THE IMPACT OF LANDFILL ON SOIL AND GROUNDWATER QUALITY OF THE NANDED CITY, MAHARASHTRA

[1]Shaikh Parveen R.*, [2]Bhosle Arjun B., [3]Yannawar Vyankatesh B.

[1,3]Research Student & [2]Assistant Professor, School of Earth Sciences, Swami Ramanand Teerth Marathwada University, Vishnupuri, Nanded 431606 (Maharashtra) India.
E-mail: parveen_earth@yahoo.co.in

ABSTRACT: A field study was conducted near municipal solid waste dumping site at Nanded in Maharashtra. The objective of the study was to assess and compare the physical, chemical and biological properties of groundwater and soil samples. Also to study the effect of dumping on their quality. The leachate produced by waste disposal sites contains a large amount of substances which are likely to contaminate ground water and soil. The water parameters studied were pH, EC, total hardness, chlorides, salinity, Phenolphthalein alkalinity , fluoride, chromium, carbon dioxide, sulphate, phosphate, TS, total alkalinity, iron, magnesium, sodium, potassium, calcium, SPC and MPN. Parameters measured in the field included soil moisture, EC, WHC, soil pH, chloride, alkalinity, organic carbon (OC), organic matter, exchangeable cations (Ca, Mg, K and Na) and SPC. All the parameters were found to be significantly different in the different sampling sites.
[Shaikh P. R., Bhosle A. B., Yannawar V. B. **THE IMPACT OF LANDFILL ON SOIL AND GROUNDWATER QUALITY OF THE NANDED CITY, MAHARASHTRA** *Researcher.* 2012;4(7):56-63]. (ISSN: 1553-9865). http://www.sciencepub.net/researcher . 7

KEY WORDS: Soil analysis, water quality, Ground water contamination, Heavy metals, Leachate, Municipal solid waste, open dumping yard, Leachate impact.

INTRODUCTION

The water quality undergoes rapid changes due to contamination. The quality of ground water is continuously changing as a result of natural and human activities. Water is polluted due to different phenomenon. Industrial water entering in to ground water is the major source of organic and inorganic pollutants. Due to rapid growth of industrialization, much sewage is disposed off that generates fair changes of ground water pollution (Gadhave et.al., 2008).

The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Ground water occurs in

Leachate is any liquid that, in passing through matter, extracts solutes, suspended solids or any other component of the material through which it has passed.Leachate from a solid waste disposal site generally contain major elements like calcium, magnesium, potassium, nitrogen and ammonia, trace metals like iron, copper, manganese, chromium, nickel, lead and organic compounds like phenols, polyaromatic hydrocarbons, acetone, benzene, toluene, chloroform etc (Freeze and Cherry, 1979). The concentration of these in the leachate and water depends on the composition of wastes. Some of the pollutants may be adsorbed on to the soil during their diffusion in the soil (Alker et al., 1995).

STUDY AREA

weathered portion, along the joints and fractures of the rocks. In fact, industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water (Gupta et. al., 2009).

Waste is any substance, solution mixture or article for which no direct use is envisaged but which is transported for reprocessing, dumping, elimination by incineration or other methods of disposal. With urban industrialization, social development and increased population cause rapid solid waste production which results in a serious problem (Elizabeth et.al., 2003).If not properly disposed and managed the resulting environmental impart from these wastes can be disastrous (Martin,1994).

The Nanded is located between 18°.15' and 19°.55' North latitude and 77°.7' to 78°.15' east longitudes. The district has a geographical area of 10528 Sq. Km. Nanded is one of the fastest growing city of Marathwada region of Maharashtra. It is second largest city in the Marathwada region of Maharashtra state with a population of 7.3 lakh (2010 census). The locations of sampling stations from dumping site are shown in figure 1.

The total amount of solid waste generated in Nanded is to the tune of about 149 tons/ day, at an average of about 300 gm / person / day. While there has been no initiative to establish the waste characteristics source-wise. About 73 % of waste is to be generated from domestic sources, followed by

about 23 % from commercial establishments and markets and the rest of from industries.

