Impact of Municipal Solid Waste on the Ground Water Quality in Vijayawada City, Andhra Pradesh

Shaheda Niloufer	A.V. V. S. Swamy
Department of Science & Humanities, Lakireddy Bali Reddy College of Engineering, Mylavaram, Krishna Dist., A.P.	Head, Department of Environmental Sciences, Acharya Nagarjuna University, Guntur, A.P.

K. Syamala Devi

Dept. of Basic Sciences, GNITS, Hyderabad 500 008

ABSTRACT *The leachate generated from municipal solid waste (MSW) dump site affects the groundwater quality in the adjacent areas. In the present study, the quality of groundwater around a municipal solid waste dumping site in Vijayawada city was analyzed to study the possible impact of solid waste in ground water quality. The increase or decrease in the values of certain parameters due to monsoon changes was noticed. Ground water samples from the hand bores near the MSW dump sites of Vijayawada were analyzed for the major water quality parameters, such as Biological oxygen demand(BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), pH, Alkalinity, Hardness, Conductivity, Nitrates, Phosphates, Chlorides, Sodium, Potassium and Fluorides. It has been found that most of the parameters of water quality were not in the acceptable limit in accordance with the IS 10500 Drinking Water Quality Standards that was due to the contamination from solid waste materials that are dumped in the area.*

Introduction

Unorganized, indiscriminate and unscientific dumping of municipal solid wastes is very common disposal method in many Indian cities which cause adverse impacts to the environment (Mahar, 2007). Environmental impact of land filling of MSW can usually result from the run-off of the toxic compounds into surface water and ground water (Belevi & Baccini, 1989) which eventually lead to water pollution as a result of percolation of leachate (Beaven & Walker, 1997) (Rajkumar, Subrama and Elango, 2010). Contamination of ground water can take place from either a wider source like percolation from landfills on account of application of solid and liquid wastes from a point source lie waste disposal sites (Singhal & Gupta, 2010). As water filters through any material, chemicals in the material may dissolve in the water, this process is called leaching and the resulting mixture is called leachate (Agrawal, Rama pandey & Agrawal, 2011). The leachate generated from solid waste dumps may have the potential to pollute the surrounding waters sources and soil also. The most serious problem is groundwater contamination (Sabahi, Rahim, Zuhari, Nazaily and Alshaebi, 2009). It is proved that this polluted ground water is unfit for drinking and causes health complaints like jaundice, nausea, asthma, miscarriage and infertility have described in detail about the environmental impacts of leachate pollution on ground water supplies in Nigeria (Chain, 2009) (Akinbile & Yusoff, 2011).

There are only few reports on the status of waste management in Vijayawada city where emphasis is laid down on the characterization and management conditions. The study area is lacking information of the ground water qualities in and around MSW dump sites. Therefore this study attempted to quantify the changes in the properties of ground water near municipal solid waste dumping by comparing them with the standard water quality parameters. Keeping these specifics in mind, the present study was undertaken to compare the influences of MSW dumping on the ground water quality and heavy metal levels in ground water.

Study Area

Vijayawada is the third largest city in the state of Andhra Pradesh, India, after Hyderabad and Visakhapatnam, with an area of 261.88 km2 and population of 1,048,240. Vijayawada is surrounded by the Krishna River on the east and west and the Budameru River on the north. The northern, northwestern, and southwestern parts of the city are covered by a low range of hills, while the central, southwestern and northwestern parts are covered by rich and fertile agriculture lands with three major irrigation canals. The topography of Vijayawada is flat, with a few small- to medium-sized hills. The Krishna River runs through the city. These hills are part of the Eastern Ghats cut through by the Krishna River. The city generates solid waste of 534Tons/Day. Generally low lying areas and outskirts of the city Vijayawada are used for the purpose of open dumping. The management of solid wastes in Indian cities like Vijayawada is largely unscientific and unsatisfactory. The uncontrolled dumping of urban wastes destroys the beauty of country side also there is danger of water pollution when the leachate from a refuse dump enters surface water or ground water resource. In addition uncontrolled release of landfill gas, burning of open dumps can cause air pollution. The main risks of human health arise from the breeding of disease vectors, primary flies and rats thriving in the exposed garbage and refuse dumps.

