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A STUDY ON MUNICIPAL SOLID WASTE AND GROUND WATER QUALITY IN UDUMALPET, TAMILNADU, INDIA

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Abstract:

Municipal solid waste was collected in Residential area, Commercial area and Dump yard to identify the nature of waste which would give idea to handle the waste. Also the ground water samples were collected in and around Udumalpet land fill site to study the possible impact of municipal solid waste (MSW) on ground water resources in that area. The main objective of this study is to determine the generation rate and composition of municipal solid waste and ground water pollution related to waste disposal with the intention of providing base line data for development of municipal solid waste management system in Udumalpet Municipality which is pivotal for the decision towards the appropriate waste management system, the bio degradable portion of MSW was used for physico chemical analysis which implies that potassium and sodium were in higher concentration and thus the soluble nature of waste been identified. The MSW is characterized and it shows high level of biodegradable waste, whereas the percentages of recyclables are low hence that implies the need for segregation of waste at source. Also ground water was tested for pollution studies which revealed high concentration of hardness and sodium which may be due to dumping of waste in open environment.

Key Words: Municipal Solid Waste, Ground Water, Characterization, Pollution, Solid Waste Management & Landfill

1. Introduction:

In the developing countries, the ever increasing human population and the associated anthropogenic activities have accelerated the phenomenon of urbanization in the past decade. This scenario has left many Indian cities lacking in basic infrastructural services like water supply, sanitation and sewerage and solid waste management. With the rising population and the associated unsustainable practices, there has been an enormous increase in the quantum as well as the diversity of the solid waste being generated.

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, construction or institutional) according to its contents (organic material, glass, metal, plastic, polythene paper etc) or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc). Globally, MSW generation has continued to increase in line with growth in other socio-economic parameters such as population, personal income and consumption patterns (Achankeng, 2003; IPCC, 2006). In the last two decades, per capita waste generation in the developed economies has increased nearly threefold (AfDB, 2002). According to the same study, waste generation in the developing nations is growing rapidly and may double in aggregate volume within this decade, driven largely by growth in population and improvements in living standards. If current trends persist, a fivefold increase in global MSW generation is probable by the year 2025 (AfDB, 2002).

Management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. A number of processes are involved in effectively managing the waste for a municipality. These include monitoring, collection, transport, processing, recycling and disposal. In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste. In 1997 it was about 48 million tonnes. (CPCB 2000a)

More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are neither well equipped nor well managed and are not lined properly to protect against contamination of soil and ground water. Improper disposal of solid wastes pollutes all the vital components of the living environment (i.e., air, land and water) at local and global levels. The problem is more acute in developing nations than in developed nations, as their economic growth as well as urbanization is more rapid.

Waste quantities are increasing and municipal authorities are not able to upgrade or scale up the facilities required for proper management of such wastes. In many cities and towns, garbage is littered on roads and foot-paths. At large, lack of organized system of house-to-house collection of waste has created the littering habits.

2. Objectives of the Present Study:

The success of waste management requires accurate data on generation and composition of waste which is pivotal for the decisions towards the appropriate waste management system. At present there is no data available on Municipal Solid Waste (MSW) generation and composition collected systematically in Udumalpet Municipality of Tirupur District, Tamilnadu, India. Hence, this Municipality selected as case study region for the present study. The main objective of this study is to determine the generation rate and composition of municipal solid waste with the intention of providing base line data for development of municipal solid waste management system in Udumalpet Municipality.

3. Materials and Methods:

Udumalaipettai is a town in Tirupur district in the Indian state of Tamil Nadu. Udumalaipettai had a population of 61,133 with a sex-ratio of 1041 females for every 1000 males, much above the national average of 929. The town had a total of 17132 households. There were a total of 24,756 workers, comprising 226 cultivators, 289 main agricultural laborers, 450 in house hold industries, 21,403 other workers, 2,388 marginal workers, 51 marginal cultivators, 70 marginal agricultural laborers, 46 marginal workers in household industries and 2,221 other marginal workers. There are paper manufacturing plants located alongside the Amaravathi River Only 1.25% of land to the total area of the town is covered under agricultural usage.

