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Application of multivariate statistical methods to surface and ground water quality and health risk assessment of Attock Basin, Pakistan

Shazia Jabeen and M. Tahir Shah
National Centre of Excellence in Geology, University of Peshawar, Peshawar

Attock Basin, previously known as Campbelpur Basin, is lying at the southeastern margin of the Peshawar Basin and is separated from it by the Indus River. It is generally covered with the Quaternary alluvial and fluvial sand, gravels and lacustine deposits. It is mainly drained by Haro River with its three main tributaries named as Nandna, Dhamruh and Reshi streams. Attock is the main city of the basin. For the last two decades the basin has tremendous increase in the population and establishment of industrial units. The increasing population and industrial developments in the basin have significantly affected the water resources of the basin. In order to investigate the quality of water of the basin, representative water samples from surface and ground water were collected according to the guidelines of the WHO. These samples were analyzed for physico-chemical parameters using sophisticated instruments including atomic absorption spectrometer equipped with graphite furnace and Hach DR2800 spectrometer in the Geochemsitry laboratory of the National Centre of Excellence in Geology, University of Peshawar. During this study more emphasis was given to the heavy and trace metals such as Fe, Mn, Cu, Pb, Zn, Ni, Cr, Co, CD, As and Hg. The data obtained was compared with the permissible limits of these elements set by the WHO, US-EPA and Pak-EPA for drinking water. The heavy and trace elements in most of the studied water samples were found within the permissible limits. In this study different multivariate statistical data analysis techniques were applied to find out the heavy and trace elements contamination contributed either by industrial and municipal solid waste and or by the various types of minerals of the soil of the basin. Data set thus obtained was treated using factor analysis (FA), principal component analysis and cluster analysis. FA identified four factors responsible for data structure explaining 67.04% of total variance in ground water and four factors in surface water explaining 83.13% of total variance and hence allowed to group selected parameters according to common features. Questionnaires were distributed to the individuals from each sampling unit to estimate the drinking water consumption. Exposure and risks for each individual was also determined by using health risk assessment statistical tools. This study indicated the necessity and usefulness of multivariate statistical methods for evaluation and interpretation of data in understanding the quality of water and related health risk assessment.