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A tree-based intelligence ensemble approach for spatial prediction of potential groundwater

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ABSTRACT

The objective of this research is to propose and confirm a new machine learning approach of Best-First tree (BFtree), AdaBoost (AB), MultiBoosting (MB), and Bagging (Bag) ensembles for potential groundwater mapping and assessing role of influencing factors. The Yasuj-Dena area (Iran) is selected as a case study. For this regard, a Yasuj-Dena database was established with 362 springs locations and 12 groundwater-influencing factors (slope, aspect, elevation, stream power index (SPI), length of slope (LS), topographic wetness index (TWI), topographic position index (TPI), land use, lithology, distance from fault, distance from river, and rainfall). The database was employed to train and validate the proposed groundwater models. The area under the curve (AUC) and statistical metrics were employed to check and confirm the quality of the models. The result shows that the BFTree-Bag model (AUC = 0.810, kappa = 0.495) has the highest prediction performance, followed by the BFTree-MB model (AUC = 0.785, kappa = 0.477), and the BFTree-MB model (AUC = 0.745, kappa = 0.422). Compared to the benchmark of Random Forests, the BFTree-Bag model performs better; therefore, we conclude that the BFtree-Bag is a new tool should be used for modeling of groundwater potential.

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1. Introduction

Water below the surface, which accounts for nearly 30% of the freshwater worldwide (Lo et al. 2016), has a particularly important role to human consumption, socio-economic development, and ecological processes (Bui et al. 2018; Kooy, Walter, and Prabaharyaka 2018; Lv, Ling et al. 2019). However, due to population growth and industrial development (de Graaf et al. 2019; Zhang et al. 2019), groundwater withdrawals are much higher than their natural rates. Thus, over-exploitations of groundwater have reached an alarming rate at many countries, in particular, at arid and semi-arid countries, where the surface water is limited (Alfarrah and Walraevens 2018; Kammoun et al. 2018; Cavalcante Júnior et al. 2019; Razzaq et al. 2019; Suryanarayana and Mahammood 2019); therefore, accurately determination of groundwater potential is considered as a critical issue of the groundwater sustainable strategies to protect and manage this vital resource. This has clearly stated by the United Nations in the world water development report (Connor 2015).

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