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Environmental Impact of Municipal Solid Waste in Karachi City

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Abstract: Developing countries face serious problem in managing Municipal solid waste. The municipal solid waste generation rapidly increases in proportion to the rises in population and urbanization. A reliable estimate of the quantity and quality of municipal solid waste is very important for a proper planning and management of the municipal solid waste. This paper deals with the generation, composition of municipal solid waste (MSW) and their impact on the ground water contamination. The data of municipal solid waste generation and their composition was found during the month of November, 2011 to January, 2012. Our study suggests that 10,000 ton per day of municipal solid waste generated from Karachi city out of which 60% of the waste is dumped at the landfill site and rest of the 40% is left on the streets which disturb the aesthetic beauty of the Karachi city. Also, my study examined municipal solid waste as well as ground water contamination around municipal landfill site in Karachi city. Sampling was carried out according to the spot sampling method of municipal solid waste as well as groundwater and analysis them physical and chemical parameters, such as, pH, TDS, Moisture Content, Total Hardness, Calcium (Ca), Magnesium (Mg), COD, Sodium (Na), Phosphorous (PO4), Potassium (K) and the metals like Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni) using analytical techniques. It has been found that most of the parameters of municipal solid waste and ground waste are beyond the permissible limits in accordance with the Pakistani Standards as well as Indian Standards. It is concluded that the contamination is due to the solid waste material that are dumped at the landfill site.

Key words: Municipal solid waste generation · Composition · Characterization and ground water

INTRODUCTION

Developing countries face serious problem in managing solid wastes. The annual waste generation increases in proportion to the rises in population and urbanization. Rapid urbanization, development and change of life style in the cities have also changed the generation rate and the composition of the municipal solid waste.

Solid waste other than hazardous and radioactive material are often referred to as municipal solid waste (MSW). Municipal solid waste is useless unwanted material discharged as a result of human activity. Most commonly, they are solids, semi solid or liquids in containers thrown out of houses, commercial or industrial premises (Nyangababo, *et al*., 1980) [1].

Solid waste (SW) constitutes a huge challenge for local governments due to its constant increase and the majority of the municipalities do not keep records on waste generation, origin and characteristics. This lack of information causes that the decisions regarding proper waste management are based on assumption and inferences, which brings about its mishandling with serious consequences for the environment (O. Buenrostro, *et al*., 2003) [2].

World population continues to rise with projections nearing 7.2 billion by 2015 (UNEP, 2005) [3]. The increasing volume of waste being generated would not be a problem if waste was viewed as a resource and managed properly (UNEP, 2001) [4].

Municipal solid waste (MSW) management is a highly neglected factor of environmental management in

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all low and most middle-income countries (Murtaza, *et al*., 2000) [5]. Poorly managed waste stream are causing adverse environmental impact and may result in health hazards (Misra, *et al*., 2005) [6]. Environmental concerns are assuming ever-increasing importance in the MSW decision-making process (Elizabeth, 1998) [7]. Appropriate waste management strategies can substantially reduce the burden placed on the environment. If the waste management system is based on sound data and is well executed with public awareness, it can reduce emission and resource depletion (Jurczak, 2003, [8] Woodard, *et al*., 2004 [9]). Global generation of municipal solid waste in 1997 was 0.49 billion tones with an estimated annual growth rate of 3.2-4.5% in developed nations and 2-3% in developing nations (Suocheng, *et al*., 2001) [10]. Inappropriate management of urban solid waste not only increases the pollution to the environment, but also threatens human health through its collection, transfer and disposal processes (Dong, *et al*., 2001) [11].

Landfills have been identified as one of the major threat to groundwater resources (Fatta, *et al*., 1999; [12] USEPA, 1984 [13]). Waste placed in landfill or open dumps are subjected to either groundwater underflow or infiltration from precipitation. The dumped solid wastes gradually release its initial interstitial water and some of its decomposition by-product gets into water moving through the waste deposit. Such liquid containing innumerable organic and inorganic compounds is called leachate. This leachate accumulates at the bottom of the landfill and percolates through the soil. Areas near landfill have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby site. Such contamination of groundwater resource poses a substantial risk to local resource user and to the natural environment. The impact of landfill leachate on the surface and groundwater has given rise to a number of studies in recent years (Saarela, 2003; [14] Abu-Rukah, *et al*., 2001; [15] Looser, *et al*., 1999; [16] Christensen, *et al*., 1998; [17] De Rosa, *et al*., 1996; [18] Flyhammar, 1995 [19]).

In the present study, it was estimated that the generation of municipal solid waste and their impact on the ground water at the landfill site of Karachi city. Various physico-chemical parameters including heavy metals were analyzed of municipal solid waste as well as groundwater and the quantity of municipal solid waste generated by the Karachi city.

Experimental

Study Area: Karachi is the biggest city in Pakistan having population is more than nineteen (19) million. It comprises 18 Union Councils (U.C), Karachi generates municipal solid waste more than 10,000 tons per day, 60% of that waste is dumped at the landfill site and the 40% remains on the streets, which is not properly collected. There are two official landfill sites JAM CHAKRO, near Surjani town and GOND PASS, near Hub river road and two unofficial landfill sites are IBRAHIM HYDERI and REHRI GOTH landfill sites; these sites are 30 to 35 Km away from the city centre.

It was found that the municipal solid waste of 14 towns of the Karachi city is dumped at JAM CHAKRO landfill site and the municipal solid waste of remaining 04 towns is dumped at GOND PASS. On the landfill sites the municipal solid waste (mixed garbage) is brought through uncovered vehicles comes from the different areas of the cities and dumped openly without any segregation and discipline.

