ASSESSMENT OF GROUNDWATER QUALITY NEAR MUNICIPAL SOLID WASTE LANDFILL SITE

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ABSTRACT-Groundwater sample collected from nearby sources of Dubagga landfill site to study the impact of pollution caused due to open dumping. Physico-chemical parameters, heavy metals (Cd and Cr^{6+}) and microbiological parameter (total coliform(TC)) and water quality index(WQI) of groundwater were determined to study the extent of pollution caused due to municipal solid waste site. The concentrations of Mg^{2+} and Cr^{6+} have exceeded their respective permissible limits recommended by Bureau of Indian Standards (BIS. The presence of TC indicates the contamination of groundwater. WQI warns about the quality of groundwater. Correlation analysis shows highly positive relation between EC and TDS, TA and Mg; TDS and Mg; TH and TA; Ca and Mg; $NO_3$and F and Cr.

KEYWORDS- Groundwater, Muncipal landfill site, Water Quality Index, Correlation.

1. INTRODUCTION

Development often leads so many changes that have serious impacts on earth's environment encompassing ecology, water resources, flora. Fast growth of urban zones has additionally influenced the ground water quality due to over abuse of resources (Mohrir et al., 2002). Generation of muncipal solid waste increased by many fold due to rapid urbanization and population.

Leachate, a fluid generating from MSW, has been considered as a genuine threat to surface and ground waters resources, human health and cleanliness. It is a foul fluid exuding from the base of the solid waste sites, for example, leachate are exceedingly concentrated complex effluents which contain organic matter; inorganic mixes, for example, ammonium, calcium, magnesium, sodium, potassium, iron, sulfates, chlorides and heavy metals, for example, cadmium, chromium, copper, lead, zinc, nickel; and xenobiotic natural substances (Lee and Jones-Lee, 1993; Christensen et al., 2001) during acid phase of waste decaying process leachate gets generated.

Groundwater one of the principle source of drinking water on earth. It consisting 90 % of the fresh water source and is a vital storage of good quality water. Groundwater is a crucial ecological function (Armon and Kitty 1994). The appropriateness of groundwater as a source of water relies on its arrangement for the utilization of human and animal utilization, agricultural use, and for industrial and different purposes (Babiker et al. 2007). In this manner, checking the quality of water is imperative since clean water is fundamental for human wellbeing and the dependability of aquatic communities.

This study aims to find thequality of groundwater quality nearby Dubagga open dumpingsite in Lucknow through the hand pumps and tube wells that have been selected for this purpose. To estimate how far groundwater quality has been affected by the open dumping atDubaggasite, groundwater samples were collected and analyzed for various physicochemical parameters, microbiological contamination and heavy metals. Water quality index of groundwater are also accessed to determine extent of pollution due to open landfill.

2. STUDY AREA

Lucknow is capital of the province of Uttar Pradesh in India, with a zone of 2528 sq. km and a populace of around 4.58 million (Census of India, 2011). The monsoon season is from July to September when the city gets a average precipitation of 896.2 millimeters from the south-west monsoon winds, and sometimes frontal precipitation will happen in January. Lucknow city creates around 1600 tons of MSW every day, out of which the organics portion is a noteworthy contributor (47-55%). Open dumping in discouraged or low-lying territories without liners and without a leachate collection facility is the typical practice. The lucknow Municipal Corporation (LMC) as of now works a few unsecured landfill sites for the transfer of gathered solid wastes. The LMC has tried to manage the collection of waste through a private association, while squander processing and disposal have unregulated. In Lucknow there are around 23 new and old municipal strong waste dumping destinations, among which Dubagga is main one.

Dubagga landfill lies at 26.47” North and 80.55” East. It is located at 160 meter distance of the Chandoia Village in north near Musabag and western direction of Lucknow city (Fig. 2.1) is low lying area and close to the fish market and Kadimi Kabristan, receives about 1000 Metric tons municipal solid waste daily. The Dubagga landfill started in the year 2007 and still in use. It spreads over an area of approximately 61420.08 m^2. On an average 2500 MT/day of waste is dumped and the landfill height varies from 4 m to 5 m.

Fig. 2.1. Dubagga landfill site view. (source: Google earth)

3. MATERIALS AND METHODS

3.1. Sampling of groundwater

To understand the effect of open dumping on the groundwater samples are collected from nearby sources. Groundwater samples were collected from the hand-pumps and tube-wells present near the landfill site. Site specifications for sampling points are presented in Table 3.1.

