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IMPACT OF URBANIZATION ON GROUND WATER PHYSICO-CHEMICAL PROPERTIES IN THE ALWAL AREA, HYDERABAD, TELANGANA.

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ABSTRACT

Water is an indispensable natural resource that plays a vital role in sustaining life, maintaining public health, supporting economic development, and ensuring environmental sustainability. Rapid urbanization and associated anthropogenic activities have significantly altered natural landscapes, thereby affecting groundwater quality in many urban and peri-urban regions. The present study evaluates the impact of urbanization on the physico-chemical characteristics of groundwater in Alwal, a rapidly developing suburban area of Hyderabad, Telangana. The region is characterized by semi-arid climatic conditions and rocky terrain, which strongly influence groundwater occurrence and quality. Groundwater samples were collected from selected borewells located in residential, commercial, and peri-urban areas during different seasons to assess spatial and temporal variations in water quality. Physico-chemical parameters including pH, temperature, total dissolved solids (TDS), alkalinity, hardness, chlorides, nitrates, sulphates, phosphates, and fluoride were analyzed using standard analytical procedures. The results revealed considerable variations among sampling locations and seasons, with higher concentrations of several parameters recorded during the dry season, likely due to reduced dilution and increased groundwater extraction. Elevated levels of TDS, hardness, alkalinity, chlorides, nitrates, phosphates, and fluoride were observed in some samples, indicating the influence of urban activities and local geological conditions on groundwater quality.

Keywords: Groundwater quality, Urbanization, Physico-chemical parameters, Water quality assessment, Alwal, Hyderabad, Sustainable groundwater management.

1. INTRODUCTION

Groundwater serves as a primary source of potable water in many urban and peri-urban regions. However, accelerated urban expansion, particularly in cities like Hyderabad, has raised concerns regarding both the quantity and quality of groundwater resources. Urban growth alters the natural hydrological cycle by Increasing surface sealing through construction activities reducing infiltration and groundwater recharge . Introducing contaminants from domestic, commercial, and industrial sources (T Trauth R and Xanthopoulus C. 1997) increase in impermeable surfaces of land such as buildings, pavements, and roads limits rainwater infiltration, while construction-related activities and growing human settlements may introduce contaminants into the subsurface environment. Impact of urbanization on groundwater recharge and urban water balance for the city of Hyderabad were studied (Hemant Balwant Wakode et al., 2018)

In this paper I have also put in my observation about the noticeable transformations in groundwater levels, availability, and usage patterns have been observed over the past two decades (Hemant Balwant Wakode et al., 2018). These changes are closely associated with urban expansion, loss of

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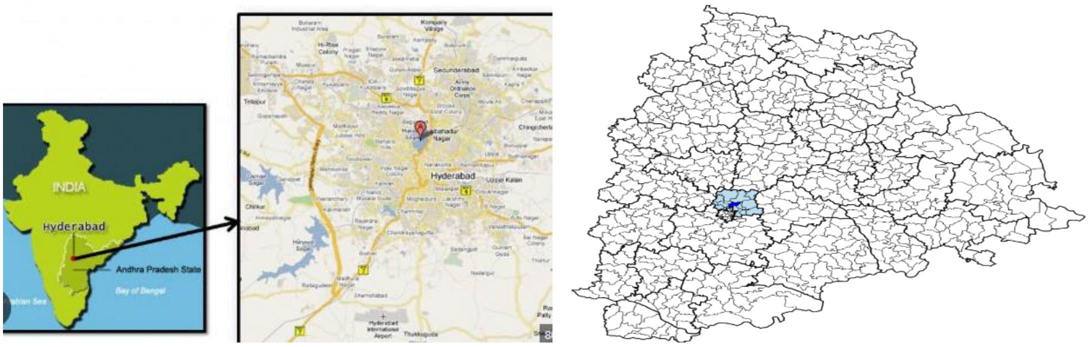
natural water bodies, and increased dependence on groundwater resources. The observations presented below demonstrate how the groundwater system has gradually shifted from stability to a condition of stress and decline (M. R. G. Sayyed et al., 2013). This declined in ground water quantities lead to increase in the concentration of certain organic and inorganic components (Yousef, et al., 2009). Prolonged depletion of groundwater resources may further accelerate water quality deterioration and pose risks to both environmental sustainability and public health. The groundwater quality in the Alwal area of Hyderabad, Telangana, is evaluated in this paper by analyzing the results of specific physicochemical parameters.

