International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.9, No.09 pp 571-579, 2016

Impact of Municipal Solid Waste Dump Yard on Ground Water – A Case Study of Kanchipuram Municipality, Tamilnadu, India

M.Sureshkumar[1]*, R.Sivakumar[1], M.Nagarajan[2]

[1]Department of Civil Engineering, SRM University, Kattankulathur, Chennai, Tamil Nadu, India. *Department of Civil & Structural Engineering, SCSVMV University, Enathur, Kanchipuram Tamil Nadu, India. [2]Tamil Nadu Agriculture University, Thanjavur, Tamil Nadu, India.

Abstract : Improper municipal solid waste dumping may lead to serious environmental hazards. This study was conducted to understand the ground water quality of Kanchipuram municipal solid waste dump yard surroundings. In this process 15 groundwater samples were collected close to the dump yard during July 2015. Water quality parameters like pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mn), Free Ammonia (NH_3), Nitrate (NO_3), Chloride (Cl), Fluoride (F), Sulphate (SO_4) and Phosphate (PO_4) were analysed. The analysis result was compared with World Health Organization (WHO) and Bureau of Indian Standard (BIS) potable drinking water standards. Water quality index (WQI) has been calculated for each sample location by using standard calculation methods. In statistical method, the correlation coefficient was applied with sample test result. The study concludes that ground water nearby to the municipal solid waste dump yard in Kanchipuram municipality gets polluted. So it is necessary to do proper treatment before consuming the ground water.
Keywords : Groundwater, WQI, Correlation, Water quality and Solid waste.

Introduction

Developing countries like India, practicing of improper and unscientific disposal of solid waste in dump yard is a usual one and this may lead to ground water pollution. Conventional method of landfill is general practice in India and the groundwater pollution was not identified initially. There is a severe threat to groundwater pollution in the country, unless a necessary steps and action are taken the water resource may be getting damaged [12]. Ground water is one of the major sources for drinking water in Kanchipuram municipality. The contamination of ground water nearby to the municipal solid waste dump yard is a common thing. Based on physicochemical analysis on groundwater nearby in landfills, it has been proved groundwater gets contaminated due to leachate [2, 15 & 27]. Solid waste quantity increased drastically due to increase in population, standard of life style, urbanization and income, this may require proper scientific method of solid waste disposal in dump yard. The quality of groundwater nearby to the dump yard may affect drastically due to the percolation of leachate. In waste management the preliminary step is to understand the waste generation for providing the facility for collection and disposal [22]. The identification of groundwater quality nearby to dump yard is essential for proper solid waste management. In this study 15 bore wells are selected in the residential areas nearby to the Nathampettai dump yard in Kanchipuram municipality. There is a possibility of leachate from landfills may directly flow with surface drainage into the wells during rainy season [26]. Water samples are collected and tested as per standard procedure. The physical and chemical characteristic of each collected groundwater sample has been identified. The test results were cross checked with BIS and WHO standards, it shows clearly there is a contamination and many samples exceed its permissible limit in the study area. The parameter test result above the WHO desirable level in wells closest to the dump yard is an indication of leachate flow possibility into groundwater [1]. Relative weight was determined by using weighted arithmetic index formula. Using sub index concept water quality index was determined. Based on Water quality of each sample location has been tabulated as excellent, good water, poor water, very poor water and unfit for use. Assessment of Physico-Chemical quality of groundwater in rural areas is essential for identifying sutability of human consumption[11]. The correlation coefficient analysis has been calculated in result of tested water samples to understand the relation between each parameter.

Study Area

The study area is Kanchipuram municipality dump yard surroundings, it lies between 12º46'30'' - 12º52'00'' North Latitude and 79º 39'00'' - 79º46'20'' East longitude. Kanchipuram is also called as temple city which is located in Tamil Nadu state of India as shown in Figure 1. As per Census 2011 data population of Kanchipurm municipality is 164384 with an aerial cover of 36.14 Sq.Km. Kanchipuram population has been increased drastically in the past few decades due to the development of Special Economic Zone (SEZ) nearby to Kanchipuram.

