Impact of Solid Waste Disposal on Quality of Ground Water Around Different Landfill Sites of Nizamabad City, Telangana State

Neeli Vasavi*, Naseem.
Department of Pharmaceutical Chemistry Telangana University,
Nizamabad.

Abstract:- One of the worldwide biggest challenges is solid waste management. Land filling is the simple and common method of disposing solid waste ever observed in developing countries. The landfill leachates loaded with pollutants percolates in to water bodies present around the landfill sites results in pollution of ground water. An attempt is made to study the impact of landfills on ground water quality present around the landfills of nizamabad city and for proper interpretation the results also compared with the results of assessment of water samples from Alwal landfill located in Greater Hyderabad where an integrated solid waste management is undertaken. The water samples collected from various radial distances from the landfill site. Results of the study clearly indicate that the ground water quality is deteriorated badly and regular monitoring of ground water quality is needed. It also recommends need of Site-specific policies on ground water pollution control for Nizamabad landfill sites.

Key words: Landfills, Solid waste, Pollution, Leachate, Ground water and WQI (water quality index).

INTRODUCTION
Disposing of solid waste at open low lying areas in unscientific manner leads to pollution of air, water and soil and also results in adverse affects on public health living nearby areas (7-9). Deterioration of ground water quality due to percolation of leachate generated from landfill sites is predominantly observed in many developing countries like in India (10-13). It is reported that most of the landfills are unlined and without leachate collection system. The rate of deterioration of quality of ground water resources near the landfill sites is need of urgent regular monitoring measures in many cities and towns of the country (14). The susceptibility of an aquifer to pollution from landfill leachate is highly dependent on number of factors like location of dumping site, composition of waste dumped, toxicity of leachate, depth and flow of water table and type of landfill (15, 16). Ground water is the most common source of water supply in both urban and rural regions of developing countries and pollution of ground water is potential threat to environment and public health (14, 17).

The impact of leachate on ground water has been reported in many studies (18-20) with a common conclusion of presence of high level of organic and inorganic pollution due to percolation of leachate. A study conducted [15] reported high values of pH, nitrate and BOD in ground water sample collected from the vicinity area of Malang landfill. A research (21) conducted in metropolitan city of Delhi, reported high levels of trace elements like K⁺, Cl⁻ and NH₄⁺ Studies (22, 23) have investigated the leachate composition generated from dumping sites and related it with ground water quality of nearby areas. An improper solid waste management system and absence of properly designed solid waste disposal mechanisms, landfills with growing urbanization, industrialization and population explosion has led to environmental pollution. The contamination of ground water is a potential environmental problem and needs to be addressed. Hence, an efficient method has been carried out to monitor the ground water quality index around municipal solid waste landfill sites of Nizamabad city. The quality of the ground water has been studied.

The waste generated in Nizamabad is dumped in open dumping sites. Residential and agricultural land is located in the vicinity of the dumping sites of three selected regions of city with seasonal rivulets flowing nearby the dump sites. Although the Municipal Corporations of the city are providing water supply but around 30% residents are still using ground water supplies like bore wells for daily needs. Percolation of leachate from these open dumping sites poses threat to ground water sources so a study was planned to evaluate the effect of dumping sites on the ground water resources in the vicinity areas of dumping sites of Dharmaram, Nagaram, Nehru Nagar respectively. The study also reported the WQI, calculated over a period of two seasons (Dry & Wet) from all the three regions of study sites of Nizamabad city to cover major city topographically, for determining the impact of leachate percolation on the groundwater quality.

MATERIALS AND METHODS
Study area
Nizamabad city is the headquarters of the nizamabad district, Telangana State. It is located at the intersection of longitude of 18.672° N 78.094° E and spread over an area of about 40 Sq Km. To determine the possible ground water contamination due to percolation of leachate from selected solid waste land fill sites, the ground water samples were collected from the nearby selected land fill sites i.e Dharmaram, Nagara, Nehru nagar of Nizamabad city during dry and wet seasons of the monitoring campaign. The ground water samples were collected from
the bore well and other nearby submersibles close to the solid waste dumping sites at 5 different downstream locations (1Km, 2Km, 3Km, 4Km and 5Km) from the MSW dumping sites. Figure 3 (a), (b) (c) and (d) shows the aerial view of the studied areas with ground water sampling points. A total of 30 samples (n=5 for each site) were collected for the study purpose during entire two sampling periods (dry & wet) from three study sites of Nizamabad and 10 samples were used from alwal region of Hyderabad during entire two seasonal campaign. Separate analysis was carried out for the samples collected from different distances of study locations. The analysis of ground water samples were carried out as per the standard procedures.
Fig 3 (b) Aerial View of the Dharmaram study area with ground water sampling points.