The findings highlight the growing pressure of urbanization on groundwater resources and underscore the need for regular monitoring, effective pollution control measures, and sustainable groundwater management practices to ensure the availability of safe water for domestic use and to protect public health and environmental quality.

2. MATERIALS AND METHODS

Area of study

Alwal is a suburban locality situated in the northern part of Hyderabad city in Medchal–Malkajgiri District, Telangana. Geographically, Latitude Approximately 17.50° N, Longitude Approximately 78.50° E. it lies on the Deccan Plateau at an elevation of about 500 meters above mean sea level. The area is characterized by gently undulating terrain, granitic rock formations, and red sandy soils. Alwal experiences a semi-arid tropical climate with hot summers (30°C and 42°C.), moderate rainfall received mainly from the southwest monsoon (30°C and 42°C), and mild winters (14°C and 28°C). The locality enjoys good connectivity and possesses considerable green cover due to the presence of urban forests, parks, and military establishments, making it one of the environmentally favorable residential areas of Hyderabad.



Sample collection

Groundwater samples were obtained from different locations across the Alwal region. The collected water samples were taken from certain selected borewells from different areas in Alwal and tested in the laboratory. Standard testing methods were performed.

Physico-Chemical parameters

The analysis of all physico-chemical parameters was carried out in accordance with the standard methods prescribed by Trivedy and Goel (1986), Kodarkar (1998), and the American Public Health Association (APHA, 2017). Appropriate analytical techniques and calibrated instruments were employed to ensure accuracy and reliability of the results. The obtained data were used to evaluate the water quality status of the study area and to assess its suitability for various domestic and environmental purposes (Telangana State Ground Water Department, 2023).

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3. RESULTS AND DISCUSSION

The physico-chemical characteristics of groundwater samples collected from the study area are presented in Table 1 and compared with the Bureau of Indian Standards (BIS, 2012) for drinking water quality. The results revealed considerable spatial variation in water quality parameters, indicating the influence of both natural geochemical processes and anthropogenic activities (Todd, D. K., and Mays, L. W. ,2005).

The pH of groundwater samples ranged from 6.8 to 8.7, indicating that the water was generally neutral to moderately alkaline in nature. Most samples were within the permissible BIS range (6.5–8.5), suggesting that the groundwater is chemically stable and suitable for domestic use (Subba Rao, N., 2006). The slight alkalinity observed in some samples may be attributed to the dissolution of carbonate and bicarbonate minerals present in the aquifer system (HMDA, 2022). Temperature varied between 29°C and 34°C, reflecting the prevailing climatic conditions of the region. Although temperature does not directly affect potability, it plays an important role in controlling chemical reactions, microbial activity, and dissolved oxygen levels in water bodies (Thirumala, S. and B.R. Kiran, 2017).

The concentration of total dissolved solids (TDS) ranged from 600 to 1400 mg/L, exceeding the BIS acceptable limit of 500 mg/L in most locations. Elevated TDS values indicate a high mineral load in groundwater and may result from prolonged water-rock interaction, urban runoff, domestic sewage infiltration, and agricultural practices. High TDS levels adversely affect the palatability of drinking water and may indicate deterioration of groundwater qualityv (Trauth R and Xanthopoulus C. 1997) Total alkalinity ranged from 302 to 812 mg/L, with several samples exceeding the recommended limit of 600 mg/L. High alkalinity is generally associated with the presence of bicarbonates and carbonates derived from geological formations. Similarly, total hardness varied from 149 to 750 mg/L, significantly exceeding the BIS acceptable limit of 200 mg/L in many samples. The elevated hardness values suggest increased concentrations of calcium and magnesium ions resulting from the dissolution of carbonate-rich rocks and minerals (Sawyer, C.N. et al. 2003)

