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Assessment of Impact of Leachate on Groundwater Pollution Due to Municipal Solid Waste Landfill Site

Surbhi Sharma*, B.R. Yadav, Dwarika Nath Ratha
Thapar Institute of Engineering &Technology, Patiala, Punjab, India
Corresponding author: Surbhi Sharma

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ABSTRACT: In the recent years, due to the rapid increase in industrialization and population, the waste generated due to both industries and household has escalated in an uncontrolled fashion. In developing countries like India, the municipal solid waste management is majorly done using conventional methods like landfills and abandoning the waste at dumpsites. These landfills and dumpsites have become a major threat to groundwater quality. In this paper, the impact of leachate generated due to Municipal Solid Waste (MSW) landfill site on groundwater quality is assessed. The main aim of the study is to calculate the amount of harmful components in groundwater and to check the effect of leachate on the quality of groundwater. For this task, samples of groundwater were collected from various locations of the city. The leachate samples were produced in the lab from the garbage collected from different locations and using the artificial rainfall machine. Different physio-chemical parameters are calculated from these samples like pH, total dissolved solids (TDS), total hardness (TH), Magnesium Hardness, Calcium Hardness, turbidity, alkalinity are calculated. The Pearson correlation coefficients are calculated for this task. Statistical parameters like average, minimum, maximum and standard deviation are also calculated.

I. INTRODUCTION

Water is a crucial resource on earth for life of both flora and fauna. Currently, the world is facing
a huge problem of water pollution. Water pollution happens when toxic materials get mixed in groundwater or other water bodies like the ocean, lake, river, etc. Nearly 80% of the wastewater produced currently in the world goes untreated into the environment. This results in the contamination of water. Only 1% of clean water is accessible to humans and the demand is increasing day by day. It is expected that by 2050, the demand for clean water will rise by one-third of its present value [1-2].

Water pollution can be caused by one of the following many ways [3]:

- Citysewage discharge
- Industrial waste
- Contaminants entering the water supply from soils
- Contamination from the atmosphere via rain
- Contamination due to residues of agriculture (fertilizers and chemicals)
- Contamination due to leachate created in landfills.

Advancements in MSW management began to develop in the late 19th century. In the US,
sturdier vehicles were employed for the collection and transportation of wastes from garbage cans. The first refuse incinerator was developed and installed in England in 1874. The use of solid waste grinders, compaction vehicles, and collection systems has revolutionized the MSW management [4-6]. Studies have proven that duping of solid waste and improper incineration causeshealth problems and affects the environment. Therefore, the concept of sanitary landfills cameinto existence. Sanitary landfill (also known as controlled tipping) is a method of solid wastedisposal in which waste is deposited in thin layers of 1 meter to 3 feet and compressed usingbulldozers. Using this technique, a total of up to 3 meters, or 10 feet, a thick layer of solid wastecalled refuse cell is constructed. Finally, the refused cell is covered with a layer of soil to preventodor. The landfill is capped with clay or a synthetic liner to stop water from being mixed withthe solid waste [7-10].
Different methods are used for solid waste disposal and management which are as follows [7]:

- Burning of solid waste in open air
- Throwing away waste into the sea water
- Landfills
- Composting

In many developed countries, the MSW is divided into hazardous and nonhazardous waste

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and
then treated separately. A lot of emphases are given on recycling and waste reduction practices. Even then, however, most of the countries like India are still using open dumping on land or in water [11].

Solid wastes are usually processed by using landfills and dumpsites because it is an inexpensive
and simple technique. Leachate is defined as “liquid that takes in substances from the material through which it passes, often making the liquid harmful or poisonous”.As the leachate is produced by landfills, therefore landfills raise serious issuesabout the health of living organisms of all types around them. Landfills also affect the soil whichintern affects the agriculture process. Therefore, the study of effect of leachate on groundwaterquality becomes a major concern [12-13].

