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A Study on Ground Water Quality in and Around Kondapalli Area, Andhra Pradesh, India

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ABSTRACT

Municipal solid waste (MSW) leachate generated from open MSW dumpsite can cause groundwater contamination. The impact of open dumping of MSW on the groundwater of adjacent area was studied. To assess the variations in groundwater quality, samples were collected around an open MSW dumping site in sub-urban region of Kondapalli, Andhra Pradesh, India were compared with the water quality standards specified by Bureau of Indian Standards (BIS). Groundwater samples were analysed for various physicochemical parameters for 1 year. Results indicated that the groundwater is getting contaminated due to migration of landfill leachate. Extent of contamination was higher in areas closer to the dumpsite as indicated by high alkalinity, total dissolved solids, hardness and chloride concentrations. The Dissolved Oxygen was very low in the ground water samples when compared with the control station that was far away from the dumpsite.

Key words: *Municipal solid waste (MSW), dumpsite, ground water etc.*

INTRODUCTION

Waste is defined as any unwanted material intentionally thrown away for disposal. However, certain wastes may eventually become resources valuable to others once they are removed from our ways of life & they are generated at every stage of process of production & development (Pankaj & Prakash, 2011). Unorganized, indiscriminate and unscientific dumping of municipal wastes is very common disposal method in many Indian cities which cause adverse impacts to the environment (Mahar et al., 2007). Nearly all human activities generate waste, and the way in which this is handled, stored, collected and disposed of, can pose risks to the environment and to public health (Zhu et al., 2008). Environmental impact of land filling of MSW can usually result from the run-off of the toxic compounds into surface water and groundwater (Belevi and Baccini, 1989) which eventually lead to water pollution as a result of percolation of leachate (Beaven and Walker, 1997; Rajkumar et al., 2010).

There are very few reports on the status of waste management in Kondapalli village where emphasis is laid down on the characterization and management condition only. The study area is lacking in the information of water qualities in and around such landfill areas. Therefore this study attempted to quantify the changes in the properties of ground water under municipal waste dumping by comparing them with the properties of ground water at the adjoining areas under normal uses. Keeping these specifics in mind, the present study was undertaken to compare the influences of municipal waste dumping on selected water physicochemical properties. Our future use of ground water which is very important alternative for living cannot be allowed to degrade from these local sources of leachate pollution (Niloufer et al., 2013). A significant importance of this work will be in providing baseline information for further ground water quality monitoring studies and to understand their potential uses in making various water amendments in future studies.

STUDY AREA

Kondapalli is a census town in Krishna district of the Indian state of Andhra Pradesh. It is located in Ibrahimpatnam mandal under Vijayawada revenue division. It is located at 16 km from Vijayawada, on National Highway 221. Kondapalli is home to the Kondapalli Reserve Forest one of the last remaining pristine forests in the Krishna district, spread over an area of 30,000 acres (120 km^2). It is home to several leopards, wild dogs, jackals, wild boar, and wolves with a varied topography. The historic fort on the hill located to the west of the Kondapalli village was built by Prolaya Vema Reddy of Kondavidu during the 14th century.

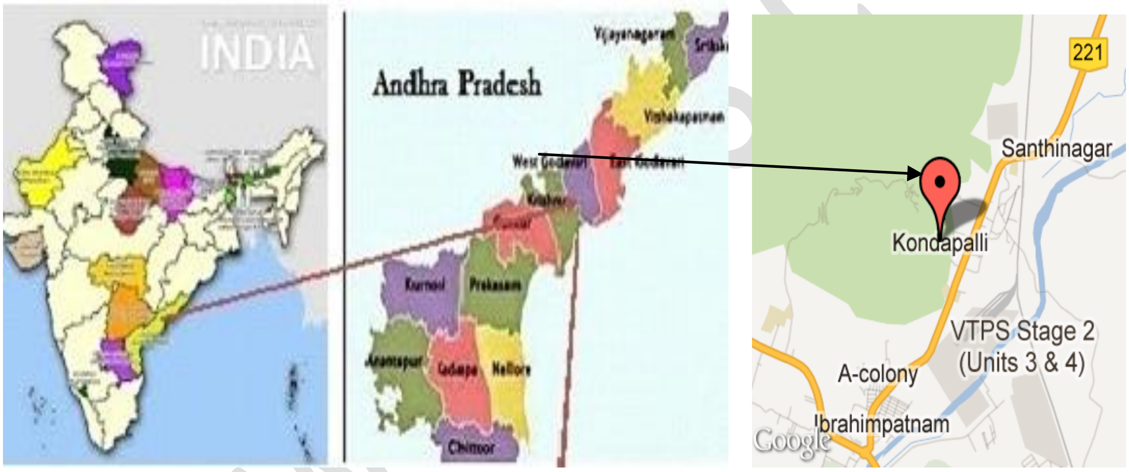

Figure 1: Location map of the study area: Kondapalli

Kondapalli is an industrial suburb of Vijayawada. It has one of the largest industrial estates (industrial parks) in Andhra Pradesh, spread over 450 acres (1.8 km^2) and supporting over 800 industrial enterprises. Second largest wagon workshop of Indian railways is present in Rayanapadu (Guntupalli) about 3 km from Kondapalli.[6] In addition to a 1760 MW Vijayawada Thermal power project (VTPS) (The VTPS name has since been replaced by NTTPs.) and 368.144 MW gas based Lanco power plant which is under expansion to 768.144 MW are located here.[7] Andhra Pradesh Heavy Machinery & Engineering Limited (APHMEL) factory is present in kondapalli. Kondapalli is hub for storage, bottling and transportation of petroleum products of all major companies. Major companies having a presence in Kondapalli include BPCL, GAIL, HPCL, IOC, RELIANCE, and LANCO.