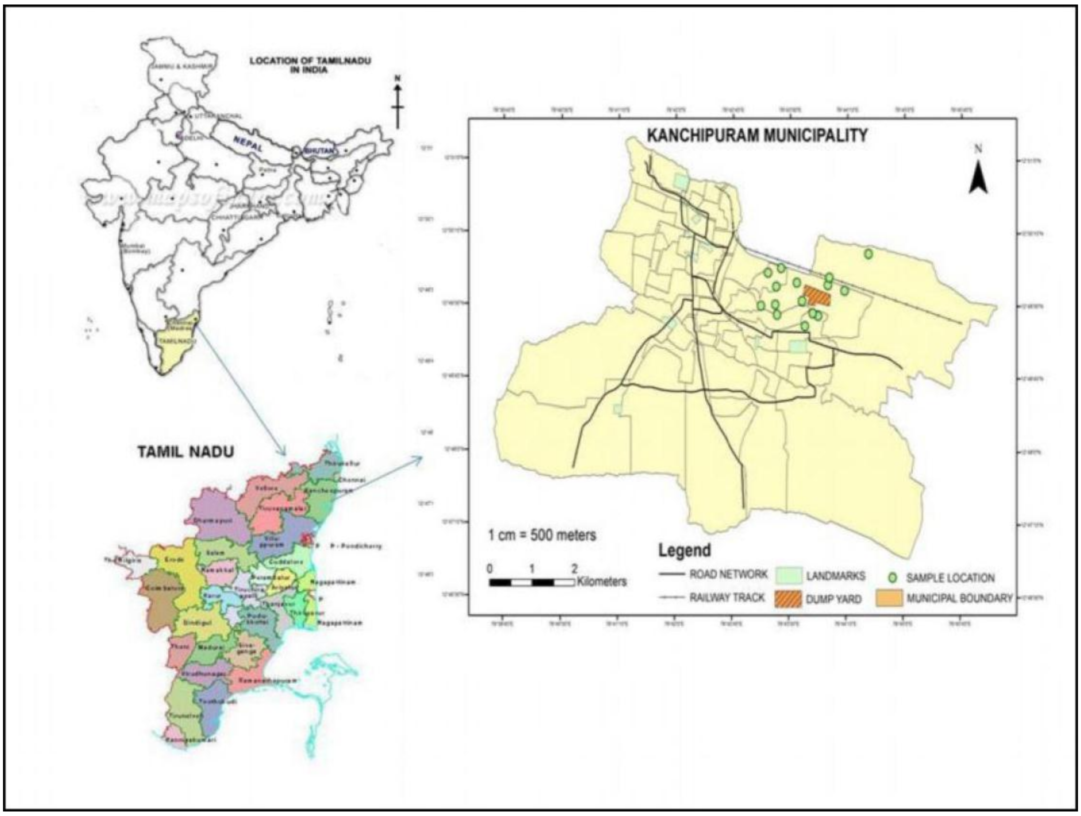

Figure1. Study Area

The average annual rainfall is 1064 mm and the temperature ranges between 20.5^{0}C to 37.5^{0}C. Elevation of Kanchipuram is 83.2 m above mean seal level and soil availability is mostly clay, sand and loam soil. As per the municipality record solid waste collection per day is 110 metric tons. In Kanchipuram municipality the Nathampettai dump yard has been operating since the year 2005 onwards where the majority of collecting solid waste is dumped. Human health and ecosystem gets effected due to the accumulation of huge quantities of solid waste in cities [14].

