Assessment of Water Quality Around the Municipal Solid Waste (MSW) Dump Site in the Mysuru City

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Abstract: This project is aimed to assess the impact of municipal solid waste (MSW) dumpsite on the quality of groundwater in the vicinity of an MSW dump site. Groundwater samples were collected from specified locations near the dump site and analyzed for physico-chemical and microbial contaminants. The objective was to evaluate the extent of contamination and its implications for the surrounding environment. This study observed that, the groundwater quality around the dump site is not satisfactory for drinking purposes in few samples out of 8 locations. In sample number 1, 4 and 6 high EC, hardness and microbial contaminations were observed as the sampling points were very much close to the dump site and also sample 6 failed to have a good WQI indicating significant pollution in water, emphasizing the urgent need for effective MSW management practices to mitigate negative impacts in the future days and protect human health. This study provides valuable insights for future research and underscores the importance of regular assessments of environmental attributes to determine the saturation capacity of the surrounding environment. By implementing scientific MSW management strategies, it is possible to minimize pollution load on the environment and promote a healthier and sustainable environment for future generation.

Keywords: **Contamination, groundwater, dump site, microbial contaminants, municipal solid waste.**

1. INTRODUCTION

Environmental pollution is a serious threat to our nation and it has become widespread problem in the most of our cities. The wide spread migration from rural areas to urban areas in search of job opportunities has led to urban overcrowding. Rapid industrialization and urbanization have increased pollution in metropolitan cities and put more pressure on natural resources that resulting in environment degradation in varying degrees, initiatives are needed to make the environmental feasible both in terms of taking action to prevent environmental degradation and ensuring eco-friendly activities. (Mahesh, 2021). Ground Water is that occurs under the surface of the Earth, where it fills the cavities in soils or geologic strata. Most groundwater comes from precipitation, which gradually percolates into the Earth. The liquid that drains or 'leaches' from a Municipal waste processing site is known as Leachate. It varies widely in composition regarding the age of processing site and the type of waste it contains. In most of the cities, uncontrolled disposal of municipal solid waste (MSW) in processing site is a common practice. As a result, the waste accumulates and produces leachate, and in absence of proper leachate collection system, it leads to ground water pollution. Groundwater pollution is a very serious and expensive problem and state level and central level governments have started to take assertive action to address it. Once contaminated, groundwater is very expensive to purify and make usable again (Nanjundaswamy et al., 2015). Landfilling is one of the major municipal solid wastes (MSW) disposal method practiced worldwide. Although it is considered as the most cost-effective means of waste disposal, but due to poor management practices especially in developing countries like India it causes environmental pollution (Premsudha et al., 2022). Landfills are properly designed to offer a great advantage over the open dumpsites like minimization of environmental issues and reduction of health risks. However, few improperly maintained landfill sites have been considered to be major contributors to groundwater pollution due to the leakage of leachate into the ground (Igboama et al., 2022) and has resulted in serious environmental pollution by polluting air and soil quality (Vongdala et al., 2018). With time, the population grows quickly and unsatisfactory urbanization occurs which leads to change in the quality of the environment. Therefore, a periodic evaluation of the various environmental attributes is required to understand the saturation capacity of the environment. In this regard the study focus on the extent of pollution status of ground water around the dump site and also the statics will serve as a baseline data for the futuristic study. The scope of the study is to identify and understand the degree of contamination of groundwater around the MSW dump site. The objective of the study is to assess and characterize groundwater for specific quality parameters in the vicinity of the existing MSW dump site.

2. MATERIALS AND METHODOLOGY

2.1 General

This section will provide detailed information about the study area, including the sampling locations, chemicals/reagents used, instruments utilized, experimental procedures conducted, and the methodology utilized for the research work.The investigation was carried out around the municipal solid waste disposal site in Mysore City. Groundwater samples were collected from locally available nearby borewells in order to assess the various physico-chemical and microbial parameters.

