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ASSESSING LEACHATE POLLUTION INDEX AND ITS VARIABILITY ACROSS VARIOUS SEASONS– A CASE OF OKHLA LANDFILL SITE

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Abstract: Open dumps are becoming the final resting place for a diverse mixture of liquid and solid waste from residential, industrial, and commercial sources, and thus, possessing the potential to produce leachate—a liquid waste product that consists of a mixture of chemicals as precipitation or due to application of water/rain upon the open dump. This leachate has the potential to leach slowly into soil, groundwater or surface water causing immense pollution. The leachate pollution index (LPI) value of Okhla landfill site indicated that the waste deposited is contaminated since all values calculated during all the three season *viz*. pre-monsoon, monsoon, post-monsoon exceeded the standards.

Keywords: Leachate; LPI; Okhla Landfill site; Pollution.

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INTRODUCTION

The major contamination threat to water body's resources throughout the world is generally open dumpsites mistaken for sanitary landfills. From the landfill sites, the leachate, a contaminated liquid, varying in composition and characteristics seeps out and percolates through the underlying soils, contaminating the groundwater resources. This leachate consists of inorganic and organic compounds as well as suspended particles. Based on the climatic conditions the leachate flow drastically increases (during rainy season) or reduces (during dry season). The organic matter present in the MSW undergoes degradation mainly due to the physical, chemical and biological processes contribute to the damage to the liners leading to leakage of the leachate to the soil and ultimately to the water bodies (Naveen *et al*, 2014). The generated leachate from a landfill may tend to migrate in surrounding soil and may lead to contamination of soil and water bodies. Once groundwater is contaminated it is very difficult or if not possible to treat. As the leachates from the landfill sites degrade the quality of the water sources, the use of these resources is discontinued particularly the shallow wells as appropriate technologies and practices have not been adopted properly and well in time. Therefore, identification of the landfills which need urgent attention should be made by assessing them with respect to their potential effects due to leachate hazards (Naveen *et al*, 2015). Delhi is a massive metropolitan area in the northern India and these 3 landfill sites are located at different places *i.e.* Gazipur, Okhla and Bhalswa landfill sites located in East Delhi, South Delhi and North Delhi, respectively. The climate of Delhi is extreme and average rainfall is about 500 mm which is about half the national average. The city has a population of around 27 million, second most crowded city after Mumbai and third biggest urban range on the planet. Delhi city generates about 10,500 metric tons of solid waste per day out of which 60% is disposed-off in the landfill. The main waste generated in Delhi is from the markets, retail and commercial markets, hospitals, slaughter houses, industries and construction and demolition wastes. The potential hazards of the leachate can be estimated by an index known as Leachate Pollution Index (LPI). Thus the purpose of this study was for evaluation of the leachate pollution index for Okhla landfill site for three seasons (pre-monsoon, monsoon and post-monsoon).

EXPERIMENTAL

Leachate Pollution Index (LPI) is a simple tool for assessing the potential hazards of the leachate from the landfill sites. In an effort to develop a method for comparing the leachate pollution potential of various landfill sites in a given geographical area, an index known as LPI was formulated by Rand Corporation using Delphi Technique. The formulation process and complete description on the development of the Leachate Pollution Index, has been discussed elsewhere (Kumar and Alappat, 2003). The LPI represents the level of leachate contamination potential of a given landfill. It is a single number ranging from 5 to 100 (like a grade) that expresses the overall leachate contamination potential of a landfill based on several leachate pollution parameters at a given time. It is an increasing scale index, wherein a higher value indicates a poor environmental condition (Kumar and Alappat, 2003).

Variable Selection: Nine leachate pollutant variables were selected for inclusion in LPI. They are pH, total dissolved solids (TDS), biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), lead, chromium, chlorides, iron and nitrogen.