Materials and Methods

Water sample collection

The groundwater samples were collected from 15 bore wells (BW) in surroundings to the Nathampettai dump yard to understand the water quality strategy. The groundwater samples were collected by using 2 litre sterilized plastic container as per standard procedure. During sample collection Global Positioning System (GPS) device is used to identify the location based on latitude and longitude. Spatial information can be used to prepare groundwater vulnerability map[4]. The sample locations with its coordinates are shown in Table 1.

Table.1 Groundwater sample location

SAMPLE	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
LATITUD E	12.82 81	12.82 31	12.82 36	12.82 33	12.82 5	12.83 38	12.83 05	12.83 7	12.82 57	12.82 75	12.82 48	12.82 84	12.82 97	12.82 88	12.82 14
LONGIT UDE	79.72 21	79.73 13	79.73 01	79.72 23	79.72 19	79.74 22	79.72 02	79.72 37	79.72 77	79.73 7	79.71 88	79.73 34	79.73 37	79.72 66	79.72 84
SOURCE	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW

Laboratory Analysis

Collected water sample was analysed in a laboratory to identify its various physical and chemical characters as per standard procedures. In this analysis process 15 water quality parameters are chosen such as pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mn), Free Ammonia (NH_3), Nitrate (NO_3), Chloride (Cl), Fluoride (F), Sulphate (SO_4) and Phosphate (PO_4). The health of residents may get affected due to consuming the lower quality of water [6]. The test result of each sample is compared with of BIS and WHO standards; it shows the majority of samples exceed the desirable limit as prescribed by the standards. The test result of physical and chemical characteristics are shown in Table.2

Table.2 Physical and chemical parameters of the water samples (All parameters, units are in mg/L except EC and pH)

Parameter / Sample No.	TDS	EC	p H	TA	TH	Ca	Mg	Fe	Mn	NH_3	NO_3	Cl	F	SO4	PO4
S1	2320	3225	7.3	820	745	192	95	0.9	0	1.95	35	520	0.45	195	0.7
S2	6230	9120	7.8	356	1730	364	213	0.65	0	0	51	2115	0.5	795	0.5
S3	2210	2950	7.3	523	510	74	78	0	0	0	35	510	0.3	205	0
S4	2410	3510	7.5	695	640	135	79	0	0	0	24	639	0.5	195	0.1
S5	3010	4320	7.5	720	712	145	93	0.1	0	1.52	42	790	0.5	156	0
S6	2100	2950	8.5	525	652	145	91	0.2	0	0.2	38	521	0.6	110	0.5
S7	2395	3590	6.7	825	441	151	65	0.57	0	1.1	43	572	0.73	465	0.5
S8	2342	2366	7.1	602	310	86	26	1.4	0	0.1	38	480	1.2	278	4.5
S9	2321	2921	7.2	706	621	48	40	0.6	0	0.56	39	145	1.2	402	1.9
S10	1963	2541	7.2	592	589	129	69	1.6	0	0.4	43	480	1.1	156	1.5
S11	2003	1923	7.5	521	698	151	81	0.8	0	0.46	33	292	1.1	139	0.9
S12	812	1225	7.8	281	425	59	23	1.2	0	0.1	20	156	1.9	132	0.3
S1	1612	1345	7.1	245	269	71	21	0.56	0.1	0.55	20	151	1.5	154	1
S14	2011	2122	7.4	225	280	72	24	0.82	0	0.4	41	239	1.1	350	0.9
S15	2123	1812	7.5	512	625	112	41	0.21	0	0.1	49	312	1.3	301	0.1