MATERIALS AND METHODS

The survey was conducted during the month of Nov-2011 to Jan-2012, because the ground water gets polluted due to solid waste dumping nearer to the location.

Weight of Municipal Solid Waste Generate in the Karachi City: For calculating the exact amount of waste generated from eighteen (18) town of the Karachi city. The sites were monitored and it was noted how many tracks dump the waste at landfill sites. For the calculation of exact weight of municipal solid waste (mixed garbage), first noted the weight of the municipal solid waste with the truck (W_1), then weight of truck. (W2), after dumped of the waste, using the weighing bridge.

Weight of waste (mixed garbage) = weight of waste with truck-weight of truck

Or,

W (in ton) = $W_1 - W_2$

In this way, note the assessed weight of municipal solid waste (mixed garbage) town wise is shown in Appendix-I.

Physical Composition of Municipal Solid Waste: For this purpose, first identified the specific town then calculated the weight of municipal solid waste (mixed garbage) by subtracting the weight of truck from the loaded truck, then the mixed garbage was dumped on the cleaned covered area was segregated. After that the weights of the segregated were noted separately and then calculated the percentages. The same procedure was repeated for the rest of the towns respectively.

Chemical Composition of Municipal Solid Waste Sampling of Solid Waste: A sample from the municipal solid waste (mixed garbage) was taken by means of spot sampling method (take a sample at random from the source); first pointed out the loaded truck and then dumped it on the clean covered smooth surface, from where was taken 50 kg amount of municipal solid waste (mixed garbage) 50-60 kg. After that, segregated it and different type of composition was taken out from the mixed garbage and then took a sample on random basis from the waste about 1 kg for further analysis. The same procedure is repeated for sample collection from 06 different trucks which came from different part of the city.

After that, the samples were immediately send to the lab and were stored in a refrigerator at 4°C. Chemical parameters analyzed from municipal solid waste (mixed garbage) include pH, moisture content, Sodium, Phosphorous and Potassium. Also were determine the heavy metal like, Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel. The pH was calculated by using HACH-SENSION 156 METER.

Moisture content of the solid waste sample, procedure is to take the weight of clean empty dry plate by electronic balance, after that take 100 gm wet sample of solid waste and put it on the clean dry steel plate and note the weight of sample with plate and then place in an oven at 40°C for 24 hrs respectively. After drying the sample, note the weight of the dry sample. The dry samples are transferred into the clean polyethylene bag, sealed and numbered accordingly.

To calculate the moisture content in the sample, procedure is to taken an empty crucible, clean it and then put it in the oven for 30 min to dry at 93.5°C, after that, put the hot crucible in the desicator for cooling. Then note the weight of the clean dry crucible ($W_{1)}$) and then take 1 gm of the dry sample of the solid waste from the sealed polyethylene bag put it in the dry crucible and note the weight of the crucible plus sample(W_2). After that put the entire crucible in an oven for one hr at 105°C, cool it in to the desicator and then note the weight of the crucible plus sample (W_3).

The percent moisture content is calculated by using the following formula,

$$\text{Moisture Content (\%)} = \frac{(W2 - W1) - (W3 - W1)}{(W2 - W1)}$$

For heavy metal analysis, procedure is to take 1 gm of the dry sample of the solid waste in a beaker and add 100ml of distilled water in the beaker, after that place it on the Hot Plate and add 20 ml Aqua Regia (mixture of 75 ml HCL + 25 ml HNO_3; ratio of 3:1) and mix it well. Then take 20 ml of Aqua-Regia and add it into the sample of 100 ml, when the sample remain of 5 ml add 2-3 drops of HCL and then immediately stop heating and makeup up to 100 ml and then filter it through filter paper No. 42 and collect it into the conical flask (100 ml), make up it into the 100 ml.

After that, give the sample No of the collected sample respectively. Before run it on the Atomic Absorption, THERMO SCIENTIFIC, ICE-3000 SERIES ATOMIC ABSORPTION, first standardize the Atomic Absorption by mean of the standard solution of the required metal having 0.1 ppm, 10 ppm and 100 ppm, then find out the value of trace metal such as, Lead (Pb), Cadmium (Cd), Chromium (Cr), Nickel (Ni), Sodium (Na) and Potassium (K) of the digest sample of the solid waste.

And Phosphorous is estimated by using of Hack-DR-2800 spectrophotometer and Hack 8114, Molybduvanadate method and fixed it at program. No 480. Where 25 ml sample is mixed with 10 ml Molybduvanadate and set timer for three (3), min. After three (3) min get required value in mg/l. This is shown in the Table 3.

Physical and Chemical Characteristic of Ground Watersampling of Groundwater: Bore wells at the different location are in operation within 2 to 2.5 km around the landfill site, i.e. JAM CHAKRO. Sample of groundwater at 06 different locations at various distance from the landfill were taken, during the month of November, 2011. Sample were stored in a cold storage bath and immediately transferred to the lab.

After sampling, the samples were urgently send to the lab and were stored in a refrigerator at 4°C. Physical parameters such as pH and Total dissolved Solid (TDS) were analyzed of the groundwater by using HACH-SENSION 156 METER.

