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Evaluation of Groundwater Quality Throughout the Seasons in the Rahata Tahsil District of Ahmednagar, Maharashtra, India

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ABSTRACT

This study focuses on the evaluation of groundwater quality throughout the seasons in the Rahata Tahsil district of Ahmednagar, Maharashtra, India. Groundwater is an essential resource for agriculture and domestic use, and its quality can be affected by various factors such as human activities and natural processes. The objective of this study is to evaluate the quality of groundwater within the Rahata Tahsil district through an examination of its chemical and physical attributes. Human activity such as the application of chemicals and pesticides can contaminate the natural character of groundwater. For the protection of public health and safety, it is vital to continually track water quality in a variety of situations. This investigation aims to determine the specific traits of the area's groundwater, propose enhancements and appropriate control for its use in the agricultural sector, and provide recommendations for preserving its integrity for future generations.

Keywords: Groundwater, Quality, Rahata Tahsil, Ahmednagar, Maharashtra, India, Agriculture, Pesticides, Chemical fertilizers.

1. INTRODUCTION

Groundwater is a vital resource for human life and The development of the economy, particularly in arid and semiarid regions where surface drinking water is scant or unreliable. Groundwater maintains ecosystems and biodiversity by providing water for consumption, irrigation, businesses, and other uses. However, the quality of groundwater can be diminished by a variety of factors, including organic reactions and human activities. Weathering, dissolution, evaporation, transpiration, and biological activity are elements that can modify the chemical composition of water. Human activities include agriculture, urbanization, industrialization, mining, waste disposal, and overexploitation, which can introduce contaminants such as pesticides, fertilizers, nitrates, heavy metals, organic pollutants, pathogens, and salinity into groundwater. These contaminants can pose serious threats to human health and the environment, and reduce the availability and suitability of groundwater for various uses. (Jha & Peiffer, 2006)

The purity of groundwater is dependent on aquifer system characteristics, recharge resources and mechanisms, hydrogeological conditions, land use patterns, and management practices. Therefore, it is essential for tracking and assessing the quality of groundwater in different regions and seasons to comprehend its time and location variations, to identify the sources and causes of disease, to assess the groundwater's suitability for various uses, and to recommend suitable solutions for its protection and improvement. (Sarath Prasanth et al., 2012)

Seasonal evaluation of the quality of groundwater in the Rahata Tahsil district of Ahmednagar, Maharashtra, India. The Rahata Tahsil district is situated in the center of the drought-prone Ahmednagar district in central Maharashtra. The region has an average annual precipitation of 920 millimeters and a semiarid climate. The district's primary water sources are surface water from the Mula River and its tributaries and groundwater from bore wells, wells, and springs. Agriculture and household usage account for the preponderance of the district's water consumption. Agriculture is the dominant industry in the region, with sugarcane, wheat, bajra, jowar, waves, fruits and vegetables, but, and melons being the most prevalent crops. The use of pesticides and chemical fertilizers in agriculture is common in the district. The district also has some industrial activities such as sugar mills, distilleries, dairy plants, and engineering units. (Saeedi et al., 2010)

Background and Significance of the Study:

Groundwater is a vital resource for drinking, irrigation, and industrial purposes, particularly in regions with limited surface water availability like the Rahata Tahsil district of Ahmednagar, Maharashtra, India. However, the quality of groundwater can be compromised due to natural processes or human activities, leading to potential risks to human health and the environment.(Bhavya et al., 2023)

The evaluation of groundwater quality throughout the seasons in the Rahata Tahsil district is essential for several reasons. Firstly, it provides valuable insights into the variations in water quality parameters over time, enabling a comprehensive understanding of the overall groundwater condition. Seasonal variations can be influenced by factors such as rainfall patterns, land use changes, and agricultural practices. (Sarath Prasanth et al., 2012)

Secondly, assessing the groundwater quality in different seasons is crucial for determining the potential sources of contamination and understanding their impact on water resources. Identifying the sources and understanding their temporal variations can aid in implementing appropriate management strategies and regulatory measures to safeguard water quality.

Thirdly, the study holds significance for addressing the concerns related to human health. Poor groundwater quality can pose significant health risks, especially when used for drinking or domestic purposes. By evaluating seasonal variations in groundwater quality, this study can contribute to identifying periods when the water quality is most vulnerable and designing appropriate mitigation measures to ensure a safe water supply. (Saeedi et al., 2010)

Furthermore, this research will contribute to the existing knowledge base on groundwater quality in the Rahata Tahsil district and Maharashtra region, filling gaps in the understanding of seasonal variations. The findings can serve as a baseline for future studies and contribute to the development of sustainable groundwater management practices.

