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IMPACT OF MUNICIPAL SOLID WASTE DUMPSITE ON THE GROUND WATER QUALITY IN VIJAYAWADA

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ABSTRACT

The present study has been conduced to assess the ground water pollution at a residential area adjacent to municipal solid waste dump site in Vijayawada city. The quality of the ground water is assessed in terms of physical & chemical parameters. Vijayawada, city is in the vicinity of the new capital of Andhra Pradesh i.e. Amaravathi. In the near future the projected population growth will be in millions. In the same proportion the solid waste will also increase in the city. MSW management gets the lowest priority, mainly because disruptions and deficiencies in it do not directly and immediately affect public life and cause public reaction. These solid wastes are generally disposed off in a low lying area called sanitary landfill area by the municipal authorities. Present paper will be a benchmark on the impacts of solid waste dumpsites on the quality of ground water resources for future studies. In the present study, the impact of leachate infiltration and percolation on groundwater quality was estimated from an unlined dump site of Vijayawada in order to find out the seasonal and temporal variations in the water quality. The results revealed a high concentrations of total dissolved solids, electrical conductivity, total alkalinity, total hardness, chlorides, sodium and lead are present in the studied samples which are in higher range than acceptable limits. The ground water in the study area is being polluted by percolation of toxic substances into it. MSW dumping in the open area should be prohibited by the authorities to control the further pollution of water.

Key words: Municipal solid wastes (MSW), dump sites, leachate, ground water etc.

I. Introduction

Water is vital for all forms of life. About 70% of the Earth's surface is covered with water. Water being an easy solvent, enables most pollutants to dissolve in it and gets contaminated. The surface water and the ground water are the two major sources of water available for mankind. The quality of this vital resource deteriorates due to human activities. Ground water is often cheaper, more convenient and less vulnerable to pollution than surface water. Therefore it is commonly used for public water supplies. Polluted ground water is less visible, but more difficult to clean up, than pollution of surface waters. Materials from the land's surface can move through the soil and end up in the groundwater.

Mankind has been producing and disposing the waste in large volumes since decades. As populations increased and became concentrated in cities and towns, the waste management issues became an area of high concern. Human activities create waste, and these wastes are handled, stored, collected and disposed which can pose risks to environment and to public health (Zhu *et al.,* 2008). Collection, transportation and handling of the waste must also be properly dealt with, if not the waste creates a number of problems many of which are related to human health and environment. The solid wastes disposed in the dumpsites may not be technologically advanced, but continuous maintenance and monitoring is essential to ensure safe operation (Uriarte, 2008). Failure of liners and/or leakage of the leachate collection systems are the primary causes of such leachate seepage and infiltration into groundwater (Lee and Jones Lee, 1994).

Kumar and Bajaj (2013) discussed about the cities of India with growing population, changing life styles, migration of people from rural areas to urban areas and rapid industrialization end up generating an enormous quantity of urban waste (Municipal Solid Waste) every day. Abolfazl *et al.,* (2008) and Akoteyon *et al.,* (2010) studied that most of the sites are not intended and engineered towards sanitary landfill for the purpose of solid waste disposal. El-Fadel *et al.,* (1997), Dsakalopoalous *et al.,* (1998), Jhamnani *et al.,* (2009), Longe and Balogun (2010) identified that the land filling of municipal solid waste is a common waste management in many parts of the world. Singh *et al.,* (2009) analysed that in the developing countries several unregulated landfills exist adjacent to large cities, releasing harmful contaminants to the underlying aquifer.

In arid climates, landfills produce leachate seasonally, or may produce leachate only as a result of compression of an initially wet waste (Blight, 1996). For climates where annual precipitation is less than 400 mm, virtually all precipitation is evapotranspirated (Christensen *et al.,* 1992). Even in an arid climate, there are occasional wet years or wet seasons (Aljaradin and Persson 2012). The influence of warm climate on landfill performance is complex and the increase in leachate production after precipitation is rapid (Lema *et al.,* 1988).

II. METHODOLOGY

Vijayawada is the second largest city in Andhra Pradesh, located on the banks of river Krishna. The Vijayawada city with a population of 1,048,240 (2011 Census) generates waste of 650 Tons/Day. The Hydro-Geological data reveals that the groundwater table in general is shallow, due to the vicinity of Krishna River. The management of solid wastes in Indian cities like Vijayawada is largely unscientific and unsatisfactory (Niloufer et al., 2013). In the present study, the impact of leachate percolation on groundwater quality was estimated from an unlined dump site of Vijayawada in order to find out the seasonal and temporal variations in the water quality.