Municipal Solid Waste is disposed in a dumping ground at Valmiki Nagar near Maltekdi in an area of 3.32 hectare. This site has been in use since around 1975. It may need to be assessed for its capacity to handle more dumping as well as to assess its suitability for installing scientific treatment and disposal methods. There is no treatment facility and the garbage collected from the city is merely dumped at this site (NWMC, 2006).

Figure 1: Map showing groundwater and soil sampling sites.

MATERIAL AND METHODS

Water Analysis

Groundwater samples collected from the dumping site and taken in pre-cleaned polyethylene bottle. The all water quality parameters estimated by the standard methods given by APHA (1998).

EC values of the water sample under investigation were measured using Digital Conductivity meter. Total Solids of water samples measured using gravimetric method.

The pH value of water sample measured by using digital pH meter. The total hardness, calcium and magnesium of the water samples were determined by complexometric titration with EDTA. The sulphate was estimated by Barium chloride and phosphate by Ammonium molybdate method. The carbon dioxide determined by titrating with NaOH using phenolphthalein as an indicator. The chloride and salinity was generally determined by titrating the water samples against standard solution of silver nitrate using potassium chromate as an indicator. The fluoride is estimated by SPANDS method. The iron and chromium estimated by Thiocynate and Diphenylcarbazide methods respectively. The sodium and potassium were detected by Flame photometer. Phenolphthalein and Total alkalinities of the water samples were determined by titrating with H_2SO_4 using phenolphthalein and methyl orange as indicators.

The SPC and MPN determined using Nutrient agar media and Mac -Conkey broth respectively.

Soil Analysis

The soil samples were collected from dumping sites by using a corer and were brought to the laboratory in a polythene bags which are properly labeled and analysed. The soil samples were mixed thoroughly, air dried and passed through a mesh sieve. The samples were used for subsequent physical, chemical and biological analysis by following methods.

The electrical conductivity (EC) of the soil was determined in 1:5 soils: water suspension with the help of Conductivity meter. The soil is dried in an oven at 150^{o}C. The difference in the initial and final weight of the soil determines soil moisture. The water holding capacity (WHC) can be determined as the amount of maximum water held in saturated solids.

The pH of the soil was determined in 1:5 soils: water suspension with the help of a pH meter. The chloride is an essential ion for plant growth. The chloride present in the sample was determined in 1:5 soils: water suspension by Argentometric method.

Soil alkalinity is due to presence of soil minerals producing sodium carbonate upon weathering .It was determined by titrating the soil suspension with a strong acid using methyl orange as an indicator. Exchangeable Sodium and Potassium determined in ammonium acetate leachate by flame photometric method. Organic carbon content of the samples was determined by Walkley and Black titrometric method and represented as % of OC. Organic matter content of the samples was calculated from organic carbon by multiplying it by Von Bemmlen factor. Exchangeable Calcium and Magnesium were determined in ammonium acetate leachate by titration method (Jackson 1973).

The soil samples were serially diluted and cultured on nutrient agar and count the bacterial colonies after 24 hours of incubation at ambient condition (Trivedy and Goel, 1998).

RESULTS AND DISCUSSION

The results obtained from the analysis of groundwater and soil samples are systematically given in table 1 and 2.

The electrical conductivity noted in the range of 520-540 uS/cm and 60-80 uS/cm in summer and monsoon respectively. The electrical conductivity above the permissible limit of 250 uS/cm except at all the sampling sites in monsoon season. The total solids ranged from 676 to 4948 mg/L which is above the permissible limit of 500 mg/L.

The pH of water samples recorded in the range of 6.84-7.27 which are within the permissible range of 6.5-8.5.The observed total hardness was from 350-1170 mg/L. Total hardness above the permissible limit of 500 mg/L except at S_2 and S_3 in summer. The total alkalinity observed ranged between 350-2250 mg/L that values are above the permissible limit of 200 mg/L in all the water samples. The carbon dioxide observed in the range of 44-70.4 mg/L in monsoon and absent in summer season. The salinity of groundwater ranged between 576.72 to 1755.75 mg/L.

