BIOLOGICAL CHARACTERISTICS OF SUB-SURFACE WATER NEAR SOLID WASTE LAND FILL SITES AT DELHI AND RISK OF SPREADING DISEASES IN THE VICINITY.

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ABSTRACT
Groundwater samples were collected from Bhalswa solid waste landfill site, Ghazipur solid waste landfill site and Okhla solid waste landfill site from different locations at less than 1.0 km and up to 2.0 km from the periphery of the landfill site. Leachate samples were also collected from the nearby drain. Following parameters were tested for assessment of groundwater quality e.g. Total coliform, fecal coliform, E-coli, Hydraulic conductivity and TKN etc. The study started with preliminary survey, reconnaissance survey, feasibility study, collection and analysis of the water samples.

Keywords:
Biological parameters, Landfill, leaching, groundwater contamination, water quality parameters.

1. INTRODUCTION
The major source of freshwater in the modern world, are being over utilized for different uses, causing depletion of this resource. It is being polluted due to uncontrolled dumping of untreated domestic, industrial, and chemical wastes and percolation of pollutants into the subsurface. The quality of groundwater in many parts of the country, particularly shallow subsurface water, is changing rapidly because of human activities, ground water is less polluted than the surface water because the soil and rocks through which water percolate filters various bacteria, but still some bacterial and chemical pollutants reach ground water. The presence of dissolved minerals, organic matters and heavy metals in the groundwater is the result of surface pollutants reaching subsurface soil. Most of them are harmful for human consumption and a few may even be highly toxic in concentration. Also, water dissolves minerals from the soil and rocks and over ground dumped material with which the percolating water comes in contact. Groundwater, therefore, may contain various dissolved minerals and gases that give bad odour and are not good in taste as well. The most common dissolved mineral substances found in groundwater are sodium, iron, calcium, magnesium, potassium, chloride, bicarbonate, and sulfate. Contamination of groundwater with excessive amounts of heavy metals such as cadmium, lead, mercury, zinc, and chromium pose serious threat to every ecosystem, humans, and the all living organism. Excessive dissolved matters present in water causes corrosion of the materials that comes in contact. Solid waste landfill leachate that infiltrates in the subsurface and surrounding soil also percolates in to groundwater which is highly poisonous and causes adverse impact on living being and environment. So, preventing contamination of groundwater and environmental pollution, along with providing access to safe drinking water and sanitation is essential in reducing the spread of many diseases (WHO, 1994; 2001).

Picture: 1 Bhalswa Solid Waste Landfill Site

Picture: 2 Ghazipur Solid Waste Landfill Site

Picture: 3 Okhla Solid Waste Landfill Site

1.1. Need to Study

The changed lifestyle where industrialization and urbanization, are rapid growth in population has brought a fast growing population increase in the generation of municipal solid waste. Out of the total waste the inorganic constituents in the wastes have substantially increased, due to which the SWM has severely been affected and has become a global problem today [1,2]. Presently, the waste disposal scenario has become a considerable threat compared to earlier times when the waste was primarily organic and could be safely disposed-off in low-lying areas, assimilating into the natural biogeochemical cycles [3]. Moreover, the rapid increase in industrially-manufactured materials such as metals, glass, plastics, papers, rags, and polystyrene has enhanced the share of inorganic wastes [4].

1.2. Problems/Limitations Identified

Solid waste landfills site adversely and negative impact subsurface water quality and ground water quality therefore there is a maximum possibility of poor water quality index. Our study of groundwater adjacent to the landfill sites in the capital city of India (Delhi) confirms this. Different parameters (Biological) of Groundwater, Water samples were tested.

1.3. Area of Study

In almost every metropolitan city over dumping of land fill sites are a regular practice and the Bhalswa landfill, Ghazipur landfill and Okhla landfill site, are no different. It is also an overfilled solid waste dumping site located in Delhi. This site is approximately over 75 m high and covers an area of around 200 acre. The Bhalswa landfill site, located at 28°45′ N latitude and 77°11′54″ E longitude is a major source of environmental pollution. Ghazipur landfill dumpsite was established in 1984 and Its coordinate is28° 37'30.8784"N and 77° 19' 40.764"E. and Okhla landfill site, lying between North latitude28°30'43.0848" and East longitude 77°17'1.4676" was commissioned in the year 1996 by the South Delhi Municipal Corporation (SDMC). (Figure: 1).