2.2 Study area

Mysore is a lively city in southern India that is famous for its beautiful palaces, colourful festivals, and rich heritage. Mysore City is home to a large population, and with each passing day, the amount of waste generated has been steadily increasing. Managing this growing waste has posed significant challenges. However, to address this issue, the Municipal Solid Waste (MSW) facility located in Vidyaranyapuram Mysore, has played a vital role. With a daily capacity of ~450 tonnes, this facility handles the waste and managesthe needs of the city, ensuring a cleaner and healthier environment for its residents. The study focused on the Mysore landfill, a solid waste disposal site situated on the border of Mysore City, Karnataka. The landfill has been used for 20 years to store a lot of municipal solid waste.

Figure 2(a). Aerial view of the study area.

2.3 Materials

2.3.1 Chemical used

In the analysis of various water samples, we utilized specific chemicals to accurately measure and assess different parameters. The chemicals used in the analysis such as Hydrazine sulphate , HexamethyleneTetramine, ammonium chloride, ammonium hydroxide, magnesium sulphate , magnesium chloride, sulphuric acid , sodium hydroxide, Phenolphthalein indicator , methyl organic indicator, Glycerol, Ethyl isopropyl alcohol , barium chloride crystals , silver nitrate , potassium chromate indicator, manganoussulphate solution , azide reagent , concentrated sulphuric acid, starch indicator solution, standard sodium thiosulphate solution , conditioning reagent , barium chloride crystals, standard sulphate solution, potassium dichromate, sulphuric acid, ferroin indicator, Ferrous ammonium sulphate, Sodium lauryl sulfate.

2.3.2 Instrument used

Various instruments used for the analysis of water samples such as pH meter, spectrophotometer, conductivity Meter, turbidity meter, flame photometer and EDS detector.

2.3.3 Parameter analyzed

These are parameters we have analyzed for better understanding of the contamination level of pollutants around landfill site. 2These includes: pH, Electrical Conductivity, Dissolved Oxygen, Nitrate, Sulphate, Phosphate, Chemical Oxygen Demand, Sodium, Chloride, Total Hardness, Total dissolved solids, Iron, Total coliform and Fecal Coliform.

2.4 Methodology

To assess the groundwater quality near a dump site, a comprehensive procedure was implemented. Initially, specific locations in the proximity of the dump site were identified and marked for water sample collection. Various water samples were then collected from the identified sampling locations to represent the different areassurrounding the dump site.The collected water samples were taken to the lab for additional examination. According to regional water quality standards, a number of factors were examined, including pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Sulphate, Nitrate, and other applicable parameters. This detailed analysis generated quantitative data for each parameter, offering insights into the water quality at each location. The analysis findings were collected and presented in a tabular style to make comparison and understanding easier. This made it possible to get a thorough picture of the water quality characteristics in various places. The ten most important parameters were chosen from the collected data based on their importance in determining water quality. The significant influence these and other parameters have on determining the quality of water led to their selection. To provide an overall assessment of water quality, a Water Quality Index (WQI) was employed. The selected ten parameters were utilized to calculate the WQI for each location. The WQI is a numerical value that represents the overall water quality level, considering multiple parameters. By utilizing the chosen parameters in the WQI calculation, a comprehensive evaluation of water quality was achieved. Based on the calculated WQI values, the water quality levels of different locations near the dump site were determined. Higher WQI values indicated better water quality, while lower values indicated poorer water quality. This determination allowed for a comparative analysis of water quality levels among different locations.

3. RESULTS AND DISCUSSION

Groundwater analysis was done according to the standard procedure and checked for parameters such as Nitrate, Phosphate, pH, temperature, EC, TDS etc., To indicate Water quality WQI (Water Quality index) was done using Physico-chemical and microbial Characteristics such as TC, FS, and FC. Groundwater analysis involves collecting of water samples from wells, boreholes and subjecting them to a series of tests to help evaluate parameters such as pH levels, DO. EC TSS, TDS, Concentration of various chemical constituents like sulphate, nitrate, VOC`s etc. The results from Groundwater analysis provide valuable information about over all water quality and identify potential contaminants or pollutant.

