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A LEACHATE POLLUTION INDEX APPROACH TO UNDERSTANDING SEASONAL VARIABILITY IN LANDFILL LEACHATE: A CASE STUDY IN SOUTHERN BENGALURU, KARNATAKA

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ABSTRACT

One of the main issues with solid waste landfilling is the poor handling of landfill leachates, which severely pollutes the environment at waste landfill sites and in the area around them. It's crucial to identify seasonal and temporal fluctuations in landfill leachates in order to design an effective system for treating them and reducing the chance of environmental damage. This study examined the southern region of Bengaluru city municipal dump's leachate quality from 2021 to 2023 and used a leachate pollution index to categorize the possible dangers of landfill leachate (LPI). The findings of this study demonstrated that the overall LPI during the monitoring period experienced only minor seasonal and temporal variation, with values in the range of 20–25 (values 2.5 times higher than the maximum allowable limits). The LPI's sub-indices for organic and inorganic pollutants were its main constituents. Particularly, the LPI values for inorganic pollutants were 7.7 times higher on an annual average than the maximum permissible limits, indicating that Nam Son landfill's treatment of inorganic pollutants like ammonium-nitrogen (NH_4 +-N) and total nitrogen (TN) is crucial for preventing environmental pollution in the area surrounding the landfill site.

Key words: Leachate Pollution Index, municipal solid waste, Bangalore.

Introduction:

An engineered municipal solid waste (MSW) landfill is designed to carefully isolate the dumped waste from the surrounding environment to prevent water, soil, and air pollution. The isolation is accomplished commonly with a combination facility including a bottom liner, gas ventilation, drainage system, and daily soil cover as well as a facility for treatment of landfill leachate (Aziz et al., 2007)

Landfills have been identified as one of the major threats to the groundwater from the unlined and uncontrolled landfills exist in many parts of the world, particularly in the under-developed and developing countries where hazardous industrial waste is also co-disposed with municipal waste, and there are no provisions for separate secured hazardous landfills exists. Even if there are no hazardous wastes placed in municipal landfills, leachate is still reported as a significant threat to groundwater (Lee, 2002).

The health hazards and environmental degradation from uncontrolled and unlined landfills are well-known facts. Leachate Pollution Index (LPI) is a quantitative tool by which the leachate pollution data of landfill sites can be reported uniformly. The LPI is an increasing scale index and has been formulated based on the Delphi technique.

LPI is the tool used to indicate the contamination potential of leachate generated from open dumping of MSW. LPI is an increasing scale index in which the higher value denotes the increased environmental pollution levels and is determined by Delphi Technique.

Materials and Methodology

The four municipal dumping sites were selected for the study, and the combined size of the dumping yards is 42 acres. The locations have been dumping solid garbage from 2011-2014. Locations were chosen to understand better the impact of typical solid waste leachate on groundwater in the research region. The current research additionally looks at the physicochemical properties of leachate and groundwater samples obtained from the selected dump sites.

In and around Bengaluru, there are several solid dumpling yards. For the interest of this thesis, a significant four dumping yard has been chosen.

1. Kannahalli CMSWMF
2. Lingadeeranahalli CMSWMF
3. Chikanagamangala CMSWMF
4. Subarayanapalya CMSWMF

1. Kannahalli CMSWMF: This CMSWMF is situated in Survey No. 85, Kannahalli Village, Yeshwanthpura Hobli, Seegehalli Cross, Magadi Road, Bengaluru - 560 091. The Kannenahalli facility handles 500 tonnes of mixed garbage daily (TPD). The dumping site, span about 24 acres. The plant receives the wastes collected from the central zone of Bengaluru.

2. Lingadeeranahalli CMSWMF: The CMSWMF is situated in the village of Lingadeeranahalli. Lingadeeranahalli, Kengeri Hobli, Bengaluru South Taluk, Bengaluru, at survey no. 16A and 21/1. The plant has a 9-acre footprint and processes around 200 TPD of municipal garbage collected from the RR Nagar Zone.

