*International Research Journal of Environmental Sciences*_____ ISSN 2319–1414
Vol. **7(4),** 1-5, April **(2018)** *Int. Res. J. Environmental Sci.*

Assessment of groundwater quality along with seasonal variation near Ghazipur landfill Site in Delhi, India

Priyanka Kumari[1], N.C. Gupta[1], Amarjeet Kaur[2*] and D.K. Chadha[3]
[1]University School of Environment Management, Guru Gobind Singh Indraprastha University, Sector 16C, Dwarka, New Delhi 110078, India
[2]University School of Environment Management & Director, Centre for Disaster Management Studies, Guru Gobind Singh Indraprastha University, Sector 16C, Dwarka, New Delhi 110078, India
[3]Central Ground Water Authority, Govt. of India, New Delhi, India
amarjeet_ip@yahoo.com

Available online at: www.isca.in, www.isca.me
Received 31st December 2017, revised 29th March 2018, accepted 15th April 2018

Abstract

The current study is aimed at assessing the physico-chemical characteristics of groundwater quality along with seasonal variations near the Ghazipur landfill site, Delhi. The sampling points were selected within the radius of two km from landfill location. Samples of groundwater were collected during pre & post monsoon seasons and physico-chemical parameters were analyzed. The study exhibits that groundwater in the surrounding area of Ghazipur Landfill site has been contaminated by percolation of leachate. Most of the results have shown higher concentration of chemical contaminants in ground water samples in pre-monsoon as compared to post monsoon season which may be on account of dilution effect during monsoon season. Total Dissolved Solids (TDS), hardness and iron exceeded the maximum permissible limits in most of the locations. However, the alkalinity, fluoride and chloride contents were within the permissible limit but they were found much above the desirable limit. Interestingly, the concentration of nitrate was found below permissible limit and was well in the desirable limit except one location which is contrary to the earlier studies and requires further research. These results showed that there is deterioration in the ground water quality and hence the water is not suitable for drinking purpose. This situation needs urgent attention and immediate action to prevent the further contamination of groundwater.

Keywords: Landfill, leaching, groundwater contamination, seasonal variations.

Introduction

Management of solid waste in cities have really been challenging and causing serious impact on ecology, environment and health. Disposal of Municipal Solid Waste (MSW) in open and non-engineered dumping sites is the easiest way of waste disposal which involves lowest cost and hence it is the most widely used process. About 90% of MSW in India is dumped at open landfill sites without any judicious consideration to take measures for reducing the environmental impact[1]. Rainwater percolation through the layers of waste results into generation of Leachate. It mainly contains dissolved inorganic and organic matters and compounds, heavy metals, etc. The pathway of these pollutants through soil is determined by the hydrogeological parameters through the groundwater towards the surface water. Most of the landfills are non-engineered which probably causes the severe risk to groundwater and environment.

The use of contaminated groundwater near landfill has the most frequently reported danger to the human health[2,3]. About 80% of all diseases in human being are caused by water[4]. Therefore, a periodic assessment is essential to ascertain the quality of groundwater to be used for human consumption as well as to achieve sustainable management of groundwater[5].

Study area: Ghazipur Landfill: The current study has been conducted in the surrounding area of Ghazipur landfill site, which is located at latitudes of 28°35'N and longitude77°12'E in East Delhi and occupies approximately $3x10^5$ m^2 area of land. The Ghazipur landfill site falls in the Shahadra block, which mainly has alluvium characteristics however the hard rocks are also observed at greater depths. It is surrounded by number of commercial activities i.e. meat, flower and vegetable shops and dairy farms. Wastes originated from household and nearby commercial activities are dumped here. Some construction and demolition waste are also dumped to the landfill. The waste is dumped randomly without any prior segregation. Rag pickers are the only source which helps in partial segregation. The site looks like a mountain of waste which even exceeds 50m height at some points.

Geology of the Surrounding area of Site: The surrounding area of Ghazipur landfill is mainly having geology of the younger alluvium which supports the leaching process. According to Central Ground Water Board report, about 165m thickness of alluvium was observed towards the east of the ridge, up to the river Yamuna. The east of river Yamuna covers Shahdara blocks where study site located having alluvium thickness of 48m to 240m. Shallow fresh water aquifers within 40-50m depth that acts as single unconfined aquifer system was observed in the Yamuna flood plain area.