3.1 Identification of sampling points.

Fig 3.(a). Represents the aerial view of Groundwater Sampling Location marked using QGIS.

Fig 3.(a) shows the aerial view of groundwater sampling location around the Study area .The Groundwater points are well within the range of 1 km radius area of landfill site. A total of 8 sampling point were selected and 8th sampling point being far away from the landfill site which is taken for comparative study.

Table 3.(a). Groundwater sampling points around the MSW dump site

Sample No.	Sample Location	Setup Since	Depth (ft)	*Distance (m)	Purpose
GW 1	Solid wood industry	15 years	80	20	Cleaning and Curing of Bricks
GW 2	SLV industry	20 years	60	60	Cleaning and Curing of Bricks
GW 3	Temple	15 years	350	1000	Drinking

GW 4	Near RMC	10 years	550	1000	Drinking and Cleaning
GW 5	Service Station	8 years	120	500	Washing
GW 6	Farm house	6 years	100	500	Gardening
GW 7	Zerowaste management	10 years	150	800	Gardening

*Distance from Dumpsite

3.2 Groundwater Characteristics

The collected samples from pre-identified sampling locations were subjected to laboratory analysis for various prime water quality parameters and this section gives a detailed insight about the results obtained from the analysis.

3.2.1 Physico-chemical Characteristics

Rajkumar N, et.al.,2010,‘Groundwater Contamination Due to Municipal Solid Waste Disposal

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The World Health Organization (WHO, 1997) and the Bureau of Indian Standards (BIS, 2012) have each determined a single upper limit, which is listed in Table 3.(b).The outcomes of the investigation of the water quality are shown in Table 3.(c). The subsurface water in the examined area is employed in domestic and agricultural applications. A pH range of 7.2 to 8.23 and a temperature range of 27.6 to 28.5º were all very neutral for all of the groundwater samples (Figure 3.d). Using the EC, it is possible to calculate how much of a substance is dissolved in water. It was discovered that the EC in the area under study ranged from 817 to 2660 S cm^{-1}, and that it was particularly high at sites 1, 4, and 7 (Figure 3.g). The high conductivity measurements of the subsurface water close to the landfill show the impact of the landfill on the water quality. TDS is a general indicator of water quality or salinity. TDS varies between 531 and 1680 mg L^{-1} at every site (Figure 3.g). A significantly high TDS content was found at sites 1, 4, 6, and 7. Based on TDS (Table 3.d), Rabinove et al. (1958) categorized four samples as non-salty and four samples as moderately saline. An indicator for organic pollution, COD is a measure of oxygen that is proportionate to the amount of organic matter in water that is subjected to being oxidized by a strong chemical oxidant. The COD level in the groundwater samples varied from 98 to 460 mg/L, indicating the presence of organic pollutants in the water (Figure 3.h). These concentrations can be used as organic indicators to assess the extent of groundwater pollution caused by landfills. People who have heart, kidney, or vascular problems may be at danger due to the high concentration of Na^{+}. K^{+} is an indicator of the leachate effect, according to Ellis (1980). The K^{+} concentrations in the water samples were found to be well below the permissible limit, ranging from 107 to 196.7 mg L^{-1}.The groundwater samples' chloride concentrations ranged from 47.8 mg L^{-1} to 599 mg/L. Sites 8 and 6 both have high chloride concentrations, according to Figure(3.h). High Cl^{-} content in groundwater is likely the result of both man-made sources, including fertilizers, septic tanks, and home effluents, as well as natural ones, like rainfall and the dissolving of fluid inclusions. People with heart or kidney disorders are harmed by an increase in Cl^{-} levels (WHO, 1997).

