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LONG-TERM SPATIOTEMPORAL ASSESSMENT OF GROUNDWATER QUALITY IN PATNA DISTRICT, BIHAR USING WA-WQI AND TREND ANALYSIS

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Abstract

Groundwater quality assessment is critical for ensuring a safe and sustainable water supply, particularly in rapidly urbanizing regions such as Patna District, Bihar. Despite previous studies, a comprehensive understanding of long-term spatiotemporal groundwater quality trends remains limited in this region. This study aims to evaluate the groundwater quality from 2000 to 2023 by analyzing spatiotemporal variations using the Weighted Arithmetic Water Quality Index (WA-WQI) method. The analysis incorporates GIS-based spatial mapping and trend analysis techniques. A total of 367 groundwater sample records, collected from various central and state agencies, were compiled and used to assess key physicochemical parameters including pH, total dissolved solids (TDS), electrical conductivity, hardness, alkalinity, chloride, nitrate, and fluoride. The WA-WQI scores classified groundwater into five quality categories: Excellent, Good, Medium, Bad, and Very Bad. Spatial and temporal analyses revealed that while most areas fell under 'Good' to 'Medium' quality, significant pockets of 'Bad' and 'Very Bad' water quality emerged between 2006 and 2016, primarily due to anthropogenic sources such as agricultural runoff, sewage infiltration, and industrial discharge. However, an improvement in water quality was observed after 2017, with 2021 recording the highest number of 'Excellent' and 'Good' sites. Piper diagram analysis indicated Ca–Mg–HCO_3^- and Na–HCO_3^- water types, reflecting geogenic influences with localized anthropogenic stress. The integration of WA-WQI with GIS and temporal trend analysis offers a robust framework for groundwater quality monitoring and supports the achievement of Sustainable Development Goal 6 (Clean Water and Sanitation). The study highlights the urgent need for regular monitoring, pollution control, public awareness, and sustainable groundwater management in Patna District and similar urbanizing regions.

Key words: Groundwater Quality, WA-WQI (Weighted Arithmetic Water Quality Index), GIS Mapping, Spatiotemporal Trend Analysis, Sustainable Groundwater Management, Patna District

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