



Assessment of Water Quality using Water Quality Index : A Case Study

K. Maria Das¹, T. Siva Rao², M.V. Raju³, J. Krishna Kishore⁴, M. Satish Kumar⁵

¹Assistant Professor, Department of Chemistry, School of ASH, Vignan's Foundation for Science, Technology and Research, Deemed to be University, Guntur, Andhra Pradesh, India.

²Professor, Department of Chemistry, Andhra University, Visakhapatnam, Andhra Pradesh, India.

³Assistant Professor, Centre for Environmental Pollution and Control, Vignan's Foundation for Science, Technology and Research, Deemed to be University, Guntur, Andhra Pradesh, India.

⁴Associate Professor, Department of Chemistry, St. Ann's College of Engineering and Technology, Chirala, Prakasam Andhra Pradesh, India.

⁵Professor and HOD, Department of Civil Engineering, Kallam Haranadha Reddy Institute of Technology, Chowdavaram, Guntur, Andhra Pradesh, India.

(Received: 05 January 2025

Revised: 21 February 2025

Accepted: 15 March 2025)

KEYWORDS

Groundwater, Water Quality Index (WQI), Environment, Pollution

ABSTRACT:

Water found in the natural environment is never chemically pure. It always contains one or more dissolved substances. Chemically pure water does not naturally exist, nor is it necessary for sustaining life. When rainwater initially falls from the sky, it is relatively pure, but as it passes through the atmosphere, it absorbs gases and captures particles present in the air. The specific substances and their concentrations that water picks up during this process influence its overall quality. The groundwater quality in the study area of Vadlamudi, Guntur District, Andhra Pradesh, was evaluated by analyzing various chemical parameters. These parameters include pH, conductivity, total dissolved solids (TDS), total alkalinity, total hardness, chlorides, nitrates, and iron. The assessment was conducted at eight distinct sampling stations across the study area to determine the overall water quality and its suitability for different uses.

1. Introduction:

Groundwater is a crucial water source globally. It exists almost everywhere beneath the Earth's surface, not in one large aquifer but in thousands of localized aquifer systems and compartments with similar characteristics. Understanding how groundwater occurs, replenishes, and recovers is particularly important in arid and semi-arid regions, where there is a mismatch in monsoon rainfall, limited surface water, and excessive extraction of groundwater resources. Groundwater quality is vital to the community, and it is essential to maintain its high quality at all times to protect public health. Three main activities primarily impact groundwater resources. The first is the excessive use of fertilizers and pesticides in

agricultural areas. The second is the release of untreated or partially treated wastewater into the environment. The third is the over-extraction and improper management of aquifers. Additionally, the disposal of solid waste in open, un-engineered landfills is a significant factor contributing to groundwater pollution due to the lack of pollution control measures, such as waterproof barriers, leachate treatment ponds, and monitoring wells.

Various regulatory agencies CPCB, BIS, etc. have established water quality standards. These standards are based on our current understanding of the beneficial or harmful effects of different water quality components on animal and plant health, as well as the environment.



Globally, water quality has been significantly impacted by industrial and agricultural chemicals. The degree to which polluted water needs to be purified is also determined by the standards set by these regulatory bodies.

Water Quality Index (WQI):

The WQI is a rating that reflects the combined influence of various water quality parameters. It represents the integrated impact of parameters that are relevant and significant for a specific use. WQI is designed to express water quality for different purposes, providing a single value that represents the overall quality of water at a given location and time. This makes it an effective tool for communicating water quality information and quickly assessing any water system.

The weighted index examine can be used to calculate the WQI, it shows when groundwater is suitable for domestic consumption. Tiwari and Mishra (1985) proposed a more rigorous method for calculating WQI, which is considered more stringent than the traditional approach. Overall, WQI is widely regarded as one of the most effective methods for assessing water quality, based on calculated indices.

2. Objectives of the Work

The objective of applying the WQI is to assess the suitability of water for various beneficial uses and to provide an overall evaluation of water quality.

3. Study Area:

The present study was conducted to assess the Water Quality Index (WQI) for water in Vadlamudi, Andhra Pradesh. Vadlamudi, located at geographical coordinates 16.2356°N latitude and 80.5605°E longitude, is situated at an elevation of 17 meters (56 feet) above sea level. The village covers a total area of 15.18 square kilometers.