Result and Discussion

The total dissolved solid value ranges from 812 to 6230 Mg/L, the desirable limit of TDS is 500 Mg/L as per WHO and BIS. TDS value is used to identify the presence of various dissolved solid and minerals in groundwater [3&10]. According to this all the samples exceed the desirable limit.The EC range is from 1225 to 9120 micro mho/cm, all the samples exceed the desirable limit of 1000 micro mho/cm as per standards. Due to leachate into groundwater there is a possibility of high TDS and EC [20&21]. The pH value of the collected water sample in the study area is within the desirable limit as prescribed by WHO. In study area the pH value varies from 6.7 to 8.5. This value is used to know the acidity and alkalinity condition of the sample location. The attributable of high levels of anions is due to extremely high values of EC [18]. From the test result sample S7 has the minimum value and the S6 has the maximum value. The total alkalinity value is from 225 to 825 mg/L, the desirable limit is 200 mg/L. The total hardness value is from 269 to 1730 mg/L. Sample locations S13 and S14 are 269 mg/L and 280 mg/L both are in within the desirable limit of 300 mg/L according to the BIS. During rainy periods the parameter values are higher in level due to the mixing of leachate on groundwater [13]. Calcium ranges from 48 to 364 mg/L, desirable limit is 75 mg/L as per WHO and BIS. Sample number S3, S9, S12, S13 and S14 are within the desirable limit of calcium. Magnesium minimum value is 21 and the maximum value is 213 mg/L, the desirable value is 50 mg/L. Magnesium in sample S1, S2, S3, S4, S5, S6, S6, S7, S10 and S11 are above the desirable limit. Iron value ranges from 0.00 to 1.60 mg/L. According to WHO and BIS desirable limit is 0.3 mg/L, it exceed in 10 samples in the study area. Groundwater samples test results were compared with WHO standards to identify its quality[25]. Manganese desirable limit 0.1 mg/L, all the samples is within this desirable limit. The free ammonia desirable limit is 0.5 mg/L in result five sample location S1, S5,S7, S9 and S13 exceed this value. The nitrate desirable limit is 50 mg/L, only at sample S2 it exceeds the limit. The chlorine test result shows except sample number S9, S12, S14 and S13 all the samples are exceeding the desirable limit of 250 mg/L as prescribed by WHO and BIS. The fluoride desirable limit is 1.5 mg/L as per WHO, sample number S12 and S13 only exceed this limit. In groundwater fluoride contamination may cause serious health problem[8]. Sulphate desirable value is 200 mg/L as per standards, seven sample number S2, S3, S7, S8, S9, S14 and S15 exceed the desirable level. Phosphate desirable level is 1 mg/L, sample number S8, S9, S10 and S13 exceed the desirable level in the study area.

Water Quality Index (WQI)

The individual water quality of each collected water sample is identified by using WQI based on ranking on test parameters. Based on WHO (2004) standards for drinking water WQI is calculated. The weight (w_i) was assigned in the range between 1 to 5 according to the importance in overall quality of water. Unless the complete picture of MSW problem is available it is not possible to take proper decisions[5&9]. The relative weight (W_i) is calculated based on the weighted arithmetic index method and quality rating scale (Q_i) is obtained for each sample by dividing its respective standard and then multiplied by 100. By using Water Quality Index (WQI) concept groundwater quality was assessed[17]. Standards with weights assigned and calculated relative weight are shown in Table.3.

Table.3 Standard weight (w_i) and Calculated relative weight (W_i)

Parameters	Standards	Recommended Agency	Weight (w_i)	Relative Weight (W_i)
TDS	500	WHO/BIS	5	0.13
EC	1000	BIS	1	0.03
PH	6.5-8.5	WHO/BIS	1	0.03
TA	200	BIS	4	0.10
TH	300	BIS	4	0.10
Ca	75	WHO/BIS	2	0.05
Mg	50	WHO	2	0.05
Fe	0.3	WHO/BIS	5	0.13
Mn	0.1	WHO/BIS	1	0.03
NH_3	0.5	BIS	3	0.08
NO_3	50	WHO	2	0.05
Cl	250	WHO/BIS	2	0.05
F	1.5	WHO	2	0.05
SO_4	200	BIS	3	0.08
PO_4	1	WHO/BIS	3	0.08
		Total	**40**	**1.00**

Sub index parameter (SI_i) is obtained by multiplying the W_i and Q_i. Finally the overall WQI is obtained by adding all the sub index values. The average value of WQI is obtained for the study area is 224.18 and it is shown in Table.4.

