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AN IMPACT OF HAZARDOUS WASTE ON GROUND WATER – A CASE STUDY OF VISHAKHAPATNAM DISTRICT, ANDHRA PRADESH, INDIA

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Abstract: *Ground Water plays a primary role which comprises fresh water resources in the ratio of two third of the world. The ground water is the major resource for all purposes of water requirements in India. It is to be highlighted that country's economic development and food security is dependent on ground water sources. This main aim of this research is to study the physio-chemical characteristics of ground water in the environs of dumping yard, Visakhapatnam district, Andhra Pradesh. The study is focused on the dumping yard which comprises an area of about 912 acres. The instinctive dumps in the unlined sewage drains drive pollutants in to the ground water. The natural quality of ground water tends to be degraded by human activities like improper disposal of solid waste, hazard urbanization and industrialization. The results concluded that the certain physio-chemical parameters intended for the water quality show the drastic variation when compared to Bureau of Indian Standards (BIS).This proves the impact of hazardous waste on ground water for the taken for the study.*

Key words: Physio-Chemical, Dumping Yard, Hazard Urbanization, BIS

Introduction

Ground water is one of the earth's vital renewable and widely distributed resources and equally important source of water supply around the world. The main concern for the human is the quality of water since they are interlinked with each other. The importance of water quality for human health has recently attracted a great deal of interest. This study accounts that in developing countries like India around 80 per cent of all diseases are directly related to poor drinking water quality. In the words of *Goulding (2000)*, the groundwater is believed to be comparatively much clean and free from pollution than the surface water, whereas it can become contaminated naturally or because of numerous types of human activities. Based on the research study it was identified that most of the population is wholly dependent on ground water as the only source of drinking water. The rural areas make use of ground water for the agricultural purposes in case of scarcity of rain. Contamination of groundwater can result in poor drinking water quality, loss of water supply, high clean-up costs, high costs for alternative water supplies, and/or potential health problems. A wide variety of materials have been identified as contaminants that are found in groundwater. These include synthetic organic chemicals, hydrocarbons, inorganic cations, inorganic anions, pathogens, and radio nuclides (Fetter, 1999). The huge demand and upgrading competition for water has posed a new challenge for environmental management. An uncontrolled use of bore-well technology has led to the extraction of ground water. This leads to insufficient recharge rate of ground water. Water intended for human consumption should be "safe and wholesome" i.e. free from pathogenic agent and harmful chemicals, pleasant to taste and useable for domestic purpose *(Parashar et al., 2006).*

The use of geographical information technology (GIS) technology has greatly simplified the assessment of natural resources and environmental concerns, including groundwater. In groundwater studies, GIS is commonly used for site suitability analyses, managing site inventory data, estimation of groundwater vulnerability to contamination, groundwater flow modeling, modeling the solute transport and leaching, and integrating groundwater quality assessment models with spatial data to create spatial decision support systems *(Engel and Navulur, 1999).* Groundwater is a valuable natural resource that is essential for human health, socio-economic development, and functioning of ecosystems *(Humphreys, 2009).* In India severe water scarcity is becoming common in several parts of the country, especially in arid and semi-arid regions. Remote sensing and GIS has emerged as a powerful tool for storing, analyzing, and displaying spatial data and using these data for decision making in several areas including engineering and environmental fields *(Burrough and McDonnell, 1998).* GIS has been used in the map classification of groundwater quality, based on geology, geomorphology or land-use and land-cover *(Asadi et. al., 2007).* In such studies, GIS is utilized to locate groundwater quality zones suitable for different usages such as irrigation and domestic *(Yammani, 2007).* Currently, groundwater quality is the major concern and therefore emerged as one of the main environmental issues. Water demand for drinking and domestic purposes has been increasing due to improve of way of life of folks and demographic pressures. Hence, this research has been taken to ascertain groundwater pollution hotspots in the environs of dumping area. The effluents of the Visakhapatnam Steel Plant, Hindustan Zinc Ltd, Coromandel Fertilizers, LG Polymers move around in the course of groundwater movements and move towards marsh land through home areas due to topographic control.

