A STUDY ON IMPACTS OF MUNICIPAL SOLID WASTE DUMPSITE IN GROUNDWATER QUALITY AROUND PERUNGUDI

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ABSTRACT
High standards of living and ever increasing populations have resulted in an increase in the quantity of wastes generated. Municipal Solid Waste is generally combination of household and commercial refuse which is generated from the living community. In Perungudi solid waste has been dumping in open dumpsite. There is no treatment or management of solid waste in the dumpsite. Without liners in place, precipitation seep through the solid waste, producing contaminated water referred as leachate. The leachate then seeps into the groundwater beneath the landfill, causing the groundwater to become contaminated. This contaminated groundwater is referred as a plume. Due to the normal flow of the groundwater, the plume extends away from the landfill, causing further contamination. The problem identification of study area is done with the help of Focus Group Discussion with women's group, key informant interview with VAO. The present condition of Perungudi was obtained from Situation Problem Query and Response tool and Timeline analysis. From the data analysis, the groundwater concentration has its own cyclic response of monsoon and non monsoon period. The concentrations are increase in June of the year and decrease in the January due to the monsoon behavior. Groundwater samples were collected from the wells at various distances surrounding the dumping yard. The inference obtained is well water quality within one kilometer exceeds the Bureau of Indian standard limits (BIS). The principal threat to groundwater comes from inadequately controlled landfill where leachate generated from the dumpsite is allowed to escape to the surrounding and underlying ground.

1. INTRODUCTION

Water covers the majority of the earth's surface a very small percentage is available as fresh water that humans can use. The fresh water constitutes only about 2.5% of the total quantity of water on the earth. Two-third of this is frozen as glaciers and ice caps, leaving only 0.77% of fresh water for human use.

While in developing countries the problems linked to lack of safe drinking water supply and improved sanitation are tremendous, within the so-called developed countries these infrastructures are fairly well built-up (coverage 98% in 2002). Therefore, in these regions concerns related to the water focus on water stress caused by anthropogenic influences such as industrial, agricultural or human dwelling activities and the whole range of its impact on health associated, environmental and socio-economical issues. Water resources of India are examined in the context of the growing population and the national ambition to become and be seen as a developed nation. But India is expected to experience severe water stress by 2020 with the per capita availability of water projected. Quoting a World Bank study, it said that out of 27 Asian cities with population of over 10 lakhs, Chennai and Delhi were ranked as first the worst performing metropolitan cities in terms of water availability per day, while Mumbai was ranked as second worst performer and Calcutta fourth in India.

Groundwater is one of the sources of water resources. We are in need to reduce the groundwater contamination. Therefore this study is carried out mainly to reduce the groundwater contamination which provides wholesome water to the public.

In Perungudi solid waste has been dumping in open dumpsite. There is no treatment or management of solid waste in the dumpsite. Without liners in place, precipitation seep through the solid waste, producing contaminated water referred as leachate. The leachate then seeps into the groundwater beneath the landfill, causing the groundwater to become contaminated. This contaminated groundwater is referred as a plume. Due to the normal flow of the groundwater, the plume extends away from the landfill, causing further contamination.

The Pallikaranai Marshlands that holds the Perungudi dumping ground is of unique ecological and economic importance. Pallikaranai is the largest natural rainwater harvesting system in the region, which is linked to the Bay of Bengal through a network of channels. It has been a source of drinking water to people in the immediate neighborhood (south Chennai). Pallikaranai, in its original state, used to store large quantities of storm water, even while allowing excesses to flow into the sea. This served two important functions – flood control in the surrounding

areas, and groundwater recharge. Owing to the dumping of garbage, leachate seeped into the sub-surface and entered recharge channels through domestic and deep borewells.

The Dumpsite is located in a densely populated area, people living in perungudi depends on groundwater for their domestic purposes. Well water show presence of groundwater contamination that can cause serious health problems.

2. STUDY AREA

The Perungudi dumpsite is located south of velacherry, lies between the old Mahabalipuram road in the east, Velacherry – Tambaram road on the west, Sittalapakkam on the south Alandur on the north. The area is low lying marshy land and is connected to the sea through Buckingham canal and the Kovalam Estuary at the southern end of the depression. The dumpsite is bounded by 12°50' and 13°00' North latitude and East longitude 80°05' and 80°15' falls in Survey of India topographical map 66D/1 and D/5 which is 3.5 kilometer from the Bay of Bengal.

The dumping yard started in the year 1984 and still in use. It spreads over an area of approximately 80 ha and situated near National Highway. On an average 1500 MT/day of waste is dumped and the waste fill height varies from 2.5 to 3 m. It is located at the close proximity of the Buckingham Canal. The waste dumped at this site includes domestic waste, e.g. kitchen waste; paper, plastic, glass, cardboard and cloths, some of the industrial waste as well as hospital waste.

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. Earlier, due to lack of legislation and proposed management practice, all the waste generated was only dumped at this dumpsite. Even, segregation was not carried out till recently and also there was no treatment provide to the waste.

2.1. Stakeholder Perception

Groundwater near by dumping site is not good, which is unfit for drinking water and domestic purposes. Many of the senior people expressed that they depended on the groundwater for the domestic purposes in the past. All of them complained that the present use of ground water is not possible which is highly contaