo Village, Wates District, Blitar Regency is an area where the local community continues to rely on groundwater as a primary water resource for daily activities. The groundwater utilized consists of both shallow groundwater and deeper subsurface groundwater that flows beneath the aquifer system through fractures and joints within the rock mass. The groundwater aquifer in Tugurejo Village is predominantly composed of limestone lithology with a high CaCO_3 content, which strongly influences the hydrogeochemical characteristics of the groundwater. Consequently, a geochemical assessment is essential to evaluate the chemical composition and quality of groundwater in Tugurejo Village, Wates District, Blitar Regency.

The study area is located in Tugurejo Village, Wates District, Blitar Regency, East Java Province, Indonesia. This research was conducted in 2023 through groundwater sampling from domestic wells and natural springs distributed across Tugurejo Village and its surrounding areas.

3. Theory

3.1 Groundwater Quality

Groundwater Quality Standards based on the Ministry of Health Regulation (Permenkes RI No. 492/MENKES/PER/IV/2010).

Table 1
Groundwater Quality Standars based on Ministry of Health Regulation
Physical Parameters

Parameter	Unit	Permissible Limit
Odor	–	Odorless
Taste	–	Tasteless
Temperature	°C	Air temperature ± 3
Total Dissolved Solids (TDS)	mg/L	≤ 1,500
Turbidity	NTU	≤ 25
Color	TCU	≤ 50

Chemical Parameters

Parameter	Unit	Permissible Limit
pH	–	6.5 – 9.0
Iron (Fe)	mg/L	≤ 1.0
Manganese (Mn)	mg/L	≤ 0.5
Chloride (Cl ⁻)	mg/L	≤ 600
Sulfate (SO ₄ ²⁻)	mg/L	≤ 400
Nitrate (NO ₃ ⁻ as N)	mg/L	≤ 10
Nitrite (NO ₂ ⁻ as N)	mg/L	≤ 1.0
Fluoride (F ⁻)	mg/L	≤ 1.5
Hardness (as CaCO ₃)	mg/L	≤ 500

Heavy Metal Parameters

Parameter	Unit	Permissible Limit
Mercury (Hg)	mg/L	≤ 0.001
Arsenic (As)	mg/L	≤ 0.05
Cadmium (Cd)	mg/L	≤ 0.005
Chromium (Cr ⁶⁺)	mg/L	≤ 0.05
Lead (Pb)	mg/L	≤ 0.05
Selenium (Se)	mg/L	≤ 0.01
Zinc (Zn)	mg/L	≤ 15
Cyanide (CN ⁻)	mg/L	≤ 0.1

4. Methods

Groundwater sampling was carried out at three locations, namely Tugurejo, Sumberoto, and Sukorejo. Each groundwater sample was analyzed for its physical characteristics and geochemical properties. The physical parameters assessed included color, odor, and taste. Geochemical analyses involved the measurement of pH, total dissolved solids (TDS), manganese (Mn), iron (Fe), sulfate (SO₄²⁻), and calcium carbonate (CaCO₃) concentrations. The results obtained were subsequently evaluated by

comparison with the clean water quality standards established by the Indonesian Ministry of Health Regulation No. 416/MENKES/PER/IX/1990.

5. Result

5.1 The Physical Characteristics

Field observations show that groundwater samples are generally colorless to slightly turbid, odorless, and tasteless. These characteristics indicate that groundwater in the study area is minimally affected by organic contamination or anthropogenic pollution.

5.2 Geochemical Characteristics

The pH values of groundwater samples range from 6.98 to 7.22, indicating neutral to slightly alkaline conditions. TDS concentrations vary between 528 and 784 mg/L, reflecting moderate mineralization influenced by water-rock interaction within limestone aquifers.

Iron (Fe) concentrations range from 0.144 to 0.160 mg/L, which are below the permissible limit for clean water. Manganese (Mn) concentrations vary significantly, with one sample from Sukorejo exceeding the recommended standard. Chloride (Cl⁻) concentrations are relatively low (< 25 mg/L), suggesting minimal influence from saline intrusion or anthropogenic sources. Calcium carbonate (CaCO₃) concentrations are relatively high, reaching up to 374.26 mg/L, confirming the dominance of carbonate dissolution processes. Sulfate (SO₄²⁻) concentrations remain within acceptable limits across all samples.

6. Discussion

The geochemical characteristics of groundwater in the Wates area are primarily controlled by lithological factors, particularly limestone dissolution. Neutral pH values and elevated CaCO₃ concentrations indicate active carbonate weathering, which results in hard water conditions typical of limestone aquifers. Elevated manganese concentration at one sampling point is likely associated with localized geochemical conditions and redox processes within the aquifer system.

Overall, most groundwater samples meet the clean water quality standards, indicating that groundwater in the study area is generally suitable for domestic use. However, localized manganese enrichment suggests the need for periodic monitoring to ensure long-term water quality safety.