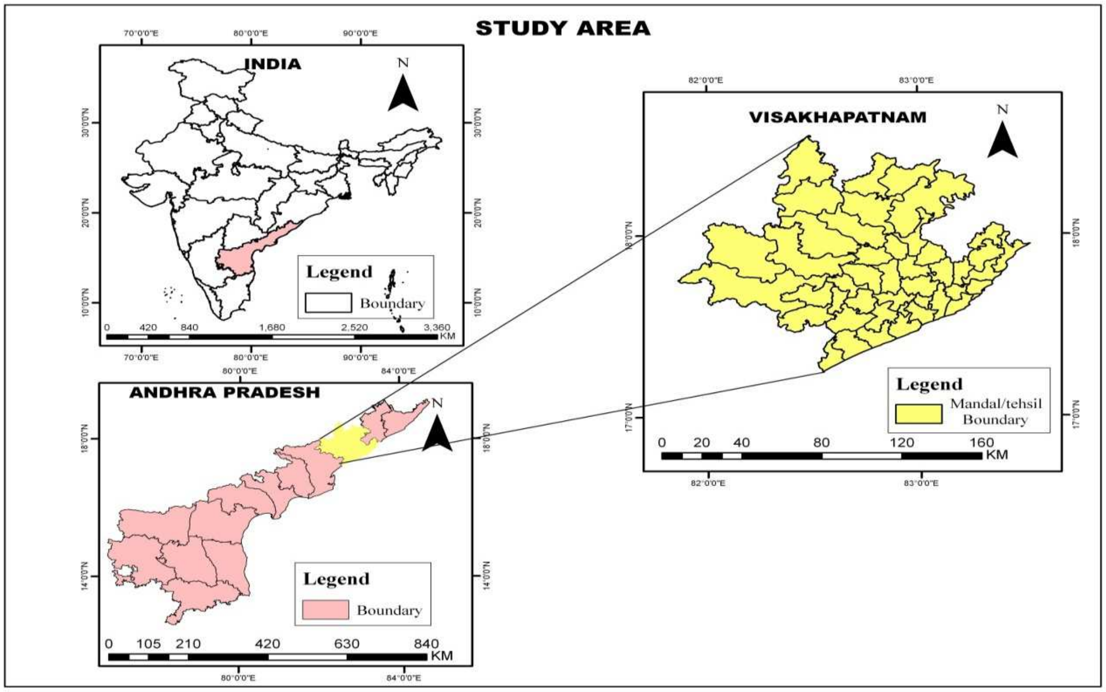
Hazardous waste products are the discarded/rejected material being left-out from the several public sources typically. Investigations declared in the study area revealed that, rapid growth in population through the recent decades have led to increasing levels of urban solid wastes. In most of the developing countries, hazardous waste disposal has become the major problem. This problem is dominant in the places where the density of population is very high and scarcity of land is adequate for landfills. They majorly consist of consumed items such as food waste and containers, and other commercial, institutional sources. A lot of the industries have their own mechanism for handling professional hazardous waste.

Study Area

Visakhapatnam district has been home for a number of large and medium industries such as the Hindustan Petroleum Corporation, Vishakhapatnam Steel plant, Bharat Heavy Plates and Vessels, Hindustan Polymers and Coromandel Fertilizers. Recently, the Visakhapatnam Export Processing Zone has come up and there are indications of the city emerging as a booming industrial metropolis. Commensurate with the growth of industrial and allied activities in and around the city, its area grew from 30 km^2. in 1960 to over 80 km^2 presently. The city's population according to 2001 census is about 1.33 million.