Calcium was detected in the range of 80.16 to 224.4 mg/L which were above the permissible limit of 75 mg/L.The magnesium ranged between 29.29 to 148.6 mg/L which are more than the permissible limit of 30 mg/L except at S_3 (29.29 mg/L) in summer. Sodium ranged from 142.7 to 308.1 mg/L which were beyond the permitted value of 30 mg/L for drinking water.The potassium observed minimum 4.2 to maximum 4.5 mg/L. Chloride investigated ranged between 319.5-972.7 mg/L which were above the permissible limit of 250 mg/L. The fluoride content of water samples are 0.1 to 2.53 mg/L that compared with standard values of 0.6-1.5 mg/L. The phosphate content lowest 0.0032 to highest 0.217 mg/L in monsoon and summer which was within the permissible limit of 5 mg/L. The sulphate content ranged from 118 to 200 mg/L which were below the prescribed value of WHO i.e.500 mg/L.

The iron observed minimum 1.2 mg/L to maximum 15.2 mg/L which was above the prescribed value of WHO i.e. 0.3 mg/L.The chromium was absent in all water samples.

The variation in standard plate count was $1.4X10^5$ cells/ml to $3.5X10^5$ cells/ml. The MPN ranged between 2 to 31 MPN/100ml from water samples.

Groundwater quality parameters obtained from this study are comparable with those of groundwater of most of the dumping sites (Singh et. al., 2008 and Vasanthi et. al., 2008).

The soil samples having electrical conductivity ranged from 80-400 uS/cm. The water holding capacity reported for the soil samples ranged from 10 to 44 %. The WHC higher in summer than monsoon and vice-versa for soil moisture may be due to rainfall in monsoon. The soil moisture was 3.22 % to 65.39 %.The soil moisture commonly ranges from 5% to 35%. Generally, it depends on void ratio, particle size, clay minerals, organic matter, and ground water conditions (Martin, 1994).

The pH of the soil mostly in alkaline range except site S_2 (6.50) in monsoon. The noted soil pH was 6.50 to 8.43. The pH values compared with the middle alkaline range of 7.51-8.3 (Agriculture dept.). The chloride content was found from 0.0426 to 0.28% with an average 0.10992 %.The alkalinity of soil samples observed in the range between 1.0 to 3.5 meq/100gm with average 1.83 meq/100gm.The sodium found from 28.6 to 236.9 mg/L and potassium from 78.6 to 97.8 mg/L. The average sodium and potassium content were 97.43 and 92.36 mg/L respectively. The percentage of organic carbon was highest (0.285 %) in site S_1 and lowest (0.12%) in site S_2 and the percentage of organic matter was highest (0.491 %) and lowest (0.206 %) at same sites .The organic carbon is low as compared with standard value of <0.5 % (Katyayan, 2008) .The magnesium ranged from 0.036 to 0.131% and calcium from 0.881 to 1.146 % with their mean values of 0.084% and 1.0 % respectively.

The standard plate count (SPC) from soil samples ranged between $1.8X10^4$to $9.0X10^4$ cells/gm. The average standard plate count of soil samples was $5.53X10^4$ cells/gm.

Similar results were found by David et. al. (2008), from soils of waste dumpsites in Port Harcourt Municipality, Nigeria.

Faith et. al. (2010), found bacterial population ranged from 4.0 X 10^5 to 12 X 10^5 cells/gm from waste dumpsite of Benin City, southern part of Nigeria.

Table 1: Water Parameters of ground water at dumping site.

Sr. No.	Water Parameters	Summer			Monsoon		
		S_1	S_2	S_3	S_1	S_2	S_3
1	EC (µS/cm)	540	520	540	60	60	80
2	Total Solids	4912	1244	1722	1298	676	4948
3	pH	6.87	6.91	7.10	7.27	6.84	6.95
4	Total Hardness	1170	350	440	730	500	620
5	Phenolphthalein alkalinity	50	50	50	Nil	Nil	Nil
6	Total Alkalinity	400	350	450	450	550	2250
7	Carbon dioxide	Nil	Nil	Nil	70.4	44	61.6
8	Salinity	1755.75	576.72	884.29	1345.65	640.8	1025.27
9	Calcium	224.4	88.17	80.16	120.24	100.2	80.16
10	Magnesium	148.6	31.67	29.29	104.76	60.91	102.33
11	Sodium	308.1	142.7	214.7	256.8	164.9	224.5
12	Potassium	4.3	1.2	2.8	4.5	3.1	3.4
13	Chloride	972.7	319.5	489.9	745.5	355	568
14	Fluoride	0.382	0.316	0.1	0.535	2.53	0.34
15	Phosphate	0.083	0.096	0.217	0.1088	0.128	0.0032
16	Sulphate	200	196	150	156	118	142
17	Iron	15.2	3.2	3.8	8	1.6	1.2
18	Chromium	Nil	Nil	Nil	Nil	Nil	Nil
19	SPC (Cells/ml)	$2.2X10^5$	$3.5X10^5$	$3.1X10^5$	$1.4X10^5$	$1.5X10^5$	$2.3X10^5$
20	MPN (MPN/100ml)	26	6	31	8	2	24