Fig 3.(b). Groundwater sampling points

3.2.2 Microbial Contamination

Microbes are found in great numbers in the waste of warm-blooded animals like humans, coliforms are thought to be a reliable predictor of the quality of the bacteria in water. Even after great dilution, these bacteria are likely to remain present if feces-related contamination enters groundwater. Most of the samples in Table 3.(c) have TC and FC, which indicates groundwater contamination that might be brought on by leachate percolation in the groundwater. Anyone who consumes this water could be putting their health at danger due to the faecal pollution.

Table 3.(b). Drinking Water Standards

SL.No.	Parameters	Standard Value	Units	Recommended
1	pH	6.5-8.5	-	ICMR / BIS
2	DO	4.0-6.0	mg/L	WHO
3	TSS	75	mg/L	ICMR / BIS
4	TDS	1000	mg/L	WHO
5	TA	200	mg/L	ICMR / BIS
6	TH	300	mg/L	WHO
7	Ca	75	mg/L	BIS
8	Mg	30	mg/L	BIS
9	Chloride	45	mg/L	ICMR / BIS
10	Sulphate	5.99	mg/L	ICMR
11	Nitrate	150	mg/L	ICMR
12	Sodium	200	mg/L	WHO

13	Potassium	10	mg/L	WHO

* Except pH, all the values are expressed in mg/L

Table 3.(c). Physico-chemical and Biological Parameters of Groundwater samples

Samples	1	2	3	4	5	6	7	8
pH	7.93	7.82	8.24	7.77	7.33	7.36	7.23	7.46
temp, °C	27.6	27.7	27.6	27.5	27.9	28.1	28.5	27.9
TDS, ppm	1046	850	531	1081	890	1680	1152	700
EC,µs/cm	1616	1309	817	1671	1373	2660	1783	1078
COD as MgO2, mg/L	460.8	403.2	416	422.4	384.1	249.6	294.4	98
Chloride, mg/L	185.94	137.9	113.96	311.9	289.91	599.81	429.86	47.98
DO, mg/L	8.86	5.8	5.51	6	6	7.38	7.88	7.38
Nitrate , mg/L	30.74	3.01	12.05	19.89	18.09	0	36.76	1.2
Phosphate, mg/L	68.89	66.98	53.58	49.76	17.22	24.88	22.96	3.82
Sulphate, mg/L	47.75	41.58	34.07	65.26	53.46	128.32	68.05	19.21
Hardness, mg/L	648	684	400	268	600	1336	564	460
Na, ppm	1477	1138	442.5	1608	1032	1432	3143	1158
K, ppm	196.7	157.7	176.9	161.2	141.3	107.9	178.4	112.2
Fe, mg/L	0.65	0.83	0.67	0.58	0.58	0.61	0.59	0.60
TC, CFU/100ml	1100+	240	240	93	43	1100+	1100+	240
FC, CFU/100ml	95	23	43	3	23	240	1100+	23
FS, CFU/100ml	240	4	43	4	23	3	240	4

Table 3.(d). Classification of groundwater samples on the basis of TDS concentration

Type of groundwater	TDS (mg L^{-1})	Samples
Non- saline	<1000	4
Slightly saline	1000–3000	4
Moderately saline	3000–10,000	Nil
Very saline	>10,000	Nil

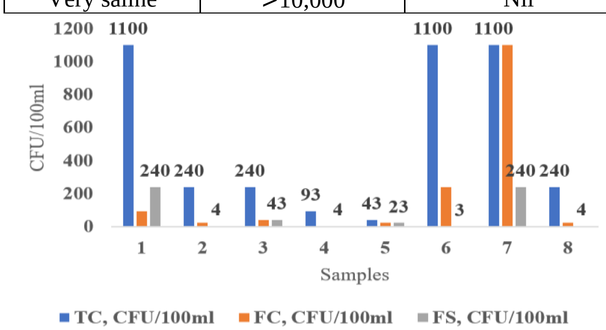

Fig 3.(c). Graphical representation of TC, FC, and FS of Groundwater samples obtained during analysis.