In case of chemical parameters, which were analysis of the sample in which includes, Total Hardness as $CaCO_3$, Calcium (Ca) and Magnesium (Mg) is estimated by using DIGITAL TITRATO (HACH). MODEL. NO. 16900. In this method take 10 ml of a sample in a measuring cylinder and add distilled water up to 100ml, after then transfer it into the conical flask and titrate it and find out the Total Hardness as $CaCO_3$, Calcium (Ca) and Magnesium (Mg). By using this meter, take a dilution factor (1:10) and also multiplied by the correction factor which is mathematically represented as,

$$Ca\ (mg/l) = (X) * 10 * 0.4 = Y_1$$

$$T.H\ (mg/l) = (X) * 10 = Y_2$$

And for Magnesium,

we subtract from Y_2 to Y_1 as, $Mg\ (mg/l) = Y_2 - Y_1$

Also, calculate COD for the ground water by using DIGITAL REACTOR BLOCK-DRB-200. In this method use prepared vial 1500 and add 2 ml sample and run for 2 hrs at 150°C after 2 hrs take it out and put it for cool and again placed it in the spectrophotometer. i.e., Spectro-DR-2800 and fixed at Program. No- 435-Program. Then get the value of the COD level in the ground water in mg/l.

For the trace of metal contents, take 100ml sample of groundwater and digest it. And placed it on the Hot Plate and add 20 ml of Aqua-Regia (mixture of 75 ml HCL + 25 ml HNO_3; ratio of 3:1) and mix it well. then takes 20 ml of Aqua-Regia and adds it into the sample of 100 ml, when the sample remain of 5 ml add 2-3 drops of HCL and then immediately stop heating and makeup up to 100 ml and then filter it through filter paper No. 42 and collect it into the conical flask (100 ml), make up it into the 100 ml.

Then gives the sample No accordingly. Before run it on the Atomic Absorption, THERMO SCIENTIFIC, ICE-3000 SERIES ATOMIC ABSORPTION, first standardized the Atomic Absorption by mean of the standard solution of the required metal having 0.1 ppm, 10 ppm and 100 ppm and then run the prepared sample accordingly and find out the value of trace metal such as, Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni), in the groundwater.

And phosphorous is estimate by using of Hack-DR-2800 spectrophotometer and Hack 8114, Molydbduvanadate method and fixed it at program. No 480. Where 25 ml sample is mixed with 10 ml Molydbduvanadate and set timer for three (3), min. After three (3) min get the required value in mg/l.

RESULTS AND DISCUSSION

Current Status of MSW Generated in Karachi City: Karachi is divided into five zones (east, west, south, central and malir), eighteen (18) towns and 178 union councils. Karachi city generated more than 10,000 ton / day of municipal solid waste and dumped at the landfill site without proper planning and segregation. Out of the total amount of municipal solid waste 60% 0f the total amount of municipal solid waste are dumped on the landfill site and rest of 40% remain on the street and did not collect from the towns. During the month of November, 2011 to December, 2012 survey was conducted and find out amount of garbage dumped at the landfill site.

Out of 18 town only eleven town such as, Gulshan, Gulberg, Gaddap, Korangi, Liaquatabad, Landhi, Malir, North-Nazimabad, North Karachi, Shah Faisal and Bin Qasim towns dumped their garbage at the Jam Chakro landfill site and too much without any proper planning and segregation of the garbage. Amongst them, Bin Qasim town does not dumped at the official landfill site; instead it dumped solid waste close to the town at kachra kundhi. This is because Bin Qasim town is too far from the Jam Chakro landfill site and the cost trip is too high. Therefore, CDGK has a plan to construct an official landfill sites near the Bin Qasim town. The town that dumped their solid waste at the Jam Chakro landfill site is shown in the Table1 and Table 2.

Rest of four towns dump their waste at the Gond Pass landfill town near Hub River due to its being much near to the town as compared to Jam Chakro landfill site. The towns which dumped at the Goud Pass landfill sites such as Baldia town, Kemari town, Lyari town and Orangi town, during sampling it was observed that the municipal solid waste (mixed garbage) generated by these towns, which indicates in the Table 3.

Three towns of them i.e., Jamshed town, Sadder town and S.I.T.E town are those that dumped their waste at both landfill sites. C.D.G.K trucks collect the municipal solid waste from roadside, Street of the town and other places to transport it to the nearest landfill sites. Sadder town and Jamshed town consists of 11 and 13 Union Councils and both the towns comprise big market of the city that produce huge amount of mixed garbage such as, house hold garbage as well as market garbage.

Table 1: Weight of MSW dumped on jam chakro landfill site, Karachi

	(1)	(2)	(3)	(4)	(5)	(6)		
	Weight (In Ton/ per day)						Total Trips	Total Weights
Date							(per day	(Ton / day)
21-Nov	470. 5	248. 82	0	0	181.31	603.3	94	1503. 93
22-Nov	359. 46	310. 51	292. 7	155. 32	157.29	211.15	136	1486. 43
23-Nov	569. 3	231. 72	44. 59	184. 27	187.22	220.98	142	1438. 08
24-Nov	527. 05	247. 35	32. 14	211. 59	211.59	351.44	138	1581. 16
25-Nov	435. 24	161. 99	188. 24	281. 1	202.01	364.83	161	1633. 41
12-Dec	385. 32	242. 46	199. 32	324. 01	180.61	341.96	165	1673. 68
13-Dec	492. 07	218. 53	137. 13	386	256.18	384.08	168	1873. 99
14-Dec	356. 45	349. 25	215. 74	554. 52	278.5	679.12	211	2433. 58
15-Dec	602. 3	274. 43	266. 97	492. 07	287.52	612.58	218	2535. 87
16-Dec	593. 84	454. 5	256. 74	494	272.24	566.58	234	2637. 9
2-Jan	358. 17	380. 22	0	441. 06	15.79	373.44	125	1568. 68
3-Jan	265. 09	378. 5	205. 2	325. 69	323.86	293.57	175	1791. 91
4-Jan	256. 98	328. 45	129. 33	106. 65	362.2	479.29	158	1662. 9
5-Jan	539. 5	410. 67	97. 82	331. 4	493.84	377.78	191	2251. 01
6-Jan	456	380. 22	127. 95	303. 62	420.09	230.19	169	1918. 07
Total Amount	6667. 27	4617. 62	2193. 87	4591. 3	3830. 25	6090. 29	2485	27990. 6
Average Amount	444. 48	307. 84	146. 25	306. 08	255. 35	406. 01		

