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Effect of Winter Season on Groundwater Quality Parameter of Jaipur City Rajasthan

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Abstract

Groundwater studies are paramount, focusing primarily on assessing groundwater quality, a critical aspect given its multifaceted importance. Jaipur city stands out as a significant case study, where groundwater quality has undergone a noticeable decline due to the rapid pace of industrialization and urban development. To comprehensively investigate this phenomenon, a field study was conducted during the winter season, involving the random collection of six groundwater samples from diverse areas within Jaipur city, sourced from different hand pumps to ensure a representative sample set. Advanced digital meters were utilized to meticulously measure parameters such as pH, electrical conductivity (EC), and total dissolved solids (TDS). The ensuing analysis uncovers a worrisome trend, highlighting the poor quality of subterranean water in Jaipur. This revelation underscores the pressing need for further research initiatives and concerted actions aimed at addressing the underlying factors contributing to the degradation of groundwater quality in rapidly urbanizing settings like Jaipur.

Keywords: Jaipur City, ground water, winter season, pH, EC, TDS

INTRODUCTION

Water, a fundamental element crucial for the sustenance of life, serves as a vital resource for both flora and fauna. Its indispensability stems from its role in supporting various ecosystems and facilitating the survival of organisms across the planet. Notably, the quality of water holds paramount importance, surpassing even its quantity, particularly in the realm of water resource management, especially for drinking purposes. Groundwater, characterized by its chemical, physical, and biological attributes, dictates its suitability for a wide array of applications including irrigation, municipal usage, commercial ventures, industrial operations, institutional facilities, and domestic consumption.

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Situated at (Longitude: 75.778° E; latitude: 26.922°N), Jaipur City, the capital of Rajasthan, stands as a prime example of a rapidly evolving urban landscape. The city's exponential growth, driven by urbanization and industrial expansion, has exerted immense pressure on its groundwater reservoirs, leading to a notable decline in water quality. Jaipur's climatic conditions, ranging from semi-arid to arid, characterize its summers with scorching heat and dryness, while its winters offer a reprieve with milder temperatures.

Water, as an irreplaceable component of the Earth's composition, remains pivotal in sustaining diverse life forms. Its indispensable role in supporting the growth and survival of plants and animals cannot be overstated. From basic hydration to complex ecological processes, water is indispensable for the functioning of ecosystems and the well-being of organisms.

In the broader context of human civilization, water holds immense significance. Access to clean water is not merely a prerequisite for individual well-being; it also serves as a cornerstone for the holistic advancement and prosperity of communities. In this regard, the quality of water takes precedence over its quantity, particularly in the realm of water supply planning. Ensuring that water is free from contaminants and pollutants is paramount, especially for drinking purposes, to safeguard public health and prevent waterborne diseases.

The quality of water, encompassing its chemical, physical, and biological characteristics, determines its suitability for various applications. Whether it's for agricultural irrigation, municipal water supply, commercial and industrial processes, or domestic use, the purity and safety of water are fundamental considerations.

Against this backdrop, Jaipur City emerges as a focal point for studying water dynamics and challenges. Located in Rajasthan, the city experiences rapid urbanization and industrial growth, exerting significant pressure on groundwater resources. The climate, characterized by semi-arid to arid conditions, further exacerbates these challenges, with hot, dry summers and relatively mild winters shaping the hydrological landscape.

Understanding the intricate interplay between urbanization, industrialization, climate dynamics, and groundwater quality is essential for formulating effective water management strategies in Jaipur City. By delving deeper into these complexities, we can develop informed policies and practices aimed at preserving water resources and ensuring the well-being of present and future generations.

LITERATURE REVIEW

Assessing groundwater quality is crucial for understanding its suitability for various purposes and identifying potential risks to human health and the environment. Numerous studies have explored groundwater quality across different regions, shedding light on factors influencing water quality parameters.

In addressing groundwater quality, a notable study focused on Jaipur city, where rapid industrialization and urban development have led to a noticeable decline in groundwater quality. Fieldwork conducted during the winter season involved collecting six groundwater samples from various areas within Jaipur city, ensuring a representative sample set.

Cutting-edge digital meters were deployed to gauge crucial parameters including pH level, electrical conductivity (EC), and total dissolved solids (TDS). The analysis revealed concerning trends, highlighting the poor quality of subterranean water in Jaipur [1].

Standard methods for water and wastewater examination offer comprehensive guidelines for water quality analysis, serving as a global benchmark [2].

Hydrogeological characteristics and the chemical composition of groundwater have been extensively studied, emphasizing their importance [3, 4].

Understanding the chemical characteristics of natural water provides a framework for analyzing water chemistry data [5].

A study assessing the Purna River's water quality for irrigation purposes underscored its impact on agricultural practices [6].

Environmental protection measures in India prioritize mitigating pollution from industrial activities, emphasizing the need for stringent regulations to safeguard water resources [7].

A case study on water pollution from major industries in the Paradip area highlighted challenges posed by industrial pollution [8].

A graphic procedure for geochemical interpretation of water analyses offers a systematic approach for interpreting water chemistry data, widely used in groundwater studies [9].