Fig.3.(c) - The graph clearly indicates that among the samples analyzed, Sample 1, 6, and 7 stand out with significantly higher microbial content than the remaining samples. These three samples exhibit a notable abundance of microorganisms, suggesting a potentially diverse and thriving microbial community in those particular environments.

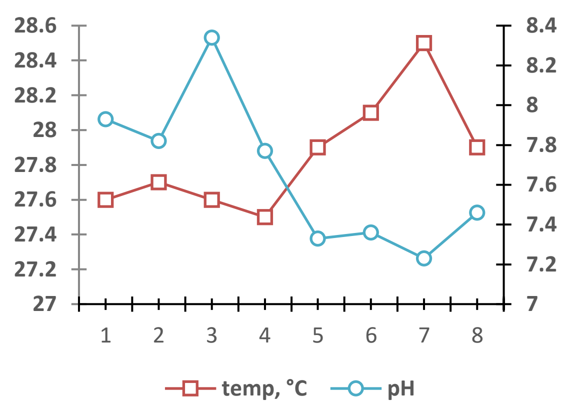

Fig.3.(d).Graphical representation of Temperature and pH of Groundwater samples obtained during analysis

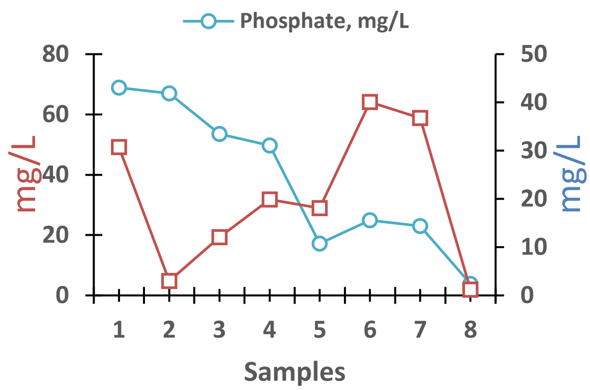

Fig 3.(e). Graphical representation of Phosphate and Nitrate of Groundwater samples obtained during analysis

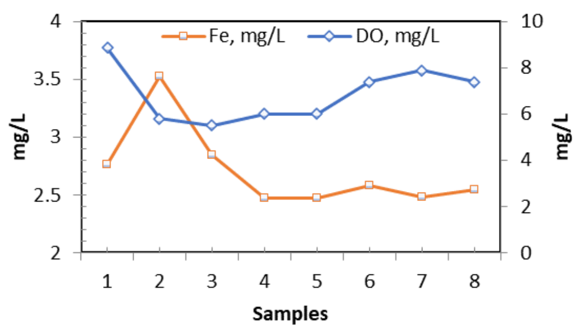

Fig 3.(f). Graphical representation ofIron andDO of Groundwater samples obtained during analysis

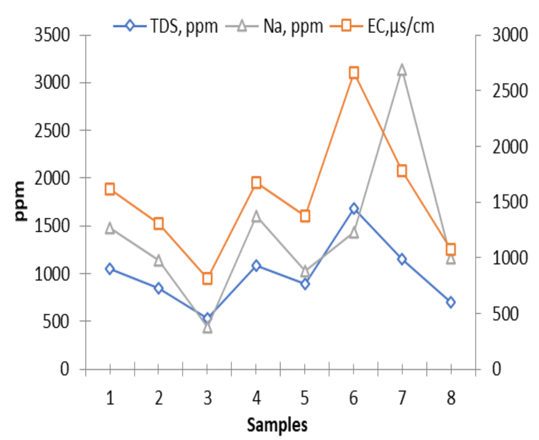

Fig 3.(g). Graphical representation of TDS, Sodium, and EC of Groundwater samples obtained during analysis