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Landfill Location Map of Delhi

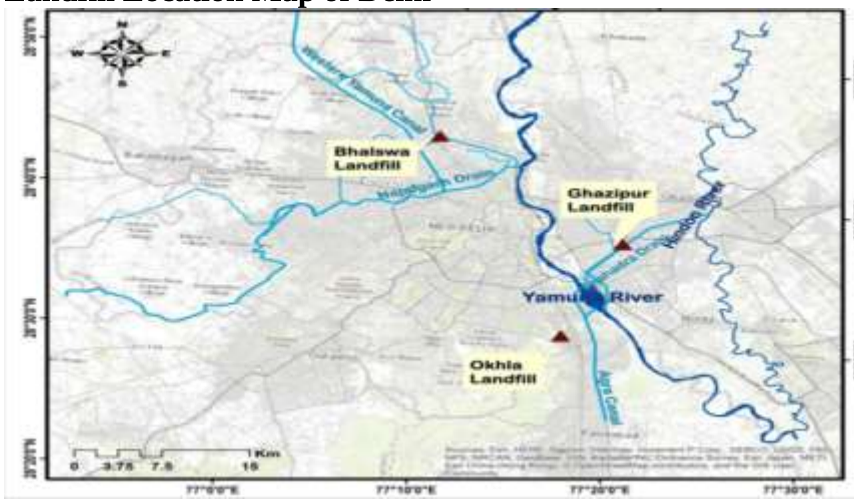


Figure: 1 Location of Solid Waste Landfill Site at Delhi

2. LITERATURE REVIEW

The enormous waste generated in the cities and towns today is a major problem for the civic bodies and the current practice of dumping it in the identified landfill site, a common practice in the modern solid waste management system, still poses threat to environment. The landfill site should be developed considering primarily its impact on environment and the geology of the adjoining area. The main geological factors that need to be considered are thickness of the soil cover, lithology of the area, and the depth of groundwater so that the leachate developed at the landfills do not percolate into the water bearing strata [5,6,7,8]. Therefore, proper selection of waste landfill site in accordance with the standard guidelines is the most important aspect in the management of urban solid waste. But the landfills developed generally do not strictly follow the guidelines and the only criteria that is followed is a low-laying area away from habitable zone, forest, water bodies, national parks, and places of important cultural, historical, or religious importance are considered suitable for its development. Where whatever wastes comes from the city is dumped indiscreetly without considering the essential procedure of segregation of wastes. This is badly affecting the environment in the vicinity of the landfill site, besides polluting groundwater by the percolation of leachate into the subsurface [9]. It is essential therefore that prior to planning and designing of landfill sites environmental issues should be taken care off because landfills badly affect whole environment. In addition, education and awareness are crucial for household waste management and sustainable development [10]. There are several papers highlighting problems of waste disposal and developing mechanism of proper solid waste management system. The fuzzy Delphi method identified 146 barriers to attaining sustainable solid waste management. The most significant ones are household hazardous waste, inadequate research capital, local architecture, lack of staff capability, and standard processes [11]. A strong correlation exists between geographical position and economic status with waste characteristics. It also undertakes LCA models to select appropriate waste management algorithms to evaluate and find a sustainable solution [12]. The rapid increase of solid waste is due to population increase, urbanization, rapid industrialization, and economic sustainability [13]. The model was generated utilizing TOPSIS in the GIS environment to develop a suitability indicator for siting the units to minimize fixed and transportation costs and maximize the system's suitability [14].

Management of municipal solid waste (MSW) is a major environmental concern in India. Appropriate Solid Waste Management System (SWM) involving actions such as waste handling, collection, storage, transport, treatment, and disposal is not followed [15]. The treatment of waste before its dumping at site is usually not done and therefore the disposed-off untreated solid waste is an environmental hazard. Proper waste collection and transportation is also lacking that results accumulation of waste everywhere in the cities and towns in India. Although Indian Government has taken many steps in this regard but still facilities for the treatment of municipal solid waste are insufficient, which adversely impact all components of the environment and human health. The rapid industrialization along with uncontrolled urbanization is aggravating the problem many folds in handling MSW as the system could not cope up with the waste generated. Municipal solid waste management system should include proper collection (prohibiting littering or burning of the waste), segregation, storage (establishing storage facility in accordance with the waste generated), transportation (wastes should be transported in a covered containers to prevent scattering), processing (adoption of technologies to recycle waste to minimize burden on landfills), and disposal of waste (biodegradable waste should be stabilized by composting and other techniques and non-biodegradable waste should only be dumped at the landfill sites to avoid environmental pollution). The efficient management of municipal solid waste requires appropriate infrastructure, maintenance, and regular upgrade of all activities as the continuous and unplanned growth of urban centres put tremendous pressure on the existing facilities [16]. But financial status of the municipal corporations is not stable, hence providing desired level of public service is difficult in the urban centres. In the present research, an attempt has been made to provide a comprehensive assessment of the groundwater condition around a landfill site due to infiltration and percolation of waste and leachate into the subsurface and forecasting projected future status of the problems of MSW landfill sites in major Indian cities.