3.2 Sample Analysis

5 groundwater sample locations were chosen nearby the dubagga municipal landfill site. Groundwater samples were collected in 5 liter capacity plastic containers. Before collection of samples all the bottles were washed with nonionic detergent and rinsed with water as part of the quality control measures. After each collected sample container bottle was labeled according to sampling location and all the samples were transported to the laboratory and preserved at 4ºC in refrigerator for further physico-chemical, heavy metal and biological analyses.The results of the

Table 3.1: Site specification for sampling stations.

Sample no.	Sampling locations	Type	Location
GW 1	M.C. Saxena College mod	Handpump	26º53’51” N 80º52’13” E
GW 2	Farm 1	Tubewell	26º53’49” N 80º52’22”E
GW 3	Mandir	Handpump	26º54’10” N 80º52’22” E
GW 4	Farm 2	Tubewell	26º53’40” N 80º52’16” E
GW 5	S S& COMPANY site office	Tubewell	26º53’58”N 80º52’10” E

physico-chemical parameter and level of trace metal concentration of groundwater are compared with the limits prescribed by Bureau of Indian Standard (BIS) 2012 and World Health Organization (WHO) 1997. All parameters and methods prescribed in Table 3.2.

Table 3.2: List of parameters analyzed and methodology followed

Parameters	**methodology**
pH, Electrical conductivity as (EC), Total dissolved solids as (TDS)	pH meter
Total hardness as (TH), Calcium as (Ca^{2+}), Magnesium as (Mg^{2+})	EDTA titrimetric method
Chloride as (Cl^-)	Argentometric method
Nitrate as (NO_3^-), Ammonium as (NH_4^+)	UV spectrometric method
Fluoride as (F^-)	Fluoride Meter
Sodium as (Na^+)	Flame photometric method
Coliforms	MPN method
Heavy Metals	Acid digestion method (AAS)

3.3 Water Quality Index (WQI)

WQI method was computed to demarcate groundwater quality and its reasonableness for drinking uses (Mitra, 1998). The strategy gives the composite impact of individual water quality parameters on the general nature of water for human utilization.For calculating WQI different formulas given below are used (Sinha et al., 2006; Singh et al., 1999).

Water Quality Rating, Qn= [(Va- Vi) / (Vs- Vi)] x 100

Qn = Quality rating for total water quality parameter.

Va = Actual value of parameter obtained from Laboratory analysis.

Vi = Ideal value of the parameter obtained from the standards. (For pH it is 7 and for others it is zero)

Vs = Value recommended by BIS India of water quality.

Unit weight (Wn) = K / Sn

Sn is accepted drinking water quality standards by BIS

K = Proportionality Constant. Calculated by K = $[1 / (\Sigma^{n}_{n=i} 1/Si)]$

Sn = Standard values of the water quality.

Based on the above water quality values, the water samples quality is categorized as Excellent, Good, poor, Very Poor, Unfit for Drinking (Tiwari et al., 1985).

3.4 Correlation Analysis

Correlationanalysisisapreliminarydescriptivetechniquetoestimatethedegreeof association among the variables involved. The purpose of the correlation analysis is to measure closeness of relationship between two continuous variables.The variables are said to be correlated when the movement of one variable is accompanied by the movement of another variable.