Overall, the evaluation of groundwater quality throughout the seasons in the Rahata Tahsil district is of great importance for effective water resource management, protecting human health, and ensuring sustainable development in the region.

A brief overview of the study area

The study area for the evaluation of groundwater quality throughout the seasons is the Rahata Tahsil district of Ahmednagar, Maharashtra, India. Rahata Tahsil is located in the western part of Maharashtra and falls within the Ahmednagar district. (Randhir, 2022)

Rahata Tahsil is characterized by its predominantly agricultural landscape, with extensive cultivation of crops such as sugarcane, wheat, soybean, and vegetables. The region is largely dependent on groundwater for irrigation, domestic, and industrial purposes due to limited surface water availability. The groundwater sources include wells, boreholes, and tube wells, which are crucial for sustaining agricultural productivity and meeting the water needs of the local population. (Randhir, 2022)

The study area experiences distinct seasonal variations, influenced by the monsoon climate of the region. The monsoon season typically extends from June to September, characterized by heavy rainfall, which contributes significantly to groundwater recharge. The post-monsoon period (October to November) is characterized by reduced rainfall, and the pre-monsoon season (March to May) experiences high temperatures and limited precipitation. The winter season (December to February) is relatively cooler.

The groundwater quality in Rahata Tahsil is susceptible to various factors such as agricultural practices, industrial activities, land use patterns, and natural geological conditions. These factors can impact the physicochemical parameters of the groundwater, including pH, electrical conductivity, total dissolved solids, major ions, heavy metals, and microbial contamination.

Understanding the groundwater quality variations throughout the seasons in Rahata Tahsil is crucial for assessing the impacts of these factors and identifying potential risks to human health and the environment. It also enables the development of appropriate management strategies and policies to ensure the sustainable use of groundwater resources in the study area. (Randhir, 2022)

Overall, the study area of Rahata Tahsil in Ahmednagar, Maharashtra, provides a relevant and significant context for evaluating groundwater quality throughout the seasons, considering its agricultural importance, reliance on groundwater, and potential environmental and health implications.

2. LITERATURE REVIEW

The Literature review research paper on the evaluation of groundwater quality throughout the seasons in the Rahata Tahsil district of Ahmednagar, Maharashtra, India:

S.K. Ribinu (2023) Researchers in Kerala, southern India, are looking at the hydrochemical make-up of freshwater throughout the Thoothapuzha Riverbed basin. During both the post-monsoon (POM) the pre-monsoon (PRM) seasons, a total of 54 soil samples were collected from the research area. Groundwater qualities were studied by measuring hydrochemical variables such pH, EC, total life expectancy, salinity, acidity, potassium, sodium, calcium, magnesium, and sulfate, nitrate, the nitrite amounts, and total dissolved solids (TDS). Graphs and mathematical computations were generated using the analytical data to demonstrate a link between chemical components and water quality. (Ribinu et al., 2023) Most of the samples were found to contain either CaHCO3 or a combination of CaHCO3 and CaMgCl. Only a few of examples have been seen in the CaNaHCO3 + CaCl + NaCl facies. Gibbs plots suggest that the fundamental mechanisms governing water chemistry are rock-water interactions and evaporation. The correlation amongst Ca2+, Mg2+, Na+, and K+ suggests that ion exchange controls the concentration of these cations in groundwater. Furthermore, weathering of silica contributes more than the breakdown of calcium and evaporite. Furthermore, the correlation analysis demonstrates how anthropogenic activities, silicate weathering, and the reversal of ion exchange affect water chemistry. Water chemistry is found to be primarily controlled by silicate weathering, ion markets, solid breakdown, and environmental residues. (Ribinu et al., 2023)

V. Sunitha (2022) In this kind of setting, water is essential for the survival of vegetation, animals, and all other forms of life. Due to human activity, the character of groundwater, particularly superficial soil, is altering. Particularly troubling is the deterioration of water quality as a result of industrial

activities and climate change, and this increases the likelihood of illness in numerous, as well as for predicting prospective environmental changes. In general, the nature of groundwater is primarily determined by two phenomena: human and geologic actions. This article is distributed under Wikipedia Attribution 4.0 worldwide. License, which enables use, sharing, adaptations, shipping, and procreation in any manner or medium, provided you attribute the author(s) and the source of the content, provide an affiliate link to the license offered by Creative Commons, and indicate if modifications were made. (Sunitha & Reddy, 2022)