World Health Organization (WHO) includes domestic refuse, construction debris and street sweepings, non-hazardous institutional and commercial wastes as solid wastes (WHO 2013). The handling and disposal of the solid waste is a major issue for the WHO world over. It is a common practice since a long time that the biodegradable waste is neutralized by the methods such as composting and decomposing. The use of non-biodegradable materials and manifold increase in the amount of waste generated has amplified the problem. The National Capital of India is inhabited by approximately 16.75 million people (Census of India 2011) [17], which are collectively producing more than 8000 tons of solid waste per day. The solid waste generated is disposed off in three major sanitary landfills in and around Delhi every day namely, Bhalswa Landfill site, Ghazipur and Okhla which were commissioned in 1994, 1984 and 1996, respectively [15]. These landfill sites are still being used even after being completely saturated that adversely affects environment and hence the concept of sustainable landfill should be implemented.

Greenhouse gas emissions, a major problem today, can be reduced by proper implementation of SWM framework, such as waste-to-energy and material recovery, instead of land filling [18]. Systems engineering approaches such as systems engineering, industrial ecology, integrated solid waste management strategies, integrated systems planning, design and management, and uncertainty analysis shall be applied to solid waste management [19]. Multiple methods for decision-making regarding waste management suggest direction by mass-balance approach, goal-oriented evaluation, and transparent and reproducible presentation of the methodology, data, and results [20].

The physico-chemical characteristics of the groundwater near Bhalsawa solid waste landfills has been studied extensively by various government and non-government research groups [21]. The groundwater near the solid waste disposal sites in Delhi has been found to be heavily contaminated by various heavy metals and inorganic elements [22, 23]. It is interesting to note that the biological and especially, microbiological quality of the groundwater in this region has not yet been analyzed adequately. The presence of microorganisms in drinking water has been correlated with numerous gastrointestinal infections in the population [24].

The review presented in this paper tends to addresses current issues in solid waste handling and management in India and points out areas for further research [25, 26, 27, 28]. The study identifies numerous barriers to effective management of municipal solid waste. It shows that implementing a systematic approach in municipal solid waste management will significantly improve the scenario.

3. MATERIALS AND METHODS

The methodology of the study comprises collection and analysis of environmental indicators that gives information regarding potential environmental problems associated with the solid waste landfills sites and its impact on all adjoining environmental.

3.1. Various Instruments Used

A multi-parameter instrument that uses optical sensors to measure total coliform was used. It included a tryptophan-like fluorescence (TLF) sensor, turbidity sensor, and thermistor. Coli Test Kit that contains tools to test for coliform and E. coli in water, including S-Pak filters, Petri-Pad petri dishes etc were used. Membrane filtration is the method was adopted for the analysis of fecal coliforms in water. Samples to be tested are passed through a membrane filter of a particular pore size (generally 0.45 micron). The microorganisms present in the water remained on the filter surface. Experimental setups were used as per BIS: 3025 [29] and APHA [30] standards for analyzing groundwater quality to ensure best results. Reagents were prepared for experimental work as per standard method.

3.2. Sample Collection

Water sample were collected at different points and directions and also leachate samples were collected near drain. Collection and transportation of the sample to the laboratory was done following the procedure of the BIS: 3025 APHA. And use of Standard method. Representative samples of leachate were taken from the Drain. The analysis of the collected samples was done at the Environmental Engineering.

Table: 1.0 Record Flow extraction for various demands (Estimated) and Measuring water level at various season (Estimated) near solid waste landfill site up to 1.0 to 2.0 km distance.