All values expressed as mg/L except EC, pH, SPC and MPN.

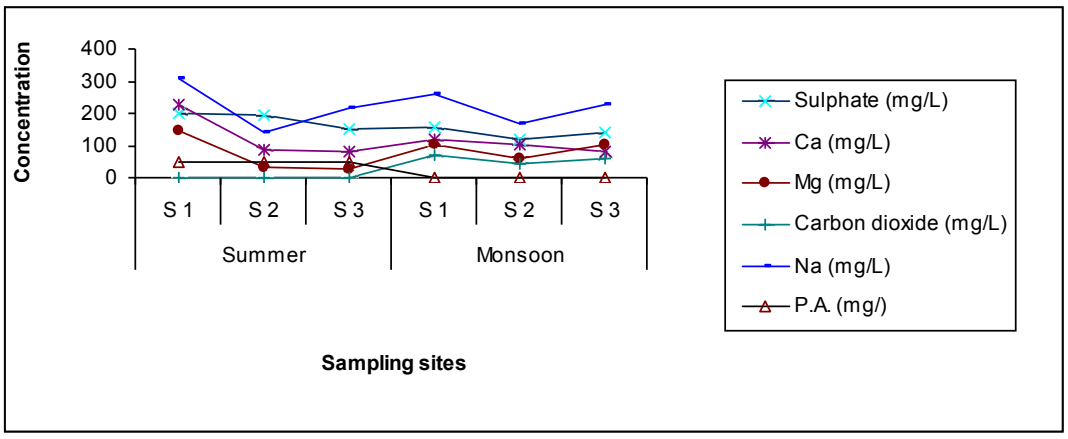

Figure 2: Observed SO_4, Ca, Mg, CO_2, Na and Phenolphthalein alkalinity of groundwater samples of dumping sites at Nanded.

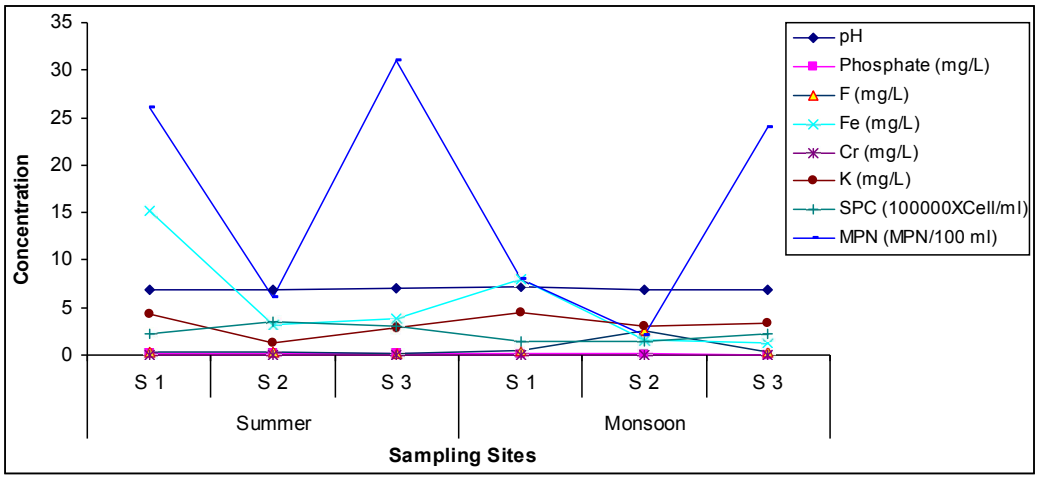

Figure 3: Observed pH, PO_4, Mg, CO_2, Na and Phenolphthalein alkalinity of groundwater samples of dumping sites at Nanded.