Table.4 Water Quality Index (WQI) for the collected samples

SAMPLE	TDS	EC	PH	TA	TH	Ca	Mg	Fe	Mn	NH_3	NO_3	Cl	F	So4	PO4	WQI
S1	60.32	9.68	2.58	41.00	24.83	12.80	9.50	39.00	0.00	31.20	3.50	26.00	1.50	7.80	5.60	275.30
S2	161.98	27.36	2.75	17.80	57.67	24.27	21.30	28.17	0.00	0.00	5.10	105.75	1.67	31.80	4.00	489.61
S3	57.46	8.85	2.58	26.15	17.00	4.93	7.80	0.00	0.00	0.00	3.50	25.50	1.00	8.20	0.00	162.97
S4	62.66	10.53	2.65	34.75	21.33	9.00	7.90	0.00	0.00	0.00	2.40	31.95	1.67	7.80	0.80	193.44
S5	78.26	12.96	2.65	36.00	23.73	9.67	9.30	4.33	0.00	24.32	4.20	39.50	1.67	6.24	0.00	252.83
S6	54.60	8.85	3.00	26.25	21.73	9.67	9.10	8.67	0.00	3.20	3.80	26.05	2.00	4.40	4.00	185.32
S7	62.27	10.77	2.36	41.25	14.70	10.07	6.50	24.70	0.00	17.60	4.30	28.60	2.43	18.60	4.00	248.15
S8	60.89	7.10	2.51	30.10	10.33	5.73	2.60	60.67	0.00	1.60	3.80	24.00	4.00	11.12	36.00	260.45
S9	60.35	8.76	2.54	35.30	20.70	3.20	4.00	26.00	0.00	8.96	3.90	7.25	4.00	16.08	15.20	216.24
S10	51.04	7.62	2.54	29.60	19.63	8.60	6.90	69.33	0.00	6.40	4.30	24.00	3.67	6.24	12.00	251.88
S11	52.08	5.77	2.65	26.05	23.27	10.07	8.10	34.67	0.00	7.36	3.30	14.60	3.67	5.56	7.20	204.33
S12	21.11	3.68	2.75	14.05	14.17	3.93	2.30	52.00	0.00	1.60	2.00	7.80	6.33	5.28	2.40	139.40
S1	41.91	4.04	2.51	12.25	8.97	4.73	2.10	24.27	3.00	8.80	2.00	7.55	5.00	6.16	8.00	141.28
S14	52.29	6.37	2.61	11.25	9.33	4.80	2.40	35.53	0.00	6.40	4.10	11.95	3.67	14.00	7.20	171.90
S15	55.20	5.44	2.65	25.60	20.83	7.47	4.10	9.10	0.00	1.60	4.90	15.60	4.33	12.04	0.80	169.65
AVERAGE VALUES OF WQI																224.18

The WQI for the collected water samples are ranging from 139 to 489.61. The graphical representation of water quality index is shown in Figure 2. Statistical data analysis has been suggested to identify the groundwater quality parameter correlation[23].