This investigation focused on evaluating the quality of water in Vadlamudi by calculating the WQI, which is an effective tool for determining the overall health of water resources in the area. By assessing the various water quality parameters, such as pH, dissolved oxygen, turbidity, and concentrations of harmful chemicals or microorganisms, the study aimed to provide a comprehensive understanding of the water's suitability for domestic, agricultural, and other beneficial uses. Vadlamudi, like many rural areas, may face challenges related to water quality due to factors such as agricultural runoff, industrial discharges, or limited access to water treatment facilities. This study is crucial in determining the current water quality status and identifying any potential risks to public health or the environment. Furthermore, the findings can be used to suggest improvements or interventions to safeguard the water resources and ensure their sustainability for future generations. The assessment of WQI in Vadlamudi will provide valuable insights into the current state of water quality and help local authorities, communities, and policymakers make informed decisions regarding water management and conservation in the region. Fig.1 has been shown the sampling stations at the study area.



Fig. 1. Sampling Point Map at Study Area.



4. Materials and Methods

Water samples were collected following the procedures outlined in the UNESCO guidelines. Each sample was properly labeled to indicate the precise location of

collection during the post-monsoon period in the study area. The samples were transported to the laboratory in bottles and analyzed for various parameters using standard methods (APHA, 1998). The methods employed for water analysis are detailed in Table 1.

Table 1. Methods used for water analysis

| Test Conducted | Units | Principle of the method |
|--------------------------------------|--------------------|--|
| Temperature | $^{\circ}\text{C}$ | Precision thermometer, measured in situ |
| Electrical conductivity | Mhoms | Digital conductivity meter |
| Turbidity | NTU | Turbidimeter |
| Total Solids | mg l^{-1} | Evaporation |
| Total Dissolved and suspended solids | mg l^{-1} | Filtration and evaporation |
| pH | | Digital pH meter |
| Total Alkalinity as CaCO_3 | mg l^{-1} | Titration with std. H_2SO_4 P-alkalinity + MO – Alkalinity ----- x 100 ml of sample taken |
| P-Alkalinity as CaCO_3 | mg l^{-1} | Vol. H_2SO_4 required in presence of phenolphthalein x 1000 ----- ml of sample taken |
| MO-Alkalinity as CaCO_3 | mg l^{-1} | Vol. H_2SO_4 required in presence of methyl orange x 1000 ----- ml of sample taken |
| Chlorides | mg l^{-1} | Titration with stand. AgNO_3 using $\text{K}_2\text{Cr}_2\text{O}_7$ as indicator |
| Total Hardness | mg l^{-1} | EDTA titrimetric method |

Source: American Public Health Association (APHA) 1998

5. Results

The study included chemical parameters for water. The samples were collected at various sampling points of waters. The Relative weight, Results are shown in Table

2. And Results of quality of water quality has been shown in Table 3 And Results Water Quality index are shown in Table 4. And Table 5 has been shown the WQI of the samples analyzed.

Table 2. Results of Relative weight of water quality

| Chemical Parameters | BIS Standards | Weight | Relative weight, W_i |
|-------------------------|---------------|--------|------------------------|
| pH | 6.5 – 8.5 | 4 | 0.12121 |
| Electrical Conductivity | 750 – 1500 | 2 | 0.06061 |
| Total Dissolved solids | 600 – 1000 | 4 | 0.12121 |
| Total Alkalinity | 200 – 600 | 2 | 0.06061 |
| Total Hardness | 300 - 600 | 2 | 0.06061 |
| Calcium | 100 – 200 | 2 | 0.06061 |
| Magnesium | 50 – 150 | 1 | 0.03030 |
| Chloride | 250 – 600 | 3 | 0.09091 |
| Nitrate | 50 – 100 | 5 | 0.15152 |
| Sulphate | 250 – 400 | 4 | 0.12121 |
| Iron | 0.3 – 1 | 4 | 0.12121 |
| | | 33 | $W_i = 1.000$ |