Chloride concentrations varied between 150 and 889 mg/L. Values exceeding the permissible limit of 250 mg/L were recorded at several sampling locations. High chloride levels are commonly associated with sewage contamination, domestic wastewater discharge, and anthropogenic activities. Elevated chloride concentrations can impair the taste of water and indicate groundwater pollution. Nitrate concentrations ranged from 26 to 75 mg/L. Several samples exceeded the BIS limit of 45 mg/L, indicating possible contamination from agricultural fertilizers, septic tank leakage, and domestic sewage. Excess nitrate contamination in drinking water is of public health concern, particularly due to its association with methemoglobinemia in infants (Manivaskam, N. 2014).

Sulphate concentrations were recorded between 100 and 155 mg/L and remained well within the BIS permissible limit of 200 mg/L. These values indicate that sulphate contamination is not a major concern in the study area. In contrast, phosphate concentrations ranged from 0.36 to 0.78 mg/L, considerably higher than the recommended level (<0.1 mg/L). Elevated phosphate levels are indicative of anthropogenic inputs such as detergents, domestic wastewater, and agricultural runoff (Kodarkar, M.S.1998). Fluoride concentrations ranged from 0.6 to 1.4 mg/L. While most samples were within acceptable limits, some exceeded the recommended BIS value of 1.0 mg/L.

Elevated fluoride concentrations may be attributed to the dissolution of fluoride-bearing minerals in the local geological formations (Sathisha, N.S. and E.T. Puttaiah, 2023). Prolonged consumption of fluoride-rich water may lead to dental and skeletal fluorosis (World Health Organization (WHO, 2017).

Overall, the study demonstrated that groundwater quality in the investigated area is affected by elevated concentrations of TDS, hardness, alkalinity, chlorides, nitrates, phosphates, and fluoride. The observed exceedances of BIS standards indicate potential risks to human health and suggest increasing anthropogenic pressure on groundwater resources. Urbanization, improper waste disposal, domestic sewage infiltration, and agricultural activities appear to be the major contributors to groundwater quality deterioration. Therefore, regular monitoring, effective groundwater management strategies, and appropriate treatment measures are recommended to safeguard public health and ensure sustainable utilization of groundwater resources.

Table 1. Observed ranges of physico-chemical parameters of water samples compared with the Bureau of Indian Standards (BIS) permissible limits.

Parameter	**Observed Range**	**Acceptable Limit (BIS)**
pH	6.8 – 8.7	6.5 – 8.5
Temperature (°C)	29 – 34	Not Specified
Total Dissolved Solids (TDS) (mg/L)	600 – 1400	500
Alkalinity (mg/L)	302 – 812	600
Hardness (mg/L)	149 – 750	200
Chlorides (mg/L)	150 – 889	250
Nitrates (mg/L)	26 – 75	45
Sulphates (mg/L)	100 – 155	200
Phosphates (mg/L)	0.36 – 0.78	Below 0.1
Fluoride (mg/L)	0.6 – 1.4	1.0

4. CONCLUSION

The present study revealed that groundwater quality in the Alwal region exhibits significant variations in physico-chemical parameters. While pH and sulphate concentrations were generally within the BIS permissible limits, parameters such as TDS, hardness, chlorides, nitrates, phosphates, and fluoride exceeded the recommended standards in several samples. These elevated concentrations indicate the influence of natural geological factors as well as anthropogenic activities, including urbanization and improper waste disposal. Therefore, regular monitoring and appropriate treatment measures are essential to ensure safe and sustainable use of groundwater resources in the study area. The findings of this study provide valuable insights into the current status of groundwater quality in Alwal, Hyderabad and emphasize the need for sustainable groundwater management to safeguard environmental and public health.

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