Figure-1: Map showing Landfill sites in Delhi[6].

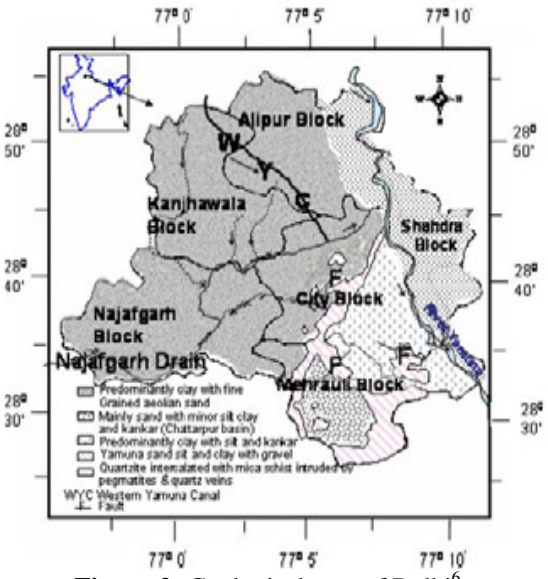

Figure-2: Geological map of Delhi[6].

The extent of leachate plume spread and the distribution of concentration of contaminants are determined by the process of advection and dispersion. Advection is the process of dissolved or suspended mass movement in the fluid due to the flow of water. Dispersion is a process of mixing of two fluids of different compositions/concentrations.

Materials and methods

Twenty ground water locations were selected within the radius of approximately 2 km of the landfill site in such a way that it may represent the maximum possible effects of landfill. All samples were collected two times in a year that is during Post Monsoon (Nov. 2016) and Pre monsoon (June 2017) seasons. Sampling locations were selected in such a manner, so that it may represent the maximum possible effects of landfill site. To assess the groundwater quality, various physico-chemical parameters like pH, Total Dissolved Solids (TDS), chloride, total hardness, total alkalinity, phosphate, fluoride, nitrate and iron were determined as per the Standard Methods[7]. Some parameters i.e. pH, EC and TDS were measured on the sampling site only.

Results and discussion

pH: pH values ranged from 7.16 to 8.15 during Pre Monsoon and from 6.86 to 7.69 during Post Monsoon seasons. All the pH values were within the prescribed limit of Bureau of Indian Standard[8]. The mean values of pH for Pre and Post Monsoon were 7.54 and 7.22, as mentioned in Table-3.

Total dissolved solid: TDS in water is due to presence of dissolved inorganic and organic substances in form of molecules, ions or micro granules[9]. TDS values ranged from 266mg/L to 2310mg/L for Pre monsoon (Table-1) and from 240 mg/L to 2640mg/L for Post monsoon (Table-2) seasons. GW11 showed highest concentration of TDS during both seasons while GW17 showed the lowest concentration of TDS during Post monsoon. Higher concentration of TDS in Post Monsoon samples represents poor quality of water which may be due to higher percolation of leachate in ground water.

Electrical conductivity: Natural weathering as well as anthropogenic sources may be the reason of high Conductivity[10]. Electrical conductivity ranged from 211 to 2111µS/cm in Pre monsoon and 211 and 2401µS/cm in Post monsoon. High amount of dissolved salts causes higher conductivity of groundwater samples.

Total hardness: Total hardness is measured as the sum of hardness contributed by Calcium and Magnesium ions. Total Hardness ranged from 290 to 850mg/L during Pre monsoon and from 130 to 840 mg/L during Post monsoon seasons.

Total alkalinity: The alkalinity ranged from 370mg/L to 680mg/L and from 105mg/L to 490mg/L during Pre and post monsoon seasons respectively. All the sites have alkalinity above the BIS standards of desirable limit (200mg/L)[8]. GW1 has the maximum value of alkalinity i.e. 680mg/L during Pre monsoon which exceeded the permissible limit of BIS as well[8].

Fluoride: The concentration of Fluoride ranged from 0.22 to 1.55 mg/L during Pre Monsoon and 0.11 to 1.77mg/L during Post Monsoon season. GW14 and GW11 have the highest fluoride concentrations i.e. even above the BIS standards permissible limit for Pre and Post monsoon seasons respectively[8] (Table-3).