Gurunanak Colony site: The Station-I selected was at a residential area of Gurunanak colony in Vijayawada city. The Station-I was considered to be a control station which was at a distance of 14.2 Km from Ajith Singh Nagar dumpsite.

Ajith Singh Nagar site: The site is sloping towards southern side. Northern side of the site is used for Municipal solid waste dump and also for the compost facility and waste to energy facility. Two Stations II and III were selected for the present study at a distance of 150 meters and 180 meters from the dumpsite.

GROUND WATER ANALYSIS

Sampling

Ground water from three bore wells one from control site (Station I) and two sites (Station II & Station III) located near the major dump site of Vijayawada were used for the ground water monitoring on a monthly basis for a period of two years (i.e. from June 2012 to June 2014).

The ground water of three sampling stations was monitored monthly. The water was tested using standard methods for physical, chemical parameters. Standard APHA water analysis procedures were used to analyze the water quality parameters, as given in the following table 1.

Table 1: Standard analytical methods used for physico-chemical parameter

Sl. No.	Parameters	Methodology	References
1	Temperature (^oC)	Direct, Mercury Thermometer	
2	pH	Electrometric method Digital pH meter (Hanna make of model PHEP)	APHA (1998)
3	Electrical Conductivity (µmhos/cm)	Electrometric method Conductivity meter (Hanna make with model number DiST-4)	APHA (1998)
5	Totlal Dissolved Solids (mg/L)	Electrometric, (Hanna make with model number DiST-4)	APHA (1998)
6	Total Alkalinity (mg/L)	Volumetric analysis, Titrimetric	Grasshoff (1999)
7	Total Hardness (mg/L) EDTA	Titrimetric method	APHA (1998)
8	Calcium Hardness (CH)	Titrimetric method	APHA (1998)
9	Magnesium Hardness (MH)	Titrimetric method	APHA (1998)
10	Fluorides	SPADNS Method, Colorimeter (ELICO make)	APHA (1998)
11	Silicates	Ammonium Molybdate method Spectrophotometer	APHA (1998)
12	Sodium (Na^+)	Flame Photometer (ELICO make)	APHA (1998)
13	Potassium (K^+)	Flame Photometer (ELICO make)	APHA (1998)
14	Chloride	Argentometric, Titration	APHA (1998)
15	Nitrate - N (mg/L)	Phenol Disulfonic Acid (PDA) method	Grasshoff (1999)
16	Total Phosphorous (mg/L)	Stannous chloride method Spectrophotometric	Grasshoff (1999)
17	Dissolved Oxygen (mg/L)	Modified Winkler's method	APHA (1998)
18	Biological Oxygen Demand (mg/L)	Winkler modified, Titration	APHA (1998)
19	Chemical Oxygen Demand (mg/L)	Open Reflux Method	APHA (1998)
20	Heavy metals (B, Cd, Cr, Cu, Pb, Ni & Zn)	AAS (Perkin Elmer-AAnalyst 300)	APHA (1998)

III. Results and Discussion

Water samples from all the three stations were analysed and their levels were compared with the BIS and WHO specified standards. The behaviour of the parameters at each station (Table 2) and the seasonal changes in the stations at the study area and control area was given in Tables 3 &4. A comparative account on the ground water quality at these stations and seasonal comparison is also given.

Table 2: Annual Means of the Ground Water Quality Parameters at the Control station and two stations at Ajith Singh Nagar dumpsite in Vijayawada