3.1 Municipal Solid Waste – Collection and Characterization:

In the present study, MSW was collected from Residential, commercial and dump yard of Udumalpet municipality. The sample was collected to identify the nature of the waste which would give an idea to handle the waste. The sampling was done in the month of December 2016. The dried samples collected from all the locations were subjected to segregation and the segregated samples were weighed separately. The dried and pulverized biodegradable portion of MSW was used for physico - chemical analysis. For the characterization of MSW, samples were thoroughly mixed for 30 minutes in the ratio of 1:10 with distilled water using mechanical shaker. The respective filtration subjected for analyzing of various physico – chemical parameters.

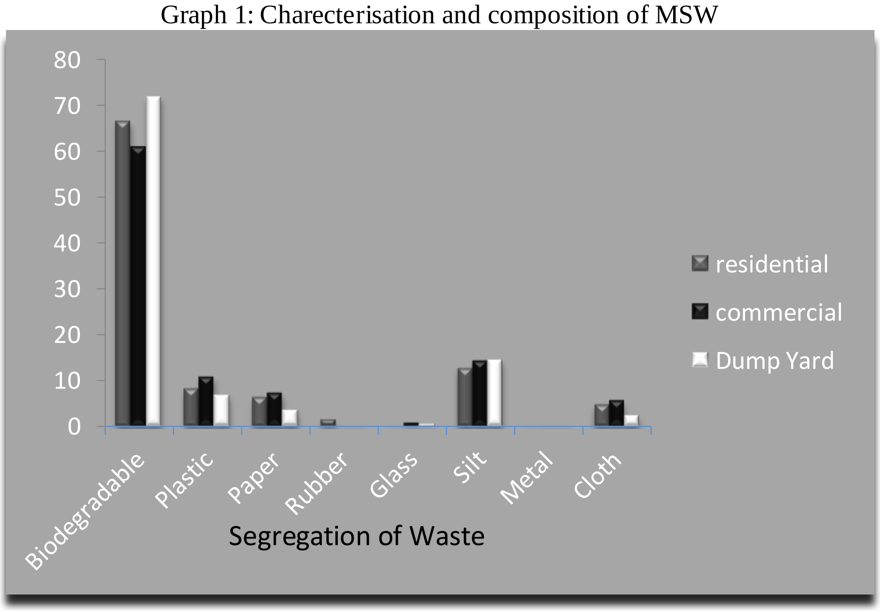
All the samples were analyzed for the following Physico-chemical parameters: Bulk Density, Moisture content, Ash Content, Loss on Ignition and Total Organic Carbon Total Nitrogen, pH, Calcium (Ca), Sodium (Na), Potassium (K), Sulphate (SO4) and Phosphate (PO4). The analysis was carried out in accordance to standard analytical methods (APHA).

3.2 Ground Water Analysis:

To study the influence of the MSW dumping on ground water quality, the water samples were collected randomly from 7 sampling sites at different directions around the entire MSW dumping yard at Udumalpet municipality. The ground water samples were collected during the months of December, 2017 and analyzed for various physico-chemical parameters to qualify the ground water (samples: S1, S2, S3, S4, S5, S6, S7). All the water samples were analyzed for the following Physico-chemical parameters: pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Turbidity, Total Hardness, Calcium (as Ca), Magnesium (as Mg), Total Alkalinity (as HCO_3), Nitrate (as NO_3), Nitrite (as NO_2), Chlorides (as Cl), Sulphate (as SO_4), Sodium (as Na) and Potassium (as K). The analysis was carried out in accordance to standard analytical methods (APHA).

4. Result and Discussion:

Graph 1: Charecterisation and composition of MSW



At present the Municipal Solid Waste Management is one of the major, neglected parts in handling the waste and it becomes a growing environmental problem of Indian megacities. Economic and human population growth as well as changes in lifestyles and is consumption patterns, have been the main drives to a progressive increase in the generation of solid waste. In the present study municipal solid waste samples were collected from Residential, Commercial and Dump yard were characterized for both physical and chemical characterstics. The physical analysis of solid waste was performed by sorting the waste manually into its components. These fractions were then represented as percentage by weight in the graph 1.

