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Analysis of Soil Infiltration Patterns: Implications for Groundwater Dynamics in Gaya District

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Understanding the intricate relationship between soil infiltration dynamics and groundwater behavior is crucial for effective water management strategies, particularly in agriculturally significant regions like Gaya District, India. In this study, we delve into the spatial variability of water infiltration patterns across the diverse landscape of Gaya District, employing mini disc infiltrometers to capture a comprehensive snapshot of soil-water interactions.

Covering 24 blocks within the district, our investigation encompasses a wide spectrum of soil types, reflecting the heterogeneous nature of the region's geology. Through meticulous field measurements and rigorous analysis, we unveil a nuanced picture of infiltration rates ranging from 0.38 to 2.20 cm/min across the study area. These rates serve as pivotal indicators of the soil's capacity to absorb and transmit water, crucial factors in agricultural productivity and groundwater recharge potential. Noteworthy findings emerge as we scrutinize the infiltration characteristics across different land use types. Forested areas emerge as key contributors to groundwater recharge, exhibiting higher cumulative infiltration rates compared to urban and grassland regions. This disparity underscores the impact of land use practices on soil permeability and water retention capabilities.

Moreover, our analysis identifies eight blocks within the district where infiltration rates surpass the area's average, signaling areas ripe for targeted aquifer recharge initiatives. By strategically implementing recharge structures in these zones, stakeholders can bolster groundwater resources and mitigate water scarcity concerns. Conversely, regions prone to inundation present a contrasting scenario, with lower infiltration rates corresponding to elevated soil water tables. This correlation highlights the intricate balance between surface water dynamics and subsurface permeability, crucial considerations in flood management and ecosystem resilience.

The culmination of our efforts is the creation of a comprehensive infiltration rate map for Gaya District, offering decision-makers a valuable tool for informed planning and resource allocation. Whether navigating high or low rainfall scenarios, understanding hydrological processes, or devising strategies for sustainable agriculture and soil-water management, this map serves as a cornerstone for evidence-based decision-making in water resource management.