Sl	Name of site	Coordinate	Measuring water level at various season		Flow extraction/ day	Average Water Quality Index (WQI)
			Pre monsoon depth (m)	Post monsoon depth (m)		
1.	Okhla landfill site	N latitude 28°30′43.0848" and E longitude 77°17′1.4676"	47	51	500 litre × 32(houses) = 16000 l/day	81.64
2.	Bhalswa landfill site	N Latitude 28°45′ and E Longitude 77°11′54″	58	61	500 litre × 57(houses) = 28500 l/day	91.42
3.	Ghazipur landfill site	N Latitude 28° 37′30.8784" and E longitude 77° 19′ 40.764"	67	73	500 litre × 85(houses) = 42500 l/day	87.72

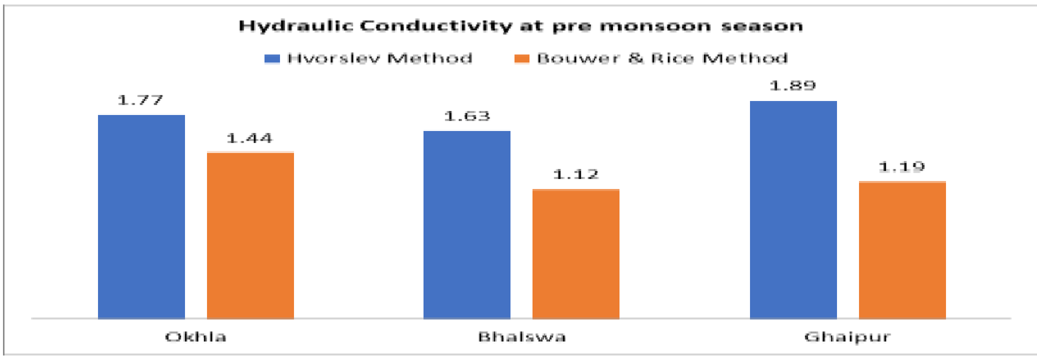
Table: 2.0 Measuring Bacterial parameter near solid waste landfill site up to 1.0 to 2.0 km distance. (Pre monsoon season)

Sl	Site Name	Source of water	Total coliform	Feacal coliform	E. coli	Hydraulic Conductivity (K) m/day		Average K m/day	TKN (Near landfill site from drain Waste water) 35-60 mg/l
						Hvorslev Method	Bouwer & Rice Method		

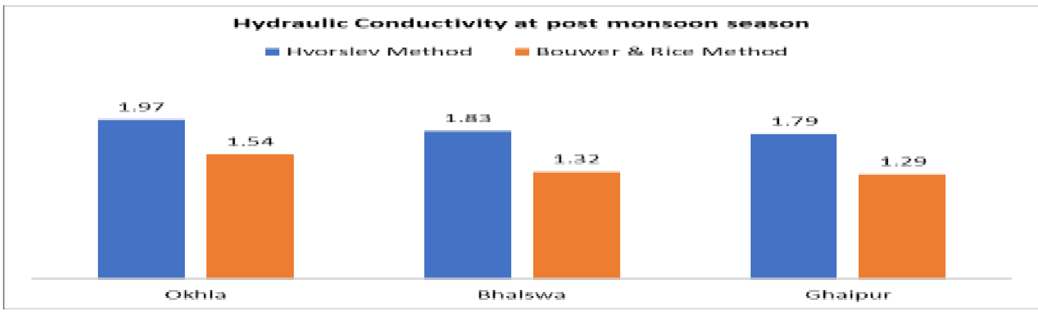
1.	Okhla landfill site	Ground water pump	Nil	Nil	Nil	1.77	1.44	1.60	64
2.	Bhalswa landfill site	Ground water pump	Nil	Nil	Nil	1.63	1.12	1.37	67
3.	Ghazipur landfill site	Ground water pump	Nil	Nil	Nil	1.89	1.19	1.54	55

Table: 3.0 Measuring Bacterial parameter near solid waste landfill site up to 1.0 to 2.0 km distance. (Post monsoon season)

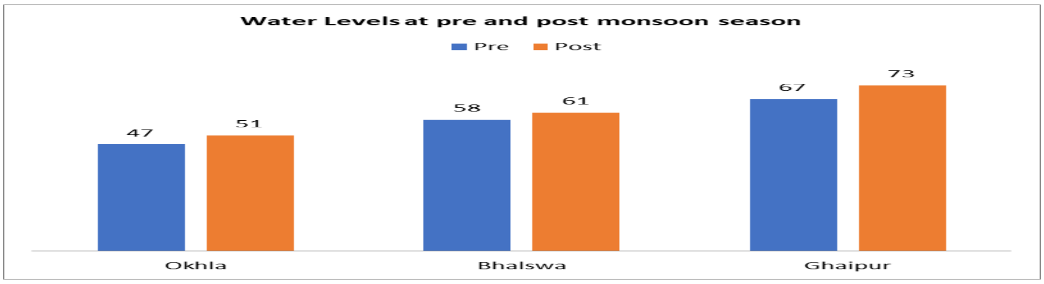
Sl	**Site Name**	**Source of water**	**Total coliform**	**Feacal coliform**	**E. coli**	**Hydraulic Conductivity (K) m/day**		**Average K m/day**	**TKN(Near landfill site from drain Waste water) 35-60 mg/l**
						Hvorslev Method	**Bouwer & Rice Method**		
1.	Okhla landfill site	Ground water pump	Nil	Nil	Nil	1.97	1.54	1.75	67
2.	Bhalswa landfill site	Ground water pump	Nil	Nil	Nil	1.83	1.32	1.57	72
3.	Ghazipur landfill site	Ground water pump	Nil	Nil	Nil	1.79	1.29	1.54	65