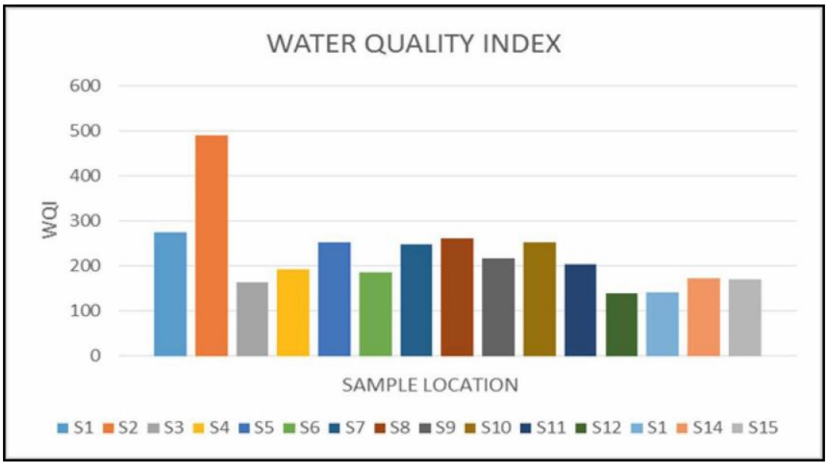

Figure 2. Graphical representation of WQI

As per standard method of classification the collected ground water sample is classified from excellent to unfit for drinking. Nowadays the groundwater quality problem has become severe [19]. The number of samples in each category and water quality percentage of each collected location is shown in Table. 5. By using Water Quality Index (WQI) concept groundwater quality was assessed[17].

Table.5 Water quality classification based on WQI value

WQI Value Range	Water Quality	No.of Station	(%)
<50	Excellent	NIL	NIL
50-100	Good Water	NIL	NIL
100-200	Poor Water	7	46.666667
200-300	Very Poor Water	7	46.666667
>300	Unfit For Use	1	6.6666667

Under the excellent and good classification no samples are identified. In poor classification seven locations are found S3, S4, S6, S12, S13, S14 and S15. In very poor classification seven locations are found such as S1, S5, S7, S8, S9, S10 and S11. Only one location S2 was identified under unfit for drinking purposes that WQI value is 489.61 which is highest in the collected samples. The direct use of contaminated groundwater due to leachate may be a serious threat to human health leachate [24].

Correlation coefficient

In this study the correlation coefficient is used to identify the relationship between the chosen dependent and independent water quality parameter as variable. The low correlation coefficient like zero indicates no relationship between two variables and high coefficient correlation nearly one means good relationship between the variables. Table 6. Indicates the correlation coefficient of the water quality parameters in the study area.

Table.6 correlation coefficient of the water quality parameters in the study area.

Parameters	**TDS**	**EC**	**PH**	**TA**	**TH**	**Ca**	**Mg**	**Fe**	**Mn**	**NH_3**	**NO3**	**Cl**	**F**	**So4**	**PO4**
TDS	1														
EC	**0.970326**	1													
PH	0.1435622	0.1839915	1												
TA	0.0417151	0.1203121	0.3264021	1											
TH	**0.891663**	**0.897467**	0.3790638	0.0418393	1										
Ca	**0.86871**	**0.877715**	0.2637422	0.1049406	**0.908149**	1									
Mg	**0.879897**	**0.917947**	0.3530855	0.1381222	**0.942682**	**0.938573**	1								
Fe	0.1693094	0.1918661	0.2480637	0.1517914	0.1444212	0.0568615	0.2202206	1							
Mn	0.1854223	0.2521171	0.2215494	0.4204911	0.2773563	0.2069701	0.276153	0.0450145	1						
NH_3	0.0426964	0.0182626	0.3220216	0.5570499	0.0474918	0.1130323	0.0461195	0.0167533	0.0253798	1					
NO3	0.5969161	0.5276311	0.0110897	0.2368442	0.480209	0.4799371	0.452216	0.0174904	0.494083	0.0778955	1				
Cl	**0.955384**	**0.970559**	0.2394894	0.0175695	**0.89411**	**0.913849**	**0.923611**	0.129048	0.2175586	0.0759521	0.496352	1			
F	0.5331632	0.6020099	0.1022645	0.5195998	0.4528852	0.5259796	0.669327	0.5304575	0.3413827	0.2769833	0.3609478	0.5512703	1		
So_4	**0.807108**	**0.766153**	0.1392089	0.0560258	0.6400697	0.6090727	0.5487948	0.0022842	0.1762263	0.136104	0.5987836	0.7080337	0.2000541	1	
PO_4	0.0667702	0.1680987	0.3275431	0.0665599	0.2656696	0.2250711	0.3198799	0.6326742	0.0259453	0.123067	0.0521065	0.1548882	0.3139891	0.0525178	1