S.No	Parameters	CONTROL STATION	AJITH SINGH NAGAR DUMPSITE		BIS-Standard	WHO-Standard
		S-I	S-II	S-III		
1	Temperature (^oC)	28.79±0.66	29.17±0.85	29.26±0.96	-	-
2	pH	7.46±0.188	7.48±0.26	7.46±0.20	6.5-8.5	-
3	Total Dissolved Solids	520.41±32.63	4074.33±1211.22	2505.88±1101.76	500	-
4	Electrical Conductivity (µmhos/cm)	776.74±48.70	6080.87±1807.43	3721.35±1620.63	750	-
5	Total hardness	235.16±15.60	1375.64±918.65	1200.67±1007.82	300	-
6	Calcium Hardness	30.62±5.371	50.04±18.27	40.79±7.50	75	-
7	Magnesium Hardness	204.542±18.68	1324.71±916.26	1168.83±998.38	50	-
8	Total Alkalinity	151.167±20.87	414.5±129.58	443.91±140.22	200	-
9	Fluorides	0.127±0.054	0.89±0.58	1.00±0.72	1	1.5
10	Silicates	4.28±0.543	8.67±7.06	9.49±6.12	-	-
11	Sodium	173.625±18.56	866.53±207.46	705.25±145.82	200	-
12	Potassium	18.03±4.198	52.58±25.06	39.18±12.96	-	-
13	Chlorides	173.62±18.56	1017.73±345.80	401.90±57.06	250	-
14	Nitrates	1.93±0.793	1.59±1.27	1.74±0.93	45	50
15	Phosphates	0.078±0.048	0.60±0.31	0.18±0.17	-	-
16	Dissolved Oxygen	6.02±0.92	1.60±1.55	3.12±1.38	6	>5
17	Biological Oxygen Demand	0.137±0.064	0.62±0.66	1.36±0.69	5	5
18	Chemical Oxygen Demand	1.862±0.321	7.37±2.56	8.07±4.76	10	10
19	Boron	BDL	BDL	BDL	1	0.5
20	Cadmium	ND	0.002±0.001	0.001±0.0006	0.01	0.003
21	Chromium	ND	ND	ND	0.05	0.05
22	Copper	ND	0.003±0.001	ND	0.05	-
23	Lead	BDL	0.135±0.010	0.025±0.009	0.1	-

24	Nickel	0.002±0.002	0.116±0.002	0.049±0.009	-	-
25	Zinc	0.110±0.022	1.680±0.165	0.273±0.108	5	-

A comparative account of ground water quality in the Study area:

To assess the potability of ground water at Ajith Singh Nagar dumpsites, a comparison was made among the annual means of three stations for all the parameters for three seasons i.e. rainy, winter and summer seasons for ground water.

Physical Parameters:

Table 3: Seasonal variations in physical parameters at three stations

	Stations	Seasonal Mean ± S.D. of Temperature			BIS	WHO
		Rainy	Winter	Summer		
Tempe-rature	I	29.45±0.218	28.46±0.611	28.47±0.262	-	-
	II	29.38±0.860	29.13±1.053	29.01±0.775		
	III	29.57±1.487	29.26±0.708	28.95±0.600		
pH	I	7.48±0.246	7.48±0.067	7.41±0.233	6.5-8.5	-
	II	7.56±0.412	7.47±0.102	7.42±0.219		
	III	7.34±0.239	7.585±0.172	7.46±0.154		
TDS	I	523.6±35.078	511.25±37.59	526.25±30.41	500	-
	II	3492.5±1149.6	3791.62±1233.81	4938.87±1002.2		
	III	1781.25±895.98	2637.5±1431.43	3098.87±481.92		
EC	I	774.21±579.99	729.47±62.71	785.44±45.39	750	-
	II	3492.5±1149.66	3791.62±1233.81	4938.87±1002.20		
	III	1781.25±895.98	2637.5±1431.43	3098.87±481.92		

The **Temperature** of Station-I (Control area) was comparatively lesser than the Temperatures recorded at the remaining stations. Without considering the Station-I (control area), when Temperatures were observed, the lowest Temperature was recorded at Station-V located at Ajith Singh Nagar Dumpsite. On comparing the seasonal variations the Temperature was high during rainy seasons at all the stations than winter and summer seasons.

The **pH** of all the stations of ground water was observed to be near neutral to alkaline during the study period. The two stations i.e. Station-V and VI near Ajith Singh Nagar dumpsite were observed to have nearly equal pH. The annual mean of the pH of ground water at Station-I was similar as that was observed at the other stations. This indicates that the leachate percolated to the ground water might be in methanogenic phase that is contributing to neutral to alkaline pH in the ground water at the stations.