Fig 3 (c) Aerial View of the Nehru Nagar study area with ground water sampling points.
ANALYTICAL METHODOLOGY
According to WHO organization, about 80% of all the diseases in human beings are caused by water. Once the groundwater is contaminated, its quality cannot be re-established easily and to devise ways and means to protect it. Groundwater Quality helps us understand the hydrogeologic system, flow dynamics and groundwater contamination Ground water samples were determined for physico-chemical parameters according to the standards APHA and BIS methods (29, 30). All the samples in the experimental work were analyzed for physico-chemical parameters like pH, electrical conductivity (EC), total dissolved solids (TDS), chemical oxygen demand (COD), biological oxygen demand (BOD), total alkalinity (TA), total hardness (TH), chloride (Cl\textsuperscript{-}), sulphate (SO\textsubscript{4}\textsuperscript{2-}), ammonium (NH\textsubscript{4}\textsuperscript{+}), fluoride (F\textsuperscript{-}), nitrate (NO\textsubscript{3}\textsuperscript{-}), sodium (Na\textsuperscript{+}) and potassium (K\textsuperscript{+}).

WATER QUALITY INDEX:
Water quality index (WQI) is a method of rating of existing water quality status in a single expression which is helpful for selection of treatment techniques (31). WQI provides information about the water quality in a single value. WQI utilizes the water quality data and helps in modification of the policies formulated by the environmental agencies (32). It represents the assessment of water quality through determination of physico-chemical and biological parameters of ground water (33). WQI was initially developed by Horton (34, 35) and after that concept has been modified by many scientists and researchers (34-37). A general approach for determination of WQI includes parameter selection wherein these parameters are selected based upon their impact on water quality. Once the parameters are fixed, determination of sub-indices of these parameters is quantified which are finally aggregated using an aggregate indexing method by means of different mathematical expressions (24, 37).

WATER QUALITY INDEX- BIS 10500:
Determination of WQI as based on the BIS 10500 standards was determined by assigning weights (w\textsubscript{i}) according to the relative importance of each chemical parameter for drinking purposes and has been summarized [12]. The parameters like chloride, nitrate, total solids, ammonical nitrogen, sulphate, fluorides and electrical conductivity has been assigned maximum Weightage of 5 because of their high significance in maintaining quality of ground water [61]. Other determined parameters like calcium, magnesium, total hardness and total alkalinity were assigned weight between 1 and 5 depending on their importance in water quality assessment. The relative weight (W\textsubscript{i}) is computed using following equation:

\[ W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \]

Where; W\textsubscript{i}= relative weight, w\textsubscript{i}= weight of each parameter, n= number of parameters. A quality index (q\textsubscript{i}) based on the parameters were computed by dividing the concentration of each sample by its respective standard as assigned by BIS 10500 and multiplying the result by 100:

\[ q_i = \frac{C_i}{S_i} \times 100 \]

Where; q\textsubscript{i}= quality rating based on concentration of the \textsubscript{i}th parameter C\textsubscript{i}= concentration of each parameter (mg/l), S\textsubscript{i}= Indian drinking water standard for computing WQI, SI is first determined for each parameter:

\[ SI = w_i \times q_i \]

Where; SI= sub-index of the \textsubscript{i}th parameter WQI is then determined using following equation:

\[ WQI = \sum SI \]
RESULTS AND DISCUSSIONS

The Physico-chemical characteristics of the groundwater samples collected from Dharmaram, Nagaram and Nerhu Nagar of Nizamabad and alwal region of Hyderabad are described in Table 2. Obtained results were also compared to the WHO and BIS standards for drinking water. The results of all the parameters are symbolized as S1 and S2 for Dharmaram, Nagaram, Nerhu Nagar and Alwal, Hyderabad for Dry and Wet seasons respectively.