4. RESULT AND DISCUSSION

4.1 Physico-chemical parameters and Heavy metals

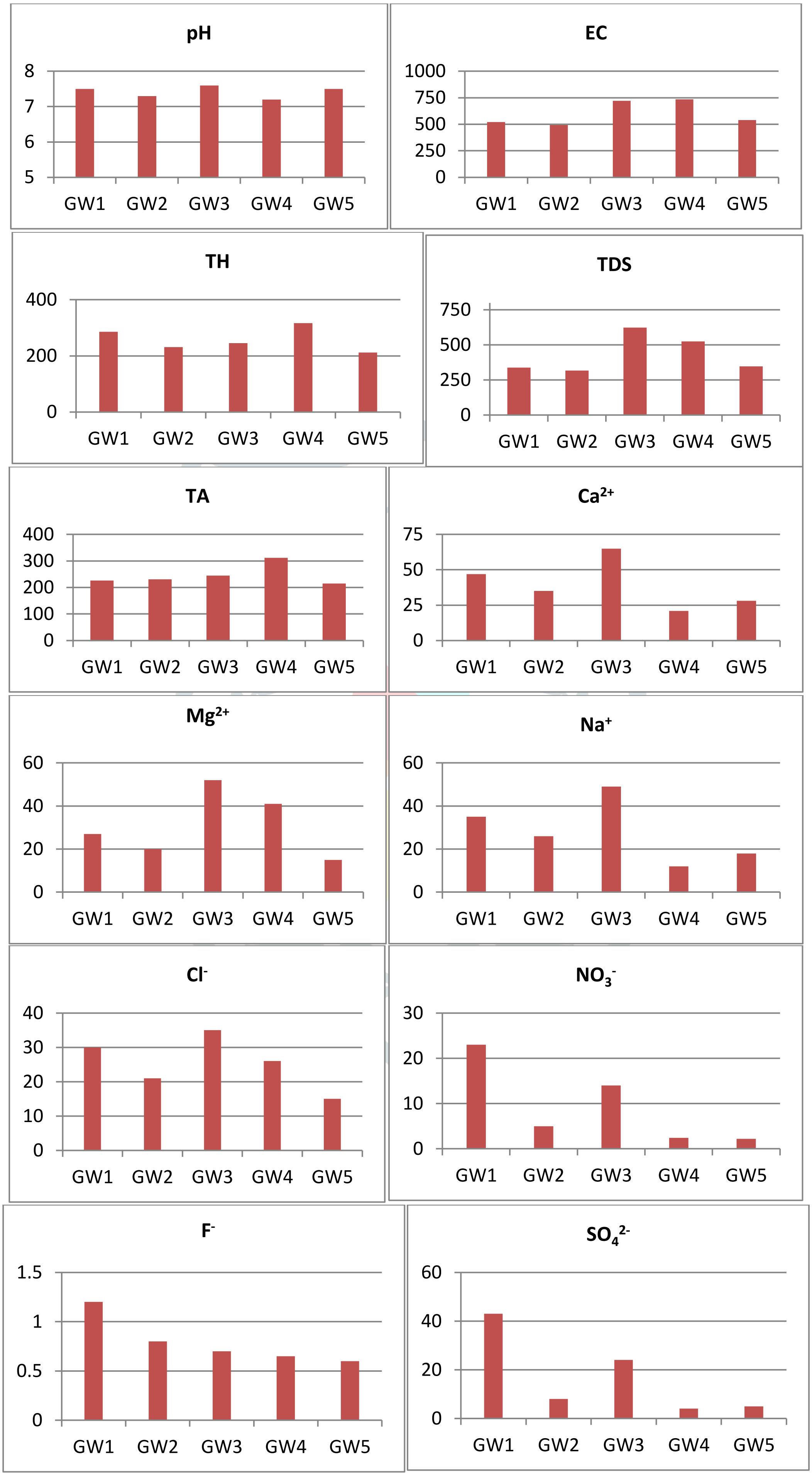
The collected ground water was analyzed for its physico-chemical characteristics. The samples were also tested for the presence of heavy metal ions Cadmium and Chromium Hexavalent.

The result of groundwater samples collected from different sources are presented in Table 4.2. The pH of all the groundwater samples was about neutral, the range being 7.2 to 7.6 The EC is an indicator that shows the amount of material dissolved in water. The EC in the studied area range are in between 492 and 735 µS/l. The TDS values of the groundwater samples are within the permissible limit vary from 339 to 624. The Total hardness (TH) values groundwater samples are found in between 212 to 317 mg/l which found higher than desirable limit but lesser than the permissible limit. The concentration of Total alkalinity (TA) as $CaCO_3$ in groundwater ranges from 215 to 312 mg/l.TH went from 212 to 317 mg/l. As indicated by the classification of Durfor and Becker (1964) for Total Hardness of groundwater predominantly dispersed in the considered territory (Table 4.1).

Table 4.1: Classification of groundwater samples on the basis of Total Hardness

Hardness	Descriptions	Samples
0-60	soft	Nil
61-120	Moderately hard	Nil
121-180	Hard	Nil
>180	Very hard	5