II. STUDY AREA

The landfill location under study is situated in the city of Patiala in Punjab state of India. Patiala
is a well-known city of Punjab which has a rich history of ostentatious rulers. This resulted in a very ironic inheritance of art and architecture. With the establishment of Qila Mubarak in 1763, the city of Patiala prospered with time. Fig. 1 shows the relative location of Patiala in Punjab, India [14].

Patiala is situated in the south-eastern side of Punjab with 29°49’ and 30°47’ as its latitude and 75°58’ and 76°54’ as the east longitude encircled by districts of Rupnagar&Fatehgarh Sahib (Punjab); Chandigarh in north, Ambala, Kurukshetra (Haryana) in east and Kaithal district (Haryana) in south and district Sangrur (Punjab) in west. The total area of the district is 4,63,426 hectare. The district of Patiala is further divided into six tehsils, two sub-tehsils and eight blocks.

As the dumpsites were not furnished with any leachate collection systems, leachate was collecting from the base of dumpsites. Three different samples were taken from each site. The samples for microbiological analysis were taken in 50ml sterile universal containers. The samples were collected from 24 locations i.e. 1. Rangesha Colony, 2. ChotiRaymajra, 3. Choura Road, 4. MSW Site, 5. New Officer Colony, 6. Mohindera Complex, 7. Ghalori Gate, 8. KesarBagh, 9. NIS Chok , 10. Lower Mall, 11. New LalBagh, 12. Devigarh Road, 13. BadiRaymajra, 14. TejBagh Colony, 15. Mohindera Colony, 16. Urban Estate Nagar, 17. SST Nagar, 18. Old Bishan Nagar, 19. Vikas Colony, 20. Abchal Nagar, 21. Udham Nagar, 22. Ghuman Nagar, 23. Ranjeet Nagar, 24. Kartar Colony.

III. MATERIALS AND METHODS

3.1 TDS calculation using TDS meter

Conductometry is related to the conductivity of electrolytes. In general, conductivity is the capability of a material to pass an electric current. The resistance of a solution is measured by applying voltage to the measuring cell [15].

3.2 Electrical conductivity calculation using Conductometery

The electrical conductivity also known as specific conductance is a measure to calculate the quality of water. Conductometery is used to calculate Electrical conductivity of a solution. In this paper, electrical conductivity is measured using a conductivity meter. Fig. 1 shows the conductivity meter used in the study [16].

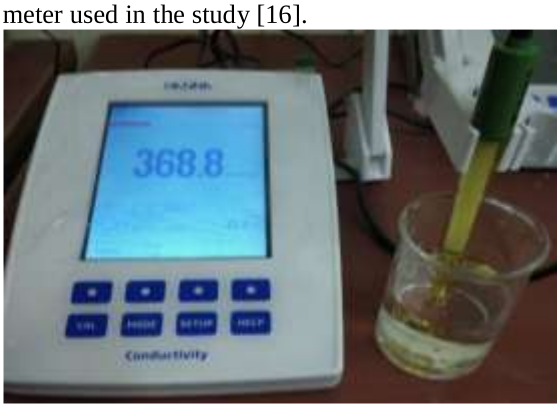

Fig. 1 conductivity meter used in the study.

IV. RESULTS AND DISCUSSION

Fig. 2-5 shows the plots of different water quality parameters calculated from different locations at different time spans for contaminated underground water. These results show that some variables remain almost constant throughout while others vary drastically with the change in location. It can be observed from Fig. 2 that the values of pH vary between the ranges 6.9 to 8. The average pH value is 7.5. The graph of pH is very smooth and show very less variations. This can also be visualized from the standard deviation of pH which is calculated to be 0.23. The graph of TDS v/s location is shown in Fig. 2. It shows a lot of fluctuations. The average value of TDS is found to be 880.1 whereas the maximum value is 1656 and minimum value is 324.4.