PHYSICO-CHEMICAL PARAMETERS

Table 2 Physico-Chemical Characteristics of ground water at different downstream distances for two seasonal campaigns for three regions of Nizamabad city and Alwal, Hyderabad.

| Parameters | X-Dist. (Km) | Dharmaram | Nagaram | Nerhu Nagar | Alwal, Hyd. | WHO | BIS |
|------------|-------------|-----------|---------|-------------|-------------|-----|-----|
| Temperature (°C) | 1' | 27.3 | 23.6 | 29.5 | 24.1 | 26.8 | 23.8 | 27.8 | 22.4 | - | - |
| | 2' | 26.5 | 22.7 | 28.6 | 23.5 | 26.2 | 23.2 | 27.1 | 21.7 | - | - |
| | 3' | 24.8 | 21.5 | 28.1 | 22.7 | 25.4 | 22.6 | 26.5 | 21.1 | - | - |
| | 4' | 22.4 | 20.4 | 27.3 | 22.1 | 23.7 | 22.3 | 25.8 | 20.6 | - | - |
| | 5' | 21.7 | 20.1 | 26.9 | 21.3 | 22.8 | 21.7 | 25.1 | 20.3 | - | - |
| pH | 1' | 7.56 | 7.83 | 6.21 | 6.33 | 6.97 | 6.84 | 7.23 | 6.99 | 6.5-9.2 | 6.5-8.5 |
| | 2' | 7.54 | 7.81 | 6.43 | 6.52 | 7.24 | 7.11 | 7.52 | 7.06 | - | - |
| | 3' | 7.43 | 7.76 | 6.49 | 6.67 | 7.28 | 7.29 | 7.53 | 7.23 | - | - |
| | 4' | 7.51 | 7.79 | 6.85 | 6.94 | 7.19 | 7.18 | 7.08 | 7.29 | - | - |
| TDS (mg/L) | 1' | 752 | 875 | 1273 | 1391 | 879 | 913 | 736 | 779 | - | - |
| | 2' | 724 | 865 | 1239 | 1374 | 851 | 898 | 721 | 752 | - | - |
| | 3' | 708 | 832 | 1144 | 1339 | 833 | 886 | 704 | 741 | - | - |
| | 4' | 645 | 809 | 1123 | 1283 | 817 | 851 | 683 | 723 | 500 | 500 |
| | 5' | 621 | 756 | 1101 | 1251 | 794 | 823 | 668 | 711 | - | - |
| Ammonical Nitrogen (NH3-N) (mg/l) | 1' | 1.4 | 1.8 | 1.8 | 1.7 | 1.6 | 1.8 | 1.2 | 1.4 | - | 0.5 |
| | 2' | 0.8 | 1.3 | 1.1 | 1.3 | 1.2 | 1.4 | 0.5 | 0.7 | - | - |
| | 3' | 0.4 | 0.7 | 0.6 | 0.8 | 0.8 | 0.7 | 0.2 | 0.3 | - | - |
| | 4' | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.6 | 0.9 | 0.04 | - | - |
| | 5' | 0.08 | 0.1 | 0.04 | 0.03 | 0.05 | 0.12 | 0.01 | 0.02 | - | - |
| Phosphate (mg/l) | 1' | 0.07 | 0.09 | 0.6 | 0.8 | 0.06 | 0.08 | 0.03 | 0.05 | - | - |
| | 2' | 0.03 | 0.04 | 0.5 | 0.6 | 0.03 | 0.04 | 0.01 | 0.02 | - | - |
| | 3' | 0.02 | 0.03 | 0.3 | 0.4 | 0.01 | 0.02 | 0.0 | 0.0 | - | - |
| | 4' | 0.01 | 0.01 | 0.07 | 0.09 | 0.0 | 0.0 | 0.0 | 0.0 | - | - |
| | 5' | 0.0 | 0.0 | 0.04 | 0.06 | 0.0 | 0.0 | 0.0 | 0.0 | - | - |
| Turbidity (JTU) | 1' | 12 | 13 | 11 | 10 | 13 | 14 | 8 | 7 | - | 1 |
| | 2' | 10 | 12 | 9 | 8 | 11 | 12 | 6 | 6 | - | - |
| | 3' | 8 | 10 | 7 | 9 | 9 | 10 | 5 | 6 | - | - |
| | 4' | 6 | 7 | 5 | 6 | 8 | 10 | 2 | 4 | - | - |
| | 5' | 5 | 6 | 4 | 5 | 6 | 7 | 2 | 3 | - | - |
| Biochemical Oxygen Demand (BOD) (mg/l) | 1' | 125 | 158 | 247 | 342 | 128 | 149 | 132 | 158 | - | 5 |
| | 2' | 114 | 143 | 239 | 331 | 121 | 142 | 108 | 127 | - | - |
| | 3' | 107 | 133 | 211 | 312 | 115 | 134 | 93 | 113 | - | - |
| | 4' | 95 | 117 | 194 | 289 | 109 | 126 | 76 | 85 | - | - |
| | 5' | 92 | 107 | 183 | 281 | 94 | 114 | 64 | 72 | - | - |
| Sulphate (mg/l) | 1' | 125 | 158 | 78 | 92 | 127 | 158 | 169 | 189 | 200 | 200 |
| | 2' | 121 | 153 | 73 | 94 | 118 | 154 | 164 | 172 | - | - |
| | 3' | 117 | 154 | 71 | 97 | 114 | 152 | 162 | 176 | - | - |
| | 4' | 116 | 156 | 74 | 88 | 113 | 161 | 152 | 169 | - | - |
| | 5' | 123 | 151 | 81 | 84 | 119 | 158 | 157 | 167 | - | - |
| Sodium (mg/l) | 1' | 89 | 72 | 124 | 114 | 116 | 108 | 158 | 169 | - | - |
| | 2' | 73 | 54 | 117 | 103 | 104 | 92 | 149 | 164 | - | - |
| | 3' | 64 | 46 | 107 | 85 | 92 | 79 | 172 | 251 | - | - |
| | 4' | 53 | 41 | 85 | 71 | 83 | 64 | 186 | 214 | - | - |
Water Quality Index (WQI): WQI is one of the most effective tools to provide feedback on the quality of water to the policy makers and environmentalists by giving a single value. In the present study WQI determined on the BIS 10500 standards and values for all the three study sites of Nizamabad respectively were calculated using equation for standards for drinking water purposes as recommended by BIS 10500.