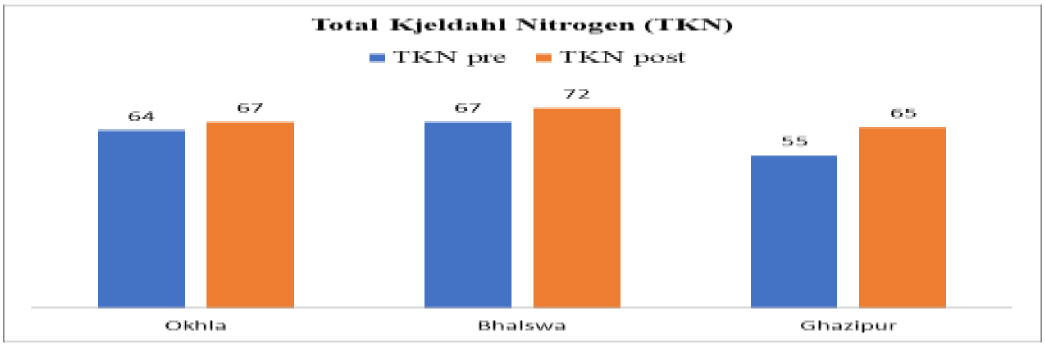
Graph: 1.0 Showing Hydraulic Conductivity at pre monsoon season



Graph: 2.0 Showing Hydraulic Conductivity at post monsoon season



Graph: 3.0 Showing Water levels at pre and post monsoon season



Graph: 4.0 Showing Total Kjeldahl Nitrogen at pre and post monsoon season

4. RESULTS AND DISCUSSION

Different Biological parameters and their dimension for experimental analysis of groundwater were conducted at different interval of time at one and two kilometers from the periphery of the land fill site.

4.1. Material and Accessories to Be Used

All apparatus and salts (reagent) were used for conducting water tests as per BIS: 3025 and APHA. And use of Standard method

Table: 4.0 Instrument used for different test

Sl	Sample test	Instrument
1	Total coliform	Total coliform kit
2	Feacal coliform	Feacal coliform kit
3	E coli	E- coli kit
4	Total Kjeldahl Nitrogen (TKN)	Kjeldahl method
5	Hydraulic conductivity	Hydraulic conductivity test kit

4.2. Environmental impact of solid waste landfill site and its effects on environment

Solid waste landfill site has severe impact on environment, particularly on the subsurface soil and water. Water infiltrating through solid waste landfill sites comes in contact with disposed waste, which extracts chemicals and other constituents forming a highly contaminated liquid i.e. leachate. Leachate penetrates into groundwater, surface water, and environmental components. The Bhalswa solid waste landfill, Ghazipur soild waste landfill site and okhla solid waste landfill sites are appears to have received the refuse to its fullest capacity.

4.3. Effects of Solid waste landfill site on environment

- Related Health issues problems among peoples
- Unhealthy environment.
- Gases can also contribute to climate effects.
- Chances of damages are high that heap of solid waste can be rolled down at nearby road
- Disturb fresh environment in this areas

- Delhi have cost in environmental degradation.
- Effect of leachates on the soil environment the consequence is harmful effects.

5. CONCLUSION

The results indicated poor underground water quality in both seasons (pre monsoon and post monsoon season) and groundwater samples close to the dumpsite showed the most pollution impact samples with drain are considered as polluted water due to landfill leachate. Samples of groundwater were collected during pre & post monsoon seasons and Biological parameters were analyzed. The study exhibits that ground water in the surrounding area of Landfill site has been contaminated by percolation of leachate. The penetration of leachate from landfills can leads to contamination of groundwater, surface water, and environmental components. Therefore engineers will build up landfill site in such a manner that a less risk and impact to human health will be avoided and will obey all rules and regulation to construct solid waste landfill sites.

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