Table 3. Results of quality of water quality

| S. No | Sample Code | Parameters (mg / l) ,* Except P ^H and Conductivity | | | | | | | |
|-------|-------------|---|-------------------------|----------|------------------|----------------|-----------|----------|--------|
| | | p ^H | Conductivity (Siemens) | TDS | Total Alkalinity | Total Hardness | Chlorides | Nitrates | Iron |
| 1 | S1 | 7.2 | 220 | 171.8498 | 325 | 132.5 | 464.85 | 11.25 | 0.2405 |
| 2 | S2 | 6.7 | 230 | 129.2903 | 450 | 145 | 489.84 | 37.5 | 0.182 |
| 3 | S3 | 6.7 | 510 | 116.2072 | 500 | 327.5 | 558.08 | 50 | 0.2516 |
| 4 | S4 | 7.1 | 190 | 128.4067 | 400 | 112.5 | 344.89 | 6.25 | 0.182 |
| 5 | S5 | 8.3 | 170 | 162.8992 | 275 | 100 | 409.87 | 56.25 | 0.222 |
| 6 | S6 | 8 | 170 | 127.9069 | 275 | 92.5 | 304.9 | 37.5 | 0.2775 |
| 7 | S7 | 7.7 | 470 | 154.6327 | 550 | 200 | 433.51 | 12.5 | 0.296 |
| 8 | S8 | 7.1 | 420 | 189.6392 | 525 | 192 | 308.94 | 31.25 | 0.1925 |

Table 4 .Results Water Quality index:

| S. No | Sample Code | Quality Index - Q _i | | | | | | | |
|-------|-------------|--------------------------------|-------------------------|-------|------------------|----------------|-----------|----------|-------|
| | | p ^H | Conductivity (Siemens) | TDS | Total Alkalinity | Total Hardness | Chlorides | Nitrates | Iron |
| 1 | S1 | 84.75 | 14.66 | 17.18 | 54.16 | 22.08 | 77.47 | 11.25 | 24.05 |
| 2 | S2 | 79.05 | 15.33 | 12.92 | 75 | 24.16 | 81.64 | 37.5 | 18.2 |
| 3 | S3 | 79.29 | 34 | 11.62 | 83.33 | 54.58 | 93.01 | 50 | 25.16 |
| 4 | S4 | 83.88 | 12.66 | 12.84 | 66.66 | 18.75 | 57.48 | 6.25 | 18.2 |
| 5 | S5 | 97.64 | 11.33 | 16.28 | 45.83 | 16.66 | 68.31 | 56.25 | 22.2 |
| 6 | S6 | 94.94 | 11.33 | 12.79 | 45.83 | 15.41 | 50.81 | 37.5 | 27.75 |
| 7 | S7 | 90.58 | 31.33 | 15.46 | 91.66 | 33.33 | 72.25 | 12.5 | 29.6 |
| 8 | S8 | 84 | 28 | 18.96 | 87.5 | 32 | 51.49 | 31.25 | 19.25 |

Q_i = Estimated value of each parameter / Standard value of each parameter

Table 5. Water Quality index: $WQI = \sum Q_i * W_i$

| S.No | Sample Code | WQI |
|------|-------------|---------|
| 1 | S1 | 29.5291 |
| 2 | S2 | 33.3997 |
| 3 | S3 | 40.52 |
| 4 | S4 | 26.0471 |
| 5 | S5 | 35.7094 |
| 6 | S6 | 31.1234 |
| 7 | S7 | 34.38 |
| 8 | S8 | 22.9872 |

6. Conclusion:

The groundwater quality in the study area of Vadlamudi, Guntur District, Andhra Pradesh, was assessed by evaluating various chemical parameters such as pH, conductivity, total dissolved solids (TDS), total alkalinity, total hardness, chlorides, nitrates, and iron at eight different sampling stations. The Water Quality Index (WQI) values for the groundwater samples were found to be as follows: S1 - 29.52, S2 - 33.39, S3 - 40.52, S4 - 26.04, S5 - 35.70, S6 - 31.12, S7 - 34.38, and S8 - 22.98. Based on these values, the water quality is not suitable for domestic use.



To ensure the continued safety and sustainability of groundwater resources, it is essential to raise public awareness. This includes promoting the adoption of pollution control technologies, encouraging responsible water usage, and improving sanitation practices. Public education on the importance of clean water for good health, as well as steps to improve and protect water quality, is crucial for long-term water conservation and community well-being.