The Visakhapatnam municipal corporation area was 120 km^2 till January 2006 and now expanded to 545 km^2 and renamed as Greater Visakhapatnam Municipal Corporation (GVMC) under the Visakhapatnam District of Andhra Pradesh. The study area is covered in 65 O/1, O/2, O/3, O/5 and O/6 of Survey of India topo sheets on 1:50,000 scales bounded between 17^0 32' and 17^0 52' Northern latitudes and 83^0 04'and 83^0 24' Eastern longitudes (Fig.1). For the convenience of administration GVMC area is divided into 70 wards, where the area of the ward is based on density of population.

Figure: 01: Location of Study Area



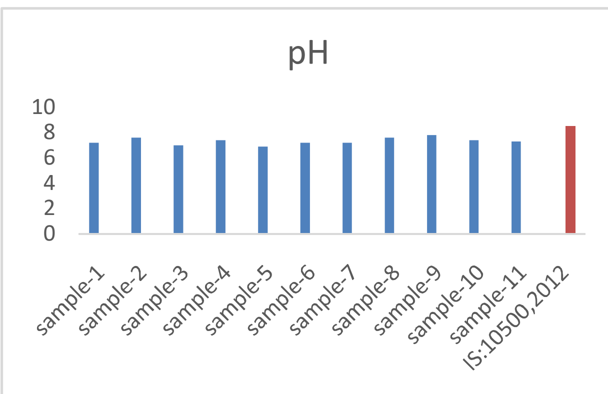
Methodology

The methodology adopted for the study is collection of ground water samples from bore wells and also from shallow deep aquifers. It is to be highlighted that the 11 water samples were collected from various in and around the dumping yards within the vicinity of 5 kilometer radius. These samples were taken for analyzing the chemical properties in the laboratory with respect to the acceptable guidelines (IS 10500, 2012). The adjacent procedure for collecting the hazardous samples are identified with the respective location predominantly includes wide diversity of population and settlements. The collected samples were analyzed for the determination of various chemical elements such as Na^+, K^+, Po_4^{3-}, NO^{3-}, SO_4^-, Cl^-, F^-, and Fe using Flame Photometer and UV Spectrophotometer method with the reference to the Indian Standards. The other trace metals of Al, Mn, Cu, Zn, Se, Rb, Cd, Pb and Co were analyzed using the Atomic Absorption Spectroscopy. About 10 kg of hazardous solid waste collected from 10 points were thoroughly mixed and then reduced by method of quartering till a sample of such a size is obtained which can be handled personally. The sample so obtained was subjected to physical analysis.

