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EFFECTS OF LEACHATE ON GROUNDWATER DUE TO MUNICIPLE SOLID WASTE LANDFILL OF DISTRICT DERABASSI, PUNJAB

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Abstract- There are 19 wards in Derabassi town of Punjab, India and the waste of these wards are dumped into a non-engineered landfill exists in Saidpura, Derabassi, Punjab, India. Leachate samples were collected from a non-engineered landfill site in Saidpura, Derabassi, Punjab, India and groundwater samples were collected from the area surrounding the landfill site, to evaluate the conceivable effects of leachate percolation impact on groundwater quality. Various physiochemical parameters' concentrations including heavy metals like Pb, Zn, Cu and Ni were measured in leachate samples and groundwater samples. The concentrations of Chlorides, Pb, Ni, Zn, Cu etc. were observed to be in extensive levels in the groundwater samples especially those which were in the proximity of the Saidpura landfill site, likely conveying that groundwater quality is being influenced by leachate percolation. Thus the presence of contaminants in groundwater especially close to the Saidpura landfill site cautions its quality and in this way unsuitable for residential water supply and different employments. People living there should avoid using groundwater from the wells in the proximity of the landfill site of Saidpura. If unavoidable, wells' depth should be more and frequent testing of water samples is desirable.

Keywords- Leachate, Groundwater quality, Contaminants, Landfill site, Water supply.

I. INTRODUCTION

Generally solid waste is categorized as domestic, industrial, agricultural, constructional, biomedical and commercial waste. Solid waste generation has become an important issue worldwide due to rapidly increasing world population. Collection and disposal of waste has always been the main aspect of solid waste management. However, with continuously increase in solid waste generation due to population increment, now we are running short of spaces to construct solid waste disposal facilities. In India, problems to human health and environment is caused by non-engineered landfills as out of only 70% solid waste collection, and 90% is disposed-off unscientifically in landfills and open dumps. Landfill disposal is the most common waste management method worldwide. Leachate seeping out from landfills and open dumps contaminate the ground water. Leachate is the result of the percolation of precipitation, irrigation water into landfill and uncontrolled runoff. Generally leachate contains high concentration of ammonia, salt, N, P, suspended solids and heavy metals. Quantity of leachate produced depends upon amount of rainfall, moisture content of waste and cover design. Also greenhouse gases are emitted from landfills. So, new effective methods are required to reduce greenhouse gases emissions from landfills. In case of landfills, there should be secured landfill having proper lining, leachate collection and treatment facility so that problems created due to disposing off waste on the open dump are reduced. The secured landfills dispose solid waste in a secure manner thus minimizes the impacts on the environment. A few years later when the landfill gases are produced due to degradation of the biodegradable part, these gases are trapped by a series of wells placed all over the site and is incinerated or transformed into energy.

Now-a-days, global trend is towards resource recovery from the waste rather than disposal of waste. Resource recovery means not only recycling materials like metals, glass, rubber, paper and plastic. But now resource recovery includes regaining all solid waste materials, adding residual waste. Solid waste should be considered as source of energy rather than considering it as a waste. If managed effectively, bio-degradable waste gives biodiesel, fuel ethanol, bio CNG, liquid manure etc. Non-biodegradable waste can be recycled or can be converted into pellets through RDF technology or land filled.

II. STUDY AREA

Study area is Derabassiwhich is a city and a municipal council in Mohali district in the state of Punjab, India. Derabassi is located on the Chandigarh – Delhi National Highway, 20 km from Chandigarh. It is strategically located near the boundary of Haryana and Punjab. In 2001, Derabassi had a population of 15,690. Derabassi has an average literacy rate of 76%, higher than the national average of 59.5%: male literacy is 80% and, female literacy is 72%. In Dera Bassi, 13% of the population is under 6 years of age. Dera Bassi population of 2016 is 1,35,685. Derabassi has a cluster of Pharma Industry mostly manufacturing of bulk drugs. The process of production includes extraction, processing, purification and packaging.

