Journal of Mineral Resources Engineering, 7(3): 19-38, (2022)

Imam Khomeini International University

Vol. 7, No. 3, Autumn 2022

نشریه مهندسی منابع معدنی

Journal of Mineral Resources Engineering (JMRE)

Research Paper

Assessment of Groundwaters Quality for Industrial and Agricultural Applications Using Consecutive Gaussian Simulation

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Received: 11 Apr. 2021 **Accepted: 28 Dec. 2021**

Abstract: The geostatistical method is one of the most advanced techniques to assess and survey groundwater quality. Using unsuitable water results in some problems such as soil salinity, reduction of soil permeability, decrease in water absorption by plant roots, diminution of crop productivity, or even menace agricultural production. Accordingly, in this study, the groundwater quality in the study's area for agricultural uses as well as industrial applications by using common diagrams and components related to the classification of water quality was investigated. ISATIS and Surfur software were used to illustrate changes in quality characteristics in the study's area graphically and Consecutive Gaussian simulations to analyze spatial connection among variables and estimate some of the quality indexes such as PH, RSC, Na%, SAR, and Ec. After data normalization, the variogram was calculated, and a sufficient model was selected to fit the experimental variogram based on the lowest SSR Error. Afterward, Consecutive Gaussian simulation in 100 samples in the study's area was examined using the fitted model based on the experimental model, and the maps resulting through simulation in different thresholds were provided. The results showed that the majority of samples have fairly suitable quality in terms of SAR, and in general, they are appropriate for agricultural uses. Percentage risk of Sodium in agricultural water in the study's area was also classified into the appropriate class. Except for four samples whose spatial connection of the forgoing cases have been interpolated and the interpolated probability maps have been provided, the water quality for industrial uses is susceptible to sedimentation in all statutes.

Keywords: Geostatistical, ISATIS, Gaussian simulations, Water quality.

How to cite this article

Dehshibi, R., and Agah, A. (2022). *"Assessment of groundwaters quality for industrial and agricultural applications using Consecutive Gaussian simulation"*. Journal of Mineral Resources Engineering, 7(3): 19-38.

DOI: 10.30479/JMRE.2022.15192.1504

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INTRODUCTION

Today geostatistical methods are widely used in the exploration of groundwater sources and reserves. These methods are more popular due to the ability to produce multiple realizations of variables (1000 stimulations) rather than providing only one realization of the variable in the Kriging method and don't generate biased results. The sequential methods, matrix separation, continuous spectrum, and rotating bands can be mentioned as Gaussian simulations. Consecutive Gaussian simulation is a fast and simple way to do geostatistical stimulation since solving only one kriging system is required for any location for Gaussian stimulation. Although it's not able to illustrate spatial connection for different number of classes and the stimulation of large terminal amounts isn't also available in this method. Non-Gaussian simulation algorithms can be used to achieve more accurate results in smaller ranges which allow using large terminal connections [1]. The geostatistical method is widely used in hydrogeological studies and groundwater quality assessments among which Hoimsens et.al [2], March et.al [3], Ving et.al [4] can be referred.

Given that groundwater reserves are the only water source to supply drinking, agricultural, and industrial water in the Birjand's plain, studying water quality for exploration and using it for correct application in different parts is so important. There are many hydrochemical studies done on groundwater and their correct application by using graphical and statistical methods but not many studies focused on modeling this subject by geostatistical with Gaussian simulations and Indicator. Recent studies provide the estimation by using the Kriging and other interpolating methods. Nowadays geostatistical stimulations are widely used in the exploration of water sources and reverses. Due to their ability to produce multiple realizations of the variable (100 stimulations) rather than the kriging's method providing only one realization of the variable, these methods are more popular without creating biased results. Sequential methods, matrix separation, continuous spectrum, and rotating bands can be remarked as some examples of Gaussian simulations. The study aimed to apply geostatistical methods for hydrochemical data modeling in Birjand's plain to evaluate this tool and also provide spatial maps of water quality variables in the aquifer.

METHODS

Consecutive Gaussian simulations

Application of the sequence principle incorporated in a multi-Gaussian model is called random functions Consecutive Gaussian simulations. These algorithms have been introduced to stimulate one feature by using a single amount and obtain subsequent information further, and corporate stimulating of multiple dependent variables. Normalized standard data are required to simulate by using this algorithm. Simulating of Z feature connection at N node in the network is conditioned to $\{(ua), a = 1, \ldots, n\}$ data set. Steps of consecutive Gaussian simulations include:

1. The first step is confirming the validity of the multi-Gaussian model, which requires to histogram plots to present primary data and normalize data and convert z-data into y-data by a Normal standard cumulative distribution (CDF) function.

2. If the multi-Gaussian model holds for the y variable, Consecutive Gaussian simulations can be applied to y-data by the implementation of the following steps:

_Diagram's Plotting by using normalized data.

- Selecting a random path to perform simulation so that any network node would be simulated only once.
- Mean and variance parameters are determined for each u' node and then simple kriging is performed by using a normalized data view model to estimate data on the network.
- Calculating the estimated amount of cumulative distribution function and adding it to data sat.
- Passing to the next node along a random path and repeating the previous two steps.
- Repeating all the above steps so that N nude is simulated and the total network is given the appropriate number.
- Consecutive Gaussian simulation is a simple and fast way to geostatistical simulation; because Gaussian simulation in each location requires solving only one kriging system there. Nevertheless, this simulation isn't able to illustrate the spatial connection for different classes and also doesn't allow simulating of large terminal amounts. Non-Gaussian simulation algorithms can be used to achieve more accurate results in smaller ranges, which allow using large terminal connections [1].

FINDINGS AND ARGUMENT

According to the results of analysis of affected parameters on water quality for agricultural uses, the water quality of the study area samples had the highest frequency of electrical conductivity in terms of EC parameter in the 2250-750, respectively. In the respect of the SAR parameter, the highest frequency belonged to the second class of s2 with the value of 10 to 18.

Based on the Wilcox classification diagram, samples were mostly in the irrigation classes C4-S3 (high salinity- unsuitable for agricultural uses) and C4-S4 (high salinity- unsuitable for agricultural uses).

The classification of Sodium risk in agricultural water in the study area with the value of 40-60 percent was also in the suspicious class.

Expects for five samples, all of the samples collected from the study area were in the high class based on RSC parameter classification. In the terms of the water PH classification, most of the measured samples were up to the threshold of 7. According to water quality assessment for industrial applications, all samples were susceptible to sedimentation despite four samples located in Mokhtaran, Boshrouyeh, and Esfanden areas.

CONCLUSIONS

In this study geostatistical method was used incorporated with other techniques and observed that different parameters and various statistical parameter requires distinct algebraic and statistical methods and by using the same parameter for zoning different parameters isn’t allowed. However, both methods can be applied sufficiently for the zoning of different elements. Geostatistical methods are reasonable to the analysis of the achieved results of decomposition groundwater samples and can be exerted as an additional tool in decision-making about spatial variations of water quality variables. Similarly, in the geostatistical method, after data normalization, a sufficient model was selected to fit the experimental variogram based on the lowest SSR Error and then, the best interpolation method was selected by using cross-evaluation and SSR. The results of our study showed that the Consecutive Gaussian simulation could simulate and validate preceding parameters for all of water quality indexes better than other techniques.

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