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ENVIRONMENTAL ASPECTS OF GROUNDWATER RESOURCES DETERIORATION IN THE CITY OF THE TAJ

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ABSTRACT

The problem of groundwater deterioration in the environmental regime of the city of the Taj (Agra, latitudes 27°10′ N and longitudes 78° 5′ E), India situated at the river bank of the Yamuna, has been discussed. The present study is based on the physico-chemical analysis of 486 groundwater samples from the residential, commercial, industrial areas; Yamuna banks and dumping areas of Agra city. The analysis of 486 groundwater samples reveals that groundwater of Agra city is contaminated with inorganic species like Ca2+, Mg_2+, Cl-, F- and NO_3-; metallic species like Fe_2+, Pb_2+, Cd_2+, Zn_2+, Hg_2+, Cu2+ & Cr_6+; organic species like polyaromatic hydrocarbons. In the most of the areas the deterioration of groundwater exceeds with the limit set by the national and international agencies. The possible causes for the deterioration of groundwater resources have been assigned to over exploitation of groundwater and mobilization of contaminants by leaching of continental rocks as well as contaminated soil through dumping sites and wastewater drains etc. It has been concluded that the groundwater of the Agra city is not fit for drinking.

INTRODUCTION

The ground water is a dynamic, replenishable and dependable earth resource which acts as a viable substitute to the surface water supply. The indiscriminate extraction of ground water is developing into drought conditions in several regions of the country which can be controlled by implementing schemes of effective management of ground water resource. Groundwater passing through soil dissolves various salts and minerals causing a direct threat to the life of human beings and other organisms. These substances may be the important components of the human environment. Some of them may be either beneficial or toxic depending on their concentrations. The mobilization of various toxics in an environment may be hazardous to human health.

Pollution comes from both natural and anthropogenic sources. The sources of toxic metals that can potentially contaminate groundwater include industrial and municipal landfills, septic tanks, mining, agricultural practices and midnight dumping.

In recent years quality of groundwater has undergone a considerable change with respect to contamination of heavy metals. Studies throughout the country especially in urban areas (Amadi *et al*. 1989; Brink

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& Zaadnoordjik 1995; Jain, 1996; Panda *et al*. 1996; Shrikantha *et al.* 1993; Charles *et al*. 2005) have indicated heavy metal contamination. Out of 20 parameters analyzed in the present investigation, some have been detected above maximum permissible concentration at different places. Tripathi *et al*. 1995 studied Fe, Zn, Cu, Mn and Cr in hand pump waters of Rewa city. Iron content was found to be higher while Cu, Mn & Zn contents were lower.

In view of the prevailing scenario, such an area has been selected in the Taj city (Agra, latitudes 27°10′ N and longitudes 78° 5′ E) located at a distance of 200 kms from Delhi (capital of India) in Uttar Pradesh. Keeping this in view it was thought worthwhile to determine physicochemical parameters of Agra groundwater to establish the baseline for the estimation of future contamination by external agents. It is important because groundwater is consumed by about 80% of population of Agra city.

EXPERIMENT

Initially, Agra city was divided into four broad areas as residential areas (RA), commercial areas (CA), industrial areas (IA) and dumping areas (DA). Residential areas were further classified as higher income group (HIG), middle income group (MIG), lower income group (LIG) and slum areas (SA). Groundwater samples were collected from various sources like jet pumps, handpumps, dugwells depending upon their availability and public use. All 486 samples were collected in one-litre polythene screw bottles from each area between October to December 2006. The sample bottles were thoroughly precleaned with 50 % HNO_3 followed by thrice washing with double distilled water. The samples were filtered through filters and physicochemical analysis was done as per Standards Methods (Clesceri *et al*. 1998). Samples for heavy metal analysis were immediately acidified with 5 ml HNO3 per litre sample. Heavy metal analysis was done with atomic absorption spectrophotometer by direct aspiration method. Prior to analysis all the samples were subjected to controlled nitric acid digestion on a hot plate until a clear light coloured solution was obtained. Filtrate was cooled, diluted and mixed thoroughly. All reagents used were of AR grade.