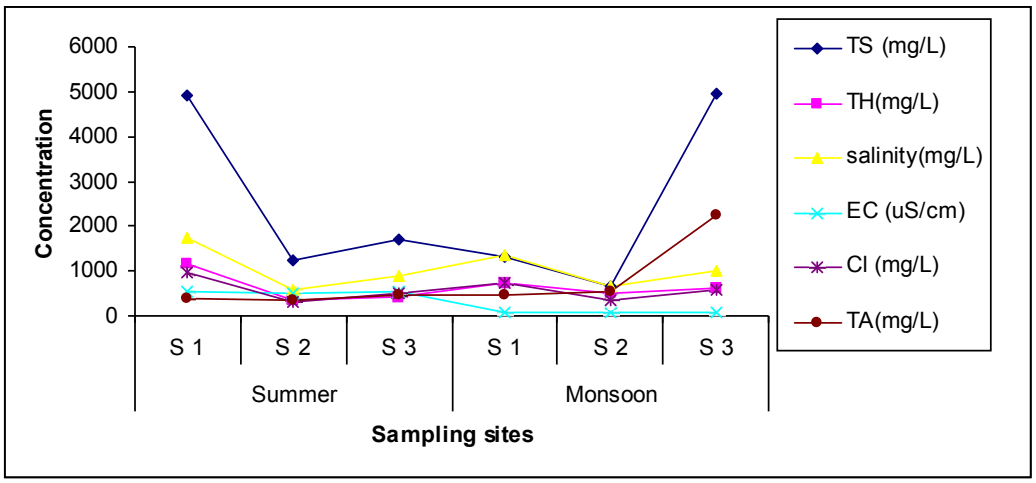

Figure 4: Observed TS, TH, salinity, EC, Chloride and Total alkalinity of groundwater samples of dumping sites at Nanded.

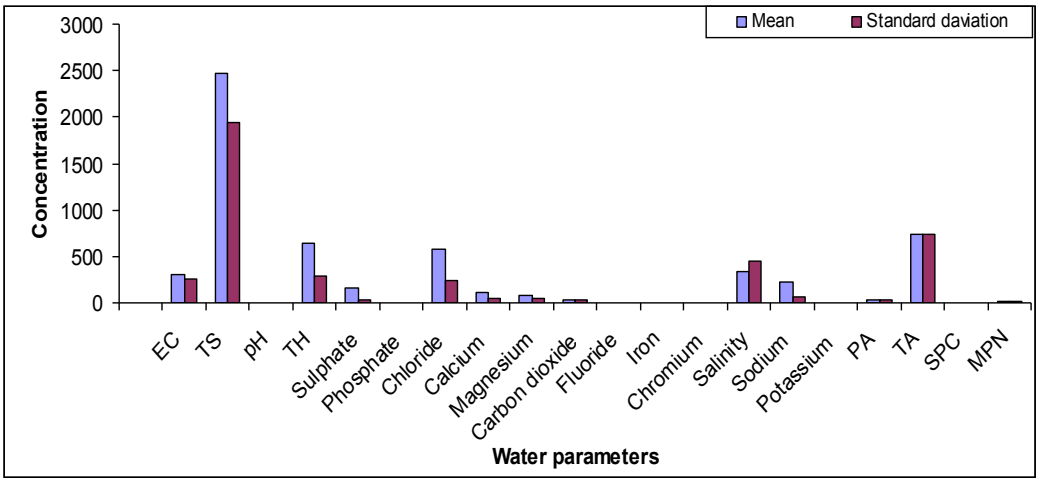

Figure 5: Observed mean and standard deviation of groundwater samples of dumping sites at Nanded.

Table 2: Soil Parameters of dumping site.