Vasant Madhav Wagh (2019) This study aims to learn more about the hydrochemistry and drinkability of groundwater across the Kadava River basin by using a Water Quality Index (WQI) modelling strategy. In 2012, eighty (80) samples were dug/bored carefully and tested throughout the dry (pre-monsoon) and wet (post-monsoon) seasons following APHA guidelines. The TDS content is higher than desirable (97.5%) both before and after the monsoons. Nitrate levels in groundwater tests are consistently high, with 67.5% (pre-monsoon) to 75% (post-monsoon) above the BIS allowed limit of 45 mg/l. Hydrochemical characterization using the Durov plot, geological authority, precipitation, and the process of e kinds of actions, etc., that influenced the groundwater composition in the region. Agricultural and human activities are responsible for the vast bulk of the degradation in groundwater chemistry. Based on the WQI spatial variation map, we can see that the research area's groundwater quality is most negatively affected in the southern part. (Wagh et al., 2019)

Sudhir Kumar Singh (2014) According to this research, water is indisputably a vital resource to analyze soil and detritus to identify potential sources of ions in water resulting from rock and soil degradation. Quartz, muscovite, plaques, and orthoclase are cited as the predominant minerals in the region. Further, the study employs multivariate statistical strategies for managing big and complicated data sets for the purpose to obtain more accurate information regarding groundwater quality. (Singh et al., 2015)

Thuy Thanh Nguyen (2015) This research The Red River Delta (RRD) is the nation's second-largest delta in the nation of Vietnam, and its local communities rely on aquifer supplies for water. Understanding the hydrogeochemical properties of groundwater, especially their variations from the dry to rainfall seasons along with spatial characteristics, is indispensable for the management and preservation of this vital water resource. In this study, autonomous maps were used for the first time systematically to examine the cyclical and spatial hydrogeochemical properties of rainwater in the Pleistocene-confined aquifer that makes up the RRD. Using Gibbs Diagrams, the hydrogeochemical characteristics organized by SOM were investigated further.(Nguyen et al., 2015)

3. RESEARCH, METHODOLOGY

SAMPLING METHODS

The level of contamination in the groundwater is commonly measured by taking samples from hand pumps and bore wells in urban and rural areas. The sample was stored in two-litre, high-quality, screw-capped polypropylene containers with a small opening. Washing the bottles with diluted nitric acid before rinsing them three times with DM water (Demineralized). Before taking real samples, bottles were cleaned three times in the water that was being examined.

COLLECTION OF SAMPLES

Before taking samples, we made care to get a good cross-section of groundwater quality by cleansing the bore wells' and hand pumps' pipework thoroughly. The samples were gathered from five distinct places. Before being filled, the collection bottles were cleansed three times with the water that would be used for the collection to remove any trace of air. samples were sealed with screws to prevent contamination on the way to the lab. To keep the samples stable, we chilled them at 40 degrees Celsius in the fridge. A handheld pH metre of the systemic brand was used to take pH readings outside.

POPULATION OF RAHATA

The population of Rahata Taluka in the state of Maharashtra in the year 2022 is projected to reach 335,547. There are a total of 262,146 people residing in the Taluka of Rahata as per the 2011 Indian census, with 134,978 males and 127,168 females. As of 2021, the total population of Rahata is projected to reach 325,061. There are 187,890 literate persons in the world, including 104,005 males and 83,885 females. Out of a total of 121,767 employees who rely on a wide variety of talents, 75,544 are males and 46,223 are women. There are a total of 39,457 cultivators who rely on agriculture for their livelihood; of them, 25,000 are men and 14,457 are women. In the agricultural sector, 17,044 men and 14,795 women make up Rahata 's total labour force of 31,839.