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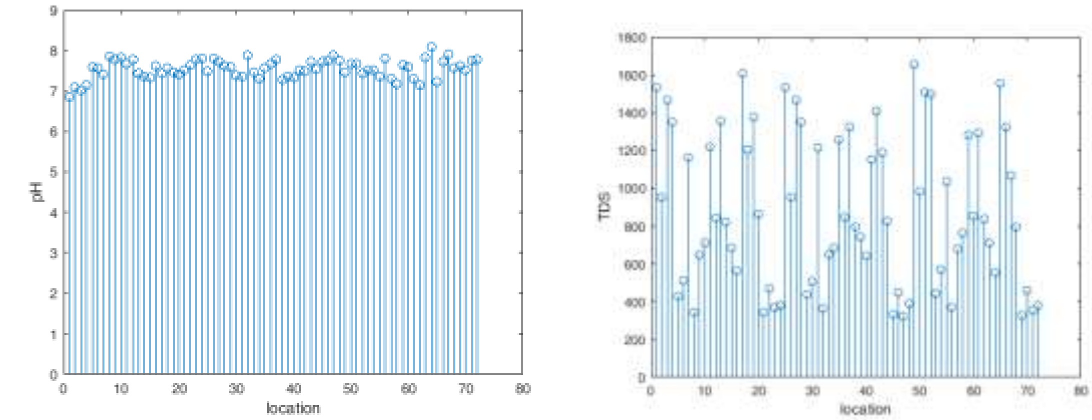
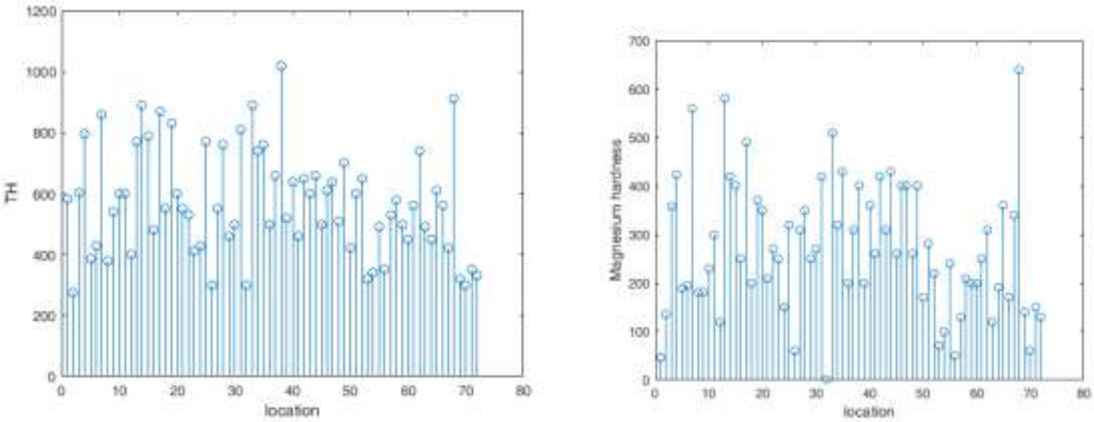


(a) (b)

Fig. **2**: Plot of (a) pH v/s location and (b) TDS v/s location



(a) (b)

Fig. 3: Plot of (a) TH v/s location and (b) Magnesium Hardness v/s location

As in the case of Fig. 2, similar observations can be made in Fig. 3. Fig. 3 (a) shows the results of TH v/s location while the results of Magnesium Hardness v/s location are given in Fig. 3 (b). For TH, the average value is 568.5 whereas; the average for Magnesium hardness is 269.9. The standard deviations for TH and Magnesium hardness are 134.5 and 94.4 respectively.