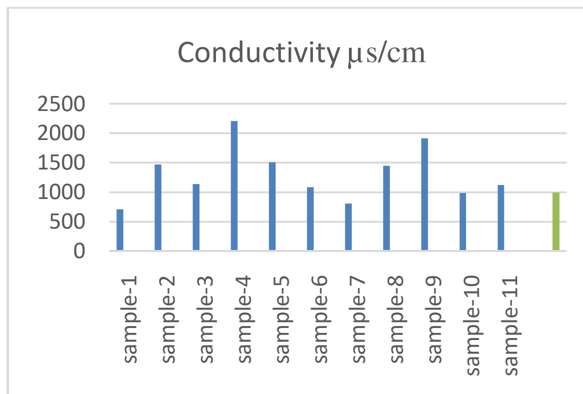
Results and Discussion

The details of the results of physio-chemical analysis of water samples of the study area are given in table 1. The laboratory analysis highlights that the pH values of the collected water samples varies from 6.9 to 7.8 (Graph. 2) with the average value of 7.323 which indicates the alkaline nature. The electrical conductivity (Graph.3) measured from 710 µs to 2205 µs with a mean value 1308.364. The Total dissolved solids have exceeded the permissible limits of BIS standards which records an average value of 772 mg/L (Fig.4). The status of N O^3 is shown in Graph. 5. There is crystal evident from the (Graph. 6 and 7) that Na^+, K^+ ions are in the permissible limits of BIS. The sample analysis results for potassium, nitrites, sulphate and phosphate are shown in Graph. 8, 9, 10, and 11 respectively. It is noted that the major source of sodium is due to anthropogenic agents. The concentration of sodium observed was ranging from 10 mg/L to 540 mg/L with average value of 61.3636. The concentration of chloride is in the permissible limit of BIS standards (Graph. 12) as an exceptional of two samples which exceed the maximum permissible limit of BIS standards and an average value is observed to be 191.0909. It is very well known that if the Chlorine (Cl) level is more than 250 mg/L, which tends to make the water saline and affects real taste.

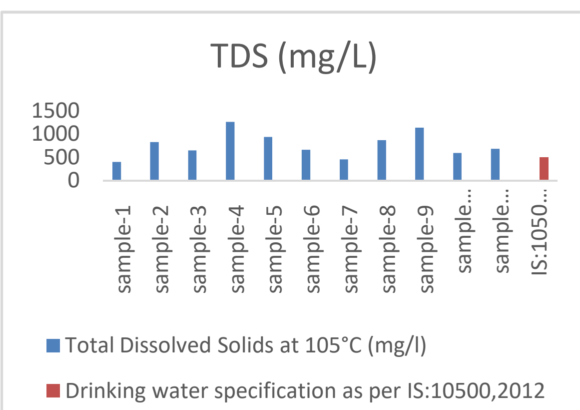
The fluoride (Graph. 6) content present in the samples lies between 0.38 and 0.72 mg/L with an average value of 0.56. The sulphate content analysis provided in the (Graph.10) are in the range from 24 to 246 mg/L with average value of 94.818 and other side Zn ranges from 0.27-0.307mg/L with an average value of 0.873. Other metals like lead, cadmium, chromium and copper were found to be negligible in all the samples. The coefficient of correlation was plotted against the various ions which are clearly mentioned in the (Table 2). The coefficient of correlation between Cl and TDS are found to be high (0.8) that indicates dominance level of Cl ions in the ground water of study area. The K^+, and Na^+ have also shown the positive correlation with TDS (Na, TDS, R2=0.8) & (K, TDS, R2=0.83) which indicates dominance of Na and K in the study area. The coefficient of correlation of sulphates with TDS was, 0.8 which is possibly due to the weathering of rocks. Among the analyzed cations and anions, the Cl was most dominant ion contributing (48%), followed by SO_4 (23%) and Na (16%) which is shown in Graph 14. Cl (48%)>SO_4 (23%)>Na (16%)>NO_3 (1.54%)>K (0.9%)>PO_4, F (0.14%). In Graph the coefficient of correlation between TDS and conductivity is depicted.