A dumping ground exists at Barala road in Saidpura, Derabassi, is becoming a major health hazard for residents. The dumping area is hardly 2.5 km away from the local municipal council. It is spread over 5 acres. There are 19 wards of Derabassi having area $64km^2$ which wastes are dumped here. Dumping ground was established in 2010. The weight of the waste dumped here every day is 15tons and this waste is not recycled before dumping on the ground. Since there is no any leachate collector equipped at the site, the leachate samples were sampled randomly at the base of the landfill.

III. MATERIALS AND METHODS

Sampling of leachate and groundwater

Leachate was collected from Saidpura dumping ground and six water samples were collected from handpumps and tubewells in the months of November 2017, December 2017, January 2018 and February 2018. They were collected at difference distance from the landfill and at different depths to measure the impact that leachate from landfill has caused to the groundwater quality of Saidpura region. Their physiochemical properties like pH, Chlorides, total hardness, alkalinity, BOD, COD, TDS and heavy metals like Pb, Ni, Cu, and Zn were determined. Experiments were conducted based on different methodologies and results of the leachate obtained from Saidpura landfill were obtained.

Groundwater Sampling Sites details

Table1: Groundwater sampling sites details

Sr. No.	Name given to The sample taken	Location	Approx. Distance from Saidpura landfill	Depth	Source of water sample
1.	GW1	At Hearth Realtors(shop)	200 m	100 ft	Handpump
2.	GW2	In nearby field	500m	500 m	Tube well
3.	GW3	In nearby industry	1 km	150 ft	Handpump
4.	GW4	Near Municiple council of Derabassi	2.5 km	50 m	Handpump
5.	GW5	In the field of Bhankharpur village	3.5 km	1000 m	Tube well
6.	GW6	In Bhankharpur village	4 km	200 ft	Handpump

Different methods which were used to test different parameters are:

Table2: Methodology used for different tests

Sr. No.	Parameter	Method	Instrument
1.	pH	Electrometric	pH meter
2.	Colour	Visual Comparison	-
3.	Total Hardness	EDTA Titrimetry	Titrimetry
4.	Chlorides	Argentometric	Titrimetry
5.	TDS	Oven Drying Method	Oven
6.	Alkalinity	Titration	Titrimetry
7.	COD	Reflux Titrimetry	COD Digester
8.	BOD	Winkler’s Method	BOD bottle and incubator
9.	Lead	AAS (Atomic Absorption Spectroscopy)	AAS (Atomic Absorption Spectrometer)
10.	Copper	AAS	AAS
11.	Zinc	AAS	AAS
12.	Nickel	AAS	AAS

IV. RESULTS AND DISCUSSION

Leacahte characteristics of the Saidpura landfill in the months of November, December, January and February were measured on 15th date of each month in 2017-18, which are:

Table3: Leachate characteristics of Saidpura landfill

Sr. No.	Parameters	Nov 2017	Dec 2017	Jan 2018	Feb 2018
1.	pH	6.5	6.7	6.6	6.9
2.	Colour	Almost Black	Almost Black	Almost Black	Almost Black
3.	Total Hardness(mg/L)	510	523	539	572
4.	Chlorides(mg/L)	8310	8145	7938	8012
5.	TDS(mg/L)	22178	24786	23864	24993
6.	Alkalinity(mg/L)	7518	7442	7368	7462
7.	COD(mg/L)	21469	22645	22768	23173
8.	BOD(mg/L)	3017	2877	3034	3183
9.	Lead(mg/L)	1.83	1.51	1.36	1.67
10.	Copper(mg/L)	0.16	0.24	0.19	0.26
11.	Zinc(mg/L)	2.4	3.12	3.74	3.48
12.	Nickel(mg/L)	0.71	0.9	0.66	0.83

Results show that leachate obtained from unsecured Saidpura landfill is acidic in nature. Because no treatment methods are followed for the treatment of waste in the dumping ground, decomposition of the organic content takes place which produces Carbon-dioxide. This CO_2thus produced reacts with water and formation of Carbonic acid, which is weak in nature, takes place. And this formation of acid lowers the pH. Also reason of low pH initially is presence of volatile fatty acids in high concentration. pH of leachate may be as low as 4.5 for young leachate and as high as 9 for old leachate.