RESULTS AND DICUSSION

The results of analysis for physicochemical parameters are given in Table 1. The highest value of total acidity (TA) was observed in IA and T. Alk. in slum Areas. The maximum electrical conductivity (EC) and total dissolved solids (TDS) values were found in DA, IA and slum areas. EC value high due to sanitary unhygienic. Total hardness (TH), hardness (Ca & Mg) and PO_4^{3-} were found above their maximum permissible limit (MPL) in all the seven areas. So, Agra's groundwater is not so good in respect to hardness. Na, K, CI^- & NO_3 were measured under its MPL. Fluoride concentration has been analyzed upper to its MPL in all locations except commercial areas. F- high concentration in six areas is due to bed rock structure in geological stratas. So, it has been concluded that F- may become the major problem in Agra in coming years. According to sulphate concentration, Agra groundwater is not good for health. Due to the higher numbers of coliforms in slum and dumping area samples indicate that groundwater has become pathogenic.

The important sources of iron in groundwater consists of various geological stratas through which it passes and is finally stored. The iron contents in all samples ranged between 0.01 to 0.32 mg/L. It is observed that iron content in all the sample is within MPL. High values are probably due to the existence of ferrous, electroplating, beverage and other industries while leaching from dumping sites may be possible cause of high iron content in DA and IA. Cd is toxic to humans and its concentrations was well below the MPL in all samples. In the present study it ranged between 0.001 to 0.02 mg. Zinc is essential for functioning of various enzyme but its concentration above 5 mg/L causes bitter taste. In Agra, Zn content varied between 0.1 to 0.34 mg/L which is quite safe and well below the MPL. In the study area lead concentration ranged between 0.001 to 0.019 mg/L which was under MPL, The higher concentration of zinc and lead in IA and DA due to various galvanizing, electroplating and other industries which surely reached upto underground sources due to leaching from dumping site.

CONCLUSION

The possible causes for the depletion of groundwater levels have been assigned to over exploitation of ground water, reducing trend of recharge due to decrease in amount and intensity of rainfall, and nature of topography.

The ground water movement in general, is towards the Yamuna River indicating effluent condi-

Table 1. Physicochemical and bacteriological characteristics of groundwater in different areas of Agra city during October to December 2006

Parameters	DL-MPL	HIG Areas	MIG Areas	LIG Areas	Slum s Areas	Commercial Areas	Dumping Areas	Industrial Areas
pH	6.5-8.5	7.64	7.80	7.59	8.16	7.33	7.87	6.92
TA	4.2-31.4	12.27	18. I 8	8.91	7.40	10.63	8.33	13.00
T.Alk.	200-600	12.33	601.0	616	669	155.0	578.5	617.3
EC	200-600	609	740	780	855	670	881	788
TDS	500-2000	1670	1178	2348	2463.6	2570.9	2739	2625
TH	300-600	666	679.4	818.4	698	789.8	745.0	638.0
Ca	75-200	297.4	273.4	213.4	307.8	297.8	392.8	298.6
Mg	30-100	146.0	115.8	129.0	198.2	165.0	199.5	71.0
Na	200-*	99.0	83.7	77.0	96.4	60.1	83.33	71.0
K	200-*	18.9	14.27	23.9	26.3	21.9	30.5	23.5
Sulphate	200-400	165.0	189.4	195.0	241.1	242.2	279.8	313.1
Chloride	250-1000	231.5	236.2	280.2	311.7	248.5	254.6	277.0
Fluoride	1.0- 1.5	1.76	1.88	2.83	3.75	2.41	2.42	3.97
Nitrate	45-100	21.8	17.02	25.6	28.6	36.1	37.7	28.5
Phosphate	0.5-1.0	1.87	1.10	2.9	6.21	2.28	1.33	1.54
Coliform	100-500	116.0	117.6	258.0	456.0	213.3	363	239
Iron	0.3-1.0	0.06	0.05	0.03	0.05	0.08	0.26	0.32
Cadmium	0.01- No rel.[C]	0.001	0.006	0.007	0.008	0.008	0.009	0.01
Zinc	5.0-15.0	0.10	0.12	0.14	0.08	0.13	0.20	0.23
Lead	0.05- No rel.	0.003	0.003	0.002	0.003	0.004	0.014	0.017

a - All mean concentrations are reported in mg/L except pH in numerical range, EC in µmhos/cm and coliforms in MPN/100 mL sample.

b - DL is desirable limit above which undesirable effects occur, MPL is the maximum permissible limit above which water cannot be allowed for consumption

c - No relaxation

tion. Based on the nature of ground water level contours, suitable sites for the construction of dug wells have been demarcated.

The current trend of ground water level deterioration and over exploitation of ground water resource is causing drought situation in Agra area. The remedial measures to combat with the prevailing phenomena of water crisis include (1) implementation of a scheme to develop rain water harvesting through afforestation (Singh *et al*. 2003), (2) conservation of ground water resource by means of executing proper management plan of ground water reservoir and (3) launching of awareness programmes of ground water utilization.

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