Sr. No.	Soil Parameters	Summer			Monsoon		
		S_1	S_2	S_3	S_1	S_2	S_3
1	EC (uS/cm)	120	260	380	400	100	80
2	WHC (%)	44	43	42	10	11	11
3	Soil Moisture (%)	6.0	5.0	3.22	65.39	64.77	65.27
4	pH	8.19	8.43	7.77	8.12	6.50	7.26
5	Chloride (%)	0.0816	0.280	0.092	0.0497	0.1136	0.0426
6	Alkalinity (meq/100g)	1.5	2.0	1.5	3.5	1.5	1.0
7	Sodium (ppm)	236.9	106.3	120.8	56	36	28.6
8	Potassium (ppm)	97.8	97.3	97.7	78.6	90.3	92.5
9	Organic Carbon (%)	0.195	0.27	0.213	0.285	0.12	0.24
10	Organic Matter (%)	0.336	0.465	0.367	0.491	0.206	0.413
11	Calcium (%)	1.002	0.921	1.04	1.146	1.05	0.881
12	Magnesium (%)	0.036	0.109	0.131	0.114	0.043	0.073
13	SPC (cells/gm)	$3.5 X10^4$	$5.0X10^4$	$8.6X10^4$	$9.0X10^4$	$5.3X10^4$	$1.8X10^4$

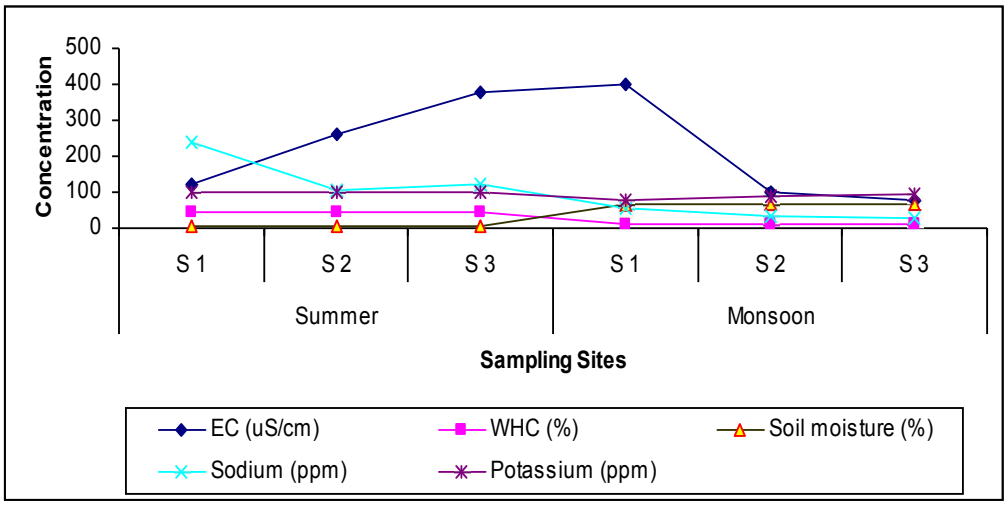

Figure 6: Observed EC, WHC, Soil moisture, sodium and potassium of soil samples of dumping sites at Nanded.

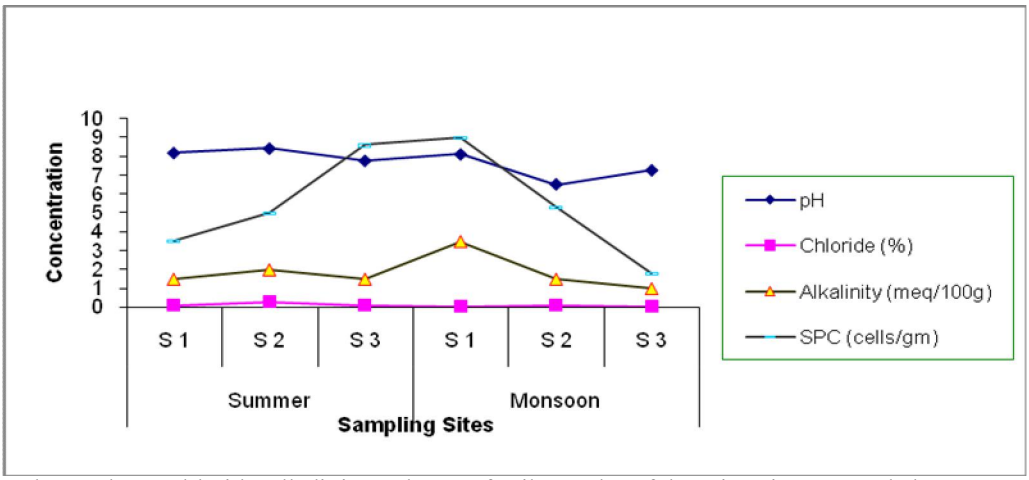

Figure 7: Observed pH, Chloride, alkalinity and SPC of soil samples of dumping sites at Nanded.