3.Chikanagamangala CMSWMF: The CMSWMF is situated at Survey No. 31, Chikanagamangala. Sarjapur Hobli, Anekal Taluk, in Chikanagamangala village Bengaluru, which was built on 15.3 acres and had a design capacity processing of 500 TPD of municipal wastes collected from the BBMP South and West Zones.

4. Subarayanapalya CMSWMF: This CMSWMF is situated in Kumbalgoodu village, Kengeri Hobli, Bengaluru South Taluk, Bengaluru, at survey No. 143 covers an area of 9.3 acres and process around 200 TPD of municipal wastes collected from the RR Nagar and Bengaluru South Zones.

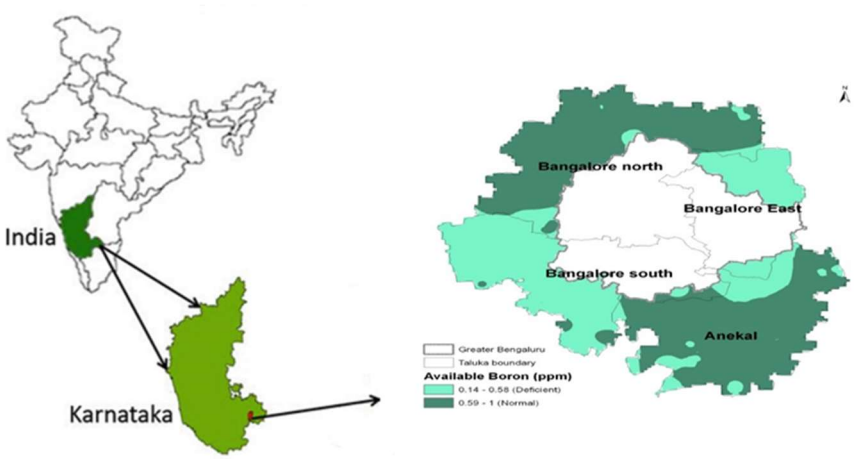

Fig : 1 . Map of the study area

Table .1: Leachate and Sludge Samples with Location and geographical coordinates

Sample No	Location	Longitude	Latitude
KL1, KL2,	Kannalli MSW Dumping Yard Site	$12^0$96'90"N	$77^0$44'72"E
LL1, LL2	Lingadeeranahalli MSW Dumping Yard Site	12°52'36"N	77°30'22"E
CL1, CL2	Chikanagamangala MSW Dumping Yard Site	12°51'40"N	77°41'10"E
SL1, SL2	Subarayanapalya MSW Dumping Yard Site	12°53'01"N	77°25'50"E

A total of eight landfill leachate samples (L1 to L8) were collected every two samples from the four solid waste dumping sites, one each sample in pre-monsoon and post-monsoon season. The leachate sample was collected using a Lysimeter, and the pH, EC, TDS, and DO were determined using a pH and DO meter. The sample was then carefully transported to the laboratory for the analysis of physicochemical characteristics and heavy metals concentration analysis.

Landfill leachate sampling:

A total of eight landfill leachate samples (L1 to L8) were collected every two samples from the four solid waste dumping sites, namely Kannahalli, Lingadeeranahalli, Chikanagamangala and Subarayanapalya CMSWTFs in pre-monsoon and post-monsoon season. The sampling locations and its geographical coordinates are shown in Table 3.6. The leachate sample was collected using a Lysimeter and the pH, EC, TDS and DO were determined using a pH and DO meter. The sample was then carefully transported to the laboratory for the analysis of physicochemical characteristics and heavy metals concentration analysis.