Nitrate: The concentration of Nitrate ranged from 0.52 to 20.86 mg/L during Pre Monsoon and 0.25 to 43.97mg/L during Post Monsoon season which is interestingly less than the BIS standard desirable limit[8].

Chloride: Chloride concentration of the groundwater samples ranged from 80 to 1080mg/L during Pre Monsoon and 28 to 451 mg/L during Post Monsoon with average value of 349.75mg/L and 180.65mg/L respectively. GW1, GW6, GW7, GW7, GW8, GW11, GW12, GW13, GW16, GW17, GW19 and GW20 have exceeded the BIS standard desirable limit of chloride

concentration during Pre monsoon and GW1, GW2, GW6, GW7, GW8, GW10, GW11, GW12 during Post monsoon season[8]. Increased level of chloride in groundwater may be harmful for persons suffering from kidney and heart problem and disease[11,12].

Total Iron: The iron concentration in Pre monsoon ranged from 0.08mg/L to 4mg/L and 0.04mg/L to 3.89mg/L in Post monsoon. During Pre monsoon, 12 groundwater samples (67% of the total samples) were having iron concentration beyond the BIS standard desirable limit. During Post monsoon season, iron was not traceable at some locations i.e. at GW1, GW2, GW6, GW12 and GW15, however at 10 locations (50% of sample size), exceeded the BIS standard desirable limit (0.3mg/L) [8]. The high level of iron in groundwater of study area indicates that iron and steel scrap garbage being regularly dumped at landfill site directly or indirectly.

Sodium: Sodium plays a major role in potable water[12]. The Sodium concentration ranged from 25 to 472 mg/L during Pre Monsoon and from 28mg/L to 451mg/L in Post Monsoon. Eight groundwater samples have shown higher value of Sodium than prescribed WHO standard (200mg/L) in both Pre and Post Monsoon season[11]. Sodium can easily be replaced by divalent cations like calcium and Magnesium and has a strong affinity for adsorption on soil particles. This kind of exchange can occur through water percolation which may lead to an increased concentration of sodium[13].

Potassium: The Potassium concentrations ranged from 2.8 to 62.6 during Pre Monsoon and from 2.1 to 55mg/L during Post Monsoon seasons. European Economic Community has prescribed the permissible level of potassium at 10mg/L in drinking water however the Bureau of Indian Standard has not specified Potassium concentration in Drinking Water Standards[8,14]. GW1, GW3, GW6, GW8, GW11, GW12, GW18 and GW19 in Pre Monsoon and GW1, GW3, GW6, GW8, GW11, GW12, GW18 and GW19 shows high value of Potassium above than European Standards[14].

Table-1: Data analysis of Pre monsoon ground water near Ghazipur landfill site.

Groundwater Samples	pH	TDS	EC	TH	TA	Fluoride	Nitrate	Chloride	Total Iron	Sodium	Potassium
GW1	8.02	830	740	290	680	0.79	17.06	680	0.08	389	62.6
GW2	7.65	615	546	650	370	0.41	2.15	185	ND	168	9.03
GW3	7.38	445	390	470	450	ND	1.5	120	0.7	126	29.3
GW4	7.41	707	638	420	560	0.22	13.24	120	1.48	136	9.3
GW5	7.34	870	782	630	400	0.33	20.86	140	0.23	201	7.09
GW6	7.66	266	234	520	440	0.57	7.25	1080	0.18	472	11.9
GW7	7.53	1992	1821	500	600	0.71	14.93	560	0.14	227	8.9
GW8	7.69	607	558	410	540	0.58	10	310	3.1	215	12
GW9	7.86	724	654	300	520	0.46	3.45	200	3.22	176	6.0
GW10	8.15	675	600	480	380	0.92	6.79	200	4.0	222	8.2
GW11	7.41	2310	2111	850	500	1.36	0.52	980	2.78	313	12.61
GW12	7.16	1660	1710	760	580	0.52	10.1	600	0.3	290	32.3
GW13	7.62	1128	761	600	420	0.9	19.37	200	0.52	83	7.11
GW14	7.43	890	387	520	520	1.55	12.08	80	0.9	36	3.9
GW15	7.4	829	834	580	480	1.31	5.27	190	0.2	107	5.2
GW16	7.42	776	1253	450	580	0.84	2.57	440	0.2	160	7.47
GW17	7.58	470	211	360	520	0.46	7.28	200	0.2	25	2.8
GW18	7.3	667	722	520	620	0.82	14.39	140	0.41	88	20.19
GW19	7.45	958	1005	600	580	0.46	4.57	360	0.36	141	27.2
GW20	7.37	965	800	580	580	0.57	15.44	210	0.53	136	6.8

