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Assessing managed recharge potential and water resource vulnerability: A large-scale analysis of infiltration and runoff utilizing the IDPR method in South Quebec

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Groundwater resources have become a focal point of research in recent years, with investigations focusing on vulnerability, recharge dynamics, and surface-groundwater interactions. However, methodologies employed in these studies often face challenges in comparability across diverse hydro-geomorphological landscapes and resolutions.

Drawing on established methodologies, such as the network development and persistence index (IDPR) introduced in France by Uhan et al. (2004) and Mardhel et al. (2021), we leverage existing datasets of river networks and digital elevations in South Quebec. Utilizing these datasets, we calculate the IDPR index at various topographic resolutions (CDEM, BDTQ, LIDAR). Generally, IDPR quantifies the disparity between the thalweg network and the actual hydrographic network, calculated for each cell. This ratio of distances enables the identification of areas where the theoretical network exceeds the natural hydrographic network density (indicating high infiltration zones), and conversely, areas where the natural network surpasses the density of the numerical model derived from the DEM, indicating significant runoff. Subsequently, we establish correlations between the Base Flow Index (BFI), the unsaturated zone (USZ), and the IDPR index to explore implications for recharge quantification and the mapping of groundwater vulnerability. We also endeavor to create chemical resistance indexes based on these correlations.

Through the development of a cartographic index, this research aims to furnish a straightforward tool for identifying areas of aquifer recharge, runoff, or infiltration. Such an index holds promise for delineating regions of interest critical for protecting water resources and potentially optimizing them through targeted recharge management strategies.

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