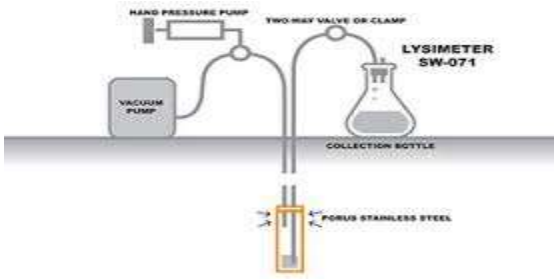

Fig: 2. Lysimeter for collection of Leachate sample

Eighteen parameters and their weightages, as reported by Kumar and Alappat (2004), are considered. The sub-index (pi) values of each parameter based on its concentration are obtained from the graphs, which are in the range of 5–100. Sub-index is a pollution index of an individual parameter based on its concentration. Individual sub-index values are then aggregated using various methods into a final index value. For determining the sub-index value of each parameter, the rating curves are used, which establish the relationship between concentrations and sub-index values. These rating curves are used to determine the sub-index values of all 18 parameters. The value of 5 shows the best value of the sub-index, and 100 shows the worst value of the sub-index. A minimum value of 5 of leachate pollution is considered to ensure that a multiplicative aggregation function could be used if required, and the minimum value of 5 units of leachate pollution will ensure that the LPI value does not result in zero even if some of the pollutants do not show any pollution. Therefore, the theoretical range of LPI is from 5 to 100.

About 18 parameters have been proposed for utilization to determine the LPI. In this study, both physical as well as chemical parameters are considered for the determination of LPI. In principle, each of these selected parameters is assigned a certain weightage depending on the importance of the parameter. If all eighteen parameters are present in the tested samples, then the summation of the weights assigned for individual parameters should be one.

Finally, LPI is determined using equations.

$$\sum_{i=1}^{n} wipi$$

LPI = Leachate pollution index

wi = weight assigned for the pollutants

pi = sub-index of the pollutants

n = number of pollutants that can be utilized for the evaluation of the leachate pollution index

Results and discussion:

Calculation of Leachate Pollution Index: Eighteen parameters and their weightage, as reported by Kumar and Alappat (2004), are considered the sub-index (pi) values of each parameter based on its concentration obtained from the graphs, which are in the range of 5-100. subindices are a pollution index of an individual parameter based on its concentration. Individual sub-index values are then aggregated using various methods into a final index value. For determining the sub-index value of each parameter, the rating curves outlined by Kumar & Alappat 2003 are used, which establish the relationship between concentration and sub-index values. These

curves are used to determine the sub-index value of all 18 parameters and are presented in tables 4.11.2 to 4.11.5. The value of 5 shows the best value of the sub-index, and 100 shows the worst value of the sub-index.

The LPI of the samples of the dumpsites from Kannahalli, Lingadeeranahalli, Chikanagamangala, and Subarayanapalya were determined to be 40.44, 40.22, 31.68 and 27.76 respectively in the PRM of 2017. The pollution index is more in Chikanagamangala and Lingadeeranahalli dumping sites compared to others. The reason may be these sites are handling a high rate of municipal solid waste. In the 2017 POM, the LPI index of Kannahalli, Lingadeeranahalli, Chikanagamangala and Subarayanapalya CMSWTF is 38.45, 43.23, 26.91, and 43.40, respectively. In the PRM of 2018, the value of the LPI of Kannahalli, Lingadeeranahalli, Chikanagamangala, and Subarayanapalya CMSWMTF is 43.29, 40.64, 35.62, and 44.61, respectively. In the POM, the value of LPI is Kannahalli, Lingadeeranahalli, Chikanagamangala, and Subarayanapalya CMSWMTF 25.34, 50.89, 46.35, and 44.61, respectively. A graphical representation of LPI values for each landfill site is presented in table 4.11.1. The LPI values for all the dumpsites investigated were above the standard of 7.378 in all the seasons, which exceeded the permissible values and indicated high toxicity levels. This indicates that leachates from each dumpsite have a great potential to contaminate the groundwater within the vicinity of the dumpsites.

Table: 1: Overall results of Leachate pollution index of all dumping sites in pre-monsoon and post-monsoon seasons of 2017 and 2018

	2017		2018	
	PRM	POM	PRM	POM
Kannahalli	40.45	38.45	43.29	52.34
Lingadheeranahalli	40.22	43.23	40.64	50.89
Chikkanagamamgala	31.69	26.91	35.42	46.35
Subrayanapalya	27.76	43.40	31.28	44.61

