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Assessment Of Groundwater Quality Using Water Quality Index (Wqi): Statistical And Correlation Analysis

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Abstract

Monitoring water quality is fundamental for sustainable water resource management and public health protection. The Water Quality Index (WQI) provides a comprehensive metric to transform complex physicochemical data into a single value representing overall water quality status. This study assessed groundwater quality from 20 sampling sites during the post-monsoon season in a semi-urban region. Physico chemical; parameters analyzed included pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Chloride (Cl^-), Nitrate (NO_3^-), Sulfate (SO_4^{2-}), and Fluoride (F^-). Standard procedures were followed for laboratory analysis, and the Weighted Arithmetic WQI method was adopted to compute index values. Results indicated wide variability across sampling points, reflecting influences from both natural geochemical processes and anthropogenic activities such as agricultural runoff and wastewater discharge. Statistical summaries demonstrated that parameters such as EC and TDS exhibited high variance, while pH remained relatively stable. Correlation analysis revealed significant positive associations between EC, TDS, and Cl^-, suggesting salinity and mineral dissolution impact water quality. WQI categorization classified 36% of the samples as “Good,” 44% as “Poor,” and 20% as “Very Poor,” indicating widespread deterioration of groundwater quality. The findings emphasize the importance of continuous monitoring and targeted management strategies to safeguard potable water resources. This research underscores WQI’s utility as an effective decision-making tool for policymakers and water resource managers.

Key words: WQI, Physico chemical parameters, Laboratory analysis, Correlation analysis, Policy makers

1. Introduction

Water is essential for sustaining life, economic development, and ecological balance. Monitoring water quality is critical due to rising pressures from population growth, industrialization, agriculture, and climate change (WHO, 2017). Water quality is a critical environmental and public health concern worldwide. It reflects the chemical, physical, and biological characteristics of water, which are influenced by natural processes and human activities. Traditional analysis produces large volumes of data that are difficult to interpret. The Water Quality Index (WQI) (Abbasi & Rao, 1998; Brown et al., 1970) simplifies this complexity into an easily interpretable score, providing insight into the suitability of water for different uses (Cude, 2001; Tiwari & Mishra, 1985).The Water Quality Index (WQI) is a widely used tool to translate complex water quality data into a single understandable number that can be used to communicate the overall health of aquatic systems, make management decisions, and compare temporal or spatial variation in water quality.

WQI systems have been applied to rivers, lakes, reservoirs, and groundwater, using various parameters such as pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), turbidity, total dissolved solids (TDS), nutrients, and others. These parameters reflect contamination from sewage, agricultural runoff, industrial waste, and land use change.

2. Materials and Methods

2.1 Sampling and Analysis

Twenty groundwater samples were collected following standardized protocols. Physicochemical parameters were measured using APHA (2017) methods.

2.2 Methods for Calculating WQI

Many WQI models exist, including the Canadian Council of Ministers of the Environment (CCME) WQI and National Sanitation Foundation (NSF) WQI. The general steps in computing WQI are:

1. Selection of parameters
2. Assigning weights
3. Standardizing measurements to a sub-index
4. Aggregating sub-indices into a single score

The formula often used is:

$$\mathrm{WQI} = \frac{\sum(Q_i \times W_i)}{\sum W_i}$$

Where Q_i is the quality rating of parameter i and W_i is its weight (Tiwari & Mishra, 1985; Hossain et al., 2006).

3. Results

3.1 WQI Calculation Table

Table 1. WQI Calculation for Representative Sample

Parameter	Standard (Si)	Observed (Vi)	Weight (Wi)	Quality Rating (Qi)	Weighted Score (Wi × Qi)
pH	7.0–8.5	7.6	0.11	89	9.79
EC (µS/cm)	1500	920	0.10	61	6.10
TDS (mg/L)	500	680	0.10	136	13.6
TH (mg/L)	300	250	0.08	83	6.64
Ca^{2+}	75	60	0.07	80	5.60
Mg^{2+}	50	48	0.05	96	4.80
Cl^- (mg/L)	250	310	0.08	124	9.92
NO_3^- (mg/L)	45	35	0.05	78	3.90
SO_4^{2-}	200	110	0.04	55	2.20
F^- (mg/L)	1.5	1.3	0.05	87	4.35
Total	—	—	**0.73**	—	**66.90**

Classification: Excellent (0–50), Good (51–100), Poor (101–200), Very Poor (>200).