In winter season highest **Total Dissolved Solids** concentration was observed at Station-II and lowest Total Dissolved Solids was recorded at Station-III. And during summer season the concentrations of Total Dissolved Solids were high at station-II. It is also significant to mention that the Ajith Singh Nagar dumpsite is located within a residential zone, contributing to more deleterious effect to the domestic use of ground water. An increasing trend of high Total Dissolved Solids was observed for all the stations from summer season followed by winter and rainy seasons during the study period.The mean of Total Dissolved Solids concentration at all the stations was much more than the BIS specified standard of 500 mg/L. Only at Station-I (Control area), the Total Dissolved Solids concentration was just above the BIS prescribed limit and comparatively lower than the other stations for Total Dissolved Solids concentration during the study period.

The **Electrical Conductivity** values of all the stations were exceeding the BIS prescribed standard of 750 μmhos/cm for drinking water. This high conductivity values obtained for the groundwater near the dumpsite is an indication of its effect on the water quality. Conductivity was used to give an idea of the amount of dissolved chemicals in water. Excluding the control station the lowest concentration of Electrical Conductivity was recorded at station-III that was located at a distance of 180 m from the Ajith Singh Nagar dumpsite. The ground water Stations near the Ajith Singh Nagar dumpsite were located along the ground water flow direction i.e. from north to south. This might have contributed to easy transport of pollutants through leachate to the ground water near Ajith Singh Nagar dumpsite. A trend of high Electrical Conductivity was observed for all the stations during summer season followed by winter and rainy seasons during the study period indicating more ions in the ground water due to leachate percolation.

Chemical Parameters:

Table 4: Seasonal variations in Chemical parameters at three stations

	Stations	Seasonal Mean ± S.D. of Temperature			BIS	WHO
		Rainy				
Total Hardness	I	243.37±16.08	236.62±28.95	225.25±18.47	300	-
	II	1063.12±1264.79	1429.37±6921.89	1632.62±482.24		
	III	981.5±1127.78	1583.87±1295.35	1036.62±471.98		
Calcium Hardness	I	27±5.825	30.25±4.627	34.5±3.186	75	-
	II	144.87±103.36	51.375±14.47	63.875±2.638		
	III	38.875±11.96	41.375±6.007	40.625±3.691		
Magnesium Hardness	I	216.375±20.460	236.625±28.951	190.625±17.044	50	-
	II	1027.375±1266.79	1378±6924.76	1568.75±481.18		
	III	969.5±1109.12	1541±1293.06	996±471.99		
Total Alkalinity	I	177.375±7.308	132.75±7.374	143.375±9.773	200	-
	II	354.87±168.61	395±84.60	493.62±105.58		
	III	403.37±145.60	429.5±185.72	498.87±53.25		
Fluorides	I	0.09±0.036	0.1±0.036	0.175±0.039	1	1.5
	II	0.84±0.440	0.447±0.476	1.275±0.627		
	III	0.97±0.5867	0.53±1.114	1.375±0.884		
Silicates	I	4.335±0.271	3.72±0.264	4.81±0.392	-	-
	II	5.36±0.394	5.322±0.737	15.335±9.869		
	III	5.985±0.235	10.005±6.373	12.495±8.073		
Sodium	I	169.125±19.592	173.75±19.973	178±16.783	200	-
	II	730.61±276.339	903.48±181.907	965.5±47.226		
	III	661.16±213.63	760.195±152.502	694.385±34.575		
Potassium	I	19.425±3.345	13.925±2.055	20.75±3.551	-	-
	II	38.56±21.441	48.17±18.448	71.01±25.156		
	III	35.645±18.826	42.585±7.997	39.32±10.427		
Chlorides	I	178±16.783	173.75±19.973	169.125±19.583	250	-
	II	2276.295±1092.49	1075.88±207.64	1201.01±159.62		
	III	381.175±76.369	413.21±25.730	411.315±64.316		
Nitrates	I	2.845±0.552	1.437±0.270	1.512±0.522	45	50
	II	1.095±0.750	1.13±1.127	2.535±1.438		
	III	2.165±0.910	1.625±0.992	1.415±0.865		
Phosphates	I	0.11±0.013	0.018±0.007	0.101±0.035	-	-
	II	0.761±0.240	0.46±0.338	0.61±0.346		
	III	0.235±0.200	0.075±0.098	0.22±0.150		

