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Identify the Effective Wells in Determination of Groundwater Depth in Urmia Plain Using Principle Component Analysis

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Introduction: Groundwater is the most important resource of providing sanitary water for potable and household consumption. So continuous monitoring of groundwater level will play an important role in water resource management. But because of the large amount of information, evaluation of water table is a costly and time consuming process. Therefore, in many studies, the data and information aren't suitable and useful and so, must be neglected. The PCA technique is an optimized mathematical method that reserve data with the highest share in affirming variance with recognizing less important data and limits the original variables into to a few components. In this technique, variation factors called principle components are identified with considering data structures. Thus, variables those have the highest correlation coefficient with principal components are extracted as a result of identifying the components that create the greatest variance.

Materials and Methods: The study region has an area of approximately 962 Km^2 and area located between 37º 21´ N to 37º 49´ N and 44º 57´ E to 45º 16´ E in West Azerbaijan province of Iran. This area placed along the mountainous north-west of the country, which ends with the plane Urmia Lake and has vast groundwater resources. However, recently the water table has been reduced considerably because of the exceeded exploitation as a result of urbanization and increased agricultural and horticultural land uses. In the present study, the annual water table datasets in 51wells monitored by Ministry of Energy during statistical periods of 2002-2011 were used to data analysis. In order to identify the effective wells in determination of groundwater level, the PCA technique was used. In this research to compute the relative importance of each well, 10 wells were identified with the nearest neighbor for each one. The number of wells (p) as a general rule must be less or equal to the maximum number of observations (n), here it is the number of years. So, for each well there are a 10 * 10 matrix. It should be noted in monitoring adjacent wells to a specific well, its dataset is not used. To quantify the effect of each well according to the number of its participation in the analysis and frequency of its effectiveness, each well is ranked. In the next step, the ineffective wells were recognized and eliminated using both the variation coefficient and Error criteria. Following, the procedure will be discussed.

Results and Discussion: In this study, at first step using PCA technique wells were identified with a more than 0.9 correlation coefficient. Then each well ranked based on the relative importance and according to the specified thresholds, the variation coefficient and error of monitoring was estimated. The wells remain in threshold 1 led to the lowest variation coefficient, considered as effective wells in the evaluation of aquifer parameters. By eliminating ineffective wells at each threshold, the variation coefficient is reduced because of the elimination of wells with a greater difference in water depth compared to the average of whole wells. To check the certainty of obtained results, the error criteria were calculated for each threshold. According to the results, both variation coefficient and standard error of monitoring in threshold 1 come to be at least. Thus, 12 wells remain in the threshold 1 are considered as the important wells in monitoring the water table of plain Urmia. Monitoring error for these 12 wells is equal to 5.1 % which is negligible and can be introduced as index wells in sampling and estimation of groundwater table in plain Urmia. Using this method, instead measurements of water table in 51 wells it can be performed exclusively in the 12 wells.

Conclusion: Due to reduction of precipitation and unauthorized uses of groundwater resources, water table monitoring is very important in the accurate management of these resources. Because of extensive aquifers and large number of wells, water sampling and data collection is very time consuming and costly process, that leads to no economic justification in the lot of proceedings. Principal component analysis technique is suitable method to reduce sampling points and summarize information. In this study, at first step using PCA technique wells were identified with a more than 0.9 correlation coefficient. Then each well ranked based on the relative importance and according to the specified thresholds, the variation coefficient and error of monitoring was estimated. The

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results showed that the 12 wells remain in threshold 1. In this way, the cost, time and manpower required to measurements and analysis process cut into quarters.

Keywords: Coefficient of variation, Groundwater, Effective wells, Monitoring, Urmia Plain