In 15 to 20 years life time leachates and heavy metals enter the ground water from the vicinity of these dumpsites. These aquifers radiate into many parts of the city and carry along with it all the components that have entered from the municipal solid waste sites. Vijayawada city has not been systematically studied to reveal the impacts of organized as well as unorganized municipal solid waste dumping. The MSW dump site at Pathapadu has been selected for the present study.

Material and Methods

The dump site of Vijayawada near Pathapadu village is located in the suburban area of the Vijayawada city is the main dump site of the city has been selected for monitoring the ground water quality. The deep tube wells (India Mark-II hand pumps) having depth of more than 50m which were devel-

oped by Government of India for providing safe drinking water to mass populations were selected as sample stations. All the sample stations were hand bores having a depth of at least 50 m. The stations were located at a distance of 30 to 1600 m distance. The station located at 1600 m was nearer to residential area.

Groundwater sampling was carried out during a period of six months i.e., from June 2012 to November 2012. Ground water samples were then collected monthly from the same locations to determine the impact of leachate discharge from solid waste dumping site on ground water of the adjoining area. The parameters were selected based on their relative importance in municipal landfill leachate composition and their pollution potential on ground water resources.

A group of physical and chemical parameters were tested in groundwater samples. The Physical parameters include temperature, pH, Conductivity, Total dissolved solids (TDS). The chemical parameters include: Alkalinity, Hardness, Chloride (Cl), Fluorides, Sodium, potassium, Nitrates, Phosphates, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

Ground water samples collected from the dumping site were taken in pre-cleaned polyethylene bottle whereas glass bottles were used to collect the samples for BOD and COD tests. All the water quality parameters were estimated by the standard methods given by APHA, (1989). The Temperature was measured by a Digital Thermometer with measuring range -50oC- + 300oC. The pH was measured by pocket sized pH tester (HANNA make) whereas, Conductivity/TDS was measured by DiST Conductivity/TDS Meters with Automatic Temperature Compensation (HANNA make). Nitrates were determined using Phenol Disulphonic Acid (PDA) method and Phosphate using Total Phosphate method. Fluorides were estimated by SPADNS method. Sodium and Potassium were estimated using Flame Photometer (ELICO make). The BOD5 test was done to analyze the BOD using BOD incubator. The COD was determined using COD reactor. The chlorides were determined by titrating the water samples against standard solution of silver nitrate using potassium chromate as an indicator.

Results and Discussion:
Understanding the quality of ground water is as important as that of its quantity as it is the main factor that determines its suitability for drinking, domestic, agricultural and industrial purposes Rajkumar et al. (2010). 35 ground water samples analyzed during the study period.

Temperature: The temperature at 5 sample stations ranged between 28.7 - 32.1oC. High temperatures in the ground water m ay be due to decomposition rate of organic matter present in the leachate which is contaminating the ground water.

pH: The pH of the ground water varied between 7.1-7.8 which is within the limit prescribed by Indian Standards IS 10500 (1991). This shows that the water in the study area is alkaline.

Total Dissolved Solids (TDS): The total dissolved solids at five sampling stations ranged between 200-1700 mg/l which are within the permissible limit of Indian Standards i.e., 2000mg/l. High TDS may affect the persons who are suffering from kidney and heart diseases Gupta, Kumar, Ojha and Singh, 2004). The sample station 1 recorded high TDS where the water was having obnoxious odors and objectionable color. The TDS values were high in the months of October and November-2012.

Electrical Conductivity (EC): The EC values were found to vary between 298.50-2537.313µmhos/cm. The electrical conductivity was above the permissible limit of 250 µmhos/cm in all the sampling sites. The highest EC was recorded during the month of November.

Total Hardness (TH): The total hardness of ground water samples were found in the range of 473 up to 1380 mg/l. Most of the sample stations were exceeding the maximum permissible limit 600mg/l according to the Indian Standards IS 10500 (1991). The high values of TH do not have any associated adverse health related effects on humans but are an indicator of deposits of Ca and/or Mg ions. Their presence will disallow water from farming lather with soap thereby preventing economic management of water resources (Christopher, 2004).