Variable Weights: The weights for these nine parameters were calculated based on the significance levels of the individual pollutants. The weight factor indicates the importance of each pollutant variable to the overall leachate pollution. For example, the weight factor for chromium is 0.064, and so it is most important variable than the other pollutant variables, while total iron with a weight factor of 0.045 is least important variable as compared to other pollutant variables included in LPI (Kumar and Alappat, 2003). The weights for other pollutant variables are TDS: 0.050; BOD_5: 0.061; COD: 0.062; Lead: 0.063; Chlorides: 0.049).

Variable Curves: The averaged sub index curves for each parameter were drawn to establish a relation between the leachate pollution and strength or concentration of the parameter.

Variable Aggregation: The weighted sum linear aggregation function was used to sum up the behavior of all the leachate pollutant variables. LPI can be calculated by the equation:

$$\mathbf{LPI} = \frac{\sum_{i=1}^{m} wipi}{\sum wi} \qquad \text{i}$$

LPI =weighted additive leachate pollution index,
Wi = weight for i^{th} pollutant variable
Pi =subindex value of i^{th} leachate pollutant variable
n = number of leachate pollutant variables

Leachate pollution index was calculated for three seasons (pre-monsoon, monsoon and post-monsoon) to determine the contamination level of the collected leachate samples. For this estimation, leachate samples were collected from the Okhla landfill site. Table 1 describes the levels of various parameters in the leachate collected during the pre-monsoon season. Leachate Pollution Index was calculated using the eq. i (Kumar and Allapat, 2004). The value of LPI (pre-monsoon) was 27.01. Table 2 describes the levels of various parameters in the leachate collected during the monsoon season. Leachate pollution index was calculated using the formula given by Kumar and Allapat, 2004. The value of LPI (monsoon) is 23.8. Table 3 describes the levels of various parameters in the leachate collected during the post-monsoon season. Leachate pollution index was calculated using the formula given by Kumar and Allapat, 2004. The value of LPI (post-monsoon) is 43.13. Table 4 defines the level of various parameters in the treated leachate (as per the standards mentioned in the solid waste management rules, 2016) and was calculated using the formula by Kumar and Allapat, 2004. The value of LPI is 6.80. Figure 1 describes the comparison between the LPI of the three seasons (pre-monsoon, monsoon and post-monsoon).

Table 1. Parameters in the Leachate collected during Pre-monsoon season

S. No.	Parameter	Value	Unit	Wi	Pi	PiWi
1.	pH	8.3	NA	0.055	5	0.275
2.	TDS	2.2	mg/L	0.05	5	0.25
3.	BOD	119	mg/L	0.061	10	0.61
4.	COD	4000	mg/L	0.062	60	3.72
5.	Nitrogen	1400	mg/L	0.051	100	5.1
6.	Iron	3.76	mg/L	0.044	5	0.22
7.	Chromium	0.234	mg/L	0.064	5	0.32
8.	Lead	0.256	mg/L	0.063	5	0.315
9.	Chloride	2600	mg/L	0.048	55	2.64
Total						27.01

Table 2. Parameters in the Leachate collected during Monsoon season

S. No.	Parameter	Value	Unit	Wi	Pi	PiWi
1.	pH	6.8	NA	0.055	5	0.275
2.	TDS	17680	mg/L	0.05	40	2
3.	BOD	1450	mg/L	0.061	30	1.83
4.	COD	1192	mg/L	0.062	35	2.17
5.	Nitrogen	500	mg/L	0.051	55	2.805
6.	Iron	2.4	mg/L	0.044	5	0.22
7.	Chromium	0.021	mg/L	0.064	5	0.32
8.	Lead	0.002	mg/L	0.063	5	0.315
9.	Chloride	4930	mg/L	0.048	40	1.92
Total						23.8

Table 3. Parameters in the Leachate collected during the Post-monsoon season

S. No.	Parameter	Value	Unit	Wi	Pi	PiWi
1.	pH	8.3	NA	0.055	5	0.275
2.	TDS	67000	mg/L	0.05	100	5.00
3.	BOD	43550	mg/L	0.061	75	4.575
4.	COD	600	mg/L	0.062	10	0.62
5.	Nitrogen	2630	mg/L	0.051	100	5.1
6.	Iron	13000	mg/L	0.044	100	4.4
7.	Chromium	0.032	mg/L	0.064	10	0.64
8.	Lead	1.5	mg/L	0.063	10	0.63
9.	Chloride	0	mg/L	0.048	5	0.24
Total						43.13

