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Groundwater Potential Mapping using Frequency Ratio and Shannon's Entropy Models in Lesser Himalaya Zone, Nepal

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Abstract : The Lesser Himalaya zone of Nepal consists of thrusting and folding belts, which play an important role in the sustainable management of groundwater in the Himalayan regions. The study area is located in the Dolakha and Ramechhap Districts of Bagmati Province, Nepal. Geologically, these districts are situated in the Lesser Himalayas and partly encompass the Higher Himalayan rock sequence, which includes low-grade to high-grade metamorphic rocks. Following the Gorkha Earthquake in 2015, numerous springs dried up, and many others are currently experiencing depletion due to the distortion of the natural groundwater flow. The primary objective of this study is to identify potential groundwater areas and determine suitable sites for artificial groundwater recharge. Two distinct statistical approaches were used to develop models: The Frequency Ratio (FR) and Shannon Entropy (SE) methods. The study utilized both primary and secondary datasets and incorporated significant role and controlling factors derived from field works and literature reviews. Field data collection involved spring inventory, soil analysis, lithology assessment, and hydro-geomorphology study. Additionally, slope, aspect, drainage density, and lineament density were extracted from a Digital Elevation Model (DEM) using GIS and transformed into thematic layers. For training and validation, 114 springs were divided into a 70/30 ratio, with an equal number of non-spring pixels. After assigning weights to each class based on the two proposed models, a groundwater potential map was generated using GIS, classifying the area into five levels: very low, low, moderate, high, and very high. The model's outcome reveals that over 41% of the area falls into the low and very low potential categories, while only 30% of the area demonstrates a high probability of groundwater potential. To evaluate model performance, accuracy was assessed using the Area under the Curve (AUC). The success rate AUC values for the FR and SE methods were determined to be 78.73% and 77.09%, respectively. Additionally, the prediction rate AUC values for the FR and SE methods were calculated as 76.31% and 74.08%. The results indicate that the FR model exhibits greater prediction capability compared to the SE model in this case study.

Keywords : groundwater potential mapping, frequency ratio, Shannon's Entropy, Lesser Himalaya Zone, sustainable groundwater management
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