RESEARCH ARTICLE

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Evaluation of ground water quality of residential areas on the basis of chemical parameters

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ABSTRACT - A laboratory study was analyzed to observe the ground water quality of residential areas (Higher Income Group, Minimum Income Group, Lower Income Group, Juggi Jhopari, and Industrial Area) of Kanpur metro by examining the chemical parameter like calcium (Ca^{+2}), magnesium (Mg^{+2}), sulphate (SO_4^{-2}), chloride (Cl^-), fluoride (F^-) and nitrate (NO_3^-) as per the method assessment of ground water quality described in Standard methods for the examination of water and wastewater Indian Council of Medical Research (ICMR) and WHO. The result revealed that much variation was observed during October to April, most parameters decreased during summer and increase during the rainy season and then began to decrease again in winter followed by summer. HIG groundwater appeared to be the best ground water available in Kanpur metro.

Key words - Ground water, Chemical parameters, Residential areas, Kanpur city, Pollution

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Groundwater is precious and most widely distributed mineral resource of the earth and is annually replenished from the rainwater precipitation. Industrial and municipal effluents, landfills, septic tanks, mining and agricultural practices can potentially contaminate groundwater with toxic chemicals. Contamination also depends on geology and hydrology of the area. Chemicals pass through different hydrological zones as they migrate through the soil to the groundwater systems. The pores in unsaturated zones are occupied by both air and water. So flow in this zone for liquid contamination is downward by gravity. In the upper region of the unsaturated zone, some chemicals are retained by adsorption into organic matter and chemically active soil particles. These adsorbed chemicals get decomposed through oxidation and microbial activity. Below the soil zone, the pore spaces are also unsaturated and as chemicals pass downward, oxidation and aerobic biological degradation occur. In the capillary zone, spaces between soil particles may be saturated by water rising from water table. Lighter chemicals float on the top of the water table in this zone and move in different directions and rates with respect to dissolved contaminants. Once dissolved contaminants reach the water table, they may flow in both horizontal and vertical directions depending on hydraulic gradients. All the pore spaces between soil particles below the water table are saturated and lack dissolved oxygen and limits the oxidation of chemicals and groundwater flow is laminar with minimal mixing occurring as the groundwater moves. Since groundwater involves laminar flow, dissolved chemicals flow groundwater and form distinct plumes. These plumes of contaminated groundwater may be upto several miles downstream of the pollution source. Generally average rate of plume movement is less than 30 cm a day. The situation is aggravated by the problem of pollution or contamination. Aquifer pollution from both point and nonpoint sources is becoming extensive worldwide. Nearly 45 million people around the world are affected by water pollution marked by excess fluoride, arsenic, iron, or the ingress of salt water (State of Environment Report, Karnataka, 2003). A survey by Central Pollution Control Board of India in 1995 identified 22 sites in 16 states of India as critical for groundwater pollution, the primary cause being industrial effluents. A recent survey undertaken by the Centre for Science and Environment from eight places in Gujarat, Andhra Pradesh and Haryana reported traces of heavy metals such as lead, cadmium, zinc and mercury. Excessive withdrawal from coastal aquifers has led to induced pollution in the form of seawater intrusion in Kachchh, Saurashtra, Chennai and Calicut. Waterborne diseases constituted 80 per cent of the health problems in India. Mandays lost due to such easily preventable disease are estimated to be around 73 million (Wishwakarma, 1993).

EXPERIMENTAL METHODOLOGY

Area under study:

The present study covers the residential areas of Kanpur metro.

Selection of sampling points:

After a survey of the city, five types of locations were chosen for collecting groundwater samples. Each type of location had five sampling stations which included mostly the hand pumps, and some dug wells. The sampling points were classified occupation wise using stratified Random Sampling techniques as HIG –I, MIG -I, LIG -I, JJ-I and IA -I.

Identity of sampling stations:

Higher Income Group (HIG-I): Residence of Tilak Chauraha, Azad Nagar, Kanpur

Minimum Income Group (MIG-I): Residence of P.Road, Kanpur

Lower Income Group (LIG-I): Residence of Ratan Lal Nagar, Kanpur

Juggi Jhopari (JJ-I): Residence of Jhhakarkati near bus station, Kanpur

Industrial Area (IA-I): Residence of LML Chauraha, Kanpur

Sample collection:

Samples from various groundwater sources were collected for the evaluation of chemical parameters.

The collected samples were analyzed in the laboratory as per standards methods. Assessment of chemical parameters was done by using trimetric analysis.

EXPERIMENTAL FINDINGS AND ANALYSIS

The chemical analysis of the groundwater samples in different five types of residential areas (Higher Income Group, Minimum Income Group, Lower Income Group, Juggi Jhopari And Industrial Area) are reported in Table 1, 2, 3,4 and 5; all results are compared with standard limit recommended by the, Indian Council of Medical Research (ICMR) and WHO.