(*1)=Gulshan Town, (2)=Gulberg Town, (3)=Gaddap Town, (4)=Korangi Town, (5)=Liaquatabad Town, (6)=Landhi Town*

Table 2: Weight of garbage dumped on jam chakro landfill site, Karachi

	(1)	(2)	(3)	(4)	(5)		
	Weight (In Ton/ per day)					Total Trips	Total Weights
Date						(per day)	(Ton / day)
21-Nov	217.7	330.83	297.88	237.95	0	156	1084.36
22-Nov	212.45	311.56	300.82	283.77	0	174	1108.6
23-Nov	176.17	587.9	284.9	239.64	30	183	1288.61
24-Nov	193.67	326.49	221.3	235.84	0	85	977.3
25-Nov	287.28	494.84	360.25	274.41	0	193	1416.78
12-Dec	301.65	509.07	452.32	223.11	0	191	1486.15
13-Dec	270.18	423.99	371.15	246.3	0	186	1311.62
14-Dec	202.88	462.92	323.3	257.97	0	160	1247.07
15-Dec	205.18	344.09	320.35	263.15	0	167	1132.77
16-Dec	234.83	380.45	353.2	271.26	0	172	1239.74
2-Jan	231.08	228.71	128.29	207.47	0	70	795.55
3-Jan	239.1	468.47	456.58	191.92	0	206	1356.07
4-Jan	196.21	384.5	462.09	217.81	0	199	1260.61
5-Jan	229.01	361.56	375.23	202.75	0	177	1168.55
6-Jan	237.83	483.68	363.07	263.61	0	192	1348.19
Total Amount	3435.22	6099.06	5070.73	3616.96	0	2511	18221.97
Average Amount	229.01	406.604	338.04	241.13	0		

(1)=Malir Town, (2)=North Nazimabad Town, (3)=North Karachi Town,

(4)=Shah Faisal Town, (5)=Bin Qasim Town

Table 3: Weight of garbage dumped on Gond pass landfill site, Karachi

Date	(1) Weight (In Ton/ per day)	(2)	(3)	(4)	Total Trips (per day	Total Weights (Ton / day)
21-Nov	273.9	147.2	0	0	51	421.1
22-Nov	255	92.66	284	76.49	95	708.15
23-Nov	266.9	88.04	498.99	0	114	853.93
24-Nov	0	187.76	356.04	300.12	78	843.92
25-Nov	300.13	81.81	406.05	331.91	133	1119.9
12-Dec	472.54	70.07	374.64	323.15	128	1240.4
13-Dec	480.41	82.79	379.663	434.94	131	1377.803
14-Dec	502.34	73.5	446.52	387.46	131	1409.82
15-Dec	449.21	163.27	431.03	301.97	153	1345.48
16-Dec	532.97	92.6	580.81	323.18	173	1529.56
2-Jan	429.95	49.46	149.92	341.51	101	970.84
3-Jan	456.06	66.32	500.99	363.68	145	1387.05
4-Jan	230.77	87.69	566.29	326.2	135	1210.95
5-Jan	261.97	84.05	115.94	246.7	87	708.66
6-Jan	679.06	19.23	318.65	454.85	132	1471.79
Total Amount	5591.21	1386.45	5409.53	4212.16	1787	16599.353
Average Amount	372.74	92.43	360.63	280.81		

(1)=Baldia Town, (2)=Kemari Town, (3)=Layari Town (4)=Orangi Town

Table 4: Weight of garbage dumped on Jam chakro and Gond pass landfill site, Karachi

