Abstract
identification of homogeneous regions in terms of groundwater quality in Golestan province of northern Iran using K-Means Clustering and Fuzzy Clustering Method combination with non-dominated sorting genetic algorithm (NSGA-FCM) was performed on 14 parameters in a 5- year- time step in 2006, 2011 and 2016. To determine the homogeneous regions for each year, the optimal number of clusters was initially obtained. Two silhouette and Davis-Bouldin verification indexes were used in the K-Means clustering as a objective function in the genetic algorithm. For FCM fuzzy clustering, two-objective functions have the maximum similarity between elements within the categories and at least similarity with elements of other categories for classifying classes optimally. After data clustering in Matlab software, the results of clustering were evaluated qualitatively with Schuler and Wilcox diagrams. For better representation of homogeneous regions, classification maps for the study area were presented. The results showed that the optimal number of clusters in 2006, 2011 and 2016 for K-Means clustering with silhouette width function was 3, 4 and 5, respectively, and for the Davis-Boulder function 4, 3 and 4 respectively. The results of the K-Means models with the width of the silhouette and Davis Bouldin suggest that Kalaleh region is in an inapproprate area for drinking and agricultural. But the rest of the regions are good and acceptable for drinking and agricultural. The results showed that the optimum numbers of clusters in 2006, 2011, and 2016 were 6, 5, and 6, respectively. Analysis of groundwater quality classification maps showed that in 2006, cluster no.6 was in inapproprate condition in terms of groundwater quality for drinking and agricultural purposes, which are located within the city of Kalaleh. Also, based on the results, it can be seen that 36.8% of the wells across the province were in good condition in terms of quality of drinking and agricultural parameters in 2011. Likewise, 33.33% of the wells are in a moderate condition in terms of drinking quality, and the status of their groundwater has improved in terms of quality since 2006. Also, the results of NSGA- FCM in 2016 showed that most of the parameters (55.5% of the wells in the province) in the cluster 3 have a moderate quality. The findings of this study showed that the groundwater quality in the province in 2016 is lower than in 2011, so appropriate management plans should be adopted. Moreover, it was observed that the fuzzy clustering method is a suitable method for assessing the quality of groundwater resources, since it considers the uncertainty conditions in the classes of the classification system.

Key words: Genetic Algorithm, Fuzzy Clustering, Classic Clustring,Water Quality

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