The values of WQI obtained using the methodology based on BIS 10500 have been summarized in Table 3 and the classification of water quality have been summarized in Table 4

| Dist. / Monitoring | Dharmaram (DRM) | Nagaram (NRM) | Nehru nagar (NN) | Alwal, Hyderabad |
|--------------------|-----------------|---------------|------------------|------------------|
|                    | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 |
| 1 km               | 117 | 132 | 123 | 136 | 121 | 128 | 97 | 102 |
| 2 km               | 105 | 109 | 113 | 108 | 104 | 110 | 91 | 96 |
| 3 km               | 85  | 89  | 92  | 96  | 82  | 86  | 69 | 72 |
| 4 km               | 47  | 56  | 52  | 63  | 49  | 48  | 41 | 48 |
| 5 km               | 112 | 127 | 174 | 189 | 108 | 137 | 80 | 105 |
| Avg.               | 79.4| 86 | 84.6| 90.4 | 79.4| 83 | 67.2| 72.2|
| Avg. of 2 seasons  | 82.7| 87.2| 81.2| 81.2 | 82.7| 87.2| 69.7| 69.7|

Table 3 WQI for Three sites of Nizamabad and alwal, Hyderabad as per BIS 10500
Table 4. Showing output result of Water quality index (WQI) at different distances of all the study regions.

| Dist. / Monitorin | Dharmaram (DRM) | Nagaram (NRM) | Nehru nagar (NN) | Alwal, Hyderabad | Average |
|------------------|-----------------|---------------|------------------|-----------------|---------|
|                  | S1 | S2 | S1 | S2 | S1 | S2 | S1 | S2 | DRM | NRM | NN | Alwal |
| 1 km             | U.D | U.D | U.D | U.D | U.D | U.D | Very Poor | U.D | U.D | U.D | U.D | Very Poor |
| 2 Km             | Very Poor | Very Poor | Very Poor | Very Poor | Very Poor | Poor | Very Poor | Very Poor | Very Poor | Very Poor | Very Poor |
| 3 Km             | Poor | Poor | Poor | Poor | Very Poor | Poor | Poor | Poor | Poor | Poor | Poor | Poor |
| 4 Km             | Good | Poor | Poor | Poor | Good | Good | Good | Poor | Good | Good | Good |
| 5 Km             | Good | Good | Good | Good | Good | Good | Good | Good | Good | Good | Good | Good |

U.D: Unsuitable for drinking

CONCLUSION AND DISCUSSION

It was observed from Table 4 that the ground water quality in almost all study sites of Nizamabad within a 2 km vicinity of the dumpsite experiences poor quality of ground water for drinking purpose, without any exception during entire seasonal monitoring campaign. Beyond 2km radius vicinity of any dumping site of Nizamabad that are located in Dharmaram, Nagaram and Nehru nagar experienced a good water quality value. The poor quality of groundwater in Dharmaram is primarily because having more dense small and medium scale industries. The primary reason behind poor water quality in Nagaram is might be due to high dense population and highest socio-economic status among all areas of Nizamabad city. That could be result in disposal of high amount solid waste into the environment. Lack of proper solid waste management systems could be considered as primary reasons for poor water quality on Nehru nagar. The cumulative average of all distance collection points of any of the study site lies under the category of good water quality, as shown in Table 3.