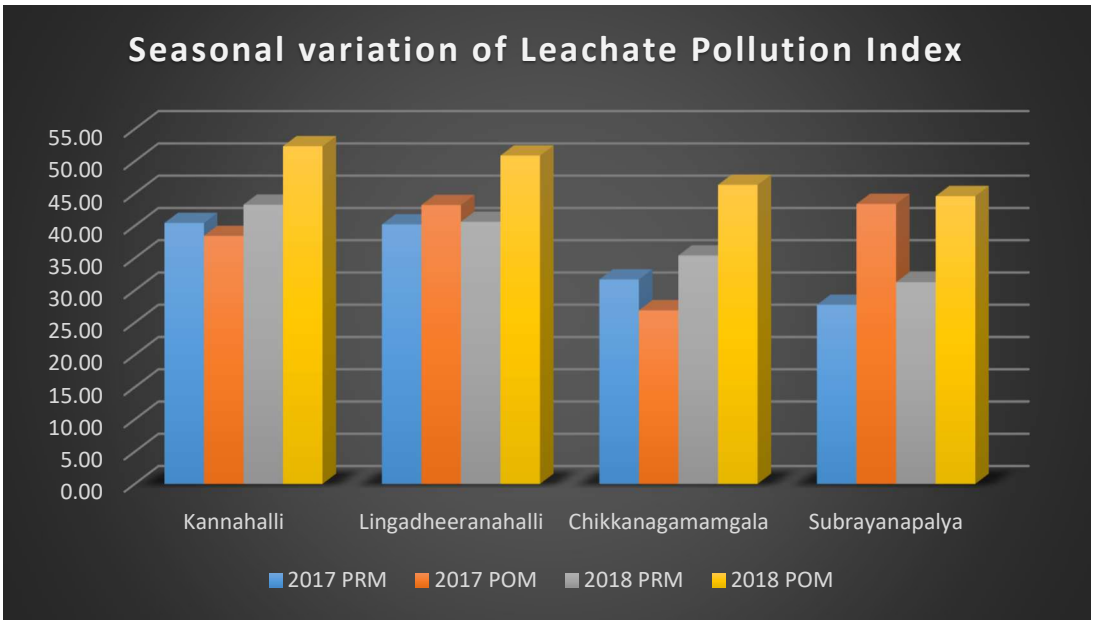

Fig: 1.Graph of Leachate pollution index of all dumping sites in pre-monsoon and post-monsoon seasons of 2017 and 2018

Parameter	unit	Kannahalli				Lingadheeranahalli				Chikkanagamangala				Subrayanapalya			
		Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi
Cr	mg/L	0.8	8.0	0.125	1.0	0.7	7.0	0.125	0.9	0.0	0.0	0.125	0.0	0.0	0.0	0.125	0.0
Pb	mg/L	6.5	70.0	0.123	8.6	5.9	65.0	0.123	8.0	0.2	7.0	0.123	0.9	0.3	8.0	0.123	1.0
COD	mg/L	14900	80	0.267	21.4	13850	80	0.267	21.4	9424	75	0.267	20.0	9423	75	0.267	20.0
Hg	mg/L	0.6	65.0	0.121	7.9	1.1	90.0	0.121	10.9	0.0	0.0	0.121	0.0	0.0	0.0	0.121	0.0
BOD	mg/L	7060	60	0.263	15.8	7060	60	0.263	15.8	3800	50	0.263	13.2	3650	50	0.263	13.2
As	mg/L	1.3	5.0	0.119	0.6	0.4	5.0	0.119	0.6	1.2	6.0	0.119	0.7	0.0	0.0	0.119	0.0
Cyanide	mg/L	0.2	6.0	0.114	0.7	0.3	7.0	0.114	0.8	0.0	0.0	0.114	0.0	0.0	0.0	0.114	0.0
Phenol	mg/L	88.0	50.0	0.246	12.3	60.0	46.0	0.246	11.3	45.0	44.0	0.246	10.8	40.0	40.0	0.246	9.8
Zn	mg/L	5.2	7.0	0.110	0.8	4.6	4.0	0.110	0.4	1.3	6.0	0.110	0.7	1.2	6.0	0.110	0.7
pH		7.2	5.0	0.214	1.1	7.2	5.0	0.214	1.1	7.7	5.0	0.214	1.1	7.3	5.0	0.214	1.1
TKN	mg/L	450.0	15.0	0.206	3.1	280.0	10.0	0.206	2.1	300.0	10.0	0.206	2.1	220.0	9.0	0.206	1.9
Ni	mg/L	1.3	7.0	0.102	0.7	1.4	7.0	0.102	0.7	0.4	5.0	0.102	0.5	0.6	5.0	0.102	0.5
Tc	cfu/ml	55.0	38.0	0.224	8.5	40.0	36.0	0.224	8.1	60.0	42.0	0.224	9.4	50.0		0.224	0.0
NH3-N	mg/L	132.0	13.0	0.198	2.6	140.0	14.0	0.198	2.8	120.0	11.0	0.198	2.2	85.0	8.0	0.198	1.6
TDS	mg/L	80923	100	0.195	19.5	81051.0	100	0.195	19.5	74791	100	0.195	19.5	75486	100	0.195	19.5
Cu	mg/L	0.0	5.0	0.098	0.5	0.0	5.0	0.098	0.5	0.0	5.0	0.098	0.5	0.0	5.0	0.098	0.5
Cl⁻	mg/L	8973.5	85.0	0.187	15.9	8525.0	82.0	0.187	15.3	7637.0	70.0	0.187	13.1	7777.0	70.0	0.187	13.1
Fe	mg/L	147.0	6.0	0.088	0.5	170.5	7.0	0.088	0.6	70.8	6.0	0.088	0.5	66.8	6.0	0.088	0.5

