Assessment of GroundWater Quality near Municipal Solid Waste Management Plant, Shivari, Lucknow, India

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ABSTRACT

Ground water is contaminated around the Municipal Solid Waste treatment plant in shivari village. The major cause of the contamination of groundwater may be due to the disposal of leachate generated in Municipal Solid Waste treatment plant. The aim of the research work is to examine the quality of groundwater of nearby area through for various physico-chemical parameters (pH, TDS, Total Alkalinity, Total Hardness Ca^{+2}, Mg^{+2}, Na^+, Cl^-, nitrate, sulphate, F^-) along with heavy metals (Cr^{+6},Cd,As) and microbiological parameter (Total coliform). Laboratory analysis indicates concentration of various parameters ranges between TDS (348 mg/l to 632 mg/l), Total Alkalinity (358 mg/l to 400 mg/l), Ca^{+2} (67.2 mg/l to 109.6mg/l), F^- (0.49 mg/l to 1.2 mg/l), exceeds the concentration recommended by BIS whereas concentration of various parameters were on the verge of exceeding the limit such as Mg^{+2} (11.18 mg/l to 27.22 mg/l) in ground water samples. Concentration of heavy metals such as Cr^{+6} (<0.05 mg/l to 0.680 mg/l), Cd(<0.03 mg/l to 0.017 mg/l), As(0.1260 µg/l to 0.4945µg/l) indicates contamination of ground water from leachate of Municipal Solid Waste Treatment Plant. Further presence of Total coliform bacteria in water samples renders the water unfit for drinking and for domestic purpose as well. A systematic calculation of the Pearson's correlation coefficient has also been carried out between different analyzed parameters.

Keywords: Municipal Solid Waste treatment plant, groundwater samples, Pearson's correlation coefficient .

INTRODUCTION

Pure water had been a prime requisite for the existence of Human civilisation from past till now and groundwater is an important component of pure water especially in a developing country like India for drinking, domestic, irrigation purposes. But currently India is facing a water crises as India had only 4% of fresh water reserves and 16% of world's total population and this condition is going to be worsen in future as India will be the most populous country in the world. In such situation contamination of groundwater is the major problem in India especially in rural areas. Contamination of ground water may lead to outbreak of diseases like hepatitis, diarrhea, vomiting, abdominal pain, dysentery etc. (Maiti et al .,2016)

According to world bank estimate 21% of communicable diseases in India is linked with unsafe drinking water and lack of hygiene practices. More than 500 children under the age of 5 die each day from diarrhea in India alone. As per WHO, about 80% of all the diseases in human beings are caused by water (Kavitha and Elongova ., 2010). Therefore the suitability of groundwater for various purposes were determined by it's physical,

chemical and biological characteristics. MSW Treatment plant significantly affect the local environment in various ways such as contamination of surface and groundwater bodies by the percolation of leachate from MSW Treatment plant, contamination of soil strata as during leachate percolation some amount of leachate usually reside in the soil strata, awful gases released during the decomposition of organic waste may also effect local people's health. The present study was carried out to assess the groundwater quality around MSW Treatment plant during pre-monsoon season and compare the result with BIS drinking water quality standard. GPS system was also used to identify the sample location of groundwater samples around MSW Treatment plant in shivari village, Lucknow, Uttar Pradesh.

STUDY AREA

Lucknow – the state capital of Uttar Pradesh is situated at an altitude of 123 meters above mean sea level and extends between 26.30'- 27.10' North latitude and 80.30'-81.31' East longitude. Lucknow covers an area of 3244 Km^2 with a population of 3.4704 million (Census of India, 2011). It receives an average precipitation of 896.2 mm between July to September from South West monsoon winds and occasionally from frontal rainfall occurring in January.Lucknow city generates around 1534 tonnes per day with an average generation rate of 0.39 kg per capita per day.

MSW Treatment plant lies at an altitude of 26.80' North and 80.77' East in the Shivari village of Kakori district on Mohan road at a distance of 10 Km from Buddeshwar chauraha Lucknow (Fig 1). The plant receives near about 1300 tonnes per day of waste from all parts of Lucknow city and also from various open dumping sites. The plant had been started in 2010 and it extends over an area of about 62420.08 m^2.

Fig. 1 View of study area (Source: Google earth)

MATERIAL AND METHOD

Sampling of groundwater

In order to access the impact of leachate percolation on the groundwater quality, samples of groundwater were collected from the sampling points. Details of sampling points is shown in table 1. The groundwater samples were collected in polythene bottles of 1.0 litre capacity. The groundwater samples were collected from tube wells

and hand pumps of 5 different stations around MSW Treatment plant during pre-monsoon season. Polythene bottles were washed and rinsed with hot water as a part of quality control measure.