Date	(1)		(2)		(3)		(4)		Total Trips (per day	Total Weights (Ton / day)
	(J)	(G)	(J)	(G)	(J)	(G)	(J)	(G)		
	Weight (In Ton/ per day)									
21-Nov	344.0	0.0	0.0	243.2	78.7	110.7	592.0	410.3	201.0	1778.9
22-Nov	534.8	46.2	90.1	195.8	302.6	13.0	532.7	373.0	265.0	2088.2
23-Nov	743.5	0.0	292.7	197.2	0.0	0.0	255.8	358.6	279.0	1847.7
24-Nov	437.0	51.1	0.0	0.0	338.7	0.0	246.1	349.4	193.0	1422.3
25-Nov	782.7	0.0	74.3	143.7	0.0	4.5	47.6	508.4	292.0	1561.1
12-Dec	572.9	16.2	93.1	178.9	354.2	1.7	294.5	430.5	270.0	1941.9
13-Dec	912.2	0.0	195.6	54.1	393.5	2.5	299.5	433.8	299.0	2291.0
14-Dec	628.2	13.5	62.5	438.7	292.9	2.5	265.1	479.4	279.0	2182.8
15-Dec	646.8	0.0	113.4	311.5	276.6	0.0	145.5	569.6	283.0	2063.4
16-Dec	717.7	0.0	69.9	357.4	401.8	2.0	114.2	580.8	301.0	2243.7
2-Jan	394.3	0.0	0.0	240.3	345.5	0.0	22.0	0.0	112.0	1002.0
3-Jan	533.0	0.0	153.2	407.4	358.5	0.0	99.6	618.0	295.0	2169.8
4- Jan	682.4	0.0	245.4	236.3	389.2	4.7	65.3	0.0	215.0	1623.2
5- Jan	438.4	0.0	100.4	281.8	466.9	0.0	63.4	0.0	157.0	1350.9
6- Jan	358.0	5.9	67.7	257.6	641.7	64.2	32.4	32.4	224.0	1459.8
Total Amount	8725.6	132.9	1558.4	3543.8	4640.6	205.7	3075.7	5144.2	3665.0	27026.9
Average Amount	581.7	8.9	103.9	236.3	309.4	13.7	205.0	324.9		

(1)= Jamshed Town, (2)= Saddar Town, (3)= S.I.T.E Town,(4)= C.D.G.K

(J)= Jam Chakro, (G) = Gond Pass

Similarly, S.I.T.E town consists of nine Union Council and comprises largest industrial zone of Karachi city.This town also generates huge amount of garbage that is dumped at both the city landfill sites (Table 4). Some of the figure giving the amount of mixed garbage collected and dumped per day at landfill sites (60% of the total garbage generated) are as follow: 4788.25, 5391.33, 5428.33, 4824.68, 5731.23, 6342.12, 6854.443, 7273.3, 7077.56, 7650.94, 4337.11, 6704.81, 5757.7, 5479.13 and 6197.84 ton / day was collected and dumped at two landfill site and rest 40% mixed garbage was not collected and dumped at two landfill sites and rest of the 40% is not

collected from the towns that remains on the streets of Karachi city. Unfortunately, the dumping at the two landfill sites is without proper planning and segregation of the garbage, which not only adversely affected the aesthetic beauty of the Karachi city, but also causes bad odor, serious diseases and the bad impact on the environment. According to the Pak-EPA, (2005) [20] the mixed garbage generated from the different areas varies from 1.896 kg/house/day to 4.29 kg/house/day in a few major areas of the city.

An average amount (ton per 15 days) of the mixed garbage generated by each individual town is: Gulshan 444.48, Gulberg 307.84, Gaddap 146.25, Korangi 306.08, Liaquatabad 255.35, Landhi 406.01, Malir 229.01, North Nazimabad 406.60, North Karachi 338.04, Shah Faisal 241.13, Bin Qasim 0, Baldia 372.74, Kemari 92.43, Lyari 360.63, Orangi town 280.81, 590.56, 340.14, 323.08, 529.98 tons. From the tables it is indicated that Sadder town and Gulshan town produced higher amount of municipal solid waste (MSW) than the other towns.

In 2006, CDGK solid waste management department also estimated the amount of municipal solid waste generated and actual amount lifting and the amount that remained unattended to. These values have been compared with the values obtained during the survey conducted in November, 2011 to January, 2012 for the present study. The comparison has been shown Table 5.

According to the record, amount of municipal solid waste generated and filled in 2006 were 6113 tons and 5057 tons/day respectively, while 1057 tons remained on the streets of the city. Survey conducted by us in Nov-11 to Jan-2012 showed that the amount of lifted solid waste was 8907.27 ton / day. This indicates that the amount of the MSW generated and lifted has almost doubled over a period of 5 years. 60% of MSW dumped at the landfill site and 40% of MSW did not collect from the town it shows that municipal solid waste increases 50% from 2006.

Composition of Municipal Solid Waste Generated in Karachi City: It is has found that, the mixed municipal solid waste (MSW) comprises food waste, kitchen waste, green waste, paper waste, plastic waste, glasses, can,, metal, plastic, dirt, rock, clothing, tetra pack, debris, lighting bulb, sand and wood/board and other miscellaneous items. Composition is an important tool which help us in deciding about the treatment to be given to the given to the M|SW. Particularly about the reuse and recycling of certain composition of the waste. During, the studies in November, 2011 to January, 2012, the garbage from individual towns was categorized according to its composition. It was found out as to what percentage each fraction or category of the garbage was generated in different towns. Proportion and kind of the components of varies from town to town.

Table 5: Comparison of MSW generated in Karachi city in 2006 and 2011-12

S. No	Name of Towns	MSW Generated in 2006	Actual Liftingper day(in ton)	Blocklogper day (in ton)	Actual Lifting Of MSW In 2011-2012
01	Gulshan Town	400	318	82	593.84
02	Gulberg Towm	330	330	0	410.67
03	Gaddap Town	350	320	30	266.97
04	Korangi Town	360	272	88	554.52
05	Liaquatabad Town	800	594	206	493.84
06	Landhi Town	370	324	46	679.12
07	Malir Town	280	270	10	301.65
08	North Nazimabad Town	375	336	39	587.9
09	North Karachi Town	365	280	85	462.09
10	Shah Faisal Town	105	105	-	283.77
11	Bin Qasim Town	65	27	38	0
12	Baldia Town	400	302	99	679.06
13	Kemari Town	220	180	40	163.27
14	Layari Town	350	300	50	580.81
15	Orangi Town	346	240	106	454.85
16	Jamshed Town	330	525	78	958.38
17	Sadder Town	500	454	46	684.15
18	S.I.T.E Town	167	153	14	752.38
	Total Amount	6113	5057	1057	8907.27