Table 2: LPI of leachate in all dumping sites in pre-monsoon season -2017

Parameter	unit	Kannahalli				Lingadheeranahalli				Chikkanagamangala				Subrayanapalya			
		Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi
Cr	mg/L	2.4	11.0	0.125	1.4	2.2	11.0	0.125	1.4	1.5	7.0	0.125	0.9	2.8	13.0	0.125	1.6
Pb	mg/L	28.3	100.0	0.123	12.3	27.6	100.0	0.123	12.3	0.0	0.0	0.123	0.0	2.7	20.0	0.123	2.5
COD	mg/L	9900	77	0.267	20.6	8779.5	72	0.267	19.2	14449	45	0.267	12.0	15339	80	0.267	21.4
Hg	mg/L	10.9	100.0	0.121	12.1	12.1	100.0	0.121	12.1	0.2	20.0	0.121	2.4	1.6	95.0	0.121	11.5
BOD	mg/L	2600	45	0.263	11.8	2600	45	0.263	11.8	3900	50	0.263	13.2	2600	45	0.263	11.8
As	mg/L	1.6	6.0	0.119	0.7	0.9	7.0	0.119	0.8	0.0	0.0	0.119	0.0	1.4	8.0	0.119	1.0
Cyanide	mg/L	0.7	8.0	0.114	0.9	0.4	8.0	0.114	0.9	0.2	6.0	0.114	0.7	0.0	0.0	0.114	0.0
Phenol	mg/L	129.5	40.0	0.246	9.8	87.0	50.0	0.246	12.3	71.5	49.0	0.246	12.1	78.5	50.0	0.246	12.3
Zn	mg/L	59.9	25.0	0.110	2.8	165.0	60.0	0.110	6.6	93.3	40.0	0.110	4.4	199.5	75.0	0.110	8.3
pH		8.4	5.0	0.214	1.1	8.3	5.0	0.214	1.1	7.4	5.0	0.214	1.1	8.5	5.0	0.214	1.1
TKN	mg/L	495.0	15.0	0.206	3.1	401.0	12.0	0.206	2.5	451.0	12.0	0.206	2.5	212.0	9.0	0.206	1.9
Ni	mg/L	2.0	8.0	0.102	0.8	2.0	8.0	0.102	0.8	2.1	8.0	0.102	0.8	2.5	9.0	0.102	0.9
Tc	cfu/ml	84.5	45.0	0.224	10.1	96.5	48.0	0.224	10.8	103.5	49.0	0.224	11.0	67.0	40.0	0.224	9.0
NH3-N	mg/L	178.0	18.0	0.198	3.6	140.5	14.0	0.198	2.8	150.0	15.0	0.198	3.0	110.5	10.0	0.198	2.0
TDS	mg/L	34400.0		0.195	0.0	33695.0	80	0.195	15.6	4541.0	7	0.195	1.4	51876.5	97	0.195	18.9
Cu	mg/L	30.0	100.0	0.098	9.8	28.0	100.0	0.098	9.8	10.4	100.0	0.098	9.8	34.2	100.0	0.098	9.8
Cl^-	mg/L	7650.0	75.0	0.187	14.0	5200.0	45.0	0.187	8.4	3162.0	28.0	0.187	5.2	8694.5	85.0	0.187	15.9
Fe	mg/L	70.5	6.0	0.088	0.5	55.7	6.0	0.088	0.5	37.0	5.0	0.088	0.4	65.7	6.0	0.088	0.5