MATERIAL AND METHODS

Sampling

Ground water from five wells, one from control site (Station V) and Stations I, II, III & IV located near the major dump site of Kondapalli were used for the ground water monitoring on a monthly basis for a period of one years (i.e. from January 2015 to December 2015). The ground water of three sampling stations was monitored monthly. Ground water samples collected near the dumpsite was taken from pre-cleaned polyethylene bottles. 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.

Table1: Standard analytical methods used for physico-chemical parameter

Sl. No.	Parameters	Methodology	References
1	Temperature (°C)	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	Sodium (Na^+)	Flame Photometer (ELICO make)	APHA (1998)

12	Potassium (K^+)	Flame Photometer (ELICO make)	APHA (1998)
13	Chloride	Argentometric, Titration	APHA (1998)
14	Nitrate - N (mg/L)	Phenol Disulfonic Acid (PDA) method	Grasshoff (1999)
15	Total Phosphorous (mg/L)	Stannous chloride method Spectrophotometric	Grasshoff (1999)
16	Dissolved Oxygen (mg/L)	Modified Winkler's method	APHA (1998)
17	Biological Oxygen Demand (mg/L)	Winkler modified, Titration	APHA (1998)
18	Chemical Oxygen Demand (mg/L)	Open Reflux Method	APHA (1998)

RESULTS AND DISCUSSION:

Analytical results for water like Temperature, pH, Total dissolved solids (TDS), Electrical conductivity (EC), Total Hardness, Calcium hardness, Magnesium hardness, Total alkalinity, Fluorides, Sodium, Potassium, Chlorides, Nitrates, Phosphates, Dissolved oxygen (DO), Biological oxygen demand (BOD) and Chemical oxygen demand (COD), are provided for a complete seasonal cycle from Jan-2015 to Dec-2015.

The **Temperature** of Station-V (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-IV located at the Dumpsite. A wide range of studies made by different researchers on ground water quality due to leachate contamination from Municipal Solid Waste sites in Nigeria (Akinbile & Yusoff 2011 in Akure; Saidu, 2011 in Minna of Niger state; Afolayan *et al.*, 2012 in Solous) reported a same range of temperature that was between 24^oC to 32^oC.

The **pH** of all the stations of ground water was observed to be near neutral to alkaline during the study period.. The annual mean of the pH of ground water at Station-V 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. A wide range of studies (Gautam *et al.*, (2011) in Jaipur; Jayanthi *et al.*, (2012) in Chennai; Bundela *et al.*, (2012) in Jabalpur; done throughout the India reported a neutral to alkaline pH which ranged between 7 to 9.2.

Table 2: Sampling Stations

Sampling Stations	Sampling Locations	Distance in meters	Depth of water level	Sources
Station1	APHMEL Centre	90	50	India MarII handpumps
Station2	APHMEL Centre	180	50	India MarkII handpumps
Station3	APHMEL Centre	200	50	India MarII handpumps
Station4	Saibaba Temple Centre	260	50	India MarII handpumps
Station5	Saibaba Temple Centre	1600	50	India MarII handpumps

Table3:Physical Parameters of the water quality at the dumpsite at Kondapalli

Sampling Stations	Color	Odor	Temp(oC)	TDS(ppm)	EC(μmhos/cm)
			Mean±SD	Mean±SD	Mean±SD
1	Notclear	Objectionable	31.16±0.52	1350±454.9	2014.92±679.06
2	Notclear	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	Notclear	Mild	28.88±1.53	866.66±338.6	890.53±505.40
5	Notclear	Mild	28.06±0.41	520±368.7	763.53±550.42

During the study period highest **Total Dissolved Solids** concentration was observed at Station-I and lowest Total Dissolved Solids was recorded at Station-IV. It is also significant to mention that the dumpsite is located within a residential zone, contributing to more deleterious effect to the domestic use of ground water. 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-V (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-IV that was located at a distance of 900 m from the dumpsite.