Total Alkalinity (TA): Alkalinity may be due to the presence of carbonate, bicarbonate and hydroxide compounds of calcium, sodium and potassium. The alkalinity values in study area were found in the range of 248-634 mg/l which were found to be greater than the value prescribed by Indian Standards i.e., 600mg/l. Alkalinity around 150mg/l has been found conductive to higher productivity of water bodies (Ball, 1994).

Chlorides: Chlorides ranged from 270.007-809.74 mg/l though below the Indian Standards i.e. 1000mg/l its presence connotes pollution hence require treatment before use.

Fluorides: The fluoride values ranged between 0 and 1.5 in all the five sampling sites, which were within the Indian Standards IS 10500 (1991) i.e. 1.5 mg/l.

Sodium: The sodium levels ranged between 446.9 and 1000 ppm, which were very high than the prescribed standards i.e. 200 mg/l. The sodium levels were high in the months of June-2012 and November-2012. It may be due to leaching of solid waste after the rainfall.

Potassium: The potassium levels ranged between 17 and 127.9 ppm. Potassium is weakly hazardous in water, but it does spread pretty rapidly, because of its relatively high mobility and low transformation potential.

Nitrates: Nitrates, the most highly oxidized form of nitrogen compounds is commonly present in surface and ground waters because it is the end product of the aerobic decomposition of organic nitrogenous matter. The nitrate values in this study ranged from 0.25 to 45.2 mg/l, which were within the prescribed limits of Indian Standards i.e. 45 mg/l except in the sample station 5, which showed nearly 45 mg/l in the month of November.

Phosphates: Phosphate may occur in ground water as a result of domestic sewage, detergents, agricultural effluents with fertilizers and industrial waste water. The phosphate content in the study area was found in the range of 0 and 0.6 mg/l.

Dissolved Oxygen: The value of 0.9 mg/l was an indicator of oxygen depletion in the ground water samples closer to the dump sites which also reported by (Christopher, 2011). The DO was almost nil and some times less than 0.9 mg/l in the stations 1 and 2 which showed that the wells were unsafe for consumption.

BOD: The BOD5 values ranged between 0 and 2.7 mg/l which represents low organic pollution from the leachate.

COD: The COD values ranged between 0 and 19.2 mg/l which is within the prescribed limit of Indian Standards IS 10500 (1991) i.e. 25 mg/l which indicates that the contamination is moderate as it is measure of organic and inorganic pollution.

Table 1: Physical Parameters of the water quality at the dumpsite at Vijayawada City.

Sampling Stations	Color	Odor	Temp (oC) Mean ± SD	TDS (ppm) Mean ± SD	EC (µmhos/cm) Mean ± SD
1	Not clear	Objectionable	31.16±0.52	1350±454.9	2014.92±679.06
2	Not clear	Objectionable	30.18±0.37	1300±400	1939.29±596.71
3	Clear	Mild	29.58±0.79	916.66±354.4	1368.16±529.09
4	Not clear	Mild	29.88±1.53	866.66±338.6	1293.53±505.40
5	Not clear	Mild	30.06±0.41	1000±368.7	1492.53±550.42

Table 2: Chemical Parameters of the water quality at the dumpsite at Vijayawada City.

Sampling station	Distance in m	pH	TH mg/l	CH mg/l	MH mg/l	TA	Cl- mg/l	F- mg/l	Na ppm	K ppm	NO3- mg/l	PO43 mg/l	DO mg/l	BOD mg/l	COD mg/l
1	90	7.26± 0.19	1205.6± 158.16	55.5± 9.75	1150.1± 150.7	471.6± 151.1	634.5± 119.3	0.87± 0.50	533.06 ± 69.62	84.4 ± 33.65	1.2± 0.51	0.08± 0.12	0.5± 1.22	0.2± 0.48	3.91± 1.16
2	180	7.36± 0.19	1140± 152.23	60.6± 1.63	1079.3± 151.5	476.6± 2810	482.3± 73.92	0.51± 0.08	668.3 ± 44.92	63.7± 23.56	0.33± 0.05	0.02± 0.05	0.98± 0.54	0.51± 0.33	10.28± 0.81
3	30	7.41± 0.22	575.1± 58.02	45.5± 1.97	529.6± 57.19	285± 37.93	571.6± 373.3	0.5± 0.24	926.5 ± 71.59	30.8± 15.45	0.38± 0.11	0.52± 0.11	2.65± 0.97	0.85± 0.44	9.57± 1.50
4	130	7.38± 0.24	650.8± 112.79	44± 2.60	606.8± 111.9	259.8± 8.77	385.4± 84.66	0.5± 0.22	661.6± 95.92	27.03± 9.91	2.69± 0.40	0.04± 0.40	3.73± 0.89	1.55± 0.64	9.68± 2.88
5	1600	7.45± 0.17	597.8± 36.68	39± 18.45	556.3± 49.17	451± 21.08	206.9± 33.83	0.83± 0.41	829.3± 55.47	73.2± 28.58	42.8± 5.86	0.09± 5.86	4.13± 1.08	1.65± 0.90	9.74± 1.16