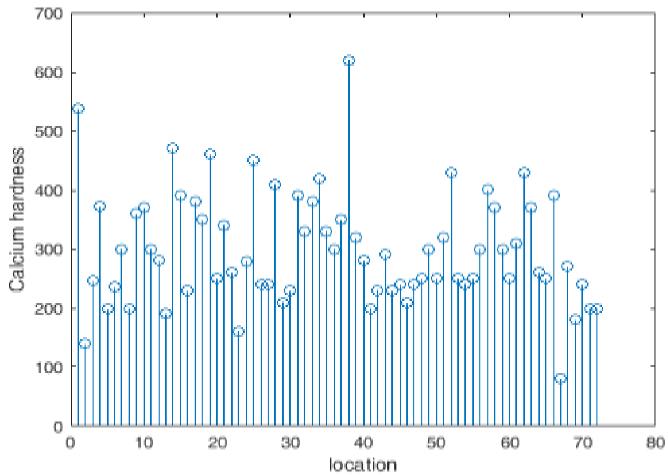


Fig. 5.4: Plot of Calcium hardness v/s location

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Fig. 4 shows the plot of Calcium hardness v/s location which shows 299.0, 80, 620 and 94.5 as the average, minimum, maximum and standard deviation values. It is important to note here that both TH and Magnesium Hardness show high standard deviations of 173.9 and 134.5. This shows that the values of TH and Magnesium Hardness vary rapidly from one location to other.

Table 1 shows the correlation coefficients of different parameters calculated from tests. The correlation coefficient matrix given in Table 1 gives the values of correlation coefficients. An interesting observation from Table 1 is that all the diagonal values are unity.

Table 1: correlation coefficients of data for contaminated underground water

	Ph	TDS	TH	Mg Hardness	CaHardness	turbidity	Alkalinity	Sulphate	Chloride	conductivity	salinity	resistivity	Ca^{2+}	Mg^{2+}
pH	1	-0.4	-0.2	-0.4	0.3	-0.3	-0.3	-0.3	-0.4	-0.4	0.4	-0.4	-0.2	1
TDS	-0.4	1	0.8	0.6	-0.1	0.3	0.3	0.5	0.5	0.5	-0.5	0.6	0.8	-0.4
TH	-0.2	0.8	1	0.1	-0.1	0.3	0.2	0.4	0.4	0.4	-0.4	0.1	1	-0.2
Mg Hardness	-0.4	0.6	0.1	1	-0.1	0.2	0.2	0.3	0.3	0.3	-0.4	1	0.1	-0.4
CaHardness	0.3	-0.1	-0.1	-0.1	1	0	0	0	0	0	0	-0.1	-0.1	0.3
Turbidity	-0.3	0.3	0.3	0.2	0	1	0.3	0.3	0.5	0.5	-0.4	0.2	0.3	-0.3
Alkalinity	-0.3	0.3	0.2	0.2	0	0.3	1	0.8	0.9	0.9	-0.8	0.2	0.2	-0.3
Sulphate	-0.3	0.5	0.4	0.3	0	0.3	0.8	1	0.9	0.9	-0.8	0.3	0.4	-0.3
Chloride	-0.4	0.5	0.4	0.3	0	0.5	0.9	0.9	1	1	-0.9	0.3	0.4	-0.4
Conductivity	-0.4	0.5	0.4	0.3	0	0.5	0.9	0.9	1	1	-0.9	0.3	0.4	-0.4
salinity	0.4	-0.5	-0.4	-0.4	0	-0.4	-0.8	-0.8	-0.9	-0.9	1	-0.4	-0.4	0.4
resistivity	-0.4	0.6	0.1	1	-0.1	0.2	0.2	0.3	0.3	0.3	-0.4	1	0.1	-0.4
Ca^{2+}	-0.2	0.8	1	0.1	-0.1	0.3	0.2	0.4	0.4	0.4	-0.4	0.1	1	-0.2
mg^{2+}	1	-0.4	-0.2	-0.4	0.3	-0.3	-0.3	-0.3	-0.4	-0.4	0.4	-0.4	-0.2	1

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V. CONCLUSION

This paper studies the impact of groundwater contamination due to leachate generated from MSW. From the results obtained in this study, the following conclusions can be drawn:

- When compared with the clean water samples, the values of parameters calculated from leachate data are found to be very deviating. This shows that the extent of contamination present in the leachate water.
- PH shows highest negative correlation with the turbidity (-0.4) which is a low negative correlation.
- TDS shows highest correlation with both chloride and conductivity (0.9).
- TH shows high correlation with all parameters apart from turbidity and pH.
- Standard deviation in results of PH is minimum i.e. 0.4 and highest in conductivity (1051.1).