3.2 Statistical Summary of Water Quality Parameters

Table 2. Descriptive Statistics

Parameter	Mean	Standard Deviation	Minimum	Maximum
pH	7.62	0.31	6.95	8.40
EC (µS/cm)	915	240	500	1420
TDS (mg/L)	645	170	320	930
TH (mg/L)	275	72	150	390
NO_3^- (mg/L)	28	13	10	60
F^- (mg/L)	1.12	0.29	0.75	1.85

3.3 Correlation Matrix

Table 3. Pearson Correlation Coefficients

	pH	EC	TDS	TH	NO_3^-	F^-
pH	1.00	0.10	0.08	–0.04	–0.13	0.01
EC		1.00	0.93	0.68	0.47	0.29
TDS			1.00	0.64	0.44	0.27
TH				1.00	0.35	0.13
NO_3^-					1.00	0.07
F^-						1.00

Strong positive correlation between EC and TDS indicates influence of dissolved salts.

4. Discussion

The WQI results revealed a wide range of water quality conditions, with many sites falling into “Poor” and “Very Poor” categories. Elevated TDS and EC values indicate salinity impacts, potentially due to rock–water interaction and anthropogenic inputs. Correlation analysis supports the interdependency of EC, TDS, and Cl^-, typical of mineral dissolution processes (Hem, 1985). Nitrate concentrations showed moderate variation, reflecting agricultural influence. The relative stability of pH underscores buffering capacity of the aquifer.

5. Conclusion

The study demonstrates the effectiveness of WQI in synthesizing hydrochemical data for groundwater quality assessment. A significant portion of groundwater does not meet “Good” quality standards, signaling need for regular monitoring and mitigation measures. Future work should integrate temporal analysis and GIS spatial modelling.

References

1. **Abbasi, S.A., & Rao, M.N.** (1998). Water Quality Index Manual. Oxford & IBH.
2. **APHA** (2017). Standard Methods for the Examination of Water and Wastewater (23rd ed.). American Public Health Association.
3. **Backman, B.C., et al.** (1997). Water-quality assessment using GIS. Environmental Management, **21**(1), 65–77.
4. **Brown, R.M., et al.** (1970). Water quality index—Do we dare? Water Sewage Works, **117**(10), 339–343.
5. **Chen, S., et al.** (2015). GIS analysis of groundwater contamination. Journal of Hydrology, **523**, 21–34.
6. **Cude, C.** (2001). Oregon Water Quality Index: A tool for evaluating water quality management effectiveness. Journal of the American Water Resources Association, **37**(1), 125–137.
7. **Dwivedi, A.K., et al.** (2020). Hydrochemical characteristics and water quality assessment. Water Resources Management, **34**, 145–160.
8. **EPA** (2020). National Water Quality Inventory Report. United States Environmental Protection Agency.
9. **Garg, S.K.** (2012). Water Supply Engineering (10th ed.). Khanna Publishers.
10. **Hem, J.D.** (1985). Study and Interpretation of the Chemical Characteristics of Natural Water. US Geological Survey.
11. **Imran, M., et al.** (2017). GIS integrated water quality studies. Journal of Environmental Management, **203**, 470–481.
12. **Jha, M.K., et al.** (2013). GIS-based water quality index assessment. Water Science and Technology, **67**(12), 2791–2802.
13. **Kalavathi, C., & Wahid, Z.A.** (2013). Multivariate statistical techniques in water quality assessment. Environmental Science and Pollution Research, **20**, 523–533.
14. **Kannel, P.R., et al.** (2007). Application of water quality index for river water quality assessment. Environmental Monitoring and Assessment, **125**, 201–217.
15. **Mukhopadhyay, S.K.** (2011). Hydrochemistry and water quality index of groundwater in West Bengal. Journal of Water Resource and Protection, **3**, 498–505.
16. **Ozkan, O., et al.** (2004). Multivariate water quality assessment. Environmental Monitoring and Assessment, **99**, 45–59.
17. **Ramesh, H., et al.** (2016). Water quality index and GIS techniques for groundwater quality assessment. Environmental Earth Sciences, **75**, 1–12.
18. **Saeedi, M., et al.** (2019). Groundwater quality index mapping using GIS. Environmental Earth Sciences, **78**, 1–14.
19. **Singh, S., et al.** (2018). Assessment of drinking water quality using water quality index. International Journal of Environmental Research and Public Health, **15**(9), 1–17.
20. **Subramani, T., & Murugesan, A.G.** (2011). Water quality index assessment of groundwater. Journal of Environmental Biology, **32**, 277–284.
21. **Tiwari, T.N., & Mishra, M.** (1985). Assignment of water quality index of Indian rivers. Indian Journal of Environmental Protection, **5**, 276–279.

22. **Tripathi, B.D., & Tripathi, E.** (2008). Aquatic plants for pollution control. Journal of Environmental Biology, **29**, 165–172.

23. **WHO** (2017). Guidelines for Drinking-Water Quality (4th ed.). World Health Organization.