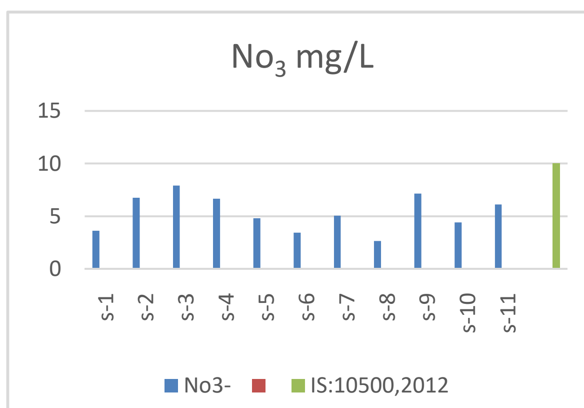
Graph. 1



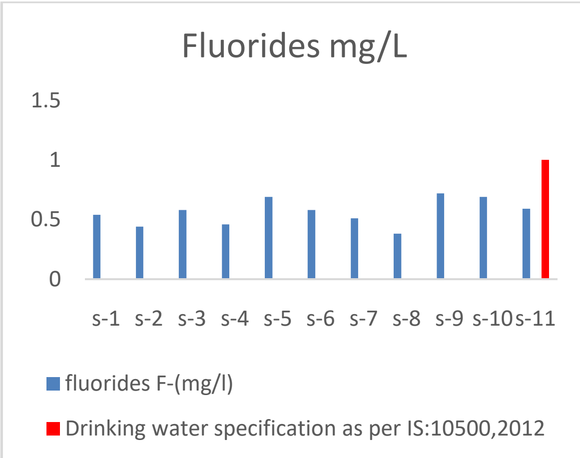
Graph. 2



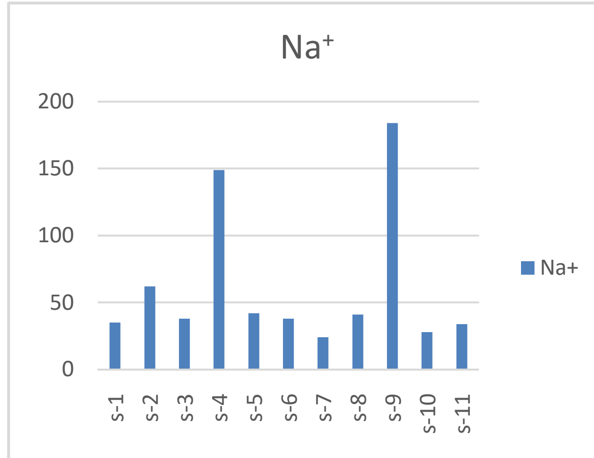
Graph. 3



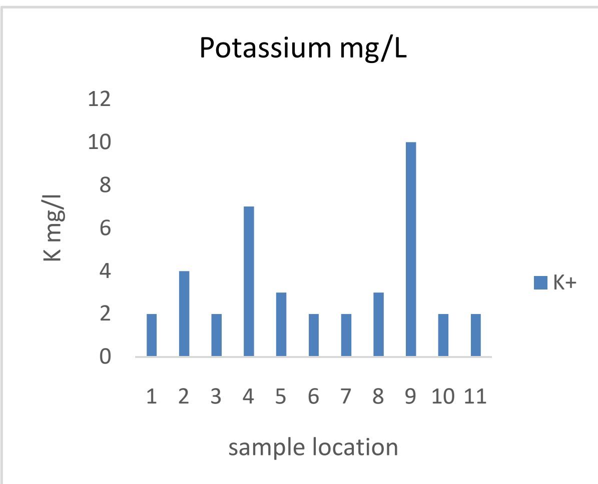
Graph. 4



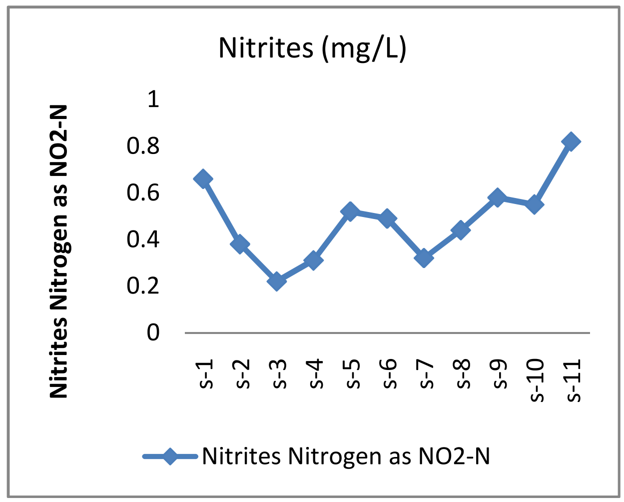
Graph. 5



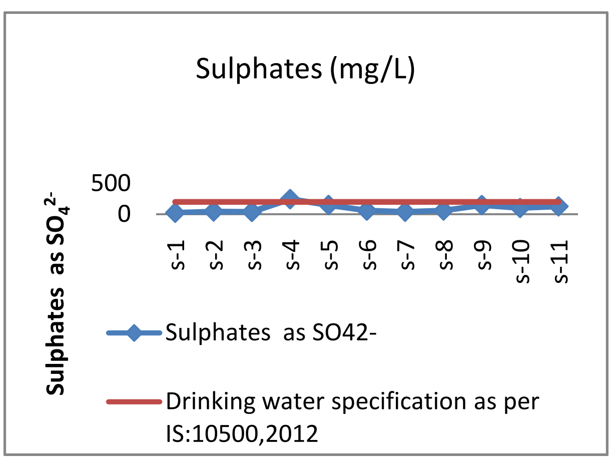
Graph. 6



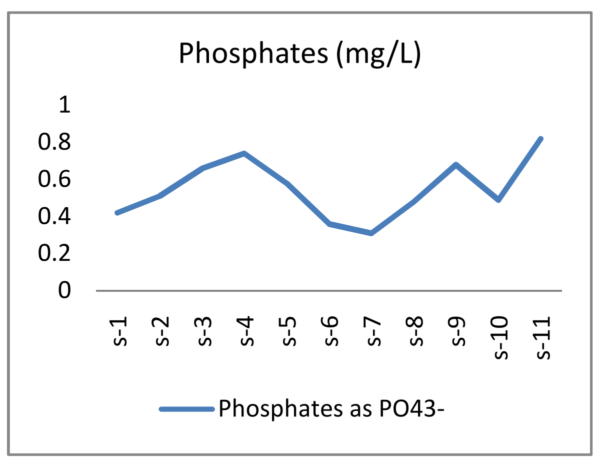
Graph. 7



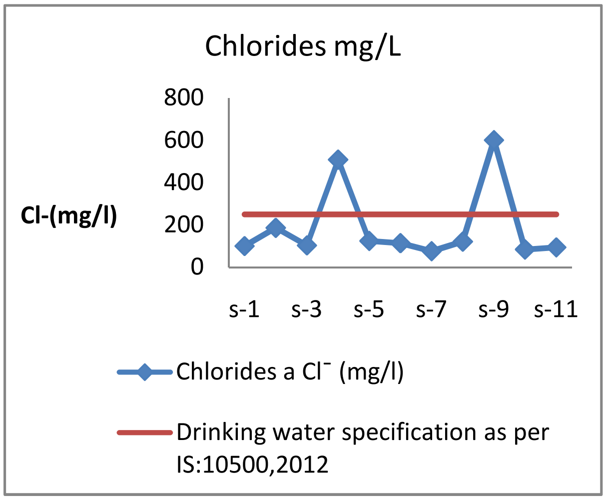
Graph. 8



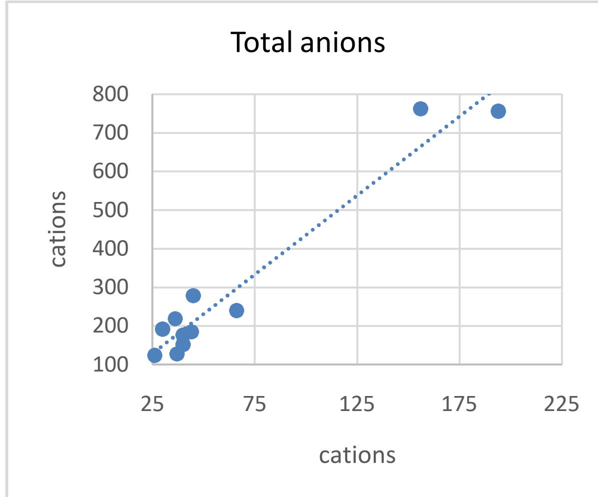
Graph. 9



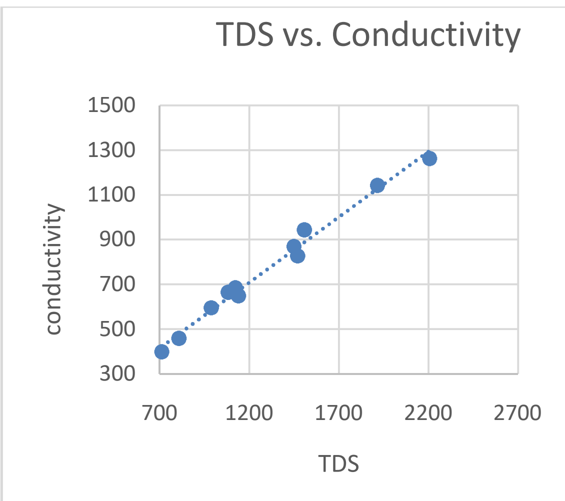
Graph. 10



