

Heavy Metal Assessment in the Groundwater of Baran District, Rajasthan, India

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Abstract

Heavy metals in groundwater were analyzed and their sources and impacts were identified using multivariate statistical tools and risk assessment. Three significant factors were extracted by factor analysis (FA), explaining 75.69% of total variance. These factors were in turn described by the clusters C3, C2 and C1, respectively, resulting from the cluster analysis (CA). Factor analysis and cluster analysis revealed significant anthropogenic contributions and water-rock interaction effects of the metals in groundwater. The mean values of heavy metal evaluation index (HEI) and degree of contamination (Cdeg) indices indicated that the groundwater samples were contaminated with high degree of pollution by cadmium (Cd) and lead (Pb). The hazard quotients (via ingestion) of Cd and Pb were found to be higher than the safe limits, posing threat to the consumers. However, no risk related to the dermal contact was associated with the measured metal levels. The present investigation explains Heavy Metal Assessment in the Groundwater of Baran District, Rajasthan, India

Keywords: heavy metals, groundwater, contamination, hazard, assessment, evaluation, Baran

Introduction



Baran district, Rajasthan

Groundwater is the principal natural water resources for both drinking and agricultural

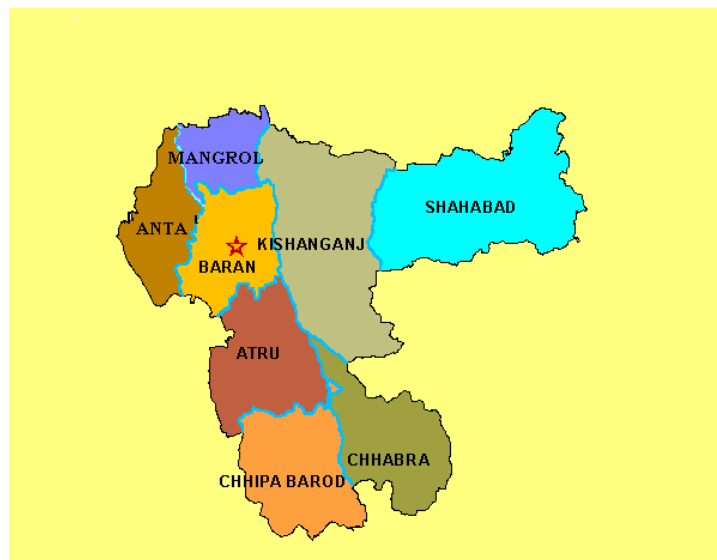
purposes. Nowadays one of the most important environmental issues is groundwater contamination [1,2] In areas where population density is high and human use of the land is intensive, groundwater is especially vulnerable. Virtually any activity whereby chemicals or wastes may be released to the

environment, either intentionally or accidentally, has the potential to pollute groundwater. When ground water becomes contaminated, it is difficult and expensive to clean up.[1,2]

Heavy metals are among the major contaminants of groundwater sources . Some of these heavy metals are essential for the growth, development and health of living organisms, whereas others are non-essential as they are indestructible and most of them are categorized as toxic species on organisms . Nonetheless, the toxicity of heavy metals depends on their concentration levels in the environment. With increasing concentrations in environment and decreasing the capacity of soils toward retaining heavy metals, they leach into groundwater and soil solution. Thus, these toxic heavy metals can be accumulated in living tissues and concentrate through the food chain.The main objectives of this study are:

- (1) to determine the spatial variation of heavy metals using multivariate statistical techniques in groundwater of Baran District, Rajasthan, India
- (2) to assess the potential health risk assessment of heavy metals and
- (3) take preventive and protective measures.

Discussion



Map showing Baran in Rajasthan

Factor analysis was employed to find and interpret the structure of the underlying data set through a reduced new set of orthogonal (non-correlated) variables (principal components, PCs), arranged in decreasing order of importance. Besides considerable data reduction, PCs can explain the entire multidimensional data set variability without losing much original information. FA with Varimax rotation of standardized component loadings was conducted for extracting and deriving factors, respectively, and those PCs with eigenvalue >1 were retained .The distribution manner of individual association of element in groundwater was determined by principal component method . Statistical treatment of these data indicates their association and grouping with three factors explained most of the variability. [3,4]



Baran , Rajasthan has improved its groundwater table

Table 1.- Statistical summary of physicochemical parameters in groundwater of Baran district , Rajasthan

	Min	Max	Mean	SD	CV
EC	830	2730	1451	557	38
T	14	18	16	1.4	8.6
pH	6.9	7.9	7.4	0.3	3.5
Al	0.01	0.09	0.05	0.02	43.69
Cd	0.009	0.165	0.066	0.045	67.646
Cu	0.056	0.43	0.241	0.102	42.248
F	0.017	0.358	0.129	0.111	86.222
Fe	0.055	0.499	0.255	0.116	45.563
Pb	0.017	0.292	0.087	0.069	79.323
Si	12.2	33.3	21.6	7.2	33.2
Zn	0.045	0.276	0.148	0.06	40.466

Results

Human health risk assessment was defined as the processes of estimating the probability of occurrence of an event and the probable magnitude of adverse health effects over a specified time period . Exposure of human beings to the metals could occur via three main pathways including direct ingestion, inhalation and dermal absorption through skin; however, ingestion and dermal absorption are common routes for water exposure. The results indicated that Fe, Cu, Zn and F are the major contributors to the ingestion and dermal exposures to the inhabitants, while Cd, Al and Pb are the least participants. Among the selected metals, Cd and Pb posed adverse health risks and potential non-carcinogenic health risks to the inhabitants, while rest of the metals caused little or no adverse effects to the residents via ingestion route. However, the metals would not pose any adverse effect and non-carcinogenic health risk to the consumers via dermal contact.[5,6]

Conclusions

In this study, the mean concentrations of heavy metals in groundwater of Baran district , Rajasthan in decreasing order was as follows: Si > Fe > Cu > Zn > F > Pb > Cd > Al. [7]

Factor analysis method identified three factors responsible for data structure explaining 75.69% of total variance in groundwater. There was high level of contamination with Al, Cd and Pb. Non-carcinogenic health risk assessment was computed to assess the adverse health effects on the population. The hazard quotients (via ingestion) of Cd and Pb were found to be higher than the safe limits, posing threat to the consumers. However, no risk related to the dermal contact was associated with the measured metal levels. In the face of this type of pollution, which has an adverse effect on human health, a number of recommendations and guidelines should be given to population of rural areas like Baran in Rajasthan [8,9]

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