Table 1: Details of sampling points

S.NO	Sample code	Source of sample	Latitude (N)	Longitude (E)
1	GW 1	Tube well	26.800148	80.780178
2	GW 2	Hand pump	26.792302	80.779367
3	GW 3	Hand pump	26.801435	80.770096
4	GW4	Hand pump	26.796260	80.770286
5	GW 5	Hand pump	26.797982	80.765562

After the collection of samples, samples were marked in accordance to its serial number and all the samples were transported to laboratory and preserved at 4º C in refrigerator for the analysis of of physico-chemical parameters, heavy metals, and biological analysis as per the standard prescribed in APHA, 23RD Edition 2017. The results obtained after laboratory analysis were compared with the limits prescribed by BIS (10500:2012). All parameters and methods were described in Table 2

Table 2: list of parameters analyzed and methodology followed

Parameters	Methodology
pH, Total dissolve solids(TDS)	pH meter
Total hardness(TH), Calcium(Ca^{+2}), Magnesium(Mg^{+2})	EDTA titrimetric method
Chloride(Cl^-)	Argentrometric method
Nitrate (No_3^-), Sulphate(So_4^{-2})	UV spectrometric method
Flouride(F^-)	Fluoride Meter
Sodiun(Na^+)	Flame photometric method
Coliforms	MPN method
Heavy Metals	Atomic absorption spectroscopy(AAS)

RESULTS AND DISCUSSION

In laboratory, samples were analysed for various physic-chemical parameters (pH, TDS, Total Alkalinity, Total Hardness Ca^{+2}, Mg^{+2}, Na^+, Cl^-, nitrate, sulphate, F^-) along with heavy metals (Cr^{+6},Cd,As). Further, the collected samples were also analysed for bacteriological analyses through microbiological parameter (Total coliform). Table 3 shows the concentration of various analysed parameters in groundwater samples. Pearson correlation coefficient analysis of various analysed parameters was performed using Microsoft Excel 2007. Pearson correlation coefficient (r) among various analysed parameters of groundwater quality is presented in Table 4

pH

pH is the potential exerted by H^+ ion in a sample. pH value of groundwater sample varies between 7.2 to 7.6. GW2 shows higher concentration of 7.6.

Total Dissolve Solids (TDS)

TDS quantifies the total amount of organic and inorganic solids dissolve in groundwater. It's values varies between 346 mg/L to 632 mg/L.

Total Alkalinity (TA)

Total Alkalinity (TA) as $CaCo_3$ ranges from 342 mg/L to 400 mg/L. GW1 shows higher concentration of TA in groundwater samples.

Total Hardness (TH)

Total Hardness here indicate carbonate hardness caused by calcium and magnesium. TH conc. As $CaCo_3$ in groundwater samples exceed the standard laid by BIS as it ranges between 94.42 mg/L to 120.78 mg/L. GW1 and GW3 shows lowest and highest conc. among all.

Calcium (Ca^{+2})

Concentration of calcium ion in groundwater samples varies between 67.2 mg/L to 109.6 mg/L. GW3 shows higher conc. among all samples.

Magnesium

Concentration of Magnesium ion in groundwater samples varies between 11.18 mg/L to 27.22 mg/L.

Sodium

Concentration of Sodium ion in groundwater samples varies between 40.14 mg/L to 400 mg/L. GW1 shows higher conc. among all samples.

Chloride

Chloride is an important indicator of pollution due to organic substances in groundwater. Concentration of chloride ion in groundwater samples varies between 8 mg/L to 28 mg/L.

Sulphate

Sulphate ion concentration is nil in 4 out of 5 groundwater samples. It is present only in GW1 sample having conc. of 1.7932 mg/L.

Nitrate

Nitrate Concentration in groundwater samples varies between 0.058 mg/L to 0.378 mg/L. GW1 and GW5 shows lowest and highest concentration.

Fluoride

One of the source of Fluoride in groundwater is Fluoride containing rock. Fluoride conc. upto 1 mg/L is required for teeth's strength and conc. beyond1.5 mg/L had detrimental effects such as skeletal fluorosis. However conc. of Fluoride in groundwater sample varies between 0.49 mg/L to 0.96 mg/L which is below desirable limit as per BIS.

Cadmium

Cadmium ion concentration is below detection limit (ND) in 3 out of 5 groundwater samples. It's conc. varies from 0.013 mg/L to 0.017 mg/L. GW 4 highest conc. of cadmium ion.

Chromium

Chromium ion concentration is below detection limit (ND) in 3 out of 5 groundwater samples. It's conc. varies from 0.450 mg/L to 0.680 mg/L.

