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Assessment of Arsenic Contamination Probability of Groundwater in Hamedan-Bahar Basin Using Geostatistical Methods

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Introduction: All living organisms, such as plants, animals and humans depends on the water and life may exist in a place where water is available. Groundwater is the main source of drinking water for more than 5.1 billion people around the world, especially in arid and semi- arid regions such as Iran. Currently, groundwater provided about 60 percent of the worlds drinking water and 77.8 percent of the Iran's drinking water. In recent years, it has been found that groundwater quality is also important as much as its quantity. Nowadays, pollution of groundwater resources from pollutants, especially heavy metals reduces the quality of these resources. Heavy metals are one of the most important environmental pollutant that its entering into the water is raised by agricultural activities, industrial and urban development. Among the heavy metals, arsenic is a toxic and carcinogenic metalloids which are widely distributed in the environment and it has a twentieth abundance of elements in the Earth's crust with an average of 1.8 mg kg^{-1}. Arsenic has been classified in the first group of cancer-causing compounds. It has different effects such as horny skin, liver, skin and bladder cancer, mental disorders, damage to neurons, blood pressure, lower IQ and reducing white blood cells and red blood. The Maximum permissible arsenic in drinking water is 10 micrograms per liter which has been identified by the World Health Organization and America Environmental Protection Agency. According to national standards of Iran, limitation of arsenic in drinking water is 10 micrograms per liter. So far, numerous studies were done to evaluate the environmental contamination of heavy metals, especially arsenic using geostatistical methods. The aim of this study was to evaluate the quality of groundwater in terms of Arsenic pollution.

Materials and Methods: study area is Hamedan - Bahar aquifer with an area of 800 square kilometers that is located on the northern slopes of Alvand Mountains. The central part of Hamadan city, Lalejin, Saleh Abad and Bahar city is located in the study area. To conduct this study, concentrations of arsenic was investigated in 94 groundwater points. To determine the spatial distribution of arsenic, different geostatistical methods were used. Then the results of this methods were compared using cross validation technique and MAE & MBE index and the most suitable method was chosen for this purpose. Eventually RBF method by multiquadric model was used. Moreover Contamination probability map was developed using indicator kriging models.

Results and Discussion: Arsenic concentrations were in the range between 5 – 79.5 micrograms per liter. Also The average concentration was 12.4 micrograms per liter. While the threshold for arsenic in water defined 10 micrograms per liter by the World Health Organization (WHO). So an average of arsenic in ground water is higher than limits of international standard. The spatial correlation analysis showed that the concentrations of arsenic in groundwater have no strong spatial dependency. So, for zoning this variable, between the nonparametric methods, radial basis function (RBF) by Multiquadric model was used. This method had lowest MAE and MBE index for arsenic in groundwater. The highest concentration of arsenic was in the industrial zone in the north of Hamadan (Hamedan, Tehran road). In general Excessive concentrations of arsenic are visible in the three areas: The first area is between Hamedan and Tehran Road Industrial Estate, that the high rate of abnormalities was found in this area (79.5 µg/L). Also the suburbs of Saleh-Abad and the Bahar city has high arsenic concentration. In these areas, groundwater levels were high and pollutants can penetrate more easily. The results of the contamination map using an indicator kriging method showed that 21.18% of aquifer moderately contaminated and about 10.9% of the aquifer area have a high contamination possibility. Polluted groundwater is matched with agricultural land especially the potato fields.

Conclusion: The results showed that the average concentration of arsenic in groundwater of Hamedan-Bahar basin is more than WHO and Iran department of environmental guidelines. The highest concentration of arsenic in agricultural lands and consequently in groundwater resources is due to the existence of polluting industries,

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the geological structure of the area where arsenic concentration naturally is high, cultivation of potatoes and other crops in the region and indiscriminate use of pesticides and chemical fertilizers in agriculture.

Keywords: Carcinogenic metalloids, Indicator kriging, Radial basic function, Spatial distribution