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Groundwater pollution potential evaluation in Khorramabad-Lorestan Plain, western Iran

Hossein Yousefi[a,*], Ali Haghizadeh[b], Yazdan Yarahmadi[a], Parvin Hasanpour[b], Parvin Noormohamadi[b]

[a] Faculty of New Sciences and Technologies, University of Tehran, Iran
[b] Faculty of Agriculture and Natural Resources, Lorestan University, Khorammabad, Iran

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ABSTRACT

Assessing the vulnerability of groundwater contamination is an important issue in water resource management. Currently, due to the increased activity in agriculture and the use of chemical fertilizers, contamination potential assessment in the Khoraramabad-Lorestan Plain has become very critical. In the present study, groundwater pollution potential is evaluated using two frameworks, namely DRASTIC and SINTACS. For this purpose, seven hydrogeological factors (i.e., groundwater depth, recharge, aquifer media, soil media, topography, unsaturated zone impact, and hydraulic conductivity) are imported to DRASTIC and SINTACS models. Then, using the overlapping method, these seven parameters are combined to prepare a final map. According to these methods, most of the high pollution potential areas are in the north and northwest plains covering an area of 50.49 km^2 in the DRASTIC framework and 65.49 km^2 in SINTACS model. Zones with less pollution potential are in the southern part of the plains. To verify the results of the two models, a vegetation map of the area was used, which shows that the area with the greatest contamination potential corresponds to the agricultural irrigated lands where chemical fertilizers are commonly applied.

1. Introduction

Increased development of societies and expansion of industrial activities has a major contribution to environmental and water pollution. In some cases, human activities hurt capacity balances in nature. In this regard, there have been taken many efforts to prevent, reduce, and limit groundwater contamination of groundwater. The concepts groundwater vulnerability, penetration possibility, and diffusion of pollutants into the groundwater system were used for the first time in France and at the end of 1960 (Thirumalaivasan and Karmegam, 2001).

Penetration possibility and emission of pollutants into the groundwater system are called vulnerabilities. Today, assessment of contamination potential of groundwater resources is increasing by countries and state companies. Moreover, mapping points and contamination potential can be helpful for decision-makers to protect groundwater resources as strategic resources of each country and the possibility of determining the protectable areas of each aquifer. The most important advantage of mapping using GIS is to perform best mergers, acquisition of intelligence layer, and a quick change in the parameters used in the classification of the contamination potential of an aquifer. One way to prevent contamination of groundwater pollution is to identify areas with high potential in order for zoning the regions in terms of their vulnerability; thereby, applying the necessary preparations can be of great assistance to prevent contamination of areas with high vulnerability. Several materials including organic chemicals, hydrocarbons, inorganic cations, organic anions, pathogens, and radiopharmaceuticals are involved in the contamination of groundwater (Fetter and Fetter, 1999).

Such a wide range of materials may lead to the low quality of drinking water and wastewater, increasing the cost of treatment and health, and environmental problems (Nas and Berktay, 2006). The methods for evaluating the vulnerability of groundwater can be mainly divided into three general categories: subjective rating (Nadiri et al., 2017b; Sadeghfam et al., 2016); (Nadiri et al., 2017a; Sadeghfam et al., 2016), statistical and process-based method (Baghapour et al., 2016), and hybrid methods (Mohammadi et al., 2009; Nadiri et al., 2018). Subjective rating method classifies aquifer intrinsic vulnerability based on high, medium, and low categories and the results are used for management decisions. Among the most important ranking methods, one can name DRASTIC (Aller et al., 1987), SINTACS (Napolitano and

* Corresponding author.
E-mail addresses: Hosseinyousefi@ut.ac.ir (H. Yousefi), Haghizadeh.a@lu.ac.ir (A. Haghizadeh).

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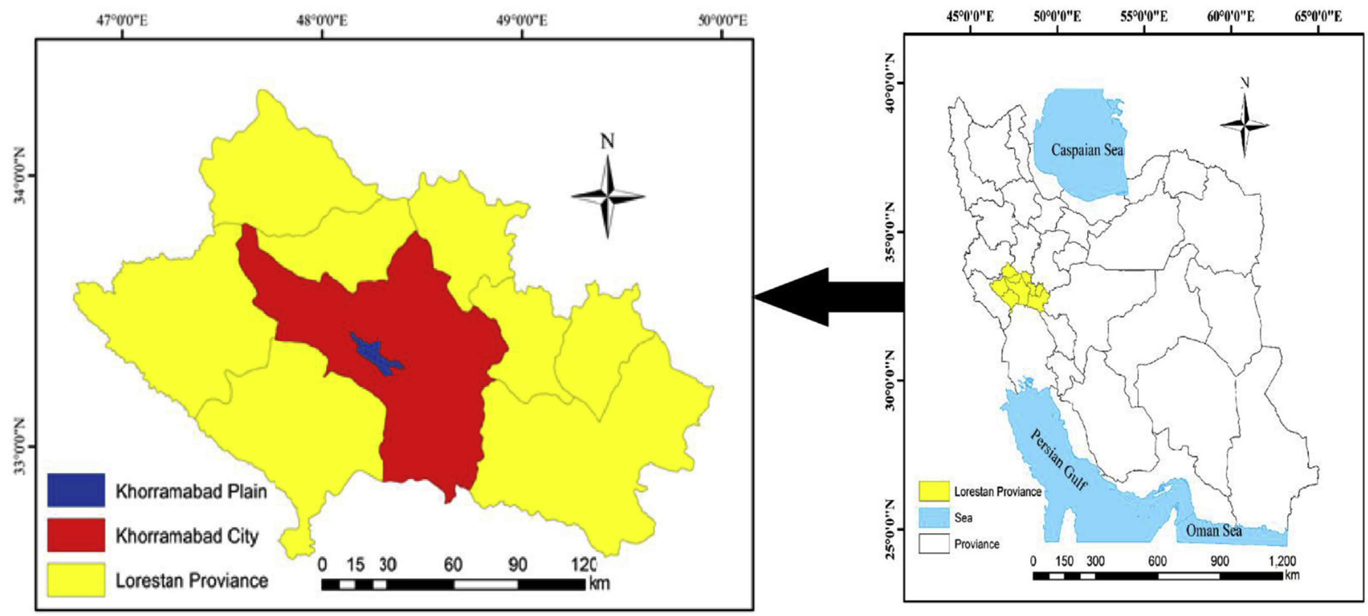