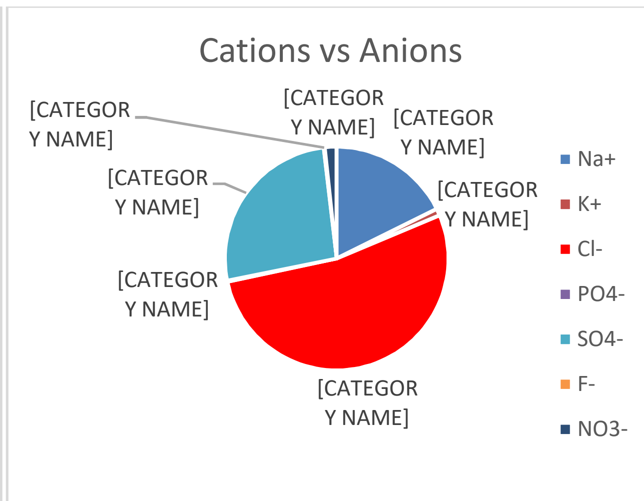
Graph. 11



Graph. 12



Graph. 13



Graph. 14

Conclusion

The analysis recorded with higher concentration of certain parameters is due to the villages disposing the waste in to the seepage of unlined sewage drain. In this ground water the major source of sodium is due to the anthropogenic sources i.e. due to improper disposal of sewage waste which is possibly by caused contamination of ground water due to leachate of ions through soil. Excess sodium content which is above 200 mg/L may lead to high blood pressure, so is the risk for heart disease and stroke and also women with pregnancy. The results of physical/chemical parameters and trace metals of groundwater have been compared with the Bureau of Indian standards-10500 (2012) and World Health Organization (1971 and 1983) standards. So far, no major studies have been carried out on hazardous waste interaction with groundwater. In this study, it is observed that the groundwater regime is being polluted due to improper dumping of solid waste in unlined sewage drains, besides geological causes.