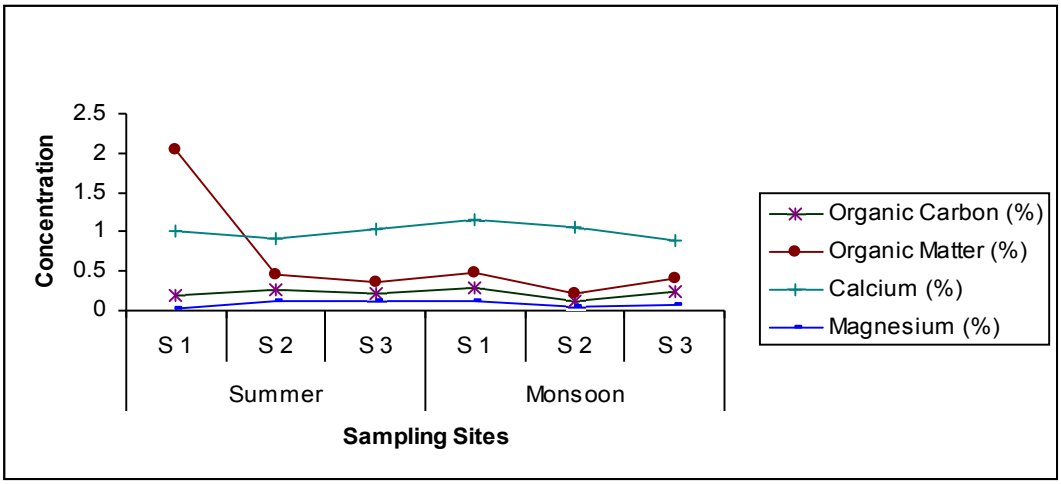

Figure 8: Concentrations of organic carbon, organic matter, calcium, and magnesium from soil samples of dumping sites at Nanded.

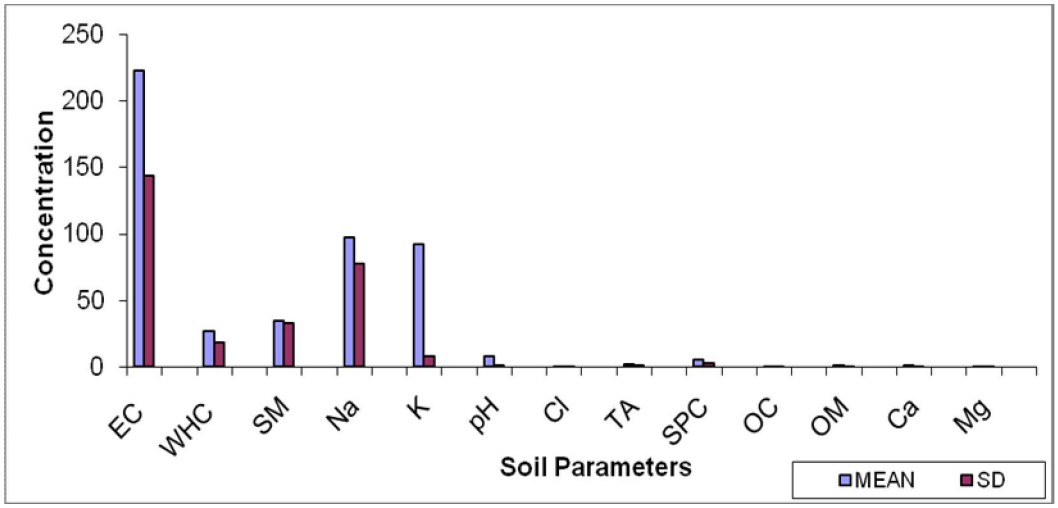

Figure 9: Observed mean and standard deviation of soil samples of dumping sites at Nanded.