Table 3: LPI of leachate in all dumping sites in post-monsoon season -2017

Parameter	unit	Kannahalli				Lingadheeranahalli				Chikkanagamangala				Subrayanapalya			
		Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi
Cr	mg/L	0.9	9.0	0.125	1.1	2.5	11.0	0.125	1.4	1.1	9.0	0.125	1.1	0.5	5.0	0.125	0.6
Pb	mg/L	11.3	95.0	0.123	11.7	12.7	97.0	0.123	11.9	13.3	98.0	0.123	12.1	2.2	15.0	0.123	1.8
COD	mg/L	9951	75	0.267	20.0	8833	72	0.267	19.2	12123	77	0.267	20.6	16139	82	0.267	21.9
Hg	mg/L	11.6	100.0	0.121	12.1	7.1	100.0	0.121	12.1	8.1	100.0	0.121	12.1	12.1	100.0	0.121	12.1
BOD	mg/L	2660	42	0.263	11.0	2700	42	0.263	11.0	1585	32	0.263	8.4	2675	40	0.263	10.5
As	mg/L	72.0	100.0	0.119	11.9	367.2	100.0	0.119	11.9	35.7	85.0	0.119	10.1	68.2	99.0	0.119	11.8
Cyanide	mg/L	0.7	8.0	0.114	0.9	0.4	7.0	0.114	0.8	0.2	6.0	0.114	0.7	0.0	0.0	0.114	0.0
Phenol	mg/L	135.0	77.0	0.246	18.9	101.0	58.0	0.246	14.3	57.0	45.0	0.246	11.1	84.0	55.0	0.246	13.5
Zn	mg/L	61.6	26.0	0.110	2.9	64.8	29.0	0.110	3.2	12.7	9.0	0.110	1.0	20.3	11.0	0.110	1.2
pH		8.59	5.0	0.214	1.1	8.55	5.0	0.214	1.1	7.62	5.0	0.214	1.1	8.52	5.0	0.214	1.1
TKN	mg/L	469.0	15.0	0.206	3.1	444.0	14.0	0.206	2.9	396.5	12.0	0.206	2.5	204.5	8.0	0.206	1.6
Ni	mg/L	0.3	5.0	0.102	0.5	0.3	5.0	0.102	0.5	0.4	6.0	0.102	0.6	0.3	5.0	0.102	0.5
Tc	cfu/ml	89.5	47.0	0.224	10.5	102.0	49.0	0.224	11.0	103.0	49.0	0.224	11.0	70.0	43.0	0.224	9.6
NH3-N	mg/L	186.5	18.0	0.198	3.6	151.0	15.0	0.198	3.0	139.5	14.0	0.198	2.8	-	0.0	0.198	0.0
TDS	mg/L	46683	96	0.195	18.7	61904	100	0.195	19.5	55225	100	0.195	19.5	45093	95	0.195	18.5
Cu	mg/L	45.2	100.0	0.098	9.8	51.5	100.0	0.098	9.8	61.1	100.0	0.098	9.8	71.4	100.0	0.098	9.8
Cl^-	mg/L	18925.0	100.0	0.187	18.7	17875.0	100.0	0.187	18.7	7925.0	76.0	0.187	14.2	17202.5	100.0	0.187	18.7
Fe	mg/L	21.2	5.0	0.088	0.4	23.5	5.0	0.088	0.4	42.9	6.0	0.088	0.5	27.5	5.0	0.088	0.4

