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Assessment of ground water quality around Autonagar dumpsite and its suitability for drinking purposes

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ABSTRACT

In this study, effect of the leachate from an open dumping site in autonagar Hyderabad, on groundwater and its suitability for drinking purposes is investigated. In order to assess the ground water quality thirty ground water samples were collected in pre-monsoon 2008 and post-monsoon 2008 and analyzed for physic-chemical parameters. Physical and chemical parameters of groundwater such as electrical conductivity, pH, total dissolved solid, Na, K, Ca, Mg, HCO_3, Cl, and SO_4 were determined.. The results indicated that, concentrations of Na, K, Ca, Mg, in the groundwater samples of pre and post monsoon seasons of 2008 are within the permissible limits of Bureau of Indian standards[1]. The pH of the groundwater reveals that it is mildly acidic to slightly alkaline in nature. Based on other parameters the ground water quality at nearby dwellings is highly deteriorating and may lead to increase in human health risk.

INTRODUCTION

Quality of groundwater is as important as its quantity and the physico-chemical characteristics determine its usefulness for various purposes. The study of groundwater quality data gives important clues to the geologic history of rocks and that groundwater has interacted with and also provides indications pertaining to groundwater recharge, discharge, movement and storage[2].

Water quality is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities[3]. Agricultural activities, population growth, rapid industrialization and unplanned urbanization have resulted in various environmental hazards are causing deterioration of groundwater quality in many ways. Understanding the quality of groundwater is particularly important as it determines the factors governing the suitability of water for drinking, domestic, agricultural and industrial purposes.

In India more than 80% of the population is dependent on groundwater as the source of drinking water supply[4]. MSW dumpsite contaminant, loads in recharging groundwater have resulted in problems related to drinking water quality and ecological effects of groundwater discharge to surface-water bodies. In addition, MSW contaminants have caused substantial changes in groundwater chemistry and water-rock interactions controlling environment. These aspects have received somewhat less attention. The quality of alluvial groundwater in rural areas is sensitive to the contaminants originated from pollutant sources.[5-7]

In view of the direct consumption of water by human beings, the domestic water supply is considered to be most critical. The water for this purpose should be chemically and biologically safe and also free from undesirable physical properties such as colour, turbidity, unpleasant taste and odour [8].

Improper municipal solid waste and many industrial solid waste disposal landfills emit large amounts of landfill leachate to the environment and are media for the breeding of disease vectors. Such emissions and breeding of vectors can have significant adverse impacts on groundwater quality of the area near the landfill. Therefore, this study was aimed to analyze groundwater pollution and assess the adverse risks due to the autonagar municipal solid waste-dumping site within its vicinity.

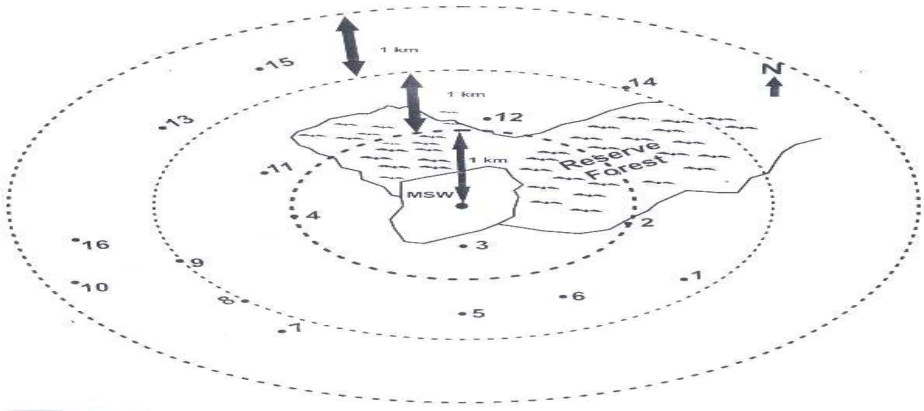
MATERIALS AND METHODS

STUDY AREA: **Autonagar MSW dumpsite area**

This dumpsite is spread over an area of about 47 acres and used to receive an average of 800 MT garbage per day. About 8.7 lakh m^3 MSW has been dumped at this dumpsite, which weighs ~4.35 lakh-tons.

The Autonagar dumpsite is in existence for more than 20 years. The height of MSW is ranging from 1.5 to 7.5 meters. Mahavir Harina Vanasthali National Park, popularly known as Deer Park is categorized as a sensitive area and is abutting the northern and eastern boundaries of Autonagar dumpsite.

The location of the Dumpsite is: **Lt: $17^0$20'59.49" N; Lg: $78^0$34'48.16" E**; Elevation (ground sea level): **1688 ft**.



