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Deep Learning Neural Networks with Metaheuristic Optimization Algorithms for Groundwater Contamination Vulnerability Mapping in Miryang Aquifer, South Korea

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This study aims to use an integration of genetic algorithm (GA) model and particle swarm optimization (PSO) with the Deep Learning Neural Networks (DLNN) for groundwater contamination vulnerability. Miryang, a city in the northeastern portion of Gyeongnam Province, South Korea was selected as a case study since it showed urban and rural functions and had undergone groundwater pollution. To initialize the modeling purposes, parameters such as depth to water, net recharge, topographic slope, aquifer type, impact to vadose zone, hydraulic conductivity and land use were classified into numerical classes and used as input variables. Two-hybrid models of DLNN-GA and DLNN-PSO were implemented using 95 measured nitrate concentration from monitoring wells for the training and testing of artificial neural networks. The performance of the hybrid models was evaluated by several statistical criteria of error: Mean Square Error (MSE), Root Mean Square Error (RMSE) and Mean Average Error (MAE). The hybrid vulnerability models were also validated by the Area Under the curve (AUC). DLNN-PSO showed the highest (AUC=0.974) performance in comparison with DLNN-GA (AUC=0.954) and Shallow Artificial Neural Networks model (AUC=0.70). The results showed that the proposed hybrid models were more superior than the benchmarked shallow artificial neural networks model used for groundwater contamination vulnerability mapping as a good alternative several years ago.