The data provided in the tables make it amply clear that during the rainy season, cationic and anionic species increase and slowly seep through the ground to pollute the water. On the onset of monsoon in later half of June, the contaminants present in the atmosphere get dissolved and are brought down to the earth. In addition, during recharge of ground water during the rainy season, greater amounts of pollutants from factories waste dumps etc. were able to reach the bottom to mix with ground water. It was also observed that in some cases the seepage was delayed due to local ground conditions

Table 1 : Monthly variation in chemical parameters of groundwater in HIG areas of Kanpur Metro from May 2002 to April 2003

Variable	Unit	May 2002	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr. 2003
Ca^{++}	Mg/l	52	54	48.8	58	58.8	60	62	63.2	61.2	56.8	52	58
Mg^{++}	Mg/l	29.16	26.9	29.16	32.8	36.2	40.3	33.2	27.7	30.4	19.9	31.8	26.9
So_4^{-2}	Mg/l	92	90	106	186	190	216	204	206	192	168	142	126
Cl^-	Mg/l	97	95	111	188	196	226	209	201	197	176	145	119
F^-	Mg/l	1.55	1.38	1.62	1.71	1.78	2.04	1.96	1.96	1.90	1.84	1.73	1.67
NO_3^-	Mg/l	16.4	14.7	17.6	26.4	31.5	35.6	36.2	31.7	21.4	22.6	17.6	17.2

Table 2 : Monthly variation in chemical parameters of groundwater in MIG areas of Kanpur Metro from May 2002 to April 2003

Variable	Unit	May 2002	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr. 2003
Ca^{++}	Mg/l	54	58.4	52.3	58.6	58.9	47.6	48.01	58.4	58.6	58.9	58.3	56
Mg^{++}	Mg/l	27.4	26.73	27.5	27.5	30.07	21.14	23.5	26.73	27.09	27.5	31.16	30.8
So_4^{-2}	Mg/l	90.0	102.6	135.5	163.2	230.6	275.5	211.6	196.4	122.2	126.3	111.6	96.8
Cl^-	Mg/l	92.4	100.2	118.3	154.6	193.6	206.4	171.2	135.9	144.8	112.6	100.2	96.6
F^-	Mg/l	1.42	1.47	1.66	1.71	1.73	1.71	1.56	1.83	1.92	1.32	1.36	1.41
NO_3^-	Mg/l	16.51	17.67	29.22	40.4	39.3	41.6	42.2	36.7	36.4	31.2	26.4	20.3

Table 3 : Monthly variation in chemical parameters of groundwater in LIG areas of Kanpur Metro from May 2002 to April 2003

Variable	Unit	May 2002	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr. 2003
Ca^{++}	Mg/l	68.9	8.0	100	81	82.9	83.2	81.0	79.4	78.5	73.5	69.8	70
Mg^{++}	Mg/l	58.2	74.11	97.6	73.7	75.5	75	73.7	68.18	05.5	56.6	56.2	58.3
So_4^{-2}	Mg/l	180.3	176.4	198.3	214.7	256.9	278.6	270.5	209.3	214.6	208.8	197.6	188.4
Cl^-	Mg/l	89.8	106.5	142.04	173.8	218.8	203.8	200.9	157.7	128.6	106.7	99.8	147.6
F^-	Mg/l	1.52	1.51	1.58	1.62	1.75	1.88	1.78	1.81	1.79	1.66	1.56	1.61
NO_3^-	Mg/l	22.3	16.8	40.9	48.6	49.7	50.4	53.6	40.3	35.9	33.3	27.5	19.6

Table 4 : Monthly variation in chemical parameters of groundwater in JJ areas of Kanpur Metro from May 2002 to April 2003

Variable	Unit	May2002	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.2003
Ca^{++}	Mg/l	98	98.8	119	132	192	232	267	29	187.8	129.3	126.5	115.4
Mg^{++}	Mg/l	67.3	72.17	80	128.3	181	196.3	207.8	188.2	139.6	117.4	97.3	79.8
So_4^{-2}	Mg/l	158.9	169.6	172.77	221.3	279.8	288.7	250.4	210.6	188.7	160.2	158.1	162.3
Cl^-	Mg/l	152.4	170.3	117.9	261.6	490.1	551.6	428.9	317.4	211.6	176.4	178.2	163
F^-	Mg/l	1.67	1.72	1.83	1.88	1.96	2.02	2.16	2.14	2.02	1.92	1.63	1.47
NO_3^-	Mg/l	27.3	30.6	43.7	53.6	54.9	58.3	60.0	61.4	58.6	52.3	34.4	32.1

Table 5 : Monthly variation in chemical parameters of groundwater in IA areas of Kanpur Metro from May 2002 to April 2003

Variable	Unit	May2002	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.2003
Ca^{++}	Mg/l	80	81.4	99	145	187.5	237.9	314.6	222.3	227.1	187.4	113.4	102.8
Mg^{++}	Mg/l	73.3	76.1	92.9	129.6	165.9	167.2	142.4	165.3	166	166.3	100.2	87.2
So_4^{-2}	Mg/l	150.4	172.2	174.8	196.4	260.5	265.2	234.7	198.4	183.6	146.9	140.4	135.9
Cl^-	Mg/l	112.4	156.7	215.6	267.3	412.5	275.2	368.4	306.9	366.7	180.8	142.6	132.8
F^-	Mg/l	1.62	1.68	1.73	1.73	1.95	1.96	2.01	1.93	1.82	.182	1.78	1.67
NO_3^-	Mg/l	234	23.9	40.6	50.1	41.9	46.6	47.7	49.2	47.3	41.2	33.4	27.6

and nature of discharge so that peak value of the pollutants was observed during the winter season. Kaur (1982), Rajas *et al.* (2005) and Thakare *et al.* (2005) had obtained similar results for groundwater. Hegde *et al.* (1999) in their study at Hubli had highlighted concentration of Ca, Mg, Na+ and K was relatively high in the older areas than the other areas. In another study, groundwater showed high concentrations of sodium, potassium and nitrate, which attributed to sewage water pollution and fertilizers, and also high concentration of total hardness (Hanamgond, 2000). Safe drinking water and sanitation facilities provided although not 100 per cent in the country is reported to have considerably brought down the incidence of diseases such as cholera, typhoid, dysentry and diarrhoea (Wishwakarma, 1993).

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