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ADVERSE IMPACT ON SOIL AND GROUNDWATER DUE TO SOLID WASTE OPENDUMP IN COIMBATORE TOWN PANCHAYATS

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ABSTRACT

The management of solid waste (MSW) is an area of universal concern for both the developed and developing world. It is imperative that efficient, technically sound, and cost effective solid waste management. Preserving a good natural environment is essential for a good health and quality of life. However, at present, the environment is damaged all around the world by several main factors, such as global warming gases emissions, excessive resources extraction or persistent organic pollutants release. Particularly MSW creates special concern among the general public due to its close relationship with the daily life of the lay person. Poor management of solid wastes materials leads to potentially disastrous environmental and health hazards. Polluted water (Leachates) flowing from waste dumps and disposal sites can cause serious pollution of water supplies, ponds and lakes. Solid wastes have potential for causing serious adverse impact on the environment. Open dumping of solid waste is done in low-lying areas and outskirts of the towns and cities. Being comparatively cheaper, this method of disposal is extensively used in India.

Key words: Leachate, Landfill.

INTRODUCTION

One of the major environmental issues in coimbatore panchayats is the improper management of solid waste. There is an increase in household waste generation and this is largely attributed to the rapid urbanization and population growth. In India like most developing nations, municipal solid wastes (MSW) are commonly disposed of in unlined landfills or open dumps, many of which are located in public places surrounded by

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residential buildings. In India due to increased population and commercial development, cities are facing problems of disposal of solid waste. The daily per capita generation ofsolid waste in India ranges about 100 g in small towns to 500 g in large towns. Solid waste generation is 6 million tones in 1947 and 48 million tones in 1997 and now expected to increases to 300 million tones per annum by 2047. The physical and chemical characterizations of solid waste leachates have been reported widely in literature[1-3]. Previous studies have also shown that leachates from MSW landfills are very similar in composition to those from hazardous waste landfills[4-6]. Municipal landfill leachate are highly concentrated complex effluents, which contain dissolved organic matters; inorganic compounds such as ammonium, calcium, magnesium, sodium, potassium, iron, sulphates, chlorides and heavy metals such as cadmium, chromium, copper, lead, zinc, nickel; and xenobiotic organic substances[7,8].

The chemical compounds in leachate may leach or percolate via the soil into groundwater for a long time and pose serious risks to ecosystems and human health if the chemicals migrate to surface waters or drinking water wells. Such risks are very high when the landfill lacks an impermeable liner and leachate collection system allowing the direct flow of leachate into groundwater. Unlined landfills have been reported to release large amounts of hazardous and deleterious chemicals in leachate to nearby groundwater[8,9] Landfill leachate is considered one of the most potentially significant sources of groundwater pollution for waters that could be used for domestic water supply purposes[7].

This leachate contamination of surface waters and groundwater may pose serious health risks to aquatic organisms as well as humans and farm animals that drink these natural resources. The realization of the polluting and potential public effects of MSW leachate has led to a number of studies on the toxicity of leachates on bacteria[11].

These MSW landfills hold discarded products many of which are manufactured from toxic materials. These products create very similar hazards for the environment, wildlife and humans as hazardous wastes after they have been buried in the ground[4]. Wastes placed in landfills are subject to either groundwater underflow or infiltration from precipitation and as water percolates through the waste, it picks up a variety of inorganic and organic compounds, flowing out of the wastes to accumulate at the bottom of the landfill. The resulting contaminated water is termed ‘leachate’ and can percolate through the soil[11].

This study will throw a light on impact of disposal of solid waste on land without proper segregation, contamination of groundwater around the places and feasible solution to control the pollution of environment. Samples were collected around the dump site in Annur, Kalapatti and Perur Town Panchayats at specific intervals and the sampling stations were

located by using GPS. The various parameters analyzed for groundwater are pH, electrical conductivity, total hardness, total dissolved solids, chloride, sulphate, calcium and magnesium, bicarbonate, and dissolved oxygen. Similarly the parameters analyzed for soil are pH, electrical conductivity, sodium, potassium, organic matter, calcium, magnesium, sodium adsorption ratio, and moisture content.