Table 01: Physio-Chemical Analysis of Water Samples

S.No	Parameters	2016 03-W 01	2016 03-W 02	2016 03-W 03	2016 03-W 04	2016 03-W 05	2016 03-W 06	2016 03-W 07	2016 03-W 08	2016 03-W 09	2016 03-W 10	2016 03-W 11	Drinking water specification as per IS:10500,2012
1.	pH	7.2	7.6	7.0	7.4	6.9	7.2	7.2	7.6	7.8	7.4	7.3	6.5-8.5
2.	Conductivity (µS/cm)	710	1470	1140	2205	1507	1082	807	1448	1914	988	1121	<1000 µS/cm
3.	Total Dissolved Solids at 105^{0}C	398	828	648	1262	943	664	458	869	1142	596	684	500 mg/l
4.	Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	Nil
5.	Chlorides a Cl^-	100	186	103	509	124	114	76	121	601	84	94	250 mg/l
6.	Total Hardness as CaCO3	268	344	340	1210	240	180	140	160	260	150	170	200 mg/l
7.	Phosphates as $PO4^{3-}$	0.42	0.51	0.66	0.74	0.58	0.36	0.31	0.48	0.68	0.49	0.82	--
8.	Sulphates as $SO4^{2-}$	24	46	40	246	149	59	42	61	148	102	128	200 mg/l
9.	Nitrates Nitrogen as NO3-N	3.63	6.76	7.92	6.66	4.82	3.44	5.04	2.66	7.14	4.40	6.11	10 mg/l
10.	Nitrites Nitrogen as NO2-N	0.66	0.38	0.22	0.31	0.52	0.49	0.32	0.44	0.58	0.55	0.82	--
11.	Ammonical Nitrogen as NH3-N	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--
12.	Fluorides as F^-	0.54	0.44	0.58	0.46	0.69	0.58	0.51	0.38	0.72	0.69	0.59	1.0 mg/l
13.	Phenols	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001
14.	Sodium as Na+	35	62	38	149	42	38	24	41	184	28	34	--
15.	Potassium K+	2	4	2	7	3	2	2	3	10	2	2	--
16.	Iron as Fe	0.974	0.450	0.053	0.062	0.124	0.104	0.098	0.214	0.182	0.091	0.102	0.3 mg/l
17.	Zinc as Zn	0.089	0.307	0.032	0.027	0.070	0.061	0.046	0.066	0.114	0.067	0.082	5 mg/l
18.	Lead as Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05 mg/l
19.	Total Chromium as Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05 mg/l
20.	Cadmium as Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.01 mg/l
21.	Copper as Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05mg/l

Table 02: Coefficient of Correlation of Ions

	Cl^-	Po_4^-	So_4^-	No_3^-	F^-	Na^+	K^+	Conductivity	TDS	pH	Total hardness	No_2^-	Fe
Cl^-	1	0.4692	0.6796	0.4786	0.126	0.9986	0.9815	0.846	0.82409	0.578243	0.612469	-0.102	-0.1292
Po_4^-	0.4692	1	0.6695	0.655	0.206	0.49119	0.4427	0.585	0.5885	0.129366	0.441797	0.2185	-0.3091
So_4^-	0.6796	0.6695	1	0.3201	0.22	0.66663	0.6175	0.79	0.80677	0.151469	0.692495	0.0793	-0.4394
No_3^-	0.4786	0.655	0.3201	1	0.194	0.49568	0.4663	0.43	0.38362	0.085029	0.397096	-0.29	-0.2839
F^-	0.1261	0.2056	0.2198	0.194	1	0.1402	0.1594	-0.059	0.0043	-0.205069	-0.30344	0.4009	-0.2145
Na^+	0.9986	0.4912	0.6666	0.4957	0.14	1	0.9857	0.844	0.82374	0.587123	0.588531	-0.078	-0.1205
K^+	0.9815	0.4427	0.6175	0.4663	0.159	0.98568	1	0.835	0.83501	0.644065	0.482611	-0.059	-0.1103
Conductivity	0.8458	0.5849	0.7901	0.4303	-0.05	0.84397	0.835	1	0.99375	0.452253	0.687847	-0.226	-0.3371
TDS	0.8241	0.5885	0.8068	0.3836	0.004	0.82374	0.835	0.994	1	0.430084	0.629913	-0.166	-0.3722
pH	0.5782	0.1294	0.1515	0.085	-0.20	0.58712	0.6441	0.452	0.43008	1	0.080339	0.1223	0.0757
Total Hardness	0.6125	0.4418	0.6925	0.3971	-0.30	0.58853	0.4826	0.688	0.62991	0.080339	1	0.1223	-0.1064
No_2^-	-0.102	0.2185	0.0793	-0.29	0.401	-0.0783	-0.0586	-0.226	-0.166	0.122253	0.122253	1	0.3074
Fe	-0.129	-0.309	-0.439	-0.284	-0.21	-0.1205	-0.1103	-0.337	-0.3722	0.075709	-0.10642	0.3074	1

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