The result of analysis clearly indicated that the major composition of the Udumalpet municipality waste was biodegradable and it was ranged between (60.8-71.81%),followed by silt (12.68-14.47%), plastics (6.78-10.78%), papers (3.52-7.22%), cloth (2.44-5.6%).The solid waste composition in the most Asian countries is highly biodegradable, mainly composed of an organic fraction with high moisture content (vishvanathan et al 2004).Also, kurian et al,(2012) stated that the biodegradable waste was high when compared to non biodegradable waste in municipal solid waste composition at Chennai corporation. The municipal solid waste is site specific and it varies on nature and source (kannani and Gandhimathi 2012).The change in the life style had caused undesirable change in the composition of municipal solid waste. The percentage of recyclable wastes (paper, glass, plastics and metals) is very low, because of rag pickers who segregate and collect the materials at generation sources, collection points and disposable sites (sharholy et al, 2008).

The Physico-chemical characteristics of solid wastes were shown in table 1.The bulk density of municipal solid waste was ranged between (71.81- 180 μg/m^3).The highest moisture content was registered (24.17%) in the residential waste. The pH values range between (7.35-9.21).There is no significant difference in the total organic content in all the three samples of solid waste at udumalpet. The ash content of the municipal solid waste was ranged between (5.88-8.26%). The calcium content in all the samples was less than 2%.The loss of Ignition was found to be lower in dump yard (11.44%) also ash content was minimum in dump yard (5.88%) which implies that the loss of organic carbon is significantly affected by composting.

Sodium was found to be high in Dump yard (0.71%) sodium content in the waste was highly soluble and readily gets leached. Up to moderate level there was no adverse effect but the higher concentration of sodium may affect soil Structure and also permeability.

Potassium was found to be higher at commercial area (2.34%). Potassium is highly soluble in wastes. Therefore it is leached easily. Potassium is not known to have harmful or toxic wastes on human beings and it helps in plant growth as essential element.

Sulphate content was found to be higher in the Dump yard (1.68%), the variation of Sulphate concentration mainly depends on the decomposition of organic matter present in solid waste. the Total Nitrogen was found to be maximum in residential area (1.21%). The increase in Total Nitrogen concentration during composting is mainly because of the decomposition of organic matter which is chemically bound to Nitrogen.

The higher concentration of phosphate was recorded at commercial area (0.81%). Total phosphorous content gradually increases during composting process and water solubility of phosphorous decreases with humification. (Elango et, al, 2009)

Table 1: Physico chemical characteristics of MSW

S.No	Parameters	Residential Area (in %)	Commercial Area (in %)	Dump Yard Area (in %)
1	Bulk Density	176 (Kg/m3)	180 (Kg/m3)	198 (Kg/m3)
2	Moisture	24.17	21.25	20.22
3	pH	9.21	7.35	8.41
4	loss on ignition	16.33	17.22	11.44
5	ash content	8.26	7.93	5.88
6	Total Organic Carbon	13.43	13.71	11.69
7	Calcium	0.98	1.08	0.87
8	Sodium	0.63	0.41	0.71
9	Potassium	1.81	2.34	2.11
10	Sulphate	1.29	1.47	1.68
11	Phosphate	0.69	0.81	0.73
12	Total Nitrogen	1.21	0.96	0.89

In the present study the ground water samples were collected randomly in seven locations around the dumping yard at Udumalpet municipality. The collected water samples were analyzed for various Physico-chemical parameters listed in table 2.

The pH of the samples was ranged between 6.58-7.52.Except samples S1 and S2 all other samples were in the alkaline range. Further the result reveals that the pH values were within the prescribed limit for drinking water purpose. Electrical conductivity is a most important water quality parameter that affects the water intake of the crop. The EC distribution is the ground water of udumalpet ranges from 180-2800 ms/cm. The EC gives as idea about the concentration of ions in solution that determines the quality of water for drinking and irrigation purpose.

Ground water usually has higher TDS than the surface water because of mineral pickup from the soil and rock. In the present study TDS was ranged between 180-2800mg/L.The EC value has higher relationship with the TDS value. High TDS value in water samples may be due to leaching from the waste into ground water. The high concentration of TDS in the ground water may be decrease the portability and may cause gastro –intestinal irritation in human and (laxative effect)particularly upon transits(WHO 1997).

