Impact Analysis of leachate from a Solid Waste Dumpyard on Groundwater Quality

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Abstract - *Physicochemical analysis was carried out on 32groundwater samples around the municipal solid waste dumpyard, Ariyamangalam, Tiruchirappalli. The dump yard is at a distance of 12 km from the city and the current rate of dumping is around 400- 500 tons per day. The parameters such as TDS, Turbidity, Alkalinity, pH, Manganese, Ammonia, Nitrate , Nitrite, Total Hardness , Sodium, Potassium, Fluoride, Chloride, Sulphate, BOD and COD were tested using standard testing procedures according to IS 3025. The obtained values were compared with BIS 10500. The Water Quality Index (WQI) has been calculated using Arithmetic Weighing method and statistical analysis of the obtained data has been done.*

Key Words: Dumpyard, leachate, Statistical analysis, Physicochemical, Water quality index.

1. INTRODUCTION

Municipal solid waste (MSW), more commonly known as trash or garbage, consist of everyday items we use and then throw away. This comes from our homes, schools, hospitals and businesses (as defined by USEPA). MSW, without any treatment like segregation or cover, is dumped openly in many places in our country. In such places when this dumped waste comes in contact with moisture, (usually precipitation) tends to extract the organic and inorganic substances from the garbage and percolates into the soil, which is called as leachate. Leachate eventually reaches the water table and contaminates the quality of groundwater. These contaminants in groundwater can either be suspended or dissolved. Open dumpyards create unhygienic environment and foul smell which attracts scavenging animals species like rats, pigs , insects etc. This becomes a great threat to the environment. The work carried out and discussed in this paper deals with the sampling and analysis of groundwater which gives a fair good idea of how leachates from the dumpyard contaminates the groundwater sources.

2. GEOGRAPHY OF THE STUDY AREA

Trichy city has a population of 27 lakhs (approx.) and the density is 602 inhabitants per square kilometer. The minimum and the maximum temperature experienced in this chosen study area is 18.9^0 and 37.7^0 respectively. The location of the dumpyard is $10^0 48'0''$ N and $78^0 43'0''$E and has an elevation of 75.87m above MSL. The study area is situated 12 km away from the city on the Trichy-Tanjore highway. The soil type of the study area is mainly consisting of Alluvial soil. (Data source: Public Works Department , Tamil Nadu).

Fig -1: Study area map (3 km around the dumpyard- hotspot sampling region)

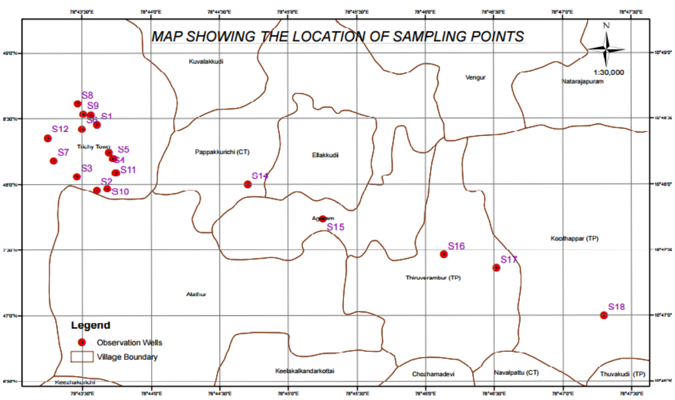

Fig -2: Map showing the hotspot sampling locations

2.1 Dumpyard details

The total surface area of the dumpyard is 47.7 acres and has been operated since 1967. Out of the total area 42 acres of land has been filled with garbage with an average height of filling as 16 feet. There are many small scale industries , boiler manufacturing units and a vegetable market (Gandhi market) which contributes to the various characters of waste in the dumpyard. The characterization of waste has been studies from previous works done. It shows the percentage of vegetable, paper, metal , debris , glass and textile in the garbage which reaches the dumpyard has been 64%, 9%, 2%, 5%, 1% and 10% respectively. Figure 3 shows the chart of waste characterization.

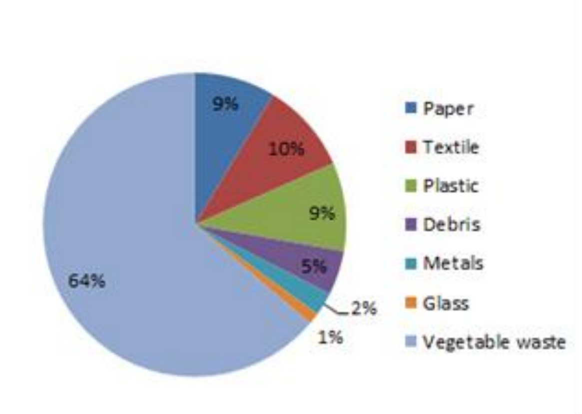

Chart -1: Characterization of waste from Ariyamangalam dumpyard.