Total hardness is due to presence of Calcium and Magnesium ions. The value of total hardness is high in the leachate obtained from unsecured or non-engineered landfill. And this is because of high accounts of Calcium and Magnesium ions.Leachate has very high concentrations of chlorides. This high value of chloride content in the sample of leachate shows that there is remarkable existence of soluble salts in the solid waste of the landfill. It reflects that there is a large quantity of agricultural, sewage and other animal waste which is deposited in the landfill site.High value of TDS in the leachate reflects the presence of a large quantity of dissolved inorganic and organic substance in the solution. This demonstrates the mineral contents and degree of salinity of the leachate. It further denotesthe strength and pollutant weight of leachate. Presence of chloride is responsible for high value of salt content in the leachate. Carbonate, Bicarbonate and Hydroxyl ions are responsible for alkalinity of leachate. The high alkalinity value in leachate denotes the intensity of biodegradation process happening within the landfill site. Due to biodegradation processes of organic content, a remarkable amount of bicarbonates is produced, which represents dissolved carbon-dioxide. The BOD/COD ratio specifies the age of the landfill. Also it indicateshow much amount the biodegradable compounds in the leachate have changed over the years. If BOD/COD ratio of waste water is more than 0.63, it is assumed to have no non-biodegradable organics.

Table4: BOD_5/COD ratio

BOD_5/COD	Age of landfill
>=0.5	Young(<5yrs.)
0.1-0.5	Medium(5yrs.-10yrs.)
<0.1	Old(>10yrs.)

Heavy metals include lead, zinc, copper and nickel. Presence of these heavy metals found in the leachate is due to presence of solid waste like electronic products, batteries, ceramics, paint chips, light bulbs, lead foils etc. in the landfill.

Same parameters were computed for six ground water samples on same date on which leachate samples' characteristics were measured near the landfill; compared with IS 10500:2012 and analyzed that are they within desirable limits or not.

Table5: Desirable limits of IS 10500:2012

Sr. No.	Parameters	IS 10500:2012
1.	pH	6.5-8.5
2.	Colour	Clear
3.	Total Hardness	200 mg/L
4.	Chlorides	250 mg/L
5.	TDS	500 mg/L
6.	Alkalinity	200 mg/L
7.	COD	Nil
8.	BOD	Nil
9.	Lead	0.01 mg/L
10.	Copper	0.05 mg/L
11.	Zinc	5 mg/L
12.	Nickel	0.02 mg/L

Characteristics of ground water samples

Table6: Variation in pH at different sites and time intervals

pH	GW1	GW2	GW3	GW4	GW5	GW6
Nov	6.4	7.2	6.9	7.1	7.7	7.5
Dec	6.4	7.4	6.8	7	7.6	7.4
Jan	6.5	7.3	7	7	7.5	7.6
Feb	6.7	7.4	6.9	7.2	7.6	7.5

Table7: Variation in total hardness at different sites and intervals

Total Hardness (mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	242	412	291	321	158	347
Dec	286	385	301	298	126	319
Jan	277	369	275	293	127	304
Feb	301	387	334	352	184	357

Table8: Variation in Chlorides at different sites and time intervals

Chlorides (mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	875	390	730	345	230	416
Dec	786	328	721	324	227	338
Jan	765	311	725	289	206	332
Feb	801	402	744	331	246	387

Table9: Variation in TDS at different sites and time intervals

TDS (mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	3245	2058	3094	2798	443	2478
Dec	3324	1986	2985	2654	369	2301
Jan	3285	1877	2964	2679	343	2295
Feb	3408	2034	3135	2842	428	2507

Table10. Variation in Alkalinity at different sites and time intervals

Alkalinity(mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	311	154	328	238	112	263
Dec	324	134	336	243	110	218
Jan	313	156	318	209	117	248
Feb	367	179	362	258	132	231