Seasonal variation showed that the overall dry seasonal water quality was superior to wet season due to increased chances of leachate percolation in to layers of soil associated with dumping sites which was resultant of high moisture content in the environment. So dry seasonal water quality index of all study sites including alwal region of Hyderabad was observed to be superior when compared to wet seasonal water quality index. One important note has been observed from the results that with increase in downstream distance, the quality of groundwater improved. Similarly, it was observed from that the overall quality of groundwater was classified as good for all study sites including the alwal region of Hyderabad. The WQI results revealed that the ground water samples from the nearby location to the dumping sites are affected due to leaching of ions from the leachate. We made an important observation from the results that relative water quality of alwal Hyderabad is good when compared to other threes study sites of Nizamabad. This observation could take a positive important note to understand implementation procedures towards sustainable development of various solid waste management practices for Nizamabad city.

ACKNOWLEDGMENTS

One of the authors (Vasavi Neeli) is grateful to staff members of the department of Telangana University for their continuous support during the period of study and also thankful for the constructive comments of the reviewers towards this article during its review process.

REFERENCES

[1] Sethi S, Kothiyal N.C., Nema A.K., Kaushik M.K., —Characterization Of Municipal Solid Waste In Jalandhar City, Punjab, Indial, J Hazard, Toxic Radioact Waste, Asce 17(2):97–106, 2013.
[2] Rana, R., Ganguly, R., Gupta, A.K. “Physico-Chemical Characterization Of Municipal Solid Waste From Tri-City Region Of Northern India- A Case Study,” The Journal Of Material Cycles And Waste Management, Doi 10.1007/S10163-017-0615-3, 2017.
[3] ASTM “Standard Test Method for Residual Moisture Of A Refuse Derived Fuel Analysis Sample”, E790, ASTM International, West Conshohocken, 2004a.
[4] ASTM “Standard Test Method for Ash In The Analysis Sample Of Refuse Derived Fuel”, E830, ASTM International, West Conshohocken, 2004b.
[5] ASTM “Standard Test Method for Determination Of Composition Of Unprocessed Municipal Solid Waste”, D5231-92, ASTM International, West Conshohocken, 2008.
[6] ASTM “Standard Test Method For Volatile Matter In The Analysis Sample Of Refuse Derived Fuel”, E897, ASTM International, West Conshohocken, 2004.
[7] Kalra N., Kumar R., Yadav S.S., Singh R.T., “Water Quality Index Assessment Of Ground Water In Kolwari Block Of Bhopur (Bihar), Journal Of Chemical And Pharmaceutical Research, 4(3), 1782-1786, 2012.
[8] Raman N., Narayanan Sathiya D., “Impact Of Solid Waste On Ground Water And Soil Quality Nearer To Pallavaram Solid Waste Landfill Site In Chennai. Rasayan J. Chem. Vol,1, No.4 (2008), 828-836, 2008.
[9] Ranjan R.K., Ramathan A.L., Parthasarthary P., Kumar A., “Hydro Chemical Characteristics Of Groundwater In The Plains Of Phaglu River In Gaya, Bihar, India.” Arabin Journal Of Geoscience 6:3257-3267.
[10] Ahsan A., Alamgir M., El-Sergany M.M., Shams S., M., Rowshon M.K., Nik Daud N.N.—Assessment Of Municipal Solid Waste Management System In A Developing Country”, Chinese Journal of Engineering 56:1935-11.
[11] Rafizul I.M., Alamgir M., Islam M.M., —Evaluation Of Contamination Potential Of Sanitary Landfill Lysimeter Using Leachate Pollution Index, Sardinia, Thirteenth International Waste Management And Landfill Symposium, Environmental Sanitary Engineering Centre, Italy, 2011.
[12] Rafizul I.M., Alamgir M., Kraft E., Haedrich G., “Monitoring Of Leachate Characteristics Of Sanitary Landfill Lysimeter Under Tropical Conditions,12nd International Conference On Solid Waste Management In Developing Asian Countries, 13-15, Waste Safe, Kuet, Bangladesh, 183-184, 2001b. 243
[13] Rafizul I.M., Alamgir M., Kraft E., Haedrich G., —Bio-Treatment Of Leachate Generated From Municipal Solid Waste In Sanitary Landfill Lysimeter,12nd International Conference On Solid Waste Management In Developing Asian Countries, 13-15, Waste Safe 2011, Kuet, Bangladesh, 191-193, 2011c.
[14] Singh S., Raju N.J., Nazeem S, “Environmental Risk Of Heavy Metal Pollution And Contamination Sources Using Multivariate
