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Analysis of Groundwater Quality near the Solid Waste Dumping Site

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Abstract : *Municipal Solid Waste (MSW) describes the stream of solid waste generated by households, commercial establishments, industries and institutions. Improper disposal of MSW has serious repercussions for the environment and human health. One of the serious problems is ground water contamination. Asian countries are facing municipal solid waste management problems due to the rapid growth in solid waste generation rate and open dumping practices. As water percolates through MSW, it makes leachate that consists of decomposing organic matter combined with iron, mercury, lead, zinc and other metal, which is the cause for the Groundwater contamination in the nearby areas of the dumpsite. So there is a need for Groundwater analysis around the dumpsite to know to what extent Groundwater has been contaminated. The present work aims to analyze the Groundwater contamination by collecting the Groundwater samples from the residential area near the dumpsite*
Keywords – *Contamination, Dumpsite, Groundwater, solid waste*

I. INTRODUCTION

Water is essential for life. Water covers majority of earth's surface a very small percentage is available as fresh water that human can use. Groundwater is one of water resources. As Ground water provides drinking water to the people and it contains over 90% of the fresh water resources, the quality of ground water is of paramount importance. In recent years the risk of groundwater pollution has become one of the most important environmental concerns, particularly in developing countries, where most of the landfills have been built without any sound engineering design such as engineered liners and leachate interception and collection system [1]. Unless properly treated, leachate that seeps from a landfill can infiltrate and contaminate the underlying groundwater.

Threats to the groundwater from the unlined and uncontrolled landfills exist in many parts of the world, particularly in the under-developed and developing countries where the hazardous industrial waste is also co-disposed with municipal waste and no provision of separate secured hazardous landfills exists. Even if there are no hazardous wastes placed in municipal landfills, the leachate is still reported as a significant threat to groundwater[2].

II. STUDY AREA

Chennai lies on India's southeast coast and is the capital of the state Tamil Nadu. Chennai city borders to Tiruvallur in the north and Kancheepuram in the south, both within Tamil Nadu. The city is located at latitude $13^{0}07^{'}$ N and longitude $16^{0}80^{'}$ E, with an area of 174 km^2. The population of the city is 4.3 million (2001 census), which makes it the fourth largest city. At present, Chennai has two open dumpsites, Perungudi in the south and Kodungaiyur in the north. These Dumpsites are placed on marshy land, which is used to be Aquifers and bird sanctuaries. The northern zones dump their waste at Kodungaiyur dumpsite and the southern zones dump their waste at Perungudi dumpsite. Rapid growth of municipal solid waste is shown in Figure 2.1.

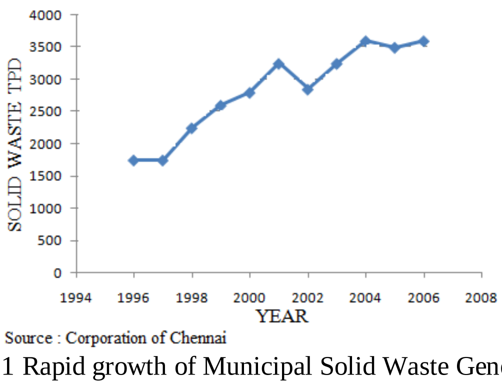

Fig.2.1 Rapid growth of Municipal Solid Waste Generation

Perungudi is used for dumping the waste collected from south since 1987. The total area of the site is about 800 acres in which about 350 acres have been used so far for dumping. Perungudi dumping ground lies at $12^0 57' 13.5''$ N and $80^0 14' 05.8''$ E. The existing dump site at Perungudi is located approximately 1.2 km south of the city centre. The whole of the area is low lying, being closed to sea level and is poorly drained being occupied by extensive areas of marsh land and mud slats which are permanently wet and seasonally inundated .Velachery marsh lies immediately north to the site. The site is non-engineered low lying open dump, looks like a huge heap of waste. Trucks from different parts of the city collect and bring waste to this site and dump the waste in irregular fashion. Residential areas are nearer to the dumpsites. Due to lack of legislation and proposed management practice, all the waste generated was only dumped at this site.

III. MATERIALS AND METHODS

3.1 Sampling and Testing Protocol

In an effort to study the extent of the groundwater contamination 11 sampling sites were selected near the dumpsite from where the samples were taken. The samples were collected in one litre capacity polythene bottles. Prior to the collection, bottles were thoroughly washed and rinsed with sample to avoid any possible contamination in bottling and every other precautionary measure was taken. The Groundwater well details including location and type is given in Table 3.1. After the sampling, the samples were immediately transferred to Centre for Environment Management Laboratory, NITTTR and were stored in cold room (4◦ C). All the samples were analyzed for selected relevant physico-chemical parameters, heavy metals. The testing process was performed according to the procedures mentioned in the Standard Methods for Examination of Water and Wastewater [3]. Various physico-chemical parameters examined in groundwater samples includes, pH, Electrical conductivity(EC), Total Dissolved Solids(TDS), Total hardness(TH), Calcium(Ca), Magnesium(Mg), Chloride(Cl), Zinc(Zn), Cadmium(Cd), Nickel(Ni), Iron(Fe), Copper(Cu), Chromium(Cr), Lead(Pb).