Sample	Place of sampling	Elevation (mean sea level)	Distance from Autonagar MSW dumpsite
S_1	Deer Park	1735 ft	1.7 km
S_2	Institute of Dry Land Agriculture	1677 ft	1 km
S_3	Autonagar	1684 ft	0.30 km
S_4	Sahara Estate	1684 ft	1 km
S_5	Vivekananda Nagar	1729 ft	1.66 km
S_6	Vijayasri colony	1713 ft	1.47Km
S_7	Local Park	1698 ft	2.08 km
S_8	Balaji Nagar	1698 ft	2km
S_9	SPS Residency	1700 ft	1.68km
S_{10}	Raja Rajeshwary Colony	1666 ft	2.32Km
S_{11}	Himapuri Colony	1660 ft	1.3 km
S_{12}	Southend Park	1652 ft	1.2 km
S_{13}	Mansoorabad	1656 ft	2.06 km
S_{14}	Tyagarayanagar	1608 ft	2.09km
S_{15}	Bandlaguda	1596 ft	2.10 km

Sampling procedure and methodology

A total number of 30 groundwater samples were collected for physico-chemical analysis in two successive pre-and post-monsoon seasons of 2008. The water samples were collected and stored in 1 liter capacity clean plastic bottles. Before collection of samples, the bottles were washed. Prior to collecting the samples, the containers were rinsed by the water to be sampled. The wells were duly pumped before collecting their sample so that the stagnant water, if any, is completely removed from storage within the well assembly. The major ion analyses were carried out at National Geophysical Research Institute, Hyderabad.

The water samples were analyzed as per the standard methods of APHA [9]. Values of pH were measured by a portable digital water analyses kit with electrodes. The values of electrical conductivity (EC) were measured by portable kit with electrodes in the lab.

The concentrations of Ca^{+2}, Mg^{+2}, Cl^-, HCO_3^- and total hardness were determined by volumetric method. Flame emission photometry has been used for the determination of Na^+ and K^+. Sulphate was determined by gravimetric method.

RESULTS AND DISCUSSION

Electrical Conductivity

In the study area, the Electrical Conductivity values ranges from 750 to 2110 µS/cm during June 2008. The EC values during November 2008 ranges from 660 to 2130 µS/cm. Twelve samples in pre-monsoon and 8 samples in post-monsoon 2008 falls under medium conductivity.

Table -1: Classification on the basis of EC by Sarma and Narayanaswamy[10], 1981

Class	EC (µS/cm)	Pre-monsoon 2008	Post-monsoon 2008
Low Conductivity	< 500	-----	------
Medium Conductivity Class I	500- 1000	20% (3 Sample)	40% (6 Sample)
Medium Conductivity Class II	1000- 3000	80% (12 Sample)	60% (9 Sample)
High Conductivity Class III	> 3000	----------	--------

Hydrogen Ion Concentration (pH)

The pH value of the ground water samples ranges from 7.08 to 7.8 and 7 to 7.8 during pre-monsoon 2008 and post-monsoon of 2008 respectively. The groundwater is thus mildly acidic to slightly alkaline in nature.

Table- 2: Chemical analysis of ground water in mg/L (pre-monsoon 2008)

S.No.	pH	EC (µs/cm)	TDS	HCO_3	Cl	SO_4	Na	K	Ca	Mg
S1	7.08	1100	700	198	130.8	51	63.6	1.6	98.5	39.3
S2	7.44	1700	1000	325	191.1	15.25	71	1.8	151.8	67.8
S3	7.37	2000	1280	180	195.2	109.8	106.6	2	161.1	64.6
S4	7.22	1400	905	300	149	69.1	68.2	1.9	128	67.4
S5	7.6	1120	720	180	120	80.2	68	1.8	95	45
S6	7.64	1120	710	175	150	70.2	72	1.9	100	42
S7	7.75	1360	830	258.9	130	60.2	75	2.4	100	62
S8	7.59	900	500	140	105.6	48	48	1.8	60	30
S9	7.14	750	480	140	80.2	62.1	35	0.7	78	20
S10	7.24	2000	1150	247	350	112.2	120	2.98	120	68
S11	7.75	1710	1000	192	226	115.8	78	38	126	50
S12	7.43	2110	1350	258	458.2	130.42	130	1.8	120	82.2
S13	7.68	1320	820	110.4	130	120.57	97	2	98.2	38.1
S14	7.8	980	620	253	58	53.8	33	1.2	78	50
S15	7.22	1900	1200	240.2	262	120.9	100	8.2	190	70.2

Table- 3: Chemical analysis of ground water in mg/L (post-monsoon 2008)