Arsenic

Arsenic concentration in groundwater samples varies between 0.1260 µg/L to 0.378 µg/L. GW1 shows highest concentration among all samples.

MPN/100 ml (Total coliform)

Total coliform is an indicator of bacterial contamination of groundwater samples. It's values varies upto 350 mg/L.

Table 3: Concentration of different parameter in groundwater samples

Parameter	GW1	GW 2	GW 3	GW 4	GW 5	BIS Standard(IS 10500:2012) Acceptable limits
PH	7.4	7.6	7.2	7.5	7.3	6.5-8.5
TDS	348	632	530	346	624	300
Total Alkalinity	400	380	372	342	358	200
Total Hardness	94.42	106.41	120.78	116.5	120.46	300
Calcium	67.2	94.4	109.6	102.4	108.8	75
Magnesium	27.22	12.01	11.18	14.1	11.66	30
Chloride	22	8	12	16	28	250
Flouride	0.49	0.94	0.91	1.2	0.96	1.0
Cadmium	0.016	ND	0.013	0.017	ND	0.003
Chromium	ND	ND	0.45	ND	0.68	0.05
Arsenic	0.0004945	0.000295	0.000126	0.000312	0.0001485	0.01

Sodium	55.02	42	40.14	48.42	44.02	-
MPN/100mL	ND	240	350	268	284	*0*
Sulphate	1.7932	0	0	0	0	*250*
Nitrate	0.058	0.248	0.304	0.356	0.378	*45*

Table 4: Pearson Coefficient correlation matrix of groundwater quality parameters

	pH	TDS	T.A	T.H	Ca^{+2}	Mg^{+2}	Cl^-	F^-	Na^+	So_4^{-2}	No_3^-	As
pH	1											
TDS	-0.082	1										
T.A	7.19017E-16	-0.027	1									
T.H	-0.458	0.398	-0.799	1								
Ca^{+2}	-0.333	0.523	-0.772	0.980	1							
Mg^{+2}	0.095	-0.684	0.659	-0.860	-0.944	1						
Cl^-	-0.397	-0.127	-0.077	0.020	-0.114	0.328	1					
F^-	0.184	0.200	0.200	0.771	0.812	-0.808	-0.257	1				
Na^+	0.215	-0.798	0.334	-0.721	-0.824	0.922	0.456	-0.542	1			
So_4^{-2}	1.25865E-15	-0.583	0.753	-0.857	-0.936	0.986	0.337	-0.893	0.855	1		
No_3^-	-0.165	0.419	-0.907	0.942	0.953	-0.888	0.017	0.902	-0.666	-0.919	1	
As	0.534	-0.671	0.534	-0.923	-0.941	0.887	0.049	-0.572	0.881	0.825	-0.821	1

Test of Significance of observed correlation coefficient

Correlation coefficient analysis is useful in determining the relationship between two or more water quality parameter which can be exploited in future. Out of 78 correlation coefficients,45 positive and 33 negative. In Table 4 highly positive correlation exist between Ca^{+2} and TH (0.980), Mg^{+2} had correlation with Na^+(0.922) and So_3^{-2}(0.986). whereas highly negative correlation exist between As and Ca^{+2}(-0.941), So_4^{-2} has highly negative correlation with Ca^{+2}(-0.936),No_3^-(-0.919) and F^-(-0.893). Very poor correlation exist between Mg^{+2} and pH(0.095),No_3^- and Cl^-(0.017), Cl^- and As (0.049)

CONCLUSION

In the present study 5 groundwater quality samples were collected from nearby area around MSW Treatment plant and analysis of these samples indicate concentration of various parameters ranges between TDS (348 mg/l to 632 mg/l), Total Alkalinity (358 mg/l to 400 mg/l), Ca^{+2} (67.2 mg/l to 109.6mg/l), F^- (0.49 mg/l to 1.2 mg/l), exceeds the concentration recommended by BIS whereas concentration of various parameters were on the verge of exceeding the limit such as Mg^{+2} (11.18 mg/l to 27.22 mg/l) in ground water samples. Concentration of heavy metals such as Cr^{+6} (<0.05 mg/l to 0.680 mg/l), Cd(<0.03 mg/l to 0.017 mg/l), As(0.1260 µg/l to 0.4945µg/l) indicates contamination of ground water from leachate of Municipal Solid Waste Treatment Plant. Further presence of Total coliform bacteria in water samples renders the water unfit for drinking and for domestic purpose as well. Further Pearson's correlation coefficient also indicate that most of the analysed parameter are more or less interreleated with each other upto some extent.

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