CONCLUSION

This study revealed that improper management of waste from generation point to the point of disposal account for contamination of groundwater and soil. The dumping of solid waste has different effects on the physicochemical and biological properties of soil and groundwater. Water pollutants in all samples indicate an empirical relation between solid waste, leachate and groundwater. The high concentration of total solids, electrical conductivity, hardness, TA, Ca, Mg, chlorides, Fe, bacteria in ground water near landfill deteriorates the water quality. The principal threat to groundwater comes from inadequately controlled landfills where leachate generated from the fill is allowed to escape to the surrounding and underlying ground. To minimize the impact of such landfills on ground water quality and the environment in general, it is necessary to properly design and build these facilities to prevent pollution.

ACKNOWLEDGEMENT

We are thankful to the School of Earth Sciences, Swami Ramanand Teerth Marathwada University, Nanded for providing laboratory and library facilities.

CORRESPONDENCE TO:

Shaikh Parveen Rajjak
Swami Ramanand Teerth Marathwada University, Nanded (Maharashtra) India.
E-mail: parveen_earth@yahoo.co.in

REFERENCES:

1) Alker, S. C., Sarsby, R. W and Howell R., 1995, Composition of leachate from waste disposal

sites, Proceedings, Waste Disposal by Landfill-Green '93, Balkena, Rotterdam, pp 215–221.
2) APHA, Standard Methods for the Examination of Water and Wastewater, 1998, American Public Health Association, 20th edition, Washington. D.C.
3) David N. Ogbonna, Benjamin L. Kii and Patrick O. Youdeowei, 2009, Some physico-chemical and Heavy metal levels in soils of waste dumpsites in Port, Harcourt Municipality and Environs, Journal of Applied Sciences and Environmental Management , Vol. 13,No.4, pp 65 – 70.
4) Elizabeth A., Martin M.A., Aggrewal R., Jobling, J.C and Taylor E., 2003, Oxford Concise Medical Dictionary, 6th edition, Oxford University Press, Hong Kong, pp 754.
5) Faith Efosa Oviasogie, Christopher Uche Ajuzie and Uyiosa Glory Ighodaro, 2010, Bacterial Analysis of Soil From Waste Dumpsite, Archives of Applied Science Research, Vol. 2, No.5, pp161-167.
6) Freeze, R. A and Cherry, J. A., 1979, Ground Water, Englewood cliffs, NJ: Prentice-Hall.
7) Gadhave A.G., Thorat D.G and Uphade B.K., 2008, Water quality parameters of ground water near industrial areas, Shrirampur (M.S), Rasayan J. Chem., Vol.1, No.4, pp 853-855.
8) Gupta D. P., Sunita and Saharan J. P., 2009, Physiochemical Analysis of Ground Water of Selected Area of Kaithal City (Haryana) India, Researcher, Vol.1, No.2, pp 1-5.
9) Jackson, M. L., 1973, Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi.
10) Katyayan Arun, 2008, Fundamentals of agriculture, Kushal publication and distributors, Varanasi, Vol.1.
11) Martin N. Sarah, 1994, Standard Handbook for Solid and Hazardous Waste Facility Assessments, Lewis Publishers, USA.
12) Nanded Vision-2025, June 2006, City Development Plan, Nanded Waghala Municipal Corporation (NWMC).
13) Obire, O., Nwallbeta, O and Adue S.B.N., 2002, Microbial community of a waste-Dump Site, Journal of applied Sciences and Environmental Management, Vol. 6, No.11, pp 78-83.
14) Singh Umesh Kumar, Manish Kumar, Chauhan Rita, Jha Pawan Kumar, AL. Ramanathan and Subramanian V., 2008, Assessment of the impact of landfill on groundwater quality: A case study of the Pirana site in western India, Environmental Monitoring and Assessment, 141, pp 309–321.
15) Soil Analysis Report, 2010, Agriculture department, government of Maharashtra, Parbhani.
16) Trivedy R.K., Goel P.K and Trisal C.L., 1998, Practical methods in Ecology and Environmental science, Enviro media publications, Karad.
17) Vasanthi P., Kaliappan S and Srinivasaraghavan R., 2008, Impact of poor solid waste management on ground water, Environmental Monitoring and Assessment, 143, pp 227–238.

7/2/2012