Table3.1. Groundwater Well Details

Well number	Northing	Easting	Well type
1	12° 57.422	80° 14'.155	bore well
2	12° 57.298	80° 14'.190	Hand pump
3	12° 57.294	80° 14'.189	Open well
4	12° 57.271	80° 14'.087	Open well
5	12° 57.179	80° 14'.130	Open well
6	12° 57.307	80° 14'.100	bore well
7	12° 57.426	80° 14'.410	Open well
8	12° 57.581	80° 14'.309	Open well
9	12° 57.547	80° 14'.406	Hand pump
10	12° 57.576	80° 14'.192	bore well
11	12° 57.432	80° 14'.980	Open well

IV. RESULTS AND DISCUSSION

The Groundwater of the study area is used for domestic and other purposes. Table 4.1 shows the concentration various parameters present in the groundwater samples from which the quality of groundwater can be understood, as it is compared with the acceptable limit The highest value of 8.1 was measured for pH, whereas the lowest value of 6.1. Although pH usually has no direct impact on consumers, it is one of the most important operational water quality parameters. If the pH is above 7, this indicates that the water is probably hard and contains calcium and magnesium. The EC is a valuable indicator of the amount of material dissolved in water. The EC in the study area ranges between 1038 and 4129 μS cm^{-1} which was found to be high. This high conductivity Values obtained for the groundwater near the dumpsite is an indication of its effect on the water quality. Conductivity was used to give an idea of the amount of dissolved chemicals in water, and the presence of Na, K, and Cl. An excess of Cl^- in water is usually taken as an index of pollution and considered as tracer for groundwater contamination [4].

The concentration of Cl^- in the groundwater samples ranged between 519.84 mg L^{-1} to 5318.35 mg L^{-1}. High Cl^- content of groundwater is likely to originate from pollution sources such as domestic effluents, fertilizers, and septic tanks. Increase in Cl^- level is injurious to people suffering from diseases of heart or kidney [5]. Figure 4.1 shows the concentration of EC and TDS for the samples. High value of EC indicates that there is some organic pollution. The high value of TDS can be attributed to the effect of leachate from the dumpsite, which contains high concentration of dissolved salt to the groundwater.

Table4.1. Concentration of Various Parameters

S No	Parameter	Range	Acceptable limit
1.	Cl	519.84 – 5318.35	250
2.	TH	726.6 – 2890.3	300
3.	Ca	14-198	75
4.	Ma	34-220	30
5.	Zn	0.01-0.12	5
6.	Cd	0.0-0.016	0.01
7.	Ni	0.09-0.35	0.02
8.	Fe	0.01-1.5	0.3
9.	Pb	0.25-0.45	0.01
10.	Cr	0.001-0.067	0.05
11.	Cu	0.016-0.047	0.05

Fig 4.2 shows the high concentration of total hardness which means the samples are recognized to be hard water. Usage of this kind of hard water for bathing and washing will lead to formation of white precipitate instead of producing lather. It also forms deposits which clog the pipelines.