EXPERIMENTAL

Materials and methods

Study site

Coimbatore city is situated in south India, has around 11º North latitude, 77º East longitude and 432 m above mean sea level, while the city is flat, it is surrounded by hilly terrain. Since it is situated at the foot of Nilgiri hills, the maximum temperature observed in this city is 34ºC and minimum temperature is 20ºC. Coimbatore popularly known as the Manchester of south India. City's population in the year 2011 is 10.59 lakhs. It has its own reputation to stand proud in the line of industrially developed areas in the sites of Tamil Nadu. Coimbatore district is situated in the Western side of the Tamil Nadu. It covers an area of 6653.73 sq. Km. The area experiences sub-humid and sub-tropical type of climate with hot dry summer and mild winter. Rainfall is obtained from the South-west monsoon during June-September and North-east monsoon during October-December. The North-east monsoon is more prominent. The average annual rainfall of the year is 614 mm received annually of which about 60% fall during the period of August-December. The mean maximum and minimum temperature during study period were 34.2^0C and 17.8^0C respectively. The soil in the area is clay loam.

Coimbatore Corporation is divided into four zones (N, S, E & W) and each zone has 18 wards. A large part of the Coimbatore urban agglomeration falls outside the municipal corporation limits. These are governed by local bodies called municipalities and Town panchayats.

Classification of municipal and local bodies	Number
Corporation	1
Municipality	6
Blocks	12
Town panchayats	44
Panchayat villages	229

The 35 Town Panchayats in Coimbatore are broadly being classified into 5 zones which are Coimbatore (North), Coimbatore (South), Avinashi, Mettupalayam, Palladam. The waste from Coimbatore corporation area are disposed at vellalore dump yard is of about 900 tonnes. Coimbatore district has nearly 44 Town panchayats out of which 3 panchayats were taken for our study purpose based on various parameters such as population, quantity of waste generated, land use pattern, nature of disposal technique adopted and no. of years of disposal. Per capita waste generation is 600 gms and 95% of wastes are collected. The extent of segregation is 40% & recovery of waste collected is 64.83% and availability of land for waste disposal is 654.54 Acres in Vellalore area. The four transfer stations are located at Peelamedu, Sathy road, Ukkadam and Ondipudur. The work involved in integrated SWM of Coimbatore city is done in four phases.

(i) Setting up of transfer stations

(ii) Processing – compost plant

(iii) Closure of existing dumpsites

(iv) Disposal – sanitary landfill

All the waste collected is transported to the transfer stations and thereafter transported to the compost plant and sanitary landfill at Vellalore site through bulk refine carrier. The scientific closure of old and abandoned dumpsites is also done at the Ondipudur, Kavundampalayam and at the Vellalore sites. Coimbatore district has nearly 44 town panchayats, out of which 3 panchayats were taken for our study purpose based on various parameters such as population, quantity of water generated, land use pattern, nature of disposal technique adopted and no. of years of disposal in particular area.

Table 1: Details of Town Panchayats

	Description	**Panchayat**		
		Annur	**Kalapatti**	**Perur**
Area details	Area	18.29 km^2	25.26 km^2	14.34 km^2
	Population	1805	22034	7936
	No. of houses	5491	12773	2059
	No. of wards	15	15	15
	No. of streets	83	270	117
	No. of industries	50	150	15

Cont…

	Description	Panchayat		
		Annur	Kalapatti	Perur
Disposal site details	Ward No.	1	13 (323/2)	2
	Area	1 acre	0.5 acres	0.75 acre
	Qty. of waste generated	4.5 Ton/Day	12 Metric Ton/Day	2 to 3 Ton/Day
	No. of year disposal	20	15	25 to 30

Location of sampling station

Annur sampling station

Sixteen soil samples were collected around the dump site out of which 8 samples of soil were collected at 1 feet depth and another 8 samples of soil were collected at 2 feet depth. Groundwater samples were collected in 3 different bore wells around the dumpsite.

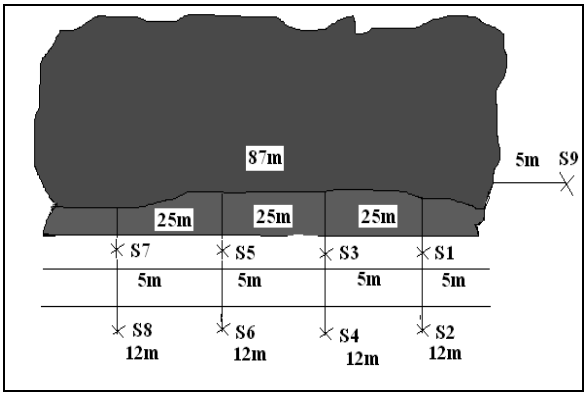

Fig. 1: Annur dumpsite

Kalapatti sampling station

Around 10 soil samples were collected along the dump site. 5 samples of soil were collected at 1 feet depth and another 5 samples of soil were collected at 2 feet depth. Groundwater samples were collected in 3 different bore wells around the dumpsite.