DO	I	7.185±0.471	5.57±0.392	5.32±0.231	6	>5
	II	2.235±1.082	1.835±1.578	0.735±1.849		
	III	2.87±0.975	3.985±1.590	2.525±1.295		
BOD	I	0.135±0.051	0.175±0.070	0.095±0.055	5	5
	II	0.725±0.419	0.835±0.754	0.312±0.801		
	III	1.31±0.457	1.75±0.736	1.035±0.743		
COD	I	2.11±0.241	1.825±0.186	1.645±0.352	10	10
	II	7.915±3.105	7.545±2.896	6.655±2.084		
	III	8.86±6.752	7.55±4.153	7.79±3.838		
Boron	I	BDL	BDL	BDL	1	0.5
	II	BDL	BDL	BDL		
	III	BDL	BDL	BDL		
Cadmium	I	ND	ND	ND	0.01	0.003
	II	0.002±0.0009	0.003±0.0004	0.002±0.0007		
	III	0.001±0.0008	0.001±0.0004	0.001±0.004		
Chromium	I	ND	ND	ND	0.05	0.05
	II	ND	ND	ND		
	III	ND	ND	ND		
Copper	I	ND	ND	ND	0.05	-
	II	0.003±0.0008	0.002±0.0009	0.003±0.001		
	III	ND	ND	ND		
Lead	I	BDL	BDL	BDL	0.1	-
	II	0.13±0.002	0.132±0.010	0.14±0.011		
	III	0.022±0.0009	0.029±0.015	0.023±0.008		
Nickel	I	0.001±0.0004	0.003±0.004	0.001±0.0003	-	-
	II	0.116±0.0007	0.116±0.003	0.116±0.002		
	III	0.0485±0.003	0.046±0.015	0.051±0.005		
Zinc	I	0.0985±0.037	0.117±0.008	0.116±0.007	5	-
	II	1.638±0.093	1.758±0.081	1.64±0.256		
	III	0.251±0.0236	0.261±0.045	0.307±0.193		

Hardness of water is not a specific constituent but is a variable and complex mixture of cations and anions. It is caused by dissolved polyvalent metallic ions. And principal Hardness causing ions are calcium and magnesium. Except the Station-I (Control Station) rest of the stations were having high mean concentration of Total Hardness which was much more than the BIS specified limit of 300 mg/L indicating that the ground water quality was poor and the water comes under the category of "very hard water". As other sources of contamination were not observed at both the dumpsites, the major contribution for more Hardness in ground water may be due to leachate contamination from the dumpsites. On comparision of all the three seasons the Total Hardness concentrations were observed to be high during rainy season followed by winter and summer seasons at Station I, whereas at Stations II and III, the Total Hardness concentrations were observed to be high during winter season followed by summer and rainy seasons. This indicates that the water quality parameter Total Hardness varied widely during the seasons among the stations in the study area. Ground water sampled from the stations situated close to the dumpsite was found to be having more C**alcium hardness** than that of the stations situated farther away. All the stations were much below the standard of 75 mg/L during the study period. From the study it can be identified that the contribution of Calcium to Total Hardness of water is comparatively less. And the reason for high Total Hardness in water may be due to other ions in water. As the summer concentrations of Calcium Hardness were high, it indicates that the effect of rain on the Calcium Hardness was less at all the stations except Station-V where the concentration was high during rainy season. Except the Station-I (Control area) rest of the stations were having high mean concentration of **Magnesium Hardness** which was much more than the BIS specified limit of 50 mg/L indicating that the much of the contribution to high total Hardness of ground is due to Magnesium ions than calcium ions. As other sources of contamination were not observed at both the dumpsites, the major contribution for more Hardness in ground water may be due to leachate contamination from the dumpsites. On comparison of all the three seasons the Magnesium Hardness concentrations were observed to be vary widely in following a seasonal trend of raise or fall among all the stations. This indicates that the water quality parameter Magnesium Hardness varied widely during the seasons among the stations in the study area. All the stations were much above the standard specified by BIS i.e. 50 mg/L during the study period.