Table 4: Chemical Parameters of the water quality at the dumpsite at Kondapalli

Sample stations	Distance in meters	Mean±SD													
		pH	**TH mg/l**	**CH mg/l**	**MH mg/l**	**TA**	**Cl- mg/l**	**F- mg/l**	**Napp m**	**K ppm**	**NO3- mg/l**	**PO4 3 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 ± 0.5	980.06±69.62	84.4±3 3.65	1.2± 0.51	0.08± 0.12	0.5± 1.22	2.5± 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	1.51± 0.33	10.28 ± 0.81
3	200	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± 1.5
4	260	7.38 ± 0.24	650.8± 112.79	44± 2.6	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± 0.4	0.04± 0.4	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	189± 21.08	206.9 ± 33.83	0.53 ± 0.41	523.3 ± 55.47	32.2± 28.58	42.8± 5.86	0.09± 5.86	4.13± 1.08	0.25± 0.9	9.74± 1.16

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-V (Control Station) which was moderately higher, 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. 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. Except the Station-V (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. 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-V (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.

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. 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-V which was a Control Station. 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. A trend of high concentration of **Potassium** was observed at Station-I followed by stations II, III & IV.

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-V highest concentration was recorded at Station-I located near to the 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. Except Station-V, 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-V it was observed that the concentrations of Nitrates were higher during the study period, this might be due to the agricultural activities near the Station-V. It was observed that the **Phosphate** concentration was high at ground water stations near the dumpsite. No standard limit was specified by BIS for Phosphate concentration.

Except Station-V (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 **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-III. 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.

CONCLUSION

Open dumping is an un-scientific method that is being practiced at Kondapalli. The water from bore wells dug for the public usage was observed to have odours, unacceptable colour and frequent sedimentation. Public have also 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. From the study done on ground water quality MSW dumpsite at Kondapalli for a period of one year, it was concluded that an extremely degraded environments in the vicinity of the dump sites is not at all suitable for human settlements.

- The condition of the ground water was degrading continuously due to mismanagement of the MSW dumpsites.
- The obnoxious odors around the dumpsites due to decomposition of the waste were continuously causing a nuisance to the surrounding communities.
- Since environmental cost of a developing country will be different from a developed country, this approximation imposes a limitation on the current study. It points to the need for carrying out further research in the direction of estimating environmental costs of waste management for Vijayawada. An Integrated approach model was built upon the following assumptions.

a. Waste nodes should be located at the centers of waste generating areas.

b. Waste separation should be done at transfer stations.

c. All the proposed plants for this model should be situated near landfill sites so that transportation cost of inert material transported from these plants to landfill becomes negligible.

- Waste pickers are an integral part of the materials supply chain to industry. Effectively this means that they contribute to national productivity and income.
- Integration of existing waste pickers and informal waste collectors for materials recovery and processing.
- Diversion of organic waste from landfills into decentralized composting, bio-methanation and non-incineration technologies diversion of recyclables into recycling with the benefit of strengthening of the informal waste sector can reduce the ground water contamination.

REFERENCES

i. Afolayan, O.S., Ogundele, F.O. and Omotayo, A., 2012. Comparative analysis of the effect of closed and operational landfills on groundwater quality in solous, Lagos Nigeria. Journal of applied technology in environmental sanitation. 2(1): 67-76.

ii. Akinbile, C.O. and Yusoff, M.S., 2011. Environmental Impact of Leachate Pollution on Groundwater Supplies in Akure, Nigeria. International Journal of Environmental Science and Development. 2(1): 81-86.

iii. 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)

iv. Belevi, H., Baccini, P. (1989). Long-term behavior of municipal solid waste landfills: Waste Management Research (Vol. 7 pp. 43-56).

v. Bundela, P.S., Sharma, A., Pandey, A.K., Pandey, P. and Awasthi, A.K., 2012. Physicochemical analysis of ground water near municipal solid waste dumping sites in Jabalpur. International journal of plant, animal and environmental sciences. 2(1): 217-222.

vi. Gowtam, A., Pathak, G. and Sahni, A., 2011. Assessment of Ground Water Quality at Municipal Solid Waste Dumping Site – Sewapura, Jaipur. Current World Environment. 6(2): 279-282.

vii. Jayanthi, M., Duraisamy, P., Sharma, K.K. and Paramasivam, K, 2012. Potential impacts of leachate generation from urban duups on the water quality of Pallikaranai Marsh – the only surviving fresh water Wetland of Chennai City in India. Indian Journal Innovations Dev. 1(3): 186-191.

viii. Mahar, R.B., Liu J., Yue D., and Nie Y., 2007. Land filling of pretreated municipal solid waste by natural convection of air and its effects. Journal of Environmental Science and Health. 42:351–359.

ix. Modak, P.R. and Nangare P.B., 2011. Quantitative and qualitative assessment of municipal solid waste for Nagpur city. Journal of Engineering Research and Studies. II(II): 55-61.

x. 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).

xi. Saidu, M., 2011. Effect of refuse dumps on ground water quality. Advances in Applied Science Research. 2 (6): 595-599.

xii. Niloufer, S., Swamy, A.V.V.S. and Devi, S.K., 2013. Ground water quality in the vicinity of municipal solid waste dumpsites in Vijayawada, A.P. International Journal of Engineering and Scientific Research, 3(8): 419-425.

xiii. Zhu, D., Asnani, P.H., Zurbrugg C., Anapolsky, S. and Mani S., 2008. Improving Municipal Solid Waste Management in India, A Source Book for Policy Makers and Practitioners. World Bank, Washington D.C.