REFERENCES:

[1]. MAHLER, R.L., PORTER, E., TAYLOR, R., 1988. Quality Of Water For Idaho, Mcgraw Hill, New York, Pg. 17-20

[2]. CHRISTENSEN, T.H., KJELDSEN, P., ALBRECHTSEN, H.J.R., HERON, G., NIELSEN, P.H., BJERG, P.L., HOLM, P.E., 1994. Attenuation Of Landfill Leachate Pollutants In Aquifers. Critical Reviews In Environmental Science And Technology, 24(2): 119-202.

[3]. Kjeldsen, P., Barlaz, M. A., Rooker, A. P., Baun, A., Ledin, A., & Christensen, T. H. (2002). Present And Long-Term Composition Of MSW Landfill Leachate: A Review. Critical Reviews In Environmental Science And Technology, 32(4), 297-336.

[4]. AFOLAYAN, O., OGUNDELE, F., ODEWUMI, S., 2012. Spatial Variation In Landfills Leachate Solution In Urbanized Area Of Lagos State, Nigeria. American International
Journal Of Contemporary Research, 2(8): 178-184.

[5]. OHWOGHERE–ASUMA, O., AWETO, K., 2013. Leachate Characterization And Assessment Of Groundwater And Surface Water Qualities Near Municipal Solid Waste Dumpsite In Effurun, Delta State, Nigeria. Journal Of Environment And Earth Science, 3(9): 126-134

[6]. LONGE, E., BALOGUN, M., 2010. Groundwater Quality Assessment Near A Municipal
Landfill, Lagos, Nigeria. Research Journal Of Applied Sciences, Engineering And Technology, 2(1): 39-44.

[7]. LEE, G.F, JONES, R.A., 1993. Groundwater Pollution By Municipal Landfills: Leachate Composition, Detection And Water Quality Significance, Proc. Sardinia, Pg 1093-1103.

[8]. Taylor, R., And A. Allen. "Waste Disposal And Landfill: Information Needs." IWA, 2006.

[9]. MASON, W.R, 2015. Pollution Of Groundwater. Available At <Http://Www.Waterencyclopedia.Com/Oc-Po/Pollution-Of-Groundwater.Html> Accessed On 22 September 2015

[10]. LEE, G.F, JONES, R.A., 1993. Groundwater Pollution By Municipal Landfills: Leachate

[11]. Composition, Detection And Water Quality Significance, Proc. Sardinia, Pg 1093-1103.

[12]. AL-SABAHI, E., RAHIM, S.A., WAN ZUHAIRI, W., AL-NOZAILY, F., ALSHAEBI, F., 2009. The Characteristics Of Leachate And Groundwater Pollution At Municipal Solid Waste Landfill Of Ibb City, Yemen. American Journal Of Environmental Sciences, 5(3): 256-266.

[13]. VASANTHI, P., KALIAPPAN, S., SRINIVASARAGHAVAN, R., 2008. Impact Of Poor Solid Waste Management On Ground Water. Environmental Monitoring And Assessment, 143(1-3): 227-238

[14]. TILAHUN, K., MERKEL, B.J., 2010. Assessment Of Groundwater Vulnerability To Pollution In Dire Dawa, Ethiopia Using DRASTIC. Environmental Earth Sciences 59(7):1485-1496

[15]. WATKINS, D., MCKINNEY, D., MAIDMENT, D., LIN, M.D., 1996. Use Of Geographic Information Systems In Groundwater Flow Modeling. Journal Of Water Resources Planning And Management, 122(2): 88-96.

[16]. ALLER, L., LEHR, J.H., PETTY, R., BENNETT, T., 1987. Drastic: A Standardized System To Evaluate Ground Water Pollution Potential Using Hydrogeologic Settings. National Water Well Association,Ohio. Pg 39 – 57