Ca^{2+} and Mg^{2+} are the imperative parameters for total hardness. Ca^{2+} concentration in groundwater extended from 21 to 65 mg/l. The concentration of Mg^{2+} particles changed from 15 to 52 mg/l. Sample of GW3 exceed Mg^{2+} permissible limit of 50 mg/l. Mg^{2+} salts are cathartic and diuretic and high concentration may cause purgative impact, while deficiency may cause auxiliary and useful changes. It is basic as an activator of numerous compound frameworks (WHO, 1997). The concentration of Na^+ in water tests differed from 12 to 49 mg/l. The hazard posture because of high concentration of Na^+ to people that they may experience the ill effects of cardiovascular, renal and circulatory ailment. Cl^- particle abundance in water is demonstrates the file of contamination and considered with respect to groundwater sullying (Loizidou and Kapetanios, 1993). The concentration of Cl^- in the groundwater tests ran between 15 mg/l to 35 mg/l. The contamination hotspots for Cl^- may be because of the residential effluents, manures, and leachates. The nitrate fixation was additionally inside as far as possible (45 mg/L) in all the testing areas yet higher most importantly in area 1 (GW1) and range between 23 to 2.2 mg/l. All in all, the real source for nitrate in groundwater incorporate local sewage, spillover from agrarian fields, and leachate from landfill destinations (Pawar and Shaikh, 1995; Jawad, et al, 1998; Lee, et al, 2003; Jalali, 2005).Higher concentration of NO_3^- in water causes an illness called "Methaemoglobinaemia" otherwise called "Blue-child Syndrome". This sickness especially influences babies that are up to a half year old (Kapil, et al, 2009).The sulfate concentration in groundwater is inside BIS and WHO guidelines for all the gathered examples range between 43 to 4 mg/l. The concentration of F^- in the gathered water tests ran from 0.6 to 1.2 mg/l. F^- at concentration under 1 mg/l in drinking water has been viewed as fundamental for the development of teeth yet more prominent than 1 mg/l concentration may causes dental fluorosis (tooth mottling) and if in excess of 1.5 mg/l truly skeletal fluorosis (Ravindra and Garg, 2006).The concentration of cadmium in all groundwater samples is below detection limit just like in all leachate sample. But the concentration Chromium Hexavalent ion is exceed the permissible limit in groundwater sample in 2 location GW1 and GW2 as 0.15 and 0.12 mg/l respectively as the permissible of chromium hexavalent is 0.05 mg/l.


pH
8
7
6
5
GW1 GW2 GW3 GW4 GW5
EC
1000
750
500
250
0
GW1 GW2 GW3 GW4 GW5
TH
400
200
0
GW1 GW2 GW3 GW4 GW5
TDS
750
500
250
0
GW1 GW2 GW3 GW4 GW5
TA
400
300
200
100
0
GW1 GW2 GW3 GW4 GW5
Ca^{2+}
75
50
25
0
GW1 GW2 GW3 GW4 GW5
Mg^{2+}
60
40
20
0
GW1 GW2 GW3 GW4 GW5
Na^{+}
60
40
20
0
GW1 GW2 GW3 GW4 GW5
Cl^{-}
40
30
20
10
0
GW1 GW2 GW3 GW4 GW5
NO_3^{-}
30
20
10
0
GW1 GW2 GW3 GW4 GW5
F^{-}
1.5
1
0.5
0
GW1 GW2 GW3 GW4 GW5
SO_4^{2-}
60
40
20
0
GW1 GW2 GW3 GW4 GW5

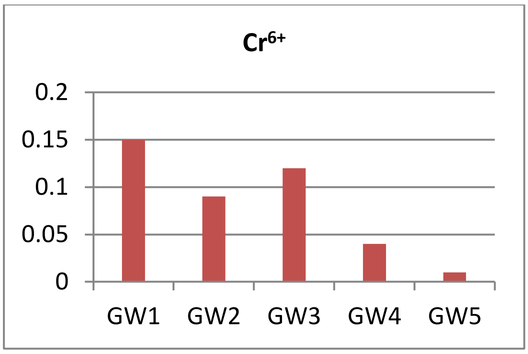


Fig 4.2 Concentration of pH, EC, TDS, TH, TA, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, NO_3^{-} F^{-}, SO_4^{2-} and Cr^{6+}groundwater.

4.2 MICROBIOLOGICAL EXAMINATION

Table 4.2 Microbiological analysis of water

Samples	Combinations of positive	Total coliform (MPN index/ 100ml)
GW1	3-1-0	11
GW2	2-0-1	7
GW3	1-0-1	4
GW4	0-0-0	<0
GW5	0-0-0	<0

Table 4.5 exhibits the present of coliform in 3 samples, demonstrating the sullying of groundwater maybe due to leachate permeation in groundwater. The GW1 test demonstrate the greatest number of total coliform 11 while at the same time GW2 and GW3 samples indicates 5 and 7 separately. The coliform microorganisms can increment when leachate enters in an oxygenated system.