Fig. 1. The study area.

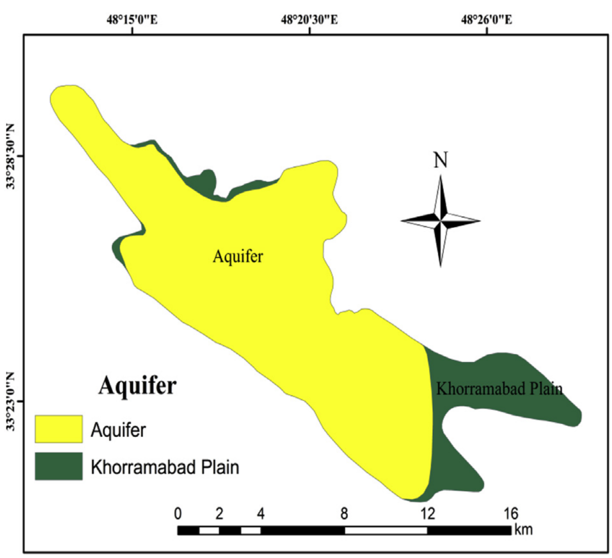

Fig. 2. Aquifer of Khorramabad plain.

Fabbri, 1996), IRISH (Daly and Drew, 1999), and SI (Ribeiro, 2000). Rating methods are the most appropriate methods for assessing the vulnerability of underground water.

Some of the advantages of rating methods are their low costs, direct reaching the target, ease of access to data or estimates, easy description of the final results, and usefulness for management decisions (Focazio, 2002). In the presents study, among several available frameworks, SINTACS and DRASTIC were selected to assess the contamination potential of the Khorramabad plain aquifer. The vulnerability and groundwater pollution have been evaluated by previous researchers:

In the map prepared by (Corniello et al., 1997), 15.05, 66.71, 48.12% of vast plains are placed in the range of low, medium, and high vulnerable, respectively. They applied four frameworks including DRASTIC, SINTACS, AVI, and GOD to assess the vulnerability of groundwater in southern Italy. Eventually, they concluded that class range of DRASTIC vulnerability is wider than that SINTACS framework and SINTACS framework parameters are more effective compared to those of land productivity. (M. Chitsazan, 2006), used DRASTIC in framework GIS environment to determine disposed points of contamination in an aquifer located in the northeast of Ahwaz Zoveyrcheri and Kharan plains (Iran) and concluded that west and southwest parts of the aquifer have a medium vulnerability while some small areas in its northwest and east are in the range without the risk of contamination. They also realized that the unsaturated zone parameter has the highest impact on groundwater vulnerability, with the groundwater depth, net recharge, soil media, saturated zone, topography, and hydraulic conductivity standing in the next ranks, in the order of their appearance.

(Mohammadi et al., 2009) evaluated the vulnerability of Tehran-Karaj aquifer using the DRASTIC framework and fuzzy logic. To calculate the recharge parameter in the DRASTIC index, groundwater balance of the area was calculated and it was observed that 50 and 20% of it has a moderate and very low contamination potential. Followed by applying the DRASTIC model implementation, they prepared vulnerability maps using fuzzy and Boolean logic and compared the obtained results. Finally, they concluded that the fuzzy model categories provide a more uniform distribution among different classes of vulnerabilities.

In a study on the vulnerability assessment of Alshart plain with DRASTIC, SINTACS, and SI models, it was concluded that, despite the desirability of water quality in Alshatr with respect to nitrate ion, DRASTIC and SINTACS models have the highest compatibility and compatibility with the nitrate layer. Therefore, these two models were proposed as effective and final models for evaluating the vulnerability of Alshat aquifer (Jafari, 2014). The Intrinsic groundwater vulnerability of the shallow aquifer in northeastern Missan governorate, south of Iraq is evaluated using commonly used DRASTIC model in the framework of GIS environment. The obtained results related to the vulnerability to general contaminants show that the study area is characterized by two vulnerability zones: low and moderate. Ninety-four percentage (94%) of the study area has a low class of groundwater vulnerability to contamination whereas a total of (6%) of the study area has a moderate vulnerability. The pesticides DRASTIC index map shows that the study area is also characterized by two zones of vulnerability: low and moderate (Al-Abadi et al., 2017).

In another study, the level of groundwater vulnerability to pollution in Wadi Al-Waleh wells and South Amman area was investigated based on SINTACS model. The vulnerability maps showed that most of the sub-surface area of WWC is characterized by medium to high levels of vulnerability to pollution, while units with very low and low vulnerability to pollution cover small areas of the western part of WWC.