7. REFERENCES:

1. APHA, AWWA, WPCF, Standard methods for the examination of water and wastewater. (20th edition). American public health association, Washington DC, New York. 1998.
2. Babuponnusami, A., Sinha, S., Ashokan, H., Paul, M. V., Hariharan, S. P., Arun, J., (2023). Advanced oxidation process (AOP) combined biological process for wastewater treatment: A review on advancements, feasibility and practicability of combined techniques. *Environmental research*, 116944.
3. Chandra, d. S., Asadi, s. s., & Raju, M. V. S. (2017). Estimation of water quality index by weighted arithmetic water quality index method: a model study. *International journal of civil engineering and technology*, 8(4), 1215-1222.
4. R. Saravanathamizhan and V. T. Perarasu, "Improvement of Biodegradability Index of Industrial Wastewater Using Different Pretreatment Techniques," in *Wastewater Treatment*, Elsevier, 2021, pp. 103–136.
5. Raju, M. V., Palivela, H., Mariadas, K., & Babu, S. R. (2019). assessment of physico-chemical and biological characteristics and suitability study of lake water: a model study. *Technology*, 10(01), 1431-1438.
6. D. Mantzavinos, "Basic Unit Operations in Wastewater Treatment," in *Utilization of By-Products and Treatment of Waste in the Food Industry*, Springer US, 2007, pp. 31–51.
7. Raju, M. V., Mariadas, K., Palivela, H., Ramesh Babu, S., & Raja Krishna Prasad, N. (2018). Mitigation plans to overcome environmental issues: A model study. *International Journal of Civil Engineering and Technology*, 9(10), 86-94.
8. H. Wei, B. Gao, J. Ren, A. Li, and H. Yang, "Coagulation/flocculation in dewatering of sludge: A review," *Water Res.*, vol. 143, pp. 608–631, Oct. 2018, doi: 10.1016/j.watres.2018.07.029.
9. Kumar, M. S., Raju, M. V., Babu, S. R., & Kumar, M. S. J. (2017). Interpretation and correlative study of water simulation in surface water bodies. *International Journal of Civil Engineering and Technology (IJCIET)*, 8(5), 1206-1211.
10. Raju, M. V., Rao, L. N., Mariadas, K., Kumar, M. S. J., & Babu, S. R. (2019). A study on metals recovery from the waste water effluents in electroplating industry. *International Journal of Civil Engineering and Technology*, 10(02), 1033-1040.
11. Rathod, J. D., Shukla, R. N., & Singh, D. M. (2012). Combination of advanced oxidation processes and biological treatment of industrialwaste water. *International Journal of Scientific Engineering and Technology*, 1(3), 24-28.
12. Kumar, M. S., Raju, M. V., & Palivela, H. (2017). An overview of managing municipal Solid waste in urban areas-A model study. *International Journal of Civil Engineering and Technology*, 8(5).
13. Kumar, M. S., Raju, M. V., Kumatr, G. V. R., & Palivela, H. (2017). Evaluation of Groundwater Pattern in Black Cotton Soils Using Geo Spatial Technology–A Model Study. *International Journal of Civil Engineering and Technology*, 8(5).
14. S. Kaushik, K.S. Alexander, A Modified Reverse-Phase HPLC Method for the Analysis of Mexiletine Hydrochloride, *J. Chromatogr. Relat. Technol.* 2003; 26: 1287–1296.
15. Satish Kumar, M., Raju, M. V., & Palivela, H. (2017). Comprehensive index of groundwater prospects by using standard protocols-A model study. Volume, 8, 521-526.
16. Sarita Kaushik and K. S. Alexander. A Modified Reverse-Phase HPLC Method for the Analysis of Mexiletine Hydrochloride. *journal of liquid*



chromatography & related technologies. 2003;
26: 1287–1296, 2003.

17. Maria Das, K., Raju, M.V., Satish Kumar, M., Rama Rao, A., Groundwater suitability for drinking at part of Tenali municipal corporation, Guntur District, Andhra Pradesh, India, *Indian Journal of Ecology*, 2020, 47, pp. 75–79.
18. Tiwari, J.N. (1988), *Water Quality Index for Indian rivers, in ecology and pollution of Indian rivers*. Ed R.K. Trivedi. Ashign Publishing House New Delhi. pp 271-286.