Perur sampling station

Around 14 soil samples were collected along the dump site. 7 samples of soil were collected at 1 feet depth and another 7 samples of soil were collected at 2 feet depth. Groundwater samples were collected in 6 different bore wells around the dumpsite.

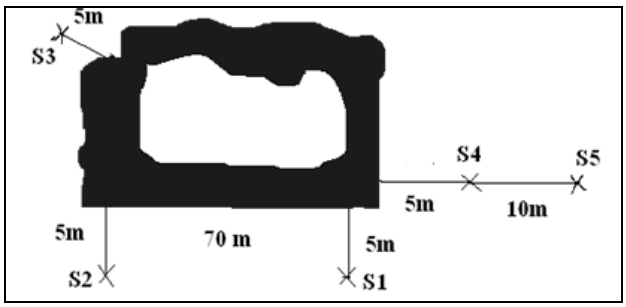

Fig. 2: Kalapatti Dumpsite

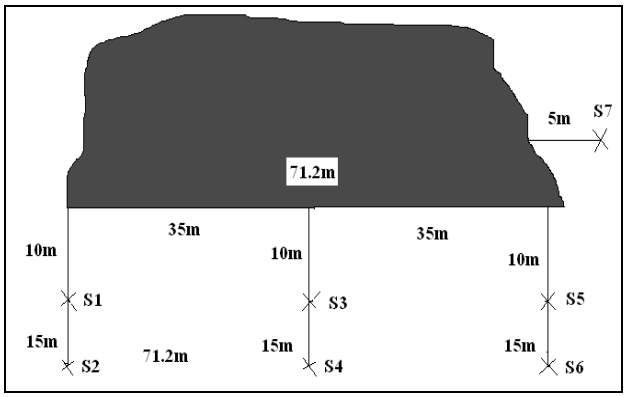

Fig. 3: Perur Dumpsite

Method of soil and water sampling

The soil samples were collected by using Scoop and Shovel method and the water samples were collected by Grab sampling technique. The soil samples were collected in polythene bags and water was collected by using plastic cans and they are preserved for testing.

Fig. 4: Soil sample collection

Analysis of soil and water samples

The soil samples were analyzed for its various characteristics such as pH, electrical conductivity, total hardness, total dissolved solids, chlorides, sulphates, calcium, magnesium, carbonate and bicarbonate, sodium and potassium as per the standards methods.

The groundwater sample were analyzed for its various physio-chemical characteristics such as pH, electrical conductivity, organic matter, magnesium, calcium, sodium, moisture content, sodium absorption ratio as per the standards methods.

Sample preparation

Soil passing through 2.36 mm sieve was taken for analysis. 25 g of dry soil sample is dissolved in 50 mL of distilled water and stirred well for 1 hr. Filter the sample solution using Whatman filter paper no. 42 and the filtrate is taken for analysis.

RESULTS AND DISCUSSION

The soil and groundwater samples collected around the dumpsite in Annur, Kalapattiand Perur Town Panchayats were analyzed for various parameters. The soil sample were analyzed for its various characteristics of soil like pH, Electrical conductivity, organic matter, magnesium, calcium, sodium, moisture content and sodium adsorption ratio.

The groundwater samples were analyzed for pH, EC, TH, TDS, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3^{2-}, Na and K as per the Standards.

Table 2: Soil characteristics around the dumpsite in Annur Town Panchayat

Sample	Depth (Ft)	pH	EC	MC	OM	Ca^{2+}	Mg^{2+}	K	Na^+	SAR
S_1	1	8.22	1.11	5.724	1.423	80.41	10.36	21	13	1.929
	2	8.44	0.94	5.963	1.641	91.23	19.01	16	43	5.791
S_2	1	8.32	0.93	6.427	1.436	83.53	13.43	33	19	2.73
	2	8.24	0.84	7.244	1.625	84.87	19.32	47	29	2.246
S_3	1	8.4	1.02	6.119	2.13	96.64	16.42	18	61	8.113
	2	8.2	0.93	7.405	3.42	101.32	28.73	24	55	6.821

