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Delineation of groundwater potential zones using remote sensing and GIS-based data driven models

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Abstract
The rapid increase in human population has increased the groundwater resources demand for drinking, agricultural, and industrial purposes. The main purpose of this study is to produce groundwater potential map (GPM) using weights-of-evidence (WOE) and evidential belief function (EBF) models based on geographic information system (GIS) in Azna plain, Lorestan province, Iran. Total number of 370 groundwater wells with discharge more than 10 m$^3$s$^{-1}$ were considered and out of them, 256 (70%) were randomly selected for training purpose, while the remaining 114 (30%) were used for validating the model. In next step, the effective factors on the groundwater potential such as altitude, slope aspect, slope angle, curvature, distance from rivers, drainage density, topographic wetness index (TWI), fault distance, fault density, lithology and land use were derived from the spatial geodatabases. Subsequently, the GPM was produced using WOE and EBF models. Finally, the validation of the GPMs was carried out using areas under the ROC curve (AUC). Results showed that the GPM prepared using WOE model has the success rate of 73.62%. Similarly, the AUC plot showed 76.21% prediction accuracy for the EBF model which means both models performed fairly good prediction accuracy. The GPMs are useful sources for planners and engineers in water resource management, land use planning and hazard mitigation purpose.

Key words: Groundwater potential mapping; GIS; Remote sensing; Weights-of-evidence (WOE); evidential belief function (EBF); Iran

1. INTRODUCTION
Groundwater is a dynamic and important natural freshwater resource and contributes around 34% of the total annual water supply (Shekhar & Pandey 2014) which support human health, economic development, and ecological diversity, however its availability is limited. This is because groundwater occurs in complex subsurface formations, cannot be directly seen on the Earth’s surface, and is a fluctuating resource difficult to measure in both time and space. Thus, quantitatively evaluating, efficiently managing, and utilizing groundwater are considerable obstacles (Lee et al. 2012). In recent years, a geographic information system (GIS) has been an important development in the field of information and it is used for spatial data management and manipulation (Ozdemir 2011a). Many studies have addressed groundwater evaluation and mapping potential zone using geographical information system and remote sensing (Chi & Lee 1994; Krishnamurthy & Srinivas 1995; Srininivasan & Subramanian 1999; Murthy 2000; Shahid et al. 2000; Gogu et al. 2001; Saraf et al. 2004; Sener et al. 2005; Sreedevi et al. 2005; Solomon & Quiel 2006; Rao 2006; Jha et al. 2007; Nobre et al. 2007; Ghayoumian et al. 2007; Prasad et al. 2008; Chowdhury et al. 2009; Ganapuram et al. 2009; Saha et al. 2010; Dar et al. 2010; Ayazi et al. 2010; Gaur et al. 2011; Manap et al. 2012, 2013; Neshat et al. 2013). On the other hand application of various models such as the frequency ratio, logistic regression, spatial and geographically weighted regression, weights-of-evidence, analytical hierarchy processes, evidential belief function, fuzzy logic, and artificial neural networks, weight of evidence, for different purposes such as landslide susceptibility (Lee et al. 2002; Lee 2005; Lee & Talib 2005; Lee & Sambath 2006; Lee & Pradhan 2006; Lee & Pradhan 2007; Lee et al. 2007; Akgün et al. 2008; Dahal et al. 2008; Yilmaz 2010; Pradhan & Lee 2010; Pradhan et al. 2010 a, b, c; Mohammady et al. 2012; Pourghasemi et al. 2012 a, b, c, d, 2013 a, b, c, d), groundwater potential assessments (Corsini et al. 2009; Oh et al. 2011; Rahmati et al. 2014; Mpgagi et al. 2014), geosciences (Moon 1990; Bonham-Carter 1994; Luzi et al. 2000; Duke & Steele 2010) Habitat quality assessment (Romero-Calcerrada & Luque 2006), Flood susceptibility (Tehrany et al. 2014; Rahmati et al. 2015), wildfire (Romero-Calcerrada et al. 2008), debris flow prediction (Chang & Chao 2006; Liu et al. 2006; Chang & Chien 2007) and mineral potential (Agterberg et al. 1993; Carranza & Hale 2003; Ozdmir & Altural 2013). In their study Nampak et al. (2014) compared EBF and LR in preparing groundwater potential map in Malaysia. The validation results demonstrated that the success-rate for EBF and LR methods