The **Total Alkalinity** in ground water is due to the presence of salts of hydroxides, carbonates and bicarbonates, silicates and phosphates. Except the Station-I (Control Station) rest of the stations were having high mean concentration of Total Alkalinity which was much more than the BIS specified limit of 200 mg/L indicating that the ground water quality was poor in quality and possess high concentrations of salts. On comparison of the Total Alkalinity with the Control Station, the Alkalinity in ground water was much more from the samples collected at the dumpsites. And it also indicated that the leachate was contaminating the ground water from both the dumpsites and the leachate might be in methanogenic phase resulting in elevated levels of Alkalinity in ground water. On comparison of all the three seasons the Total Alkalinity concentrations were observed to be high during rainy season followed by summer and winter seasons at Station I, whereas at Station-II and Station-III the Total Alkalinity was observed to be high in summer season followed winter and rainy seasons. This indicates that the Total Alkalinity varied widely during the seasons among the stations in the study area.

The essential amounts of **Fluorides** in water range between 0.8 to 1.0 mg/L to avoid dental caries. And Fluorides concentration above 1.0 mg/L causes fluorosis. At all the stations the concentrations of Fluorides were within the specified limit of 1 mg/L. A trend of high concentration of Fluorides was observed at all the stations during summer season followed by rainy and winter seasons. The existence of **Silicates** in water is always associated with hard and alkaline water. No standard was specified for Silicates in drinking water by BIS. But more Hardness in ground water is also contributed by Silicates. On comparison of the Silicates concentration at both the dumpsites with the control station, it was clear that there is a considerable difference in the water quality near the dumpsite and far away from the dumpsites. A trend of high concentration of Silicates was observed at all the stations during summer season followed by rainy and winter season.

The **Sodium** values in ground water varied widely due to high solubility of Sodium salts and minerals. The mean concentrations of Sodium were identified to be more than the BIS specified limit only at all the stations except at Station-I which was a Control Station. A trend of high concentration of Sodium was observed at Station-I during summer season followed by winter and summer seasons whereas at Stations II and III the sodium concentration was high during rainy season. The degree of contamination of ground water quality due to the dumpsites depends upon various factors like leachate composition, rainfall, depth and distance of the monitoring station from the pollution source. Usually the pollutant concentrations tend to decrease during the rainy season and tend to increase during the summer and winter seasons due to dilution effect. However in the unprotected dumpsites due to the migration of contaminants from the dumpsites, sometimes the rainy season values might be higher than the summer and winter values. A trend of high concentration of **Potassium** was observed at Station-V during summer season followed by winter and rainy seasons, whereas the concentrations were high during summer season followed by rainy and winter seasons at Station- I. And at Station-III the concentration of Potassium was high during winter season followed by summer and rainy seasons.

Chlorides in water are usually taken as an indication of pollution due to dispersion of leachate in ground water. The lowest concentration of Chlorides was recorded at Station-III located near Ajith Singh Nagar dumpsite and highest concentration was recorded at Station-II located near Ajith Singh Nagar dumpsite. On comparision of stations near dumpsites with the Control Station-I it was observed that the leachate contamination to the ground water was chiefly due to dumpsite during the study period. The study of ground water on a seasonal basis also revealed that the concentration of Chlorides was high at Station-II in rainy season located near to the Ajith Singh Nagar dumpsite. This might be due to its nearest distance from the dumpsite. Except Station-I, the ground water at rest of the stations was found to exceed the BIS specified limit of 250 mg/L during the study period.

The **Nitrate** concentrations at all the stations were far below the BIS specified limit of 45 mg/L, indicating that the Nitrates pollution at both the dumpsites can be minor. On comparision of stations near dumpsites with the Control Station-I it was observed that the concentrations of Nitrates were all most similar and there was no specific increase at the ground water stations. A trend of high concentration of Nitrates was observed at Station I during rainy season followed by summer and winter seasons, whereas the concentrations were high during rainy season followed by winter and summer seasons at Station III. And only at Station-II the summer concentration was high followed by winter and rainy seasons. It was observed that the **Phosphate** concentration was high at ground water stations near Ajith Singh Nagar dumpsite than near Pathapadu dumpsite. On comparing the Nitrate concentrations at ground water stations near dumpsites with the Control Station-I it was observed that the concentrations were nearly similar. A trend of high Phosphates was observed at Stations I & III during rainy season followed by summer and winter seasons. No standard limit was specified by BIS for Phosphate concentration.