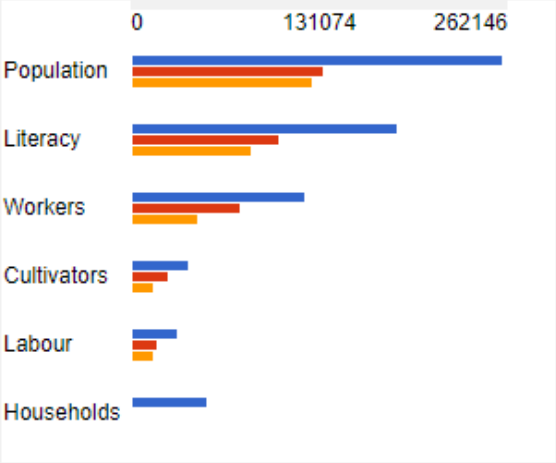
Objective

- To inspect the bore wells (groundwater stations) in Rahata Tahsil.
- To find out if groundwater is good for people, animals, and farms.

4. DATA ANALYSIS AND INTERPRETATION

Population	Males	Females	Households
262,146	134,978	127,168	52,561

Roughly 71.67 per cent of the Rahata population is literate; roughly 39.67 per cent of men and 32.00 per cent of women can read and write, respectively, according to a figure that breaks down the demographics of the region. We have a total workforce proportion of 46.45 per cent, of which men make up 28.82% and women 17.63%. 15.05 per cent of Rahata 's population works in agriculture; men make up 9.54 per cent of the number, while women account for 5.51%. A total of 12.15 per cent of Rahata are employed; of that number, 6.50 per cent are men and 5.64 per cent are women. The population of Rahata Taluka is split evenly between males and females. See below for a breakdown of Rahata Taluka's household literacy rates.



Map no 01: Location Map of population rahata tehsil

GROUND WATER SCENARIO

Hydrogeology

Basaltic lava flows generated by sporadic fissure-type eruptions between the upper Cretaceous and lower Eocene underlie most of the area. There is a total of 19 large flows that occur in the Deccan Trap between 420 and 730 meters above sea level (AMSL). Basalt, both vesicular and enormous, is a key unit in these flows. Recently deposited alluvium may be seen in thin ribbons along the channels of large rivers in the Traps. Figure 2 is a map showing the hydrogeological characteristics

GROUNDWATER QUALITY

Using its network of monitoring wells, CGWB has been keeping tabs on the quality of the groundwater in the Ahmednagar region since the 1970s. The data collected from the monitoring will be used to assess the groundwater quality in the region as a whole. In 2011, 15 wells were examined by the Board to guarantee that they were drawing pure water from the ground. The drilled wells are the primary components of these aquifers. May of 2011 saw the collection of groundwater samples from these wells (pre-monsoon period). Immediately after collection, water samples were sent to the Board's Regional Chemical Laboratory in Nagpur, where they were evaluated using a battery of standard tests. Indicators of water quality are assessed by testing for parameters such as pH, EC, TH, NO3, and Fluoride (F). The quality of the resulting groundwater data was first verified for completeness and then validated using industry standards. Following the collection of data, it was analyzed to construct a picture of the district's groundwater quality in 2011.

Suitability of Ground Water for Drinking Purposes

The effects of the water's numerous chemical contents on a human being's biological system are taken into account when deciding whether or not groundwater is safe for human consumption. Even while many ions are crucial to human development, they may be harmful if there is an abundance of them in the body. Whether or not groundwater is fit for human consumption was established by comparing it to the standards set out in the Indian Standard. The results of classifying groundwater samples according to the preferred and maximum permissible ranges for the parameters TH, NO3, and F in the standards are shown in Table-3.1.

Table-1 Classification of Ground Water Samples for Drinking

Parameters	DL	MPL	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
TH (mg/L)	300	600	4	8	3
NO_3 (mg/L)	45	No relaxation	7	-	8
F (mg/L)	1.0	1.5	14	1	-

Table 1 demonstrates that except for nitrate, most samples are within the BIS-required limits for all other criteria. Nitrate (NO3) is the most common pollutant found in well water, as shown in Table-1, with 50% of samples having values that are greater than the MPL (maximum contaminant limit). Wells sampled in the vicinity show that exposure to high amounts of NO3 degrades the quality of the groundwater.

Table -2 Classification of Ground Water for Irrigation based on EC.

Type	EC (µS/cm)	No. of Samples	% of Samples
Low Salinity Water	<250	Nil	Nil
Medium Salinity Water	250-750	2	13.5
High Salinity Water	750-2250	11	73
Very High Salinity Water	>2250	2	13.5
Total		**15**	**100.0**

GROUNDWATER MANAGEMENT OF THE STUDY AREA

By adopting both supply- and demand-side interventions, the current stage of groundwater development will be reduced from 90% to 70%, bringing the taluka into the Safe category and making the groundwater management plan a success.