Table 6: Physical COMPOSITION OF waste of MSW generated in Karachi city

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Weight (In Kilograms)								
Name of Fraction									
Kitchen	150.2	96.2	186.2	181	200.5	146.2	180.2	230.2	110
Green	110.7	75.3	95.3	101	110.3	105.3	125.3	135.3	85.3
Paper	37.1	27.5	57.5	27.1	47.2	47.5	67.5	87.5	57.5
Glass	76.3	25.6	55.6	56.3	36.2	35.6	35.6	55.6	15.6
Metal	5	1	9	8	2	8	14	12	11.6
Plastic	37.4	35.3	65.3	47.3	57.1	55.3	35.3	45.3	25.3
Dirt	20.1	16.2	26.2	18.1	28.2	16.2	24.2	14.2	14.2
Nappies	61	51.3	41.3	51.6	41.4	51.3	71.3	61.3	51.3
Clothing	20.7	38.5	48.5	18.5	28.5	58.5	62.5	72.5	35.5
Tetra Pack	86.8	41.4	51.4	71.7	51.4	41.4	61.4	81.4	41.4
Wood /Board	47.4	14.1	20.1	17.1	13.1	18.1	21.1	22.1	20.1
TotalWeight	647.3	422.4	656.4	597	616	583.4	698.4	817	468

(1)= Liaquatabad Town, (2)= Lyari Town, (3)= Malir Town, (4)= North Nazimzmbad Town, (5)= North Karachi Town, (6)= Orangi Town, (7)= Shah Faisal Town, (8)= SaddarTown, (9)= S.I.T.E Town

Table 7: Physical COMPOSITION OF waste of MSW generated in Karachi city

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Weight (In Kilograms)								
Name of Fraction									
Kitchen	119.1	72.1	112.5	175.5	265.4	190.8	89.8	100.6	118.2
Green	75.3	65.3	105.3	80.4	120.5	120.6	45.6	85.2	100.3
Paper	47.5	37.5	27.5	37.2	67.1	77.2	17.2	27.1	37.1
Glass	28.6	18.6	14.6	15.1	16.1	25.1	20.1	28.6	18.6
Metal	7	10.2	1	3	4	9	2	3	6
Plastic	15.3	16.3	14.3	47.3	67.5	67.3	57.3	77.3	45.3
Dirt	12.2	18.2	15.2	28.2	38.2	38.2	18.2	20.2	12.2
Nappies	61.3	71.3	61.3	31.4	71.4	71.4	31.4	51.4	41.3
Clothing	23.5	55.5	45.5	38.5	48.5	48.5	28.5	38.5	48.5
Tetra Pack	31.4	51.4	61.4	61.4	71.4	51.4	41.4	61.4	51.4
Wood/ Board	10.1	11.1	15.1	15.1	10.1	17.1	7.1	27.1	12.1
Total Weight	431.3	427.5	473.7	533.1	770.2	716.6	358.6	520.4	491

(1)= Baldia Town, (2)= Bin Qasim Town, (3)= Gadap Town, (4)= Gulberg Town, (5)= Gulshan Town, (6)= Jamshed Town, (7)= Kemari Town, (8)= Korangi Town, (9)= Landhi Town

For example, some town produced large amount of kitchen waste, green waste, paper plastic, tetra pack as against larger amounts of dirt debris, metal, clothing and wood produced by some other towns. The nature of the garbage produced depends upon the type of the locality you are dealing with; for example residential vs. commercial, poor and middle class residents vs. upper class and well to do class of residents. Compositions also help in separating the recyclable articles from the other type of the material such as organic type and some other that can be used for composting. According to the Ahmed, *et. al*., (2002) [21], organic waste are also responsible for pollution of soil and water bodies through leachate and in the process of uncontrolled anaerobic degradation it contributes to global warming by the produced methane.

During the survey conducted for the present study the composition of municipal solid waste and percentages of various components or categories of the waste were determined town wise. Thos indicates that 80% of the waste comprised recyclable materials such as paper, plastic, glass and metal fraction and rest of 20% was organic type waste. This indicates in the following table 6 and Table 7,

It was observed during the survey, that the waste picker or scavengers were mostly Afghani. They picked up most of the recyclable or reuse material from the municipal solid waste. These scavengers collect the

Table 8: Physico-chemical characterization of municipal solid waste (MSW)

S. #	pH	M.C (%)	(Na)	(PO4)	(K)	(Pb)	(Cd)	(Cr)	(Ni)
			mg/kg						
SW1	8.21	1.35	12875.58	1370	609.57	107.2	4.74	58.93	100.8
SW2	7.9	1.36	11129.49	1310	449.99	149.7	5.07	63.66	103.6
SW3	8.11	1.33	8154.69	1290	450.26	168.5	4.78	104.5	116.8
SW4	7.98	1.57	10525	1460	563.03	159.2	4.58	92.99	112.3
SW5	7.92	1.46	9668.03	1160	249.22	159.1	3.75	102	111
SW6	7.99	1.66	8125.05	1280	442.02	180.4	4.53	100.9	117
S 1*	5.5-9.0	No Specs	100	5	50	15			
S 2**	5.5-8.0	<50	----						

M.C indicates Moisture Content, All values in (mg/kg) except pH and moisture content, Sodium (Na), Phosphate (PO4), Potassium (K), Lead (Pb), Cadmium (Cd), Chromium (Cr), Nickel (Ni)

**S 1 (Indian Standard 1) = *MSW (Manag Handling) Rule 2000.*

*** S 2 (Standard 2) = **Zucconin and deBertoldi, 1987 standard*

waste from door to door as well as from the kachra-kundhi (dust bins), sort it out and keep the portion with worth and throw away the rest carelessly, which is littered on the streets, become stinky, cause ugliness and health hazards.