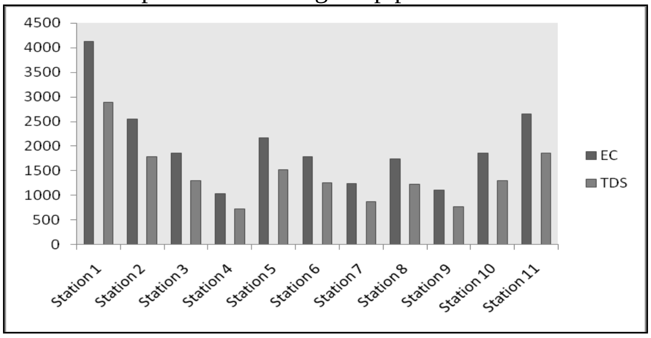

Fig.4.1 Concentration of EC and TDS

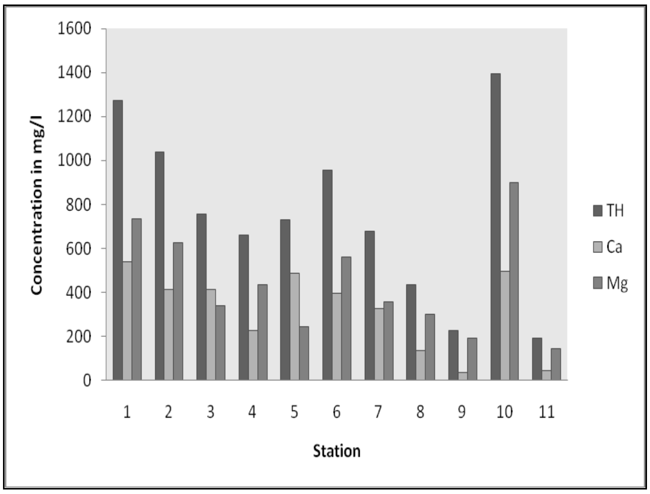

Fig.4.2 Concentration of Total hardness

The schoeller diagram is used to understand the dominancy order of the ions. From the Schoeller diagram shown in the Figure 4.3 for the dumpsite the dominancy order of the ions is understood. The order of ions are Cl>Mg>Ca>Na>HCO3>SO4. As distance increases the concentration of dominant Cl ion is decreasing but still the ion is dominant. This shows the effect of leachate from the dumpsite on the groundwater. From the Durov plot Figure 4.4, it can be easily understood that all the samples were in reverse ion exchange process. This implies the groundwater type is dominated by anion and the equilibrium between anion and cation is disturbed. Since none of the samples were in ion exchange or in the transition stage shows high anthropogenic interference in the region which here is a dumpsite.

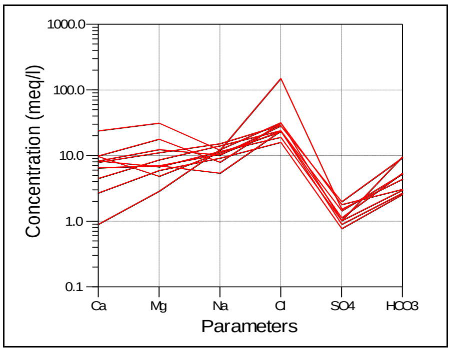

Fig.4.3. Schoeller Plot showing the dominancy of ion

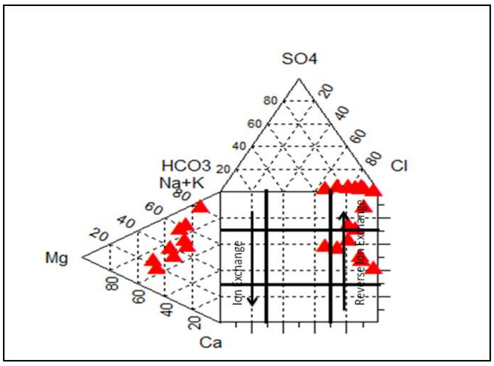

Fig.4.4. Durov Plot Showing Ion Exchange Process

Figure 4.5 is the Piper trilinear diagram for the data obtained from chemical analysis of groundwater samples. This diagram consists of two lower triangles that show the percentage distribution, on the mill equivalent basis, of the major cations (Ca++ , Mg++, Na+ & K+) and the major anions (SO4 2- , Cl- , CO32- + HCO3 -) and a diamond shaped part above that summarizes the dominant cations and anions to indicate the final water type. From the hydrochemical facies, the type of groundwater can be known. The water type of the samples is distributed among the three types i.e., CaCl, mixed CaMgCl and NaCl type. This water type is in par with the dominancy of ions. With respect to cation the type is mixed with respect to Na, Mg and Ca and in case of anions the type is controlled by Cl. Since NaCl is dominating high salinity is associated with the groundwater, which is directly contributing towards the increased EC. This supports the fact that groundwater contamination has taken place due to the presence of dumpsite.

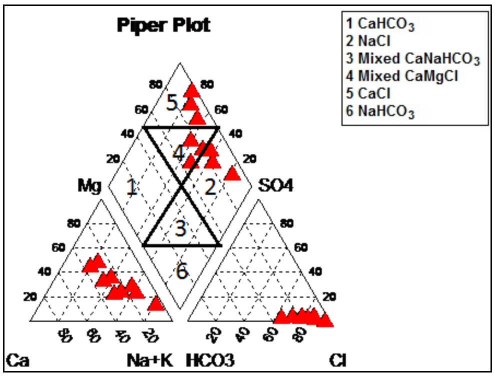

Fig.4.5. Piper Plot Showing Hydrochemical Facies

V. CONCLUSION

The solid waste disposal system presently being practiced in Chennai consists of mere dumping of waste that have been generated, at two locations Perungudi and Kodungaiyur without any regard to proper care for the protection of surrounding environment.. Perungudi dumpsite in Chennai is expected to become cause of serious groundwater pollution in its vicinity. The present study was undertaken to determine the likely concentrations of principle contaminants in the groundwater over a period of time due to the discharge of such contaminants from landfill leachate to the underlying Groundwater The result of analysis of groundwater samples show that leachate constitutes a serious threat to the local aquifer. The heavy metals exceed the acceptable limit almost in 80% of the samples. This shows the contribution of leachate on the groundwater. The moderately high concentration of EC, TDS, TH, Ca, Mg and other heavy metals in Groundwater samples near the dumpsite shows the deteriorated quality of the Groundwater which cannot be used for drinking and other domestic purposes. Although, the concentrations of few contaminants do not exceed drinking water standard even then the ground water quality represent a significant threat to public health. Urgent attention therefore, needs to be paid to the groundwater supply from this region and proper remedial should be taken to reduce further contamination of Groundwater.

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