Conclusion

The analysis result of fifteen parameters from the collected fifteen samples surroundings to the Nathampettai dump yard in Kanchipuram municipality only 46.67 % of ground water are under the condition of poor and very poor for drinking purpose. In many parts of the world landfills and open dumps are the cheapest and a common municipal solid waste management practice[16].The test results indicate no collected water samples are under the category of excellent and very good condition for drinking purpose. In that 6.7% of water under unfit for drinking water condition. The correlation coefficient shows the connection between the tested parameters. For a healthy life, it is mandatory to drink the groundwater under the prescribed limit of WHO /

BIS. Toxic solid waste must be treated before disposal this may lead to serious health threat to human beings[7]. The study suggested to the Kanchipuram municipality create awareness among the people surround to the Nathampettai dump yard to consume groundwater after proper treatment to lead healthy lives.

Acknowledgments

The authors wish to his sincere thanks to the Dean (Department of Civil Engineering), Vice-Chancellor, Director (E &T) Faculty of Engineering & Technology, SRM University, Kattankulathur, Chennai, Tamil Nadu, India. The authors wish his sincere thanks to HOD, Department of Civil & Structural Engineering, Dean (E &T), Registrar, Vice-Chancellor and Chancellor of SCSVMV University, Enathur, Kanchipuram, TamilNadu, India. The authors also wish to record a deep sense of gratitude to Tamil Nadu Agriculture University, Thanjavur, Tamil Nadu, India.

References:

1. Adeolu, O.A., Ada, V.O., Gbenga, A.A. and Adebayo, A.O., Assessment of groundwater contamination by leachate near a municipal solid waste landfill. African Journal of Environmental Science and Technology, 2011, 5(11): 933-940.
2. Akinbile, C.O. and Yusoff, M.S., Environmental impact of leachate pollution on Groundwater supplies in Akure, Nigeria, International Journal of Environmental Science and Development, 2011.
3. Balakrishnan, P., A. Saleem and N. Mallikarjun., Groundwater quality mapping using Geographic Information System (GIS): A case study of Gulbarga City, Karnataka, India. Afr. J. Environ. Sci. Technol., 2011, 5: 1069-1084.
4. Colins Johnny.J, M.C.Sashikkumar, P.A.Anas and E.Abiram Kishan, Sintacs Model for Groundwater Vulnerability Mapping using Remote Sensing and GIS Techniques: A Case Study on Dindigul Block, International Journal of ChemTech Research, 2015, vol.8, No.7, pp 56-64**.**
5. Devi s., Premkumar. P r., Physicochemical Analysis of Ground water samples near Industrial Area Cuddalore district, Tamil Nadu, India, International Journal of Chem Tech Research, 2012, 4(1), 29-34.
6. Dhakyanaika, K. and P. Kumara., Effects of pollution in River Krishni on hand pump water quality, J. Eng. Sci. Technol. Rev., 2010, 3: 14-22.
7. Farooqi, A., H. Masuda and N. Firdous., Toxic fluoride and arsenic contaminated groundwater in the Lahore and Kasur districts, Punjab, Pakistan and possible contaminant sources. Environ. Pollut., 2007, 145: 839-849.
8. Gupta S , Dutta G , Mondal D , Mechanism of Fluoride Mobilization in an Alluvial Aquifer: a Kinetic Approach, International Journal of ChemTech Research, 2016, vol.9, No.4, pp 270-278.
9. Hadjibiros, K., Dermatas, D. and Laspidou, C.S., Municipal solid waste management and landfill site selection in Greece: irrationality versus efficiency, Journal of Global NEST, 2011,13(2): 150-161
10. Hari Haran, A. Evaluation of drinking water quality at Jalaripeta village of Visakhapatnam district Andhra Pradesh, Nat. Environ. Pollut. Technology, 2002, 1(4).
11. Jacob Vincent, Assessment of Physico-Chemical Quality of Groundwater in rural areas of Thoothukudi District, Tamilnadu, India, International Journal of ChemTech Research, 2015, vol.8, No.4, pp 1826-1828**.**
12. Jain, C.K., Kumar, C.P. and Sharma, M.K. Irrigation water quality of Ghataprabha Command Area, Karnataka. Water Pollution, A.P.H. Publishing Corporation, New Delhi, 2004, 17: 145-158.
13. Jalali, M., Nitrate leaching from agricultural land in Hamadan, western Iran.Agriculture Ecosystems and Environment, 2005, 110 (3), 210-218.
14. Jha,M.K., Sondhi, O.K. and Pansare,M. , Solid waste management-a case study.Indian Journal of Environmental Protection, 2003, 23 (10), 1153-1160.
15. Jhamnani, B. and Singh S.K., Groundwater contamination due to Bhalaswa landfill site in New Delhi, International Journal of Environmental Science and Engineering, 2009 (1), 121–5.
16. Joseph, K., A cleaner production approach for minimization of total dissolved solid in reactive dying effluents, 2004, Centre for Environmental Studies, Anna University, Chennai.
17. Kalaivani.S and K. Ramesh, Groundwater Quality Assessment using WQI In South Coimbatore, Tamil Nadu, India, International Journal of ChemTech Research, 2014-2015 vol.7, No.1, pp 316-322**.**