3. MATERIALS AND METHODS

3.1 Sampling and Laboratory analysis

Random sampling of groundwater has been done from 32 locations and was labeled as S1 to S32. The locations were noted using the hand GPS - GARMIN *Etrex 30.* 18 hotspot samples were collected and tested to know the level of leachate contamination on groundwater and the control samples were tested to observe the decreasing trend of contamination as the distance from the dumpyard to the source increases.

3.2 Water Quality Index

Weighted Arithmetic method has been adopted to find the water quality index of the contaminated groundwater samples from 32 locations. The method of calculation is given below.

$$WQI= (\sum^{n}_{i=1} Q_iW_i) /(\sum^{n}_{i=10} W_i)$$

$$Q_i = \sum^{n}_{i=10} (M_i - I_i)/(S_i - I_i)$$

Mi=Laboratory estimated values of the ith parameter
Ii= Ideal value of the ith parameter
Si= Standard value of the ith parameter

Total hardness, Chloride, TDS, pH , Alkalinity, Magnesium, Calcium and Fluoride are considered as primary indicators of water quality. All the Ideal values (Ii) are taken as zero except for F=1 and pH=7.

Table -1: Classification of water quality based on WQI

Value of WQI	Water Quality
0-24	Excellent
25-50	Good
50-74	Poor
75-100	Very poor
>100	Unfit for drinking

3.3 Statistical Analysis

The correlation between the parameters has been found using XLStat and is been represented in the form of a matrix. It helps know how strength of association between the parameters.

4. RESULTS AND DISCUSSION

4.1 Water Quality Index

The water quality index of the 32 groundwater samples were calculated using Arithmetic Weighing method and it was found that 34.37% of the samples were of poor quality. 37.5% of samples were very poor in quality. 12.5% of the samples were good in quality and 6.25% were of excellent quality. 9.37% of samples were unfit for drinking. The chart showing the percentage of various quality of water based on the quality index.

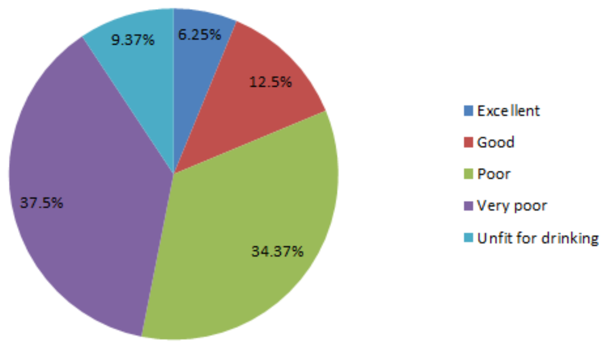

Chart -2: Percentages of different water qualities based on quality index

4.2 Correlation matrix

The correlation matrix has been obtained using XLStat for all the parameters chosen to be tested. Fig. 3 shows the matrix of correlation. From this the strongly correlated parameters can be found on the basis of the correlation value. A value above 0.6 is taken as strong correlation

	Turbidity	TDS	EC	PH	Alkalinity	tal hardne	Calcium	Magnesium	Sodium	Potassium	Iron	Ammonia	Nitrite	Nitrate	Chloride	Fluoride	Sulphate	Phosphate	BOD
Turbidity	1																		
TDS	-0.05731	1																	
EC	-0.05186	0.999709	1																
PH	0.028592	-0.53659	-0.53542	1															
Alkalinity	0.103987	0.570084	0.572443	-0.06688	1														
Total hard	-0.05952	0.987119	0.98641	-0.54441	0.460661	1													
Calcium	-0.06627	0.983574	0.982374	-0.53787	0.444301	0.998962	1												
Magnesiu	-0.07768	0.974057	0.972694	-0.5177	0.417831	0.99599	0.997171	1											
Sodium	-0.10571	0.906353	0.910798	-0.5756	0.499348	0.874903	0.874645	0.852306	1										
Potassiun	-0.03521	0.862895	0.868299	-0.53629	0.509051	0.823416	0.821213	0.80202	0.947042	1									
Iron	0.962461	-0.07355	-0.06956	0.055807	0.124345	-0.09452	-0.10239	-0.11356	-0.13318	-0.05309	1								
Ammonia	0.480319	0.074024	0.071987	0.016221	0.013747	0.03973	0.045944	0.037644	0.067651	0.148894	0.667159	1							
Nitrite	-0.25732	0.197179	0.195102	-0.10755	0.410307	0.154183	0.146466	0.1484	0.202857	0.010568	-0.20417	-0.16745	1						
Nitrate	-0.29372	-0.2462	-0.24228	0.024619	-0.65148	-0.14568	-0.1397	-0.11667	-0.20257	-0.1988	-0.34921	-0.21823	-0.30864	1					
Chloride	-0.07014	0.993219	0.991785	-0.57405	0.514933	0.987859	0.983385	0.97562	0.884283	0.833856	-0.08684	0.056076	0.176968	-0.22258	1				
Fluoride	-0.15266	-0.31646	-0.31731	-0.17045	-0.67087	-0.22687	-0.23199	-0.19427	-0.32622	-0.33645	-0.1709	-0.20432	-0.16251	0.610966	-0.2355	1			
Sulphate	0.056736	0.616988	0.61778	-0.26505	0.350075	0.559846	0.554642	0.546952	0.557745	0.583771	0.198119	0.552127	0.128166	-0.36326	0.600754	-0.37038	1		
Phosphat	-0.17541	-0.28376	-0.28582	0.239354	-0.54322	-0.2193	-0.22131	-0.17969	-0.32632	-0.29565	-0.14876	-0.06283	-0.24487	0.446803	-0.21517	0.748592	-0.22892	1	
BOD	0.482998	0.205392	0.208181	-0.2731	0.015664	0.172757	0.172837	0.150996	0.278881	0.311578	0.634736	0.9053	-0.07223	-0.11476	0.191566	-0.12608	0.581729	-0.13945	1
COD	0.448995	0.168191	0.170242	-0.26941	-0.10992	0.152122	0.155977	0.135922	0.256486	0.285418	0.587098	0.891455	-0.15947	-0.01271	0.16063	-0.06791	0.524981	-0.0871	0.986098