Table 4: LPI of leachate in all dumping sites in pre-monsoon season – 2018

Parameter	unit	Kannahalli				Lingadheeranahalli				Chikkanagamangala				Subrayanapalya			
		Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi	Avg Value	Sub index value(Pi)	weight factor(WI)	Pi*Wi
Cr	mg/L	0.8	8.0	0.125	1.0	0.8	8.0	0.125	1.0	-	0.0	0.125	0.0	-	0.0	0.125	0.0
Pb	mg/L	6.5	70.0	0.123	8.6	6.9	75.0	0.123	9.2	0.3	6.0	0.123	0.7	0.3	6.0	0.123	0.7
COD	mg/L	24900	88	0.267	23.5	20480	82	0.267	21.9	10144	75	0.267	20.0	9773	75	0.267	20.0
Hg	mg/L	0.9	85.0	0.121	10.3	0.6	60.0	0.121	7.3	1.0	88.0	0.121	10.6	-	0.0	0.121	0.0
BOD	mg/L	7060	65	0.263	17.1	7375	65	0.263	17.1	4055	49	0.263	12.9	3685	49	0.263	12.9
As	mg/L	#DIV/0!	0.0	0.119	0.0	#DIV/0!	0.0	0.119	0.0	-	0.0	0.119	0.0	-	0.0	0.119	0.0
Cyanide	mg/L	0.2	6.0	0.114	0.7	0.3	6.0	0.114	0.7	0.1	5.0	0.114	0.6	0.0	0.0	0.114	0.0
Phenol	mg/L	86.5	53.0	0.246	13.0	62.5	47.0	0.246	11.6	53.5	47.0	0.246	11.6	58.0	47.0	0.246	11.6
Zn	mg/L	5	7.0	0.110	0.8	6	7.0	0.110	0.8	1.7	6.0	0.110	0.7	2.2	7.0	0.110	0.8
pH		7	5.0	0.214	1.1	7	5.0	0.214	1.1	7.62	5.0	0.214	1.1	8.20	5.0	0.214	1.1
TKN	mg/L	400.0	12.0	0.206	2.5	230.0	8.0	0.206	1.6	285.5	10.0	0.206	2.1	186.0	7.0	0.206	1.4
Ni	mg/L	1	7.0	0.102	0.7	3	10.0	0.102	1.0	1.2	7.0	0.102	0.7	1.8	7.0	0.102	0.7
Tc	cfu/ml	75.0	43.0	0.224	9.6	43.0	42.0	0.224	9.4	62.0	43.0	0.224	9.6	49.5	40.0	0.224	9.0
NH3-N	mg/L	168.0	17.0	0.198	3.4	164.0	17.0	0.198	3.4	132.0	13.0	0.198	2.6	95.0	10.0	0.198	2.0
TDS	mg/L	80923	100	0.195	19.5	81705	100	0.195	19.5	75791	100	0.195	19.5	75786	100	0.195	19.5
Cu	mg/L	2.6	10.0	0.098	1.0	0	0.0	0.098	0.0	-	0.0	0.098	0.0	-	0.0	0.098	0.0
Cl^-	mg/L	8973.5	88.0	0.187	16.5	8725	84.0	0.187	15.7	7694.5	70.0	0.187	13.1	7830.5	73.0	0.187	13.7
Fe	mg/L	91.5	8.0	0.088	0.7	78	8.0	0.088	0.7	47.8	6.0	0.088	0.5	42.8	6.0	0.088	0.5

Table 5: LPI of leachate in all dumping sites in post-monsoon season -2018

Conclusion:

Leachate characteristics demonstrate high variations and which range of physical, chemical, and biological parameters may vary over several order magnitude. LPI is a good tool to compare pollution potential of landfill sites. Among the four sites, on an average Kannahalli has the highest LPI value while the Subarayanapalya has the lowest LPI. Although LPI of the four studied landfill sites is very high, the leachate shall be treated prior to discharge for individual pollution parameters such as BOD, COD, and ammonia to meet individual standards. The landfill sites requiring immediate attention can also be prioritized based on the value of LPI to avoid big pollution incident. Because changes in individual quality parameters alter the value of LPI, it can be used as a reliable tool to report seasonal and site specific variations in quality of landfill leachate.

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