18. Kale, S.S., Kadam, A.K.and Kumar, S., Pawar NJ. Evaluating pollution potential of leachate from landfill site, from the Pune metropolitan city and its impact on shallow basaltic aquifers. Environ Monit. Assess, 2010, 162, 327–46.
19. Kumar, N. and Sinha, D.K. , Drinking water quality management through correlation studies among various physic- chemical parameters. International Journal of Environmental Sciences, 2010, 1(2): 253-259.
20. Longe, E.O. and Enekwechi, L.O., Investigation on potential groundwater impacts and influence of local hydrogeology on natural attenuation of leachate at a municipal landfill. Int. J. Environ. Sci. Technol., 2007, 4(1): 133-140.
21. Mor, S., Ravindra, K., Dahiya, R.P., and Chandra, A., Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site. Environmental Monitoring and Assessment, 2006, 118: 435-456.
22. Oyelola, O.T., Babatunde, A.I., Characterization of domestic and market solid wastes at source in Lagos metropolis, Lagos, Nigeria',African Journal of Environmental Science andTechnology, 2008, Vol.3 No.12, pp.430- 37.
23. Prasoon Kumar Singh, Binay Prakash Panigrahy, Ashwani Kumar Tiwari, Bijendra Kumar and Poornima Verma, A statistical evaluation for the groundwater quality of Jharia coalfield, India, International Journal of ChemTech Research, 2014-2015 vol.7, No.4, pp 1880-1888**.**
24. Rajkumar, N., Subramani, T. and Elango, L., Groundwater contamination due to municipal solid waste disposal – A GIS based study in erode city. International Journal of Environmental Sciences,2010, 1: 39-55.
25. Shankar Prasad Mishra and Arun kumar Shukla, Assessment of Ground water quality of Semariya Area District Rewa, Madhya Pradesh, India, International Journal of ChemTech Research, 2016, vol.9, No.1, pp 302-307
26. Taha, M.R. and Yaacob, W.Z.W. ,Samsudin AR, Yaakob J. Groundwater quality at two landfill sites in Selangor, Malaysia. Bulletin of the Geological Society of Malaysia, 2011,57, 13-18.
27. Vasanthi, P., Kaliappan, S., and Srinivasarghavan, R., Impact of poor solid waste management on ground water, Environmental Monitoring and Assessment,2008, August(1-3), 227-238.

***** *****