Except Station-I (Control area), rest of all the stations in the study region were not meeting the minimum requirement of **Dissolved Oxygen** specified by BIS during the study period. The mean of Dissolved Oxygen values were very low indicating the ground water pollution at the Municipal Solid Waste dumpsites. The study revealed that the Dissolved Oxygen levels were to some extent better during rainy and winter seasons during the study period. The **Biological Oxygen Demand** concentration in ground water indicates the organic pollution. Without considering the Control Station the lowest Biological Oxygen Demand was observed at Station-V. The mean of Biological Oxygen Demand was almost similar and comparatively less at Control Station and at the Stations near the dumpsites indicating less organic pollution in the ground water in the study area. And the ground water from all the stations was having Biological Oxygen Demand within the BIS specified limit of 5 mg/L, representing that the organic contaminants were low in the ground water at the study area. The ground water from all the stations was having **Chemical Oxygen Demand** within the BIS specified limit of 10 mg/L, representing that the organic contaminants were low in the ground water at the study area. From this study it was clear that the Chemical Oxygen Demand values fluctuated widely among different stations among different seasons.

The **Boron** was below detection levels in the ground water at the study area during the period of study. The solubility of **Cadmium** in water is influenced by the nature of source of Cadmium and the acidity of water. All the stations were observed to be within the BIS specified limit of 0.01 mg/L for Cadmium during the period of study.On comparing the seasonal variations among the three stations the Cadmium concentrations did not differ widely and varied only with small difference during the three seasons. The **Chromium** solubility in water is usually low, hence the levels in water is low. The Chromium concentrations were not detected at any of the stations in the study area during the period of study. The nature of the **copper** in water depends on the pH and carbonate concentration in the water and other anions in solution. The Copper was not detected at Station-III during the study period. And the mean Copper concentrations at both Stations located at Ajith Singh Nagar dumpsite, were observed to be far below the BIS specified limit of 0.05 mg/L during the study period. Higher **Lead** levels may result when water is aggressive, soft or has low pH. The Lead was below detection levels at Stations I and IV during the study period. The mean concentrations of Lead ranged between 0.025 mg/L at Station-III and 0.135 mg/L at Station-II both located near Ajith Singh Nagar dumpsite. At the Station-III the mean concentrations were well below the standards specified by BIS i.e. 0.1 mg/L. Whereas at Station-II the Lead concentrations were slightly above the BIS specified limit. On comparing the seasonal variations it was observed that the highest concentrations of Lead were found during rainy and winter seasons. From this study it was identified that the Lead concentrations were observed only at the stations near to the dumpsites. Many of the **Nickel** salts are soluble in water. The mean value of Nickel concentrations were observed to be in traces at all the stations during the study period. Comparatively highest annual mean concentration was identified at Station-II located at Ajith Singh Nagar dumpsite and lowest concentration was found at Station-I (Control Station). No specific limit was specified by BIS for Nickel in drinking water. The observed seasonal variations were very small indicating that the Nickel concentration did not vary widely during different seasons. **Zinc** is a sparingly soluble salt, while the highly soluble chloride salts tend to hydrolyse to form Zinc hydroxide as the result the concentration of Zinc in water is naturally low. The mean concentrations of Zinc were far below the limit specified by BIS i.e. 5 mg/L at all the stations. It was also observed that the variations were comparatively negligible among all the stations. During the three seasons, the variations were comparably low and hence can be insignificant.

IV. Conclusion

Open dumping is still in practice at Vijayawada. This is unscientific. The bore wells dug for the public usage were voluntarily abandoned by public because of odours, unacceptable colour of the water and frequent sedimentation in the collected waters. All these indicate that the public have realized the threat of contamination of ground water. Within a very short time the adverse impacts of the dump on the ground water quality will be vogue. The following suggestions are made to avoid further deterioration of the situation:

1. Proper lining must be provided for these dumpsites in order to prevent percolation of leachate to the ground water.
2. Stray cattle were found to feed over these dumps. Hence an effective fence must be provided to prevent cattle.
3. The organic matter is least recycled or utilized for vermin-composting and other waste reuse technologies. An effective integrated management plan must be developed by incorporating subsistence component involving local poor people to generate bio-fertilizers from the organic/degradable wastes in the dump.
4. Sufficient gas analysers must be established at the dumpsite, as the public complaints over obnoxious gasses are frequent.
5. A continuous monitoring station for ground water and leachate quality must be established on permanent basis on the lines suggested in Municipal Solid Waste (Management and Handling) Rules, 2000.

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