On the whole majority of the parameters analyzed have shown an inverse relationship with the increasing distance from the margins of the dumpsite. However, the deviations were not significant statistically indicating that though presently seem to be unpolluted, as the time passes and with the continued accumulation of solid waste all the stations are potentially threatened with contamination of leachate in the near future.

Conclusion:
The five selected stations located at a distance ranging from 30 m to 1600 m are threatened with pollution by entry of leachate in near future. Majority of the parameters have shown an inverse relationship of concentration vs. distance. As dumping is continuous process in the city of Vijayawada, without proper leachate discharge and treatment facilities, the ground water in the area is going to be affected in terms of their potability and use for other purposes. Hence, immediate attention must be paid to improve the dumpsites based on MSW 2000 rules.

REFERENCE 1. Mahar, R.B., Liu J., Yue D., & Nie Y. (2007). Land filling of pretreated municipal solid waste by natural convection of air and its effects: Journal of Environmental Science and Health (Vol. 42 pp. 351–359). | 2. Belevi, H., Baccini, P. (1989). Long-term behavior of municipal solid waste landfills: Waste Management Research (Vol. 7 pp. 43-56). | 3. Beaven, R.P., Walker, A.N. (1997). Evaluation of the total pollution load of MSW, Proceedings Sardinia 97, 6th International Landfill Symposium. CSIA: Cagliari, Italy. (pp. 57-71). | 4. Rajkumar, N., Subramani, T, & Elango L. (2010). Groundwater contamination due to municipal solid waste disposal – A GIS Based Study in Erode City: International Journal of Environmental Sciences. (Vol. 1(1) pp. 39-55). | 5. Singhal, B.B.S. & Gupta, R.P. (2010). Applied Hydrogeology of Fractured Rocks. (Vol. 10 pp. 221). | 6. Agrawal, A., Rama Pandey, R., & Agrawal, M.L. (2011). Impact of Solid Waste Leachate on Ground Water Sources – A Case Study: International Journal of Chemical and Environmental Engineering. (Vol. 2(2)). | 7. Sabahi, E. A., Rahim, A., Zuhairi, W.Y., Nozaily, F.A., & Alshaebi, F. (2009). The Characteristics of Leachate and Groundwater Pollution at Municipal Solid Waste Landfill of Ibb City, Yemen: American Journal of Environmental Sciences. (Vol. 5 (3) pp. 256-266). | 8. Chian, E.S.K. (1977). Stability of organic matter in landfill leachates: Water Res. (Vol. 11 pp. 225–232). | 9. Akinbile, C.O., & Yusoff, M.S. (2011). Environmental impact of leachate pollution on groundwater supplies in Akure, Nigeria: International Journal of Environmental Science and Development(Vol. 2(1) pp. 81-89). | 10. Indian Standard – Drinking Water – Specification IS 10500 – 1991 (Reaffirmed 2009). | 11. Gupta, S., Kumar, A., Ojha, C.K., & Singh, G. (2004): Journal of Environmental Science & Engineering. (Vol. 46(1) pp. 74-78). | 12. Christopher, O. A. (2011). Environmental Impact of Landfill on Groundwater Quality and Agricultural soils in Akure, Nigeria: The Pacific Journal of Science and Technology. (Vol. 12 pp. 2). | 13. Ball, R.C. (1994). Fertilization of lake, good or bad: Michigen Conserv. (pp. 7-14).