The turbidity was due to the colloidal fine dispersion of suspended solids. The turbidity in samples ranged from 3-10 NTU. Hardness is an important parameter for determining availability of water for domestic, drinking and industrial purpose. Multivalent cations of ca^{2+} and mg^{2+} are often present at significant concentration in natural water samples, the amount of hardness was found to be recorded higher value than alkalinity. Low alkalinity and higher hardness indicate the presence of neutral salts of calcium and magnesium mostly as sulphate and not as carbonates.

The mean concentrations of ca^{2+} and mg^{2+} exceed the permissible limit of 75mg/L and 30 mg/L respectively in the ground water of udumalpet. The calcium concentration is higher than the magnesium concentration in all the sampling areas of udumalpet. Most of the ground water contains substantial amount of co_2, which is principle source for alkalinity. In the present study the value of alkalinity ranged between 160-320mg/L as $caco_3$.alkalinity itself is not harmful to human beings and no standard values are prescribed for alkalinity in drinking water.

Potassium is usually found in very lower concentration in natural water. The values of pottasium in the samples were 4.3mg/L which was minimum in S6 and the highest was recorded at S4 which ranged 83.5mg/L. Though potassium is an essential nutritional element and found abundance naturally, its concentration in most water is trivial and hence its presence in excessive amount acts as a cathartic.

The sulphate in the udumalpet ground water is well within the limit for the natural surface water. Sulphate occurs in all kinds of water, it is dissolved from rocks and soils containing gypsum, ion sulphides and other sulphate compounds. The phosphate ranged from 0.17-0.35mg/L.Sodium is a vital parameter for determining the suitability of ground water for irrigation purpose because sodium reacts with soil and reduced its permeability and supports little or no plant growth. The sodium value ranged between 46.2-1636mg/L.In the higher concentration of chloride in water is often found in conjucation of higher sodium concentration.

Table 2: Physico chemical analysis of ground water in and around dump yard site

S.No	Parameters	S1	S2	S3	S4	S5	S6	S7
1	pH	6.85	6.93	7.52	7.36	7.35	7.1	6.58
2	EC (mS/cm)	2800	2700	2100	2100	1800	180	2100
3	TDS mg/L	2300	1650	1350	1413	1821	1770	2360
4	SALINITY(mg/L)	3.97	1.86	1.5	1.6	2.24	1.32	2.01
5	TURBIDITY (NTU)	9	3	6	3	8	7	10
6	Total hardness (mg/L)	3450	2170	760	930	2510	180	2250
7	Calcium Hardness (mg/L)	1408.96	1304.24	466.48	561.68	1437.52	114.24	1428
8	Magnesium Hardness (mg/L)	2041.04	865.76	293.52	368.32	1072.48	65.76	822
9	T.ALKALINITY (mg/L)	260	240	320	280	240	160	200
11	BICARBONATE(mg/L)	158.6	146.4	195.2	170.8	146.4	97.6	122
12	NITRATE(mg/L)	200	400	300	100	600	300	300
13	NITRITE(mg/L)	700	400	200	400	2600	1000	200
14	CHLORIDE(mg/L)	2197.9	1028.05	482.12	638.1	1240.75	730	1110
15	SULPHATE(mg/L)	91	73	54	48	70	70	31
16	PHOSPATE(mg/L)	20	17	28	28	35	30	35
17	Na(as Na)(mg/L)	981.4	1419	1636.2	1281	683.8	46.2	658.6
18	k (as K)(mg/L)	82.76	83.5	21.25	82.23	38.29	4.84	16.61

5. Conclusion:

The rapid growth of urban areas, over exploitation of resources and improper waste disposal practice will affect the ground water quality. In the present study it can be concluded that the ground water in udumalpet municipality area, especially in wells located near to dump yard site are polluted and water showed elevated levels of hardness and sodium. This may be due to the indiscriminate dumping of wastes in the open environment. This is a major threat to human population especially those within the area. Consequently, it is therefore recommended that effective disposal mechanism of waste in udumalpet city, be introduced that would enhance sustainable development.

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