S.No.	pH	EC (µs/cm)	TDS	HCO_3	Cl	SO_4	Na	K	Ca	Mg
S1	7	870	550	153.8	100.2	30.28	48.2	1	80	22
S2	7.7	1310	850	293	158	48.1	55	1.1	132	56.3
S3	7.2	1720	110	148	170	80	82	1	135	40.2
S4	7.5	1230	780	242	130	42.9	40	1.2	98	40.2
S5	7.8	920	575	142	92	67.2	45	1.1	73	30
S6	7.4	900	570	130	120	55.2	55	1.3	85	28
S7	7.65	1240	790	210.25	108	58	65	1.2	98	55
S8	7.42	720	370	90	85	30.2	28	0.8	40	15
S9	7.7	660	410	133.2	75.2	50.1	31	0.52	59	15
S10	7.54	1700	1000	241.2	300	100	89	1.5	98	58
S11	7.54	1180	750	159	200	77.2	53	20	90	33
S12	7.28	1900	1195	173	350.2	90	83	1	95	60.3
S13	7.5	1080	650	90.2	110.8	99.7	77	1.2	80	27
S14	7.6	860	540	252	53	45.8	32	1.2	68	45
S15	7.44	2130	1030	210.2	230	100.2	83	7	160	55.2

Total Dissolved Solids (TDS)

TDS values for June 2008 samples ranges from 480 to 1350 mg/L, with an average value for the samples being 884 mg/L. The TDS value during November 2008 ranges from 110 to 1195 mg/L with an average value of 675 mg/L (Table-4).

Table-4: Classification of water based on TDS

Category	TDS (mg/L)	Pre- monsoon 2008	Post- monsoon 2008
Fresh water	0- 1,000	72 % (11 Sample)	87% (13 Sample)
Brackish water	1,000- 10,000	27 % (4 sample)	13 % (2 sample)
Saline water	10,000- 100,000	----	----
Brine water	> 100,000	----	----

Drinking water becomes significantly unpalatable, if TDS value is greater than 1000 mg/L. From this point of view, 4 samples in the pre-monsoon and 2 samples in post-monsoon are not ideal for drinking purposes.

DRINKING WATER QUALITY CRITERIA

The sodium concentration in all the ground water samples of pre and post monsoon 2008 is within the permissible limit (200 mg/L) as per BIS. Except S11 (Himapuri Colony) the concentration of K in all other samples are within the permissible limit (12mg/L). The potassium value is unexpectedly higher for S_{11} as it is at lower elevation with respect to dumpsite and also very near (1.3 km) to dumpsite. If K values are more than 30 mg/L must be considered anomalously high, as K is normally held in silicate mineral phases which are relatively resistant to weathering and

water – rock interaction. All the samples have magnesium and calcium concentration within the permissible limits of 100 mg/L and 200 mg/L as per BIS.

The samples S10, S12 and S15 showed the highest value of chloride which exceeds the limit 250 mg/L as per BIS. S12 has the highest chloride value as it is both near and at lower elevation with respect to dumpsite. The value of chloride for S10 is high, even though it is far from the dumpsite (2.32 km) this may be due to the polluted surface water pond which is very near to it and also lower topographical elevation with respect to the dumpsite. Chloride level in unpolluted water is often below 10 mg/L and sometimes below 1mg/L[11]. Chlorides are leached into water due to weathering of rocks. The chloride ion is highly mobile and is transported to closed basins. The highest value of sulphate is for S12 and S13 due to their lower topographical elevation with respect to dumpsite. If sulphate in water exceeds 250 mg/L, a bitter of medicinal taste may render the water unpleasant to drink, causes diarrhea and dehydration[12].

The SO_4^{-2} ion concentration is within the maximum permissible limit of 400 mg/L as per the drinking water standards (BIS 1991). The high intake of SO_4^{-2} may result in gastrointestinal irritation and respiratory problems to the human being[13-14].

Major Cation	**Pre-monsoon 2008**	**Post-monsoon 2008**
Na	33-130	28-89
K	0.7-38	0.52-20
Ca	60-190	40-160
Mg	20-82	15-60
Major Anion		
HCO_3	110-325	90-293
Cl	58-458	53-350
SO_4	15-130	30-100

CONCLUSION

The contaminants that are present in MSW leachates are hazardous chemicals, inorganic ions, heavy metals and organic compounds. The leachate generated from the dumping site affects the groundwater quality in the adjacent areas through percolation in the subsoil. The results show that the wells studied had parameters such as Na, Ca, Mg, and K within permissible limit of BIS. The moderately high concentration of EC, TDS, and chloride in ground water near landfill deteriorates water quality. As there is no natural or other possible reason for high concentration of these pollutants, it can be concluded that leachate has impact on ground water quality near the landfill area. Although, the concentrations of cations do not exceed drinking water standard even though the ground water quality represents a significant threat to public health. The ground water within 1 Km of radius from the autonagar MSW dumpsite is not fit for drinking purpose. Therefore some precautionary measures like Reverse osmosis plants in houses may be needed to use ground water for drinking purpose.

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