Contributions to diagnosing and improving saline and alkali soils provide insights into managing soil and water resources, with implications for groundwater quality [10].

These studies collectively provide valuable insights into groundwater quality assessment, stressing the significance of understanding influencing factors and implications for human and environmental well-being.

MATERIALS AND METHODS

During the winter season, groundwater samples were systematically collected from six specific sampling points. To ensure the representativeness of the samples, water from the tube wells was allowed to flow for a period of 10 to 15 minutes prior to collection. This flushing process aimed to remove any stagnant water and obtain samples that accurately reflected the groundwater quality at each location [11–15].

For sample collection, high-quality polyethylene bottles with a capacity of half a liter were utilized. These bottles underwent thorough rinsing beforehand to prevent any potential contamination, and no preservatives were added to the water during collection [16–19].

The precise geographic coordinates of every sampling point were meticulously logged using a handheld Magellan Triton global positioning system (GPS). This meticulous recording of sampling locations greatly aided in the precise mapping and thorough analysis of the gathered data [20–23].

Upon returning to the Environmental laboratory, a comprehensive array of physicochemical parameters, encompassing temperature, pH level, electrical conductivity (EC), and total dissolved solids (TDS), underwent meticulous measurement and analysis. These parameters serve as critical indicators of water quality and offer insights into the composition and suitability of groundwater for various applications [24]

To measure unstable hydrochemical parameters such as pH, EC, and TDS in situ, a digital portable water meter (specifically, model HI9811-5) was employed. This device enabled real-time assessment of these parameters directly at the sampling points, ensuring immediate data acquisition and analysis.

Through the implementation of these precise sampling and measurement techniques, the study aimed to guarantee the accuracy and reliability of the data obtained. This rigorous approach laid a solid foundation for the subsequent analysis and interpretation of groundwater quality in the study area.

RESULTS AND DISCUSSION

In the current investigation, the pH levels of the water samples were observed to range between 7.0 and 7.9.

The pH scale is utilized to assess the acidity or alkalinity of a solution, where a neutral reading is represented by 7. A pH below 7 indicates acidity, while a pH above 7 suggests alkalinity. Notably, the lowest pH value was recorded in Vaishali Nagar, while the highest was noted in Pratap Nagar. Despite these variations, the overall pH levels of the groundwater samples remained within acceptable ranges, indicating a neutral to slightly alkaline nature of the water.

The electrical conductivity (EC) of water, reflecting the presence of dissolved salts, was assessed at 25°C.

The electrical conductivity (EC) measurements of the groundwater samples varied between 687.5 and 3162.5 µS/cm. Elevated EC values may indicate higher levels of dissolved salts in the water, potentially impacting its suitability for various purposes, including drinking, irrigation, and industrial use.

Total dissolved solids (TDS) represent the combined concentration of dissolved substances in water, encompassing salts, minerals, and organic compounds. In the study, TDS levels in the groundwater samples ranged from 412.5 to 1739 mg/l. According to Indian standards, a significant majority (94.5%) of the samples exceeded the permissible limit for TDS concentration, while only a small proportion (5.5%) fell within the acceptable range. Elevated TDS levels can compromise water quality and its suitability for drinking, irrigation, and industrial applications.

These findings underscore the critical importance of ongoing monitoring and evaluation of water quality parameters such as pH, EC, and TDS to ensure the fitness of groundwater for diverse uses. Effective management strategies are essential to address elevated TDS levels and uphold water quality within acceptable standards for human consumption and other purposes. Further research and intervention efforts may be necessary to mitigate the impact of high TDS concentrations on groundwater resources and safeguard public health and environmental integrity.

CONCLUSIONS

Through the course of the investigation conducted during the winter season in Jaipur city, it has been discerned that groundwater quality parameters are significantly influenced by various factors, chiefly industrialization and urban development. The findings of this study underscore the vital importance of addressing the declining groundwater quality in Jaipur to uphold public health standards and environmental sustainability.

Examination of groundwater samples has revealed concerning trends, notably concerning elevated levels of electrical conductivity (EC) and total dissolved solids (TDS). These parameters serve as pivotal indicators of water quality, with elevated concentrations signaling potential contamination and rendering the groundwater unsuitable for potable use. The presence of excessive EC and TDS levels in the groundwater samples emphasizes the urgent need for remedial actions to curb pollution sources and uphold the integrity of groundwater reservoirs in Jaipur.

Furthermore, the identification of specific areas within Jaipur city exhibiting poorer groundwater quality underscores the necessity for targeted interventions and localized management strategies. Initiatives to address pollution hotspots and implement sustainable water management practices are imperative to ameliorate groundwater quality and ensure equitable access to safe and potable water for the inhabitants of Jaipur.

In conclusion, the outcomes of this study highlight the pressing need for collaborative endeavors from governmental bodies, policymakers, industries, and the community to tackle the challenges posed by groundwater pollution in Jaipur city. Coordinated actions aimed at pollution prevention, remediation, and sustainable water resource management are indispensable to safeguard public health and preserve the environment for present and future generations. Continual monitoring and research endeavors are also warranted to monitor changes in groundwater quality over time and facilitate informed decision-making for groundwater management in Jaipur and similar urbanizing regions.

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