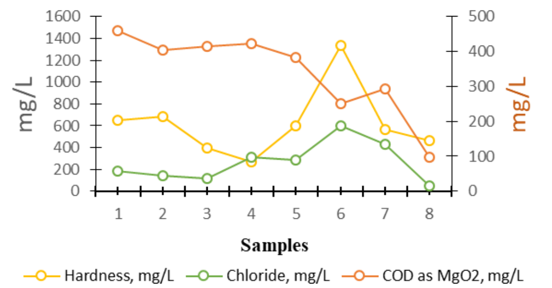

Fig 3.(h). Graphical representation of Hardness, Chloride, and COD of Groundwater samples obtained during analysis

3.2 Water Quality Index for the study point

A mathematical tool called the water quality index (WQI) is used to reduce a significant amount of water quality data to a single value that represents the level of water quality. It is a method of classifying water quality that the general people can use and comprehend. All the criteria affecting water quality are combined into a single number.

WQI has been calculated using the World Health Organization's 2017 drinking water quality standard. The weighted arithmetic method, which was created by Brown et al. (1972) after being first proposed by Horton (1965), has been used to calculate the Water Quality Index.

Table 3.(e). WQI for all the Groundwater Samples

GW Location	WQI Values
1	173.75
2	142.06
3	86.81
4	177.38
5	143.21
6	235.61
7	267.00
8	123.01

The Water Quality Index (WQI) values for each groundwater sample are shown in Table 3(e). Based on a number of factors that were assessed in the samples, the WQI provides an overall evaluation of the water quality. Sample 3 has a low WQI, as shown in the table, suggesting lower water quality when compared to the other samples. Conversely, Sample 7 has a high WQI, suggesting better water quality in that particular sample.

Table 3.(f). Water Quality Classification Based on WQI

S.No	WQI Range	Type of water	No of Samples	Samples
1	1 < 50	Excellent	0	-

2	50.1 – 100	Good	1	3
3	100.1 – 200	Poor	5	1,2,4,5,8
4	200.1 – 300	Very Poor	2	6,7
5	> 300.1	Unfit for Drinking	0	-

The WQI for the study's eight samples ranged from 86.81 to 267 (Table 3.(e). The WQI, which is the maximum allowable level for drinking water, was surpassed by over 87% of the samples. The increased levels of iron, nitrate, total dissolved solids, hardness, sodium, and chloride in the groundwater have been determined to be the key contributors to the high WQI values at these sites. Water samples with a poor quality score around 62.5% of the time. The results of the investigation revealed that locations 6 and 7's WQIs are higher than the cutoff point. Table 3.(f) lists the water quality classification based on WQI.

4. CONCLUSION

Rapid urbanization and expansion of industrial suburban areas in recent years around MSW dumpsites has shifted everyone`s concentration towards the negative impact it has on the environment attributes around its vicinity. Mysore dump site initially located just far away from residential areas, the solid waste dump site produced and stored limited waste, minimizing its environmental impact. However, urbanization led to housing and commercial zones encircling the dump, increasing waste generation and worsening environmental effects. This study observed that, the groundwater quality around the dump site is not satisfactory for drinking purposes in few samples out of 8 locations. In sample number 1, 4 and 6 high EC, hardness and microbial contaminations were observed as the sampling points were very much close to the dump site and also sample 6 failed to have a good WQI. Therefore employing waste management methods like sorting, recycling, and advanced leachate and gas control can mitigate dump-related environmental issues. This safeguards the immediate vicinity and prevents further harm during ongoing urbanization. Waste management is a joint duty, demanding collaboration among authorities and communities. Stringent policies, public education, and active community involvement are vital for eco-friendly waste practices. Addressing urban proximity problems needs a comprehensive, unified approach. Acknowledging responsible waste practices and applying suitable measures can curtail waste's air, water, and soil impact, maintaining ecosystem health amidst urban growth. This balances urban expansion with environmental preservation, ensuring sustainability. The research underscores assessing environmental factors to grasp the surrounding area's waste absorption capacity.

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