Cont…

Sample	Depth (Ft)	pH	EC	MC	OM	Ca^{2+}	Mg^{2+}	K	Na^{+}	SAR
S_4	1	8.1	0.87	6.342	1.773	78.47	22.94	28	42	5.898
	2	8.3	0.82	6.857	2.137	83.21	28.78	76	38	5.078
S_5	1	8.06	0.72	6.234	2.845	78.12	19.75	25	18	2.57
	2	8.34	1.02	7.111	3.786	91.36	22.19	60	33	5.043
S_6	1	8.64	1.08	6.755	2.308	84.83	25.28	44	25	3.369
	2	8.49	1.15	6.971	2.206	97.34	27.37	114	21	2.659
S_7	1	8.52	1.13	6.708	1.764	103.11	15.22	73	16	2.08
	2	8.6	1.06	8.013	2.593	109.15	20.4	89	49	6.08
S_8	1	7.92	1.23	7.33	2.809	91.16	20.81	30	52	6.949
	2	8.01	1.01	8.466	3.205	99.72	21.57	49	23	2.953

Table 3: Groundwater characteristics around the dumpsite in Annur Town Panchayat

Sample	pH	EC (µs/cm)	TH	TDS	Cl^{-}	SO_4^{2-}	Ca^{2+}	Mg^{2+}	HCO_3^{-}	DO
W_1	7.89	1.5	400	4000	169.99	111.37	14	18.22	270	1.4
W_2	7.14	1.63	350	3200	119.99	132.41	15.6	27.73	235	2.8
W_3	7.34	2.89	450	4640	269.99	112.47	14.8	23.77	125	2.1

Table 4: Soil characteristics around the dumpsite in Perur Town Panchayat

Sample	Depth (Ft)	pH	EC	MC	OM	Ca^{2+}	Mg^{2+}	K	Na^{+}	SAR
S_1	1	8.57	1.4	6.011	1.943	79.17	36.08	14	42	5.533
	2	7.83	1.01	8.038	2.515	83.61	24.81	19	31	4.21
S_2	1	7.5	0.97	9.201	2.657	86.43	29.28	22	16	2.104
	2	8.13	0.74	7.054	2.939	91.68	27.24	44	21	2.723
S_3	1	7.49	0.55	8.703	1.137	72.04	30.6	91	29	2.256
	2	7.63	0.73	9.751	2.543	81.81	28.4	38	41	5.522

Cont…

Sample	Depth (Ft)	pH	EC	MC	OM	Ca^{2+}	Mg^{2+}	K	Na^{+}	SAR
S_4	1	7.25	0.86	6.134	1.178	90.75	19.31	101	28	3.774
	2	8.72	0.69	6.018	1.912	95.51	33.66	84	24	2.986
S_5	1	8.12	0.51	5.968	2.654	101.18	32.41	73	36	4.406
	2	7.69	0.56	5.713	3.626	110.91	27.12	97	44	5.297
S_6	1	8.37	0.57	6.321	3.834	84.5	16.31	32	28	3.942
	2	8.69	0.92	7.192	3.512	93.82	24.27	24	18	2.343
S_7	1	7.92	0.65	8.637	1.718	73.51	28.04	28	60	8.42
	2	8.74	0.53	6.408	3.628	87.33	31.28	63	53	6.882

Table 5: Groundwater characteristics around the dumpsite in Perur Town Panchayat

Sample	pH	EC (µs/cm)	TH	TDS	Cl^{-}	SO_4^{2-}	Ca^{2+}	Mg^{2+}	HCO_3^{-}
W_1	7.68	2.97	550	1600	244.99	176.81	16	26.72	185
W_2	8.06	3.4	700	9125	254.99	172.83	20	22.76	200
W_3	7.9	2.76	500	5860	284.99	178.31	20	22.76	135
W_4	7.92	3.77	650	5860	454.98	128.93	14	24.51	425
W_5	8.15	1.38	650	1000	269.99	178.31	12.8	19.59	305
W_6	7.85	2.4	600	5380	434.98	156.37	10	16.67	240

Table 6: Soil characteristics around the dumpsite in Kalapatti Town Panchayat

Sample	Depth (Ft)	pH	EC	MC	OM	Ca^{2+}	Mg^{2+}	K	Na^{+}	SAR
S_1	1	8.2	2.1	5.219	1.014	81.54	22.78	39	42	5.815
	2	7.9	1.17	6.636	1.312	80.37	21.43	21	18	2.523
S_2	1	8.3	2.34	6.741	2.836	83.15	31.28	14	33	4.363
	2	8.1	1.22	6.456	3.441	91.93	19.13	19	47	6.307

