Optimizing the Observation Network for Groundwater Quality using Principle Component Analyses jointly with Geostatistics

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In areas where groundwater for consumption is being abstracted, it is usually stipulated that continuous observations regarding the groundwater quantity and quality must be made. Monitoring and evaluation of the observations are costly, so it is of vital importance to make the monitoring network as optimal as possible. In reality, the observations are performed as point measurements, but since the observed variable almost always has a distribution in space there is therefore need during the evaluation of the observations to make estimates of the observed variable at locations where no observations have been made for example when mapping a variable over an area.

The development of new methods for evolving the monitoring network is essential as the groundwater quality parameters are large in number. The objective of this research was to develop and test a new method for evaluating a network of groundwater quality observations. A methodology is thus developed for design of a cost-effective groundwater quality sampling network. The new proposed method is the multivariate technique of principal component analysis (PCA) jointly with Geostatistical method of kriging. Since the groundwater quality is involving a number of parameters, thus PCA, a multivariate statistical technique is used to identify important components or factors that explain most of the variances of the system. The role of PCA is to reduce the number of variables without affecting the variance of the data. Then, further geostatistical techniques help us to examine the monitoring network thereby allowing one to search for the redundant wells. The procedure developed allows analysis of an existing monitoring network of multiple parameters with lesser number of variables that can be used for evolving optimal monitoring network. A case study from a hard rock aquifer has demonstrated the methodologies developed.