TDS- Total Dissolve Solid, EC-Electrical Conductivity, TH- Total Hardness, TA- Total Alkalinity, ND- Not Detectable.

Table-2: Data analysis of Post monsoon ground water near Ghazipur landfill site.

Groundwater Sample	pH	TDS	EC	TH	TA	Fluoride	Nitrate	Chloride	Total Iron	Sodium	Potassium
GW1	7.31	2120	1880	250	350	1.28	15.6	365	ND	365	55
GW2	7.25	960	844	620	358	1.17	0.27	200	ND	200	8.4
GW3	7.28	760	659	340	415	0.41	0.41	135	0.69	135	24
GW4	7.13	660	571	270	420	0.46	10.35	118	1.37	118	8.9
GW5	7.69	420	377	180	225	1.52	12.48	178	0.17	178	6.3
GW6	7.37	298	268	520	310	1.52	4.72	451	ND	451	12.1
GW7	6.86	1700	1538	490	425	0.82	43.97	230	0.04	230	8.6
GW8	6.87	700	625	370	490	0.84	15.64	218	2.98	218	12
GW9	7.36	1320	1187	170	345	1.14	2.62	168	3.17	168	5.5
GW10	7.35	1040	963	410	350	1.09	0.25	215	3.89	215	8
GW11	7.34	2640	2401	840	295	1.77	0.27	352	2.67	352	11.7
GW12	6.93	1880	1710	510	465	1.2	8.07	275	ND	275	24
GW13	7.69	840	761	370	365	1.03	7.61	75	0.49	75	6.6
GW14	7.38	420	387	230	235	1.03	5.25	31	0.79	31	3.4
GW15	7.11	920	834	330	160	0.22	1.23	99	N.D.	99	6
GW16	6.99	1400	1253	410	350	1.03	1.44	155	0.12	155	7.7
GW17	7.54	240	211	130	105	0.35	4.78	28	0.14	28	2.1
GW18	6.94	800	722	420	360	0.11	11.17	79	0.32	79	18.7
GW19	6.89	1160	1005	540	370	0.43	3	120	0.29	120	22
GW20	7.07	1280	1155	520	420	1.33	14.05	121	0.41	121	5.9

*ND – Not Detectable

Table-3: Statistical representation of Pre and Post monsoon ground water near Ghazipur landfill site.

	Pre Monsoon			Post Monsoon			BIS Standards[8]	WHO Standards[11]
Prameter	Min.	Max.	Mean	Min.	Max.	Mean		
pH	7.16	8.15	7.54	6.86	7.69	7.22	6.5-8.5	No guideline
TDS	266	2310	919.20	240	2640	1077.90	500 mg/l	1000 mg/l
EC	211	2111	837.85	211	2401	967.55	600 µS/cm	No guideline
TH	290	850	524.50	130	840	396.00	200-600mg/l	No guideline
TA	370	680	516.00	105	490	340.65	200-600mg/l	No guideline
Fluoride	0.22	1.55	0.73	0.11	1.77	0.94	1-1.5mg/l	1.5mg/l
Nitrate	0.52	20.86	9.44	0.25	43.97	8.16	45mg/l	50 mg/l
Chloride	80	1080	349.75	28	451	180.65	250-1000mg/l	250mg/l
Total Iron	0.08	4	1.03	0.04	3.89	1.17	0.3 mg/l	0.3 mg/l
Sodium	25	472	185.55	28	451	180.65	Not mentioned	200 mg/l
Potassium	2.8	62.6	14.50	2.1	55	12.85	Not mentioned	Not mentioned

Conclusion

Ghazipur landfill site is situated in the Yamuna flood plain[15]. It has geology of young alluvium with high sand content which causes the leaching of pollutants into the nearby groundwater[15]. The above presented analysis of nearby groundwater of landfill site exhibits the evidence of leaching. Most of the Pre monsoon samples showed high concentrations of TDS, TH, TA, chloride, EC, Total iron, and sodium that indicate contamination of groundwater through anthropogenic pollutants, i.e. by the Ghazipur landfill leachates. The dilution effect due to the surface water-groundwater interactions may be the reason of low concentration of nitrate, which was mostly found below permissible limit and was well within the desirable limit[16,17].