Cont…

Sample	Depth (Ft)	pH	EC	MC	OM	Ca^{2+}	Mg^{2+}	K	Na^{+}	SAR
S_3	1	8	2.69	8.312	1.739	92.46	29.16	32	32	4.104
	2	7.8	2.06	9.951	2.498	88.71	23.48	24	24	3.204
S_4	1	7.7	2.65	7.784	2.281	93.89	41.72	48	39	4.736
	2	7.4	2.12	9.278	2.693	84.35	29.53	97	23	3.048
S_5	1	7.8	1.98	8.431	2.347	79.22	45.81	53	13	1.644
	2	7.3	1.9	9.53	3.221	80.57	28.37	64	52	7.046

Table 7: Groundwater characteristics around the dumpsite in Kalapatti Town Panchayat

Sample	pH	EC (µs/cm)	TH	TDS	Cl^{-}	SO_4^{2-}	Ca^{2+}	Mg^{2+}	HCO_3^{-}	DO
W_1	7.16	3.42	605	1140	214.99	268.84	16	25.25	110	1.6
W_2	7.4	3.67	350	2040	514.99	307.25	8.4	16.6	135	1.3
W_3	8.17	3.99	250	5480	199.99	167.34	5.2	21.72	225	1.6

Comparison of soil and groundwater samples

Table 8: Comparison of soil samples collected at 1 ft depth with permissible limits

S. No.	Parameters	Characteristics of samples			Max. permissible limit (as per Indian Standards)
		Annur	Kalapatti	Perur	
1	pH	8.2	8	7.8	6.5 – 8.5
2	EC (mmhos/cm)	0.99	2.3	0.78	1
3	MC (%)	6.4	7.2	7.25	80 – 100
4	OM (%)	2	2	2	30 – 50
5	Ca (mg/L)	87	86	84	110 – 120
6	Mg (mg/L)	18	29	27	70 – 100
7	K (mg/L)	34	37	51	0.75
8	Na (mg/L)	31	32	34	–
9	SAR	4	4	4	< 13 – Saline soil > 13 – Sodic soil

Table 9: Comparison of soil samples collected at 2 ft depth with permissible limits

S. No.	Parameters	Characteristics of Samples			Max.permissible limit (as per Indian Standards)
		Annur	Kalapatti	Perur	
1	pH	8.3	7.7	8.1	6.5 – 8.5
2	EC (mmhos/cm)	0.95	1.6	0.73	1
3	MC (%)	7.2	8	7	80 – 100
4	OM (%)	3	3	3	30 – 50
5	Ca (mg/L)	95	85	92	110 – 120
6	Mg (mg/L)	23	24	28	70 – 100
7	K (mg/L)	59	45	53	0.75
8	Na (mg/L)	36	33	33	–
9	SAR	5	4	4	< 13 – Saline soil > 13 – Sodic soil

Table 10: Comparison of groundwater samples with permissible limits

S. No.	Parameters	Characteristics of samples			Max. permissible limit (as per Indian Standards)
		Annur	Kalapatti	Perur	
1	pH	7.4	7.5	7.9	6.5-8.5
2	EC (mmhos/cm)	2	3.6	2.7	0.25-1
3	TH (mg/L)	400	401	608	300-600
4	TDS (mg/L)	3946	2886	4804	500
5	Cl (mg/L)	187	309	324	250-1000
6	So_4^{2-} (mg/L)	119	247	165	200-400
7	Ca^{2+} (mg/L)	14.8	9.8	15	75-200
8	Mg^{2+} (mg/L)	23	31	22	30-100
9	HCO_3^- (mg/L)	210	156	248	200-600

CONCLUSION

The present study summarizes the impact due to disposal of municipal solid waste dumped on land. The soil samples and water samples were analyzed and compared with

permissible limits. At the dumpsite, the concentrations of essential elements were increased nutrients in the soil, but at the same time, toxic heavy metals concentrations also increase which may reach the individuals through food chain. Hence, it is essential to study the physiochemical parameters of solid waste in detail before disposing it on land.

Since, in many places groundwater is used as the source of drinking water. The solid waste dumped on land will cause enormous pollution of groundwater by leachates percolating into soil especially during rainy seasons. The consumption these polluted water may use many health problems. Many problems can be solved by proper management of solid waste, i.e., segregation, recycling and finally processing of solid waste using appropriate technology.

As in many town panchayats, since small quantity of waste is generated the best of way of managing solid waste is organic fraction can be converted into valuable product through composting & inorganic fraction can be recycled and after recycling the remaining waste can be taken to landfills.

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