It has been survey of 18 towns that the solid waste mostly comprising, kitchen waste, garden waste, nappies and clothing materials is largely produced by the high income residential areas, whereas organic type of waste is generally generated from the vegetable markets. The towns that includes like Sadder town, Jamshed town, Gulberg town and Gulshan-e- Iqbal towns produced waste with greater amount of paper, plastic, glass and some amount of metals. Liaquatabad town generated waste consisting dominantly of wood/Board material The nature (composition) of solid waste generated in various towns of the city largely depends upon the social status of the inhabitants and the types of the markets occurring there.

Study the Quality of Municipal Solid Waste in the Vicinity of Landfill Site: In order to characterized the municipal solid waste at a landfill pH, moisture content, sodium, phosphate, potassium and heavy metal contents were determined (Table 8). Heavy metal remain unaffected during degradation of organic waste and become toxic when the concentration of heavy metal exceeding a certain limits. In case of the compost from solid waste being used as manure then heavy metals are subject to bioaccumulation and may cause risk to human health, as they are transferred to the food chain. Exposure to heavy metal may cause blood and bone disorders, kidney damage and decreased mental capacity and neurological damage. Landfill leachates are the major source of hazard to the environment. Several cases of groundwater pollution from landfill leachates were reported.

The analytical result shows that pH of Table-1 and Tabl;e-3 slightly alkaline and the moisture content is favorable for composting. Also, heavy metal contents of the municipal solid waste collected at different location (on random basis) have been shown in Table 8. The concentration of Lead, Cadmium, Chromium and Nickel are comparatively high. The analytical results of the contents of the above metals, when compared with standards, shown that the concentration of metal such as, lead, Cadmium, Chromium and Nickel were beyond the permissible limits for drinking water.

Study the Ground Water near about the Landfill Site: Landfills have been identified as one of the major threat to groundwater resources (Fatta, *et al*., 1999; USEPA, 1984). Open dumping of mixed garbage is a threat to the surface water as well as underground water and the surrounding environment. The dumped solid wastes gradually release their initial interstitial water and some of its decomposition by-products get into water moving through the waste deposit. Such a liquid containing innumerable organic and inorganic compound is called Leachate. This leachate accumulates at the bottom of the landfill and percolates through the soil.

Groundwater near the landfill sites becomes contamination because of the potential pollution source of leachate originating from the nearby site. Such contamination of groundwater resource poses a substantial risk to users and to the natural environment.

Table 9: Physico-chemical characterization of ground water sample

Sample #	pH	(TD S)	(T. H)	(Ca)	(Mg)	(CO D)	(Pb)	(Cd)	(Cr)	(Ni)
	mg/l									
GW1	7.06	1095	830	112	297.3	67	0.10	0.04	0.31	0.17
GW2	7.28	1488	800	116	283.2	70	0.11	0.04	0.32	0.16
GW3	7.36	1486	600	136	192.1	68	0.09	0.03	0.42	0.15
GW4	7.36	1489	680	128	228.5	71	0.16	0.04	0.42	0.17
GW5	7.42	1472	700	144	230.2	66	0.12	0.04	0.32	0.17
GW6	7.41	1486	820	152	276.6	80	0.08	0.03	0.32	0.17
Pak. STD.*	6.5-8.5	< 1000	< 500	---	---	---	= 0.05	0.01	= 0.05	=0.02
Ind. STD.**	--	--	300	75	30	20	---	---	---	---

Total Hardness (T.H),Calcium (Ca),Magnesium (Mg),Lead (Pb),Cadmium (Cd),Chromium (Cr),Nickel (Ni), (COD) Chemical Oxygen Demand, All values in (mg/l) except pH, Total Dissolved Solids (TDS)

**Pakistan Standard values for Pakistan*

*** Indian Standard Value*

The impact of landfill leachate on the surface and groundwater has been discussed in several studies in recent years. Our landfill sites are old and municipal waste is openly dumped at the landfill sites without taking any kind of precautions. Due to which leachate migrate from municipal waste towards the groundwater table and contaminate it. Therefore, the physical and chemical characteristics of the groundwater occurring near the landfill sites have been examined and the values are shown in the Table 9. These values have been compared with the NEQS standard.

This showed that the groundwater near the landfill site is polluted with the leachate derived from the municipal solid waste. The pH of ground water is slightly alkaline and the TDS, total hardness, calcium, magnesium and the values of COD is beyond the permissible limits.

Results of heavy metal analysis were compared with the standard values. It was found that the values of concentration of Lead, cadmium, Chromium and Nickel are beyond the permissible limits of the ground water and ground water is unfit for the use of domestic purpose as well as for the agricultural purpose. Therefore, it is necessary to make a proper plan to enhance and improve our solid waste management practices to prevent the contamination of surface as well as ground water quality.

CONCLUSION

Based on the study, it concluded that more than 10,000 ton per day of municipal solid waste generated from the Karachi city. Which is comprises 18 towns and 178 Union Council. Of the total amount of municipal solid waste 60% is dumped at the landfill sites and rest of the 40% remain littered on the street of the city, which not only spoils the face of the city but also becomes a stake for the health of its citizens.

