Abstract

Humanity's usage of water cannot be halted, as water is a necessary resource for existence and is highly valued in a variety of quotidian usages and initiatives. Hence, reliable identification of groundwater potential locations in diverse geographical areas (from low to high) is critical for ensuring its management and stability. This study aimed to predict and define groundwater potential (GWP) zones by combining machine learning (ML) models, such as random forest (RF), support vector machine (SVM), adaptive boosting (AdaBoost), and eXtreme gradient boost (XGB), with analytical hierarchy process (AHP)—multi-criteria decision analysis (MCDA) that integrates anthropological (normalized difference vegetation index), hydrogeological (geology and lineament density), hydrological (rainfall distribution and proximity to surface water bodies), and topographical factors (slope, aspect, drainage density, and topographic wetness index) as groundwater-influencing parameters. Prognostication competencies of these factors were established through the application of multicollinearity (MC) evaluation. The AHP approach was used to weight and scale these influencing variables and determine their impact on groundwater prospects. Given the constrained amount of data available, 'CreateFishnet_management' requires training the ML models with 100% borehole data. Every model's reliability was quantified using the area under the receiver-operating characteristic (AU-ROC) curve. The four (4) machine learning algorithms and AHP model divided the GWP zone into four distinct groups: high, moderate, low, and very low. The RF, AdaBoost, SVM, XGB, and AHP models show that the beneficial GWP zones encompass 41.59%, 36.42%, 45.93%, 25.30%, and 14.03% of the research region, respectively. The model dependability using measured AU-ROC curve metrics indicates that the RF model has the greatest rate of success (78.00%), preceding the AdaBoost (77.00%), SVM (73.00%), XGB (71.00%), and AHP (50.00%) models. Consequently, this multi-approach gives valuable perspectives to promote long-term groundwater governance, directing choices on the advancement of the availability of groundwater.

Keywords: AHP; AU-ROC; Fishnet; Groundwater potential; Machine learning; Multicollinearity