Acknowledgement

The authors are grateful to IL & FS Environment Infrastructure Services Limited for giving support during the study period. We are thankful to Dr. P. D. Grover, Senior Consultant, IL & FS Environment Infrastructure Services Limited, for his valuable suggestions and support. We are also thankful to Dr. N. B. Mazumdar, Director, Sulabh International Social Service Organization, Delhi for necessary help from time to time.

References

1. Sanjay J.S., Trehan C. and Koul S. (1998). Methane emission from MSW by gas chromatography. *Journal of pollution research*, 17, 367-369.

2. Kelly W.E. (1976). Groundwater Pollution near a Landfill. *Journal of Environmental Engineering Division (ASCE)*, 102(6), 1189-1199.

3. Lo I.M.C. (1996). Characteristics and Treatment of Leachates from Domestic Landfills. *Environment Interntional*, 22(4), 433-442.

4. Ramakrishnaiah C.R., Sadashivaiah C. and Ranganna G. (2009). Assessment of Water Quality Index for the groundwater in Tumkur Taluk, Karnataka state, India. *E-Journal of Chemistry*, 6(2), 523-530.

5. Nag S.K. and Lahiri A. (2012). Hydrochemical Characteristics of Groundwater for Domestic and Irrigation Purposes in Dwarakeswar Watershed Area, India. *American Journal of Climate Change*, 1, 217-230.

6. Jhamnani B. and Singh S.K. (2009). Groundwater Contamination due to Bhalaswa Landfill Site in New Delhi. *World Academy of Science, Engineering and Technology International Journal of Civil and Environmental Engineering*, 1(3), 121-125.

7. APHA, AWWA and WPCF (1998). Standard Methods for the Examination of Water and Wastewater, 15th Editions. American Public Health Association, Washington, DC, USA.

8. Standard I. (1991). Bureau of Indian Standards drinking water specifications IS 10500: 1991. New Delhi, India.

9. Sharma S. and Chhipa R.C. (2012). Evaluation and optimization of water quality index for ground water source of North West, Jaipur and agglomerates. *International Journal of Chemical Sciences*, 10(4), 2297-2305.

10. Alobaidy A.H.M.J., Abid H.S. and Maulood B.K. (2010). Application of water quality index for assessment of Dokan lake ecosystem, Kurdistan region, Iraq. *journal of water resource and protection*, 2, 792-798. DOI: 10.4236/jwarp.2010.29093

11. WHO (1997). Guidelines for Drinking Water Quality. World Health Organization, Geneva, 2.

12. Kuppuraj R.M., Selvaraj D., Govindaraj S., Rangaswamy M., Narayanasamy J.R. and Kuppanagounder K. (2012). Assessment of groundwater quality in the flood plains of upper Palar River, India. *Chinese Journal of Geochemistry*, 31(1), 15-23.

13. Goel P.K. (2006). Water pollution causes; Effects the control. 2th. Ed. International Limited Publishers, New Age Publishers.

14. Kumar A. (2004). Water Pollution. A.P.H. Publishing co-corporation. ISBN 81-7648-756-2, Delhi, India.

15. Kumar S., Sarkar A., Thakur S.K. and Shekhar S. (2017). Hydrogeological characterization of aquifer in palla flood plain of Delhi using integrated approach. *Journal of the Geological Society of India*, 90(4), 459-466.

16. Kumar M., Ramanathan A.L. and Keshri A.K. (2009). Understanding the extent of interactions between groundwater and surface water through major ion chemistry and multivariate statistical techniques. *Hydrological Process*, 23(2), 297-310.

17. Kumar M., Sharma B., Ramanathan A.L., Rao M.S. and Kumar B. (2009). Nutrient chemistry and salinity mapping of the Delhi aquifer, India: source identification perspective. *Environmental Geology,* 56, 1171-1181.