Out of total municipal solid waste generated, 80% contains recyclable material and the remaining 20 % is organic type waste.

On the basis of analysis of the municipal solid waste, it is found that the pH is slightly alkaline, moisture content is less than 50% and the amount of heavy metal like, Lead, Cadmium, Chromium and Nickel are beyond the permissible limits. They are responsible for casting bad impacts on the environment as well as for contaminating groundwater in the vicinity of the landfill sites through leachate forming.

The pH of groundwater is slightly alkaline and Hardness of ground water is due to the leaching of both Ca and Mg into the groundwater Table.

Heavy metals contents in the groundwater like Lead, Cadmium, Chromium and Nickel are beyond the permissible limits.

REFERENCES

1. Nyangababo, J.T. and J.W. Hamya, 1980. The Deposition of Lead, Cadmium, Zinc and Copper from Motor Traffic on Bradaria Enimi and Soil along a mojor Bombo Road. Int. J. Environ. Stud. Legoi, 1(32): 117.
2. Buenrostro, O. and G. Bocco, January. Solid Waste Management in Municipalities in Mexico: Goals and Perspectives, Resource. Conserv. Recycl, 39: 251-263.

3. UNEP, 2005. Global Environment Outlock (GEO) 3 Data Portal, United Nation Environment Programme. UNEP, [Online] Available: http:// geodata. Grid.unep.ch/.
4. UNEP, 2001. Solid Waste Management, Nepal: State of the Environment 2001, United Nation Environment Programme, pp: 97-118.
5. Murtaza, G. and A. Rahman, 2000. Solid waste Management in Khulana city and a Case Study of a CBO: Amader Paribartan. In: Community Based Solid Waste Management: The Asian Experience. Waste Concern, Dhaka, Bangladesh.
6. Misra, V. and S.D. Pandey, 2005. Hazardous Waste, Impact on Health and Environment for Development of Better Waste Management Strategies in Future in India. Environment International, 31(3): 417-431.
7. Elizabeth, 1998. Incorporating the environment into Municipal Solid Waste Planning: Life Cycle Inventory Tools Paper Presented at System Engineering Model for Waste Management. International Workshop in Goteborg Sweden, pp: 25-26.
8. Jurczak, G.M., 2003. The Relation between Education, Knowledge and Action for Better Waste Management in Poland. Waste Management and Research, 21: 2-18.
9. Woodard, R., M.K. Harder and N. Stantzos, 2004. The optimization of Household waste Recycling centers for Increased recycling-A case Study in Sussex, UK, Waste and Energy Research Group (WERG), School of the Environment. University of Brighton, Lewes Road, Brighton, Sussex, UK.
10. Suocheng, D., K.W. Tong and W. Yuping, 2001. Municipal Solid Waste Management in china: Using Commercial management to solve a growing problem. Utilities policy, 10: 7-11.
11. Dong, S.S., K.W. Tong and Y.P. Wu, 2001. Municipal Solid waste Management in China: Using Commercial Management to Solve a Growing Problem. Utilities Policy, 10, 7-11. http:// china 5e.com/dissertation/ naturalgas/0058.htm (in Chinese).
12. Fatta, D., A. Papadopoulos and M. Loizidou, 1999. A Study on the Landfill Leachate and Its Impact on the Groundwater Quality of the Greater area. Environ. Geochem. Health, 21(2): 175-190.
13. United States Environmental Protection Agency (USEPA), 1984. Office of Drinking Water, a Groundwater Protection Strategy for the Environmental Protection Agency, pp: 11.
14. Saarela, J., 2003. Pilot Investigations of Surface Part of three Closed Landfills and Factors affecting them environ.Monit.Assess, 84: 183-192.
15. Abu-Rukah, Y. and O. Al-Kofahi, 2001. The Assessment of the Effect of landfill Leachate on ground-Water Quality-A Case Study. El-Akader Landfill Site-North Jordan, Arid Environ, 49: 615-630.
16. Looser, M.O., A. Parriaux and M. Bensimon, 1999. Landfill Underground Pollution Detection and characterization Using Inorganic Traces. Water res., 33: 3609-3616.
17. Christensen, J.B., D.L. Jensen, C. Gron, Z. Filip and T.H. Christensen, 1998. Characterization of the Dissolved Organic Carbon in Landfill Leachate-Polluted Groundwater, Water Res., 32: 125-135.
18. DeRosa, E., D. Rubel, M. Tudino, A. Viale and R.J. Lombardo, 1996. The Leachate Composition of an Old Waste Dump Connected to Groundwater: Influence of the Reclamation Work. Environ. Monit. Assess, 40(3): 239-252.
19. Flyhammar, P., 1995. Leachate Quality and Environmental Effect at Active Swedish Municipal Landfill, in: R. Cossu, H.T. Christensen and R. Stegmann (eds) Regulations, Environmental Impact and Aftercare. Proceedings Sardiia 95, Fifth International Landfill Symposium. Vol.III, Sardinia, Italy, pp: 549-557.
20. Pak-EPA, Guidelines for Solid Waste Management, Pak-EPA in Collaboration with JICA, Ministry of Environment, PEP and UNDP (2005).
21. Ahmed Noman and Chris Zurbrugg, 2002. Urban Organic Waste Management In Karachi, Pakistan. 28th WEDC Conference in Kolkata, pp: 18-22.