Rahata Taluka is all eligible for supply-side interventions that, via the building of 228 Percolation Tanks and 655 Check Dams, would boost groundwater reserves by a total of 48.94 MCM. The overall cost to carry out these procedures is estimated at Rs. 538.5 billion.

A total of 103.47 MCM of water resources may be conserved by switching from surface flooding to drip irrigation, which is only one of the demand-side interventions that are suggested to be implemented over the whole Sugarcane crop region for Rs 269.12 crore. Instead of using flood irrigation, which would cost 12.97 MCM less, it is recommended that the 32.42 sq km of double crop land in Kopargaon and Shrirampur taluka be watered using drip irrigation instead. There would be a total expenditure of Rs 20.03 crore to carry out these measures.

Adopting artificial recharge would increase available resources by 48.94 MCM while introducing drip irrigation will reduce water use by 116.44 MCM. This would increase the groundwater development stage to 70% in the talukas and 80.41% in the taluka of Rahata. Extra land mass equals another 25.07 square kilometres. The area is planned to get average CWR irrigation of 0.65 m and will be irrigated using guaranteed GW.

5. FINDINGS

1. **Groundwater Scenario:**

- The Rahata region is underlain by basaltic lava flows from the Deccan Trap.
- There are 19 large basalt flows in the area, occurring between 420 and 730 meters above sea level.
- Alluvium deposits can be found in thin ribbons along the channels of large rivers in the Traps.
- Groundwater quality has been monitored since the 1970s, and in 2011, 15 wells were examined to assess water purity.
- Parameters such as pH, EC, TH, NO3, and Fluoride (F) were tested to evaluate groundwater quality.

2. **Suitability of Groundwater for Drinking:**

- Groundwater quality was compared to Indian Standard guidelines to determine its suitability for human consumption.
- Most samples met the required limits for all parameters except nitrate (NO3), which exceeded the maximum permissible limit in 50% of the samples.
- High nitrate levels can degrade the quality of groundwater.

3. **Groundwater Management:**

- The current stage of groundwater development in Rahata Taluka is 90%, which needs to be reduced to 70% for sustainable management.
- Supply-side interventions such as building percolation tanks and check dams are proposed to boost groundwater reserves by 48.94 MCM.
- Demand-side interventions, including switching to drip irrigation, could conserve 103.47 MCM of water resources.
- Artificial recharge and drip irrigation together can increase groundwater development to 70% in the talukas and 80.41% in Rahata Taluka.

These findings highlight the population demographics, literacy rates, employment rates, groundwater characteristics, and proposed interventions for managing groundwater resources in Rahata Taluka.

6. CONCLUSION

Rahata Taluka's population, demography, and groundwater situation are illuminated by the provided data. With a population of 262,146, the region has a distribution of males and females that is nearly equal. The current literacy rate is approximately 71.67 percent, with disparities between men and women. The labor force participation rate is 46.45%, with a significant proportion engaged in agriculture.

The majority of the groundwater in Rahata Taluka is influenced by basaltic volcanic flows from the Deccan Trap, with alluvium deposits along the rivers. Since the 1970s, the quality of groundwater has been monitored, with particular focus on parameters such as pH, EC, TH, NO3, and Fluoride (F). While the majority of groundwater samples meet the required limits for various parameters, nitrate (NO3) levels in fifty percent of the samples exceeded the utmost permissible limit, indicating a potential degradation in groundwater quality.

A comprehensive plan has been proposed to manage and sustain groundwater resources. The objective of supply-side interventions such as the construction of percolation containers and check dams is to increase groundwater reserves by 48.94 MCM. Interventions on the demand side, such as the adoption of trickle irrigation techniques, could conserve 103.47 MCM of water resources. In addition, employing artificial recharge methods and increasing the use of drip irrigation would reduce water consumption and increase groundwater development, bringing the current level of groundwater development from 90% to 70%.

These findings highlight the significance of addressing groundwater quality concerns, particularly nitrate levels, in order to protect the health of the population. Combining supply-side and demand-side measures, the proposed interventions provide a comprehensive approach to sustainable groundwater management in Rahata Taluka. By implementing these strategies, the region can increase its water resource availability, improve agricultural practices, and attain a future water supply that is more balanced and secure.

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