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STOCHASTIC FLOW MODEL OF GROUNDWATER IN A SMALL SUBSURFACE AREA IN SRI LANKA

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Porous medium and fractured hard rocks are the two main domains where groundwater can be found. As no randomness is involved, deterministic models can be utilized to represent the water flow in the porous medium. In contrast, quantifying groundwater movement through fractures is difficult due to its irregular distribution. In a heterogeneous environment, we estimate the aquifer parameter hydraulic conductivity, which has a complex spatial variation and high uncertainty. These circumstances are addressed by stochastic models. As the relevant published studies are not available in Sri Lanka, the objective of this study is to apply stochastic modelling to groundwater flow for a 20 km^2 area in Neetiyagama, Anuradhapura. This study specifically aims to quantify the spatial relationships of hydraulic conductivity between sample values using semi-variogram models, simulate the spatial distributions using Simulated Annealing and interpolate the values using Kriging interpolation. The dataset consists of hydraulic conductivities with location coordinates East and North of 41 samples. The semi-variogram is used to quantify the spatial relationship between the sample values. Semi-variance values were plotted with respect to lag distance. A Spherical model was chosen from semi-variogram models, and nugget, sill and range values were initialized based on the behaviour of semi-variance values. Simulated annealing is an application of the Monte Carlo method, which minimizes the squared difference between the desired and actual semi-variogram by generating realizations that are guaranteed to fit the actual semi-variogram. Using Simulated Annealing, the converged objective function, nugget, sill and range values were obtained, and the best fit for the Spherical model was identified. To approximate the values of unknown points in the study area, the known values of the measured data are interpolated using Kriging interpolation, and 253 realizations were yielded. Model validation was carried out by visualizing actual and predicted data, as there are few sample points in the model validation dataset. This can be further carried out with a proper validation dataset. The results of this study can be applied to geologically heterogeneous terrains and will be able to obtain a spatial distribution of hydraulic conductivity over the location coordinates.

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Keywords: Kriging interpolation, Semi variogram, Simulated annealing, Stochastic model