Fig-3: Correlation matrix of the tested parameters

From the values obtained from the correlation matrix, the strongly correlated parameters has been found and has been represented in the form of a table. Table. 2 shows the strongly correlated parameters in the chosen area of work. From this it is evident that the contaminations of these parameters are from the same source.

Table - 2 : Strongly correlated parameters

Parameter	To which it is strongly correlated
TDS	EC, Hardness, Calcium, Magnesium, Potassium
Iron	Turbidity
EC	Calcium, Magnesium, Chloride
Chloride	Total Hardness, Calcium, Magnesium, Sodium, Potassium

5. REMEDIATION AND CONCLUSION

From the work done, it is evident that the water quality of groundwater has been adversely affected due to the leachate from the Ariyamangalam dumpyard. It is high time to take measures to reduce the further contamination of groundwater. Increase in population and the changing lifestyle of people will eventually lead to more generation of waste in the years to come. Source segregation which is the main attribute in solid waste management should be done at the earliest stages of waste generation. Construction of an engineered landfill with gas collection and leachate collection facilities can be done as a best remedy for the existing problem. Geosynthetic clay liners (GCL) can also be adopted to decrease the rate of seepage of leachate into the soil to reach the water table. This can protect the groundwater from the contaminants. If immediate remediations are not taken, it shall completely degrade the groundwater sources around the area of the dumpyard.

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REFERENCES

[1] Abu-Rukah, Y., & Al-Kofahi, O. (2001). The assessment of the effect of landfill leachate on ground-water quality—a case study. El-Akader landfill site—north Jordan. Journal of Arid Environments, 49(3), 615-630.

[2] Aderemi, A. O., Oriaku, A. V., Adewumi, G. A., & Otitoloju, A. A. (2011). Assessment of groundwater contamination by leachate near a municipal solid waste landfill. African Journal of Environmental Science and Technology, 5(11), 933-940.

[3] Adeyemi, O., Oloyede, O. B., & Oladiji, A. T. (2007). Physicochemical and microbial characteristics of leachate-contaminated groundwater. Asian J. Biochem, 2(5), 343-348.

[4] 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, 2(1), 81-89.

[5] IS 3025:1985 Methods of sampling and testing.

[6] Kanmani, S., & Gandhimathi, R. (2013). Investigation of physicochemical characteristics and heavy metal distribution profile in groundwater system around the open dump site. Applied Water Science, 3(2), 387-399.

[7] Kanmani, S., & Gandhimathi, R. (2013). Assessment of heavy metal contamination in soil due to leachate migration from an open dumping site. Applied Water Science, 3(1), 193-205.

[8] El-Salam, M. M. A., & Abu-Zuid, G. I. (2014). Impact of landfill leachate on the groundwater quality: A case study in Egypt. Journal of Advanced Research, 6, 579- 586

[9] Nagarajan, R., Thirumalaisamy, S., & Lakshumanan, E. (2012). Impact of leachate on groundwater pollution due to non-engineered municipal solid waste landfill sites of erode city, Tamil Nadu, India. Iranian journal of environmental health science & engineering, 9(1), 1-12.

[10] VV, S. C., Venkateswararao, B., & Raju, P. M. (2013). Physicochemical and microbial analysis of ground water near municipal dump site for quality evaluation. International Journal of Bioassays,2(08), 1139-1144.

[11] S.Shenbagarani.(2013). Analysis of Groundwater Quality near the Solid Waste Dumping Site. Journal Of Environmental Science, Toxicology And Food Technology,4(2), 2319- 2399.