Fig. 1. Groundwater quality field sampling

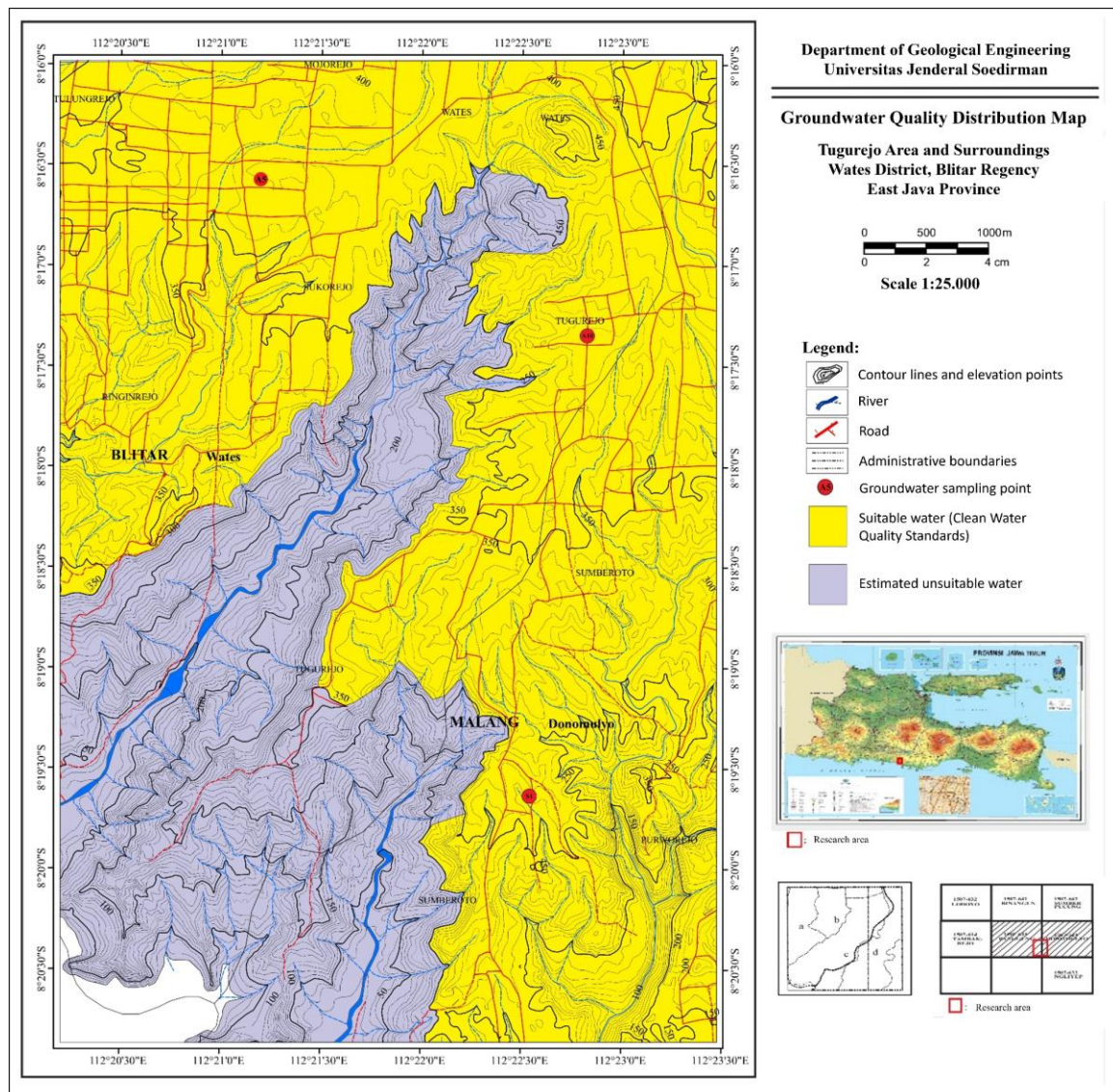


Fig. 2. Groundwater quality distribution map

Table 2
Result of physical parameters

Sample ID	Area	Source	Color	Odor
S1	Sukorejo	Well	Whitish, Turbid	Odorless
A5	Sumberoto	Spring	Colorless	Odorless
A10	Tugurejo	Well	Colorless	Odorless

Table 3
Result of chemical parameters

Sample ID	Area	Source	pH	TDS (mg/L)	Fe (mg/L)	Mn (mg/L)	Cl (mg/L)	CaCO ₃ (mg/L)	SO ₄ (mg/L)
S1	Sukorejo	Well	6.99	784	0.159	0.63	10.27	374.26	3.573
A5	Sumberoto	Spring	7.22	618	0.160	0.004	22.99	259.41	25.344
A10	Tugurejo	Well	6.98	528	0.144	0.017	22.99	229.70	10.796

Table 4
Results of Elemental Analysis Correlated with Clean Water Quality Standards (Regulation of the Ministry of Health No. 416/MENKES/PER/IX/1990)

Parameter	Recommended maximum limit (mg/L)	Permissible maximum limit (mg/L)	Measured Value (mg/L)	Compliance
Iron (Fe)	1.0	1.0	0.159-0.160	Yes
Manganese (Mn)	0.5	0.5	0.004-0.63	No
Hardness (CaCO ₃)	500	500	229.70-374.26	Yes
Sulfate (SO ₄)	200	400	3.573-25.344	Yes
Chloride (Cl)	200	600	10.27-22.99	Yes

Acknowledgements

The authors would like to acknowledge the local community of Tugurejo, Sumberoto, and Sukorejo for their support during fieldwork and sampling activities.

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