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Aquifers Recharge Potentiality Evaluation using Bivariate and Multivariate Statistical Analysis: A Case Study in Malwathu Oya River Basin

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Abstract

An aquifer is a body of porous rock or sediment saturated with groundwater that plays a vital role in the hydrological cycle. Due to rapid population growth and urbanization, these valuable resources face threats like climate changes, pollution, and over-exploitation. Overdraft, where extraction exceeds recharge, can lead to groundwater depletion. Although Sri Lanka is not considered a water-scarce country, it faces rising water demands due to rapid population growth. Especially in dry zones, groundwater is crucial for drinking and agriculture; unauthorized agro-wells exacerbate groundwater issues. Therefore, this research aims to assess groundwater recharge potential zones in Malwathu Oya river basin using Bivariate and Multivariate statistical analysis. Comparing these techniques will lead to the precise identification of potential recharge areas. And this study primarily focuses on the implementation of GIS to find solutions for this kind of challenge without performing field investigations. Therefore, eight conditioning factors; water level, electrical conductivity, lithology, soil, slope, lineament density, drainage density and land use were selected as groundwater recharge influencing factors. The well inventory database consisted of 380 well locations and, out of these, 70% was considered as the training dataset, and the remaining 30% was taken as the testing data set. Groundwater recharge potential maps (GRP) were developed in ArcGIS 10.8, based on the results obtained from Frequency Ratio (FR), Logistic Regression (LR) and their ensemble method. For testing the accuracy of the FR model, test well locations were cross tabulated with the GRP map, and the highest well percentage was achieved in high groundwater recharge potential zone (37.39%). In the LR model, cross-tabulation results showed that 62.61% of testing wells were in the very high potential zones. The ensemble method of FR and LR revealed that 53.04% of test wells fall into the very high potential class. Hence, it can be assumed that LR predictions are more reliable than the FR model. To further validate the LR model and ensemble model, Receiver Operating Characteristics curve method was used. The Area Under the Curve (AUC) values for Success rate curve (SRC) and prediction rate curve (PRC) in LR method were 63% and 57% respectively. In ensemble method, the AUC values for SRC and PRC were 89% and 75%. These results indicate that the LR model is relatively poor estimator, whereas FR and LR ensemble method is relatively good estimator to evaluate groundwater recharge potential in Mulwathu Oya river basin.

***Keywords**:* Area under curve, Frequency ratio, GIS, Groundwater recharge, Logistic regression