Table11: Variation in COD at different sites and time intervals

COD(mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	190	7	97	76	Nil	32
Dec	176	6	84	68	Nil	27
Jan	165	6	78	69	Nil	29
Feb	182	9	108	87	Nil	35

Table12: Variation in BOD at different sites and time intervals

BOD(mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	81	4	43	40	Nil	22
Dec	78	3	42	37	Nil	14
Jan	73	2	37	41	Nil	12
Feb	80	4	39	28	Nil	17

Table13: Variation in Pb at different sites and time intervals

Lead(mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	0.008	Nil	0.005	0.001	Nil	Nil
Dec	0.007	Nil	0.004	Nil	Nil	Nil
Jan	0.009	Nil	0.004	Nil	Nil	Nil
Feb	0.01	Nil	0.005	0.001	Nil	Nil

Table14: Variation in Cu at different sites and time intervals

Copper(mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	0.069	0.002	0.034	0.021	Nil	0.009
Dec	0.071	0.001	0.042	0.02	Nil	0.007
Jan	0.048	Nil	0.04	0.013	Nil	0.006
Feb	0.076	0.003	0.052	0.034	Nil	0.01

Table15: Variation in Zn at different sites and time intervals

Zinc(mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	0.4	0.003	0.314	0.091	Nil	0.064
Dec	0.394	0.001	0.283	0.078	Nil	0.054
Jan	0.385	Nil	0.205	0.063	Nil	0.058
Feb/	0.439	0.002	0.326	0.082	Nil	0.067

Table16: Variation in Ni at different sites and time intervals

Nickel(mg/L)	GW1	GW2	GW3	GW4	GW5	GW6
Nov	0.148	0.02	0.121	0.062	Nil	0.032
Dec	0.151	Nil	0.118	0.056	Nil	0.034
Jan	0.134	Nil	0.102	0.053	Nil	0.025
Feb	0.156	0.03	0.136	0.071	Nil	0.037

These tables offer the summary of the outcomes obtained from groundwater samples in the proximity of the Saidpura landfill. Comparing the resultsof groundwater quality parameters with desirable limits specified by IS 10500:2012, ground water sample from the tube well in the field of Bhankharpur village is found most safe among all six groundwater sampling locations and within the range specified by IS 10500:2012. The groundwaterof the region studied is predominantly used for irrigationpurposes as well as domestic purposes. Hence it is necessary to find appropriateness of groundwater forirrigationpurposes as well as domestic purposes.The groundwater of the region is generally clear and fresh except those places which are close to landfill site. Samples taken from the places near to the landfill site were found highly contaminated. However contamination of groundwater reduces fast with the distance of groundwater sources from the Saidpura landfill. The pH values indicate that groundwater of the region is basic in nature to some extent. The high TDS value in groundwater indicates high concentration of dissolved solids which cause gastro-intestinal problems in human. The heavy metals Pb, Ni, Cu and Zn are considered as toxic ones for drinking water.

A number of factors are responsible for the degree of contamination of groundwater due to landfill leachate like distance and depth of the groundwater source from the landfill, rainfall, chemical composition of leachate etc. Although few parameters' concentrations did not exceed IS standard for drinking water of the region even then the quality of groundwater show a notable risk to human health.

V. CONCLUSION

High concentrations of quality parameters like chlorides, COD, BODetc. and heavy metals are found higher in the groundwater samples close to the proximity of landfill. As there is no other reason which seems to possible for these high values, it may be concluded that there is impact of landfill leachate on the quality of groundwater near to the landfill site. The pH values indicate that groundwater of the region is basic in nature to some extent. However groundwater quality improves with depthand distance of the groundwater source from the landfill site of Saidpura village.Although few parameters' concentrations did not exceed IS standard for drinking water still the quality of groundwater show a remarkable risk to human health. Because of this risk to their health, people of the region should stop theconsumption of groundwater from the untreated groundwater sourcesclose to the landfill site of Saidpura. If unavoidable, wells' depth should be more andfrequent testing of water samples is desirable till the time an engineered landfill with leachate treatment facility is constructed.

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