4.3 WATER QUALITY INDEX (WQI)

Water quality index of groundwater samples is calculated on the basis of parameters pH, TDS, TH, TA, Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, NO_3^{-}, $SO_4^{2-}$and F^{-}. From Table 4.3 quality GW1 is 108.07 which comes in category of unfit for drink as described in Table 4.4. Quality GW2, GW3, GW4 and GW5 come in category of very poor, poor, poor and poor,respectively.

Table 4.3 Water Quality Index of groundwater samples.

samples	pH	TDS	TH	TA	Ca^{2+}	Mg^{2+}	Na^{+}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	WQI
GW 1	7.5	339	286	226	47	27	35	30	23	43	1.2	108.07
GW 2	7.3	318	231	200	35	20	26	21	5	8	0.8	80.17
GW 3	7.6	624	245	213	65	52	49	35	14	24	0.7	66.65
GW 4	7.2	525	312	247	21	41	12	26	2.4	4	0.65	60.68
GW 5	7.5	348	215	196	28	15	18	15	2.2	5	0.6	55.88

Table 4.4 Water quality index categories.

Location	WQI	Catogary of water
GW1	108.07	UNFIT FOR DRINKING
GW2	80.17	VERY POOR
GW3	66.65	POOR
GW4	60.68	POOR
GW5	55.88	POOR

Table 4.5 parameters wise standards and their assigned weight.

Parameter	BIS standard	Assigned unit wt
pH	8.5	0.09743
TDS	500	0.00166
TH	300	0.00276
TA	150	0.00552
Calcium	75	0.01104
Magnesium	30	0.0276
Cl-	250	0.00331
Nitrate	45	0.0184
Sulphate	200	0.00414
F-	1	0.082813

4.4 Correlation Analysis.

As shown in Table 4.6the groundwater samples correlation coefficient was highly positive between EC and TDS, TA and Mg^{2+}; TDS and Mgo^{2+}; TH and TA; Ca^{2+} and Mg^{2+}; $NO_3^-$and F^- and Cr^{6+}. Correlation coefficient was significantly positiveassotiation between EC and Mg^{2+} and Cl^-; TDS and Cl^-, TA; TH and Mg^{2+}, Cl^-; TA and Mg^{2+}, Cl^-; Ca^{2+} and Mg^{2+}, Cl^-, NO_3^-, SO_4^{2-} and Cr^{6+}; Mg^{2+} and Cl^-, Na^+; Na^+ and Cl^-, NO_3^- and Cr^{6+}; Cl^- and NO_3^-, SO_4^{2-};Significant negative correlation was observed between EC and F^-; TDS and F^- ; Mg and F^-.

5. CONCLUSION

From the analysis it is clear that quality of groundwater is being deteriorated around the Municipal open dumping landfill. $Mg^{2+}$and Cr^{6+}exceeds their respective permissible limit in groundwater samples. Water Quality Index of groundwater samples indicates that quality of water is unfit for drink in GW1 sample and very poor in GW2 sample and poor in GW3, GW4 and GW5.Despite the fact that, the concentration of some of contaminants don't surpass drinking water standard even then groundwater quality speak to a significant danger to public health.

Cr^{6+}													1
F												1	0.800
SO_4^{2-}											1	0.871	0.881
NO_3^-										1	0.997	0.858	0.908
Cl^-									1	0.701	0.661	0.383	0.769
Na^+								1	0.744	0.730	0.692	0.363	0.794
Mg^{2+}							1	0.488	0.851	0.245	0.199	-0.135	0.334
Ca^{2+}						1	0.523	0.997	0.757	0.720	0.683	0.330	0.769
TA					1	-0.189	0.553	-0.212	0.487	0.159	0.158	0.183	0.121
TH				1	0.985	-0.181	0.464	-0.195	0.483	0.256	0.258	0.335	0.220
TDS			1	0.302	0.431	0.418	0.952	0.372	0.672	0.014	-0.027	-0.408	0.070
EC		1	0.952	0.480	0.615	0.145	0.891	0.094	0.546	-0.131	-0.162	-0.461	-0.112
pH	1	-0.079	0.152	-0.457	-0.451	0.779	0.129	0.761	0.325	0.574	0.574	0.195	0.393
	Ph	EC	TDS	TH	TA	Ca^{2+}	Mg^{2+}	Na^+	Cl^-	NO_3^-	SO_4^{2-}	F^-	Cr^{6+}

Table 4.6 Pearson's correlation analysis of groundwater samples

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