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Spatial estimation of groundwater quality factors using geostatistical methods (case study: Shiraz plain)

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Abstract

Water quality mapping is the main procedure of this assessment. At present research, we compare efficiency of three interpolation techniques included inverse distance weighting, kriging and cokriging for predicting of some groundwater quality indices such as: Na^+, TH, EC, SAR, Cl^- and SO_4^{2-}. Data were related to 56 wells in Shiraz plain, Fars Province, Iran. After normalization of data, variogram was computed. Suitable model for fitness on experimental variogram was selected based on less root sum of square value. Then the best method for interpolation was selected, using cross-validation, mean error and root mean square error. Results showed that for TH, EC, CL^- SO_4^{2-} Cokriging had the lowest root mean square error and for SAR , Na^+ inverse distance weighting technique had better result than geostatistical method to simulate groundwater quality indices. Finally, using geostatistical and Kriging methods, map of Groundwater were prepared in GIS environment.

Key words: Groundwater quality, Interpolation, Geostatistics, Shiraz plain.

1. INTRODUCTION

Groundwater quality is influenced by the geological formation and anthropogenic activities e.g., changes in land use, urbanization, intensive irrigated agriculture, mining activities, disposal of untreated sewage in river, lack of rational management, etc [1]. It is pointed out that groundwater contamination may cause various diseases and other problems [2]. In mapping Groundwater quality, two main stages can be distinguished: 1) the sampling stage, during which measurements are taken of the environmental variable at selected locations; and 2) the prediction stage, during which the observations are interpolated to a fine grid. The quality of the resulting map is determined by both stages. Geostatisticians and pedometricians have concentrated most on the second stage, by applying various types of interpolation methods [4]. Geostatistical methods were developed to create mathematical models of spatial correlation structures with a variogram as the quantitative measure of spatial correlation. The variogram is commonly used in geostatistics and the interpolation technique, known as kriging, provides the best, unbiased, linear estimate of a regionalized variable in an un-sampled location, where best is defined in a least-squares sense. The emphasis is set on local accuracy, i.e. closeness of the estimate to the actual, but unknown, value without any regard for the global statistical properties of the estimates. The kriging estimation variances are independent of the value being estimated and are related only to the spatial arrangement of the sample data and to the model variogram [4]. In recent years, many scientists have evaluated accuracy of different spatial interpolation methods for prediction of groundwater quality parameters. Nazari et al. [5] used geostatistics method to study spatial variability of Groundwater quality in Balarood plain. Their results showed that spherical model is the best model for fitting on experimental variograme of EC, Cl^- and SO_4^{2-} variables. The present study was therefore, carried out with objectives to evaluate accuracy of different interpolation methods, kriging, cokriging and IDW, for prediction of some Groundwater quality parameters in Shiraz region.

2. Material and Methods

Shiraz is located in the southwest of Iran in the central district of Fars Province, in eastern longitude 52 degrees and 32 minutes and northern latitude 29 degrees and 36 minutes. It has 15-km latitude, 120-km longitude and moderate and semi-arid climate. Its height ranges between 1480 and 1670 meters from the sea level in different parts of the city. Shiraz is divided to 9 independent urban districts according to the latest official divisions and its area exceeds 178891 kilometers [6]. Groundwater resources in Shiraz Plain are very important sources of water. The underground aquifer of this plain is a large natural collecting reservoir and regulator of water inflowing from the large drainage area, which both retains water and enables its useful