Table 4. Parameters in the treated leachate (as per the standards mentioned in the solid waste management Rules, 2016)

S.No.	Parameter	Value	Unit	Wi	Pi	PiWi
1.	pH	7.25	NA	0.055	5	0.275
2.	TDS	1000	mg/L	0.05	5	0.5
3.	BOD	30	mg/L	0.061	5	0.305
4.	COD	250	mg/L	0.062	10	0.62
5.	Nitrogen	50	mg/L	0.051	5	0.255
6.	Iron	ND	mg/L	-	-	0
7.	Chromium	2	mg/L	0.064	10	0.64
8.	Lead	0.1	mg/L	0.063	5	0.315
9.	Chloride	1000	mg/L	0.048	10	0.48
Total						**6.80**

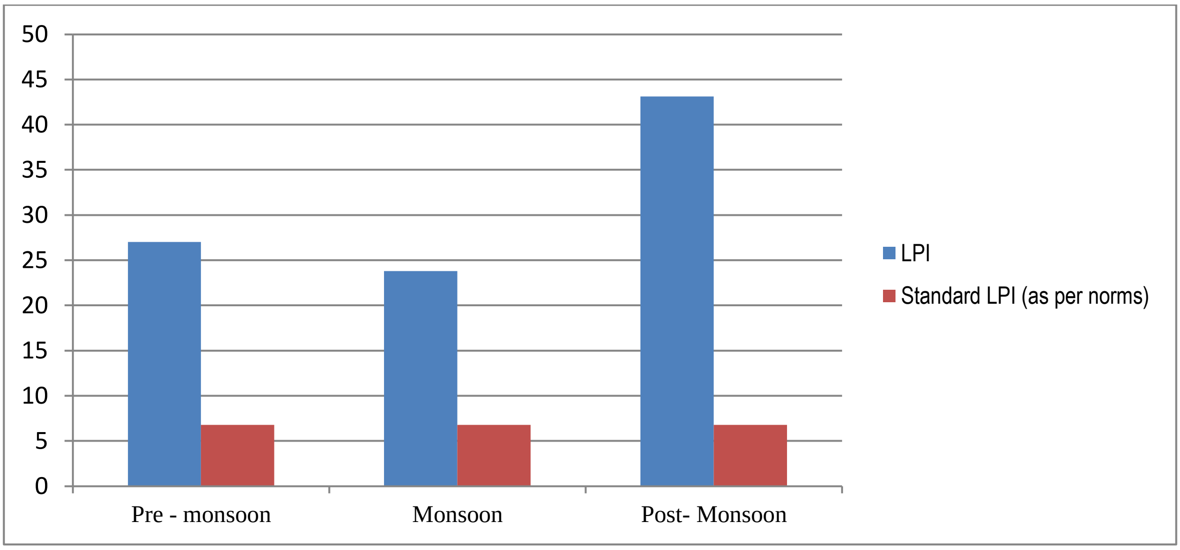

Figure 1. Leachate Pollution Index

CONCLUSION

Okhla landfill leachate sample collected during the post-monsoon season has the highest LPI value followed by the one collected in monsoon season and pre-monsoon. However when these values are compared with the standard treated leachate LPI there is a huge gap which indicates that the untreated leachate is highly contaminated and has a high potential to enter the groundwater and pollute the areas located around it. Dumping unsegregated solid waste is against the SWM Rules, 2016 especially dumping those kinds of waste which have the potential to harm the environment and enter the food chain of human beings and become accumulated in blood, muscles and other tissue which may result in severe debility and diseases like cancers. Hence, waste should be segregated at source and processed as close to the point of generation, as is possible *e.g.* like composting wet waste, recycling dry waste and separating the domestic hazardous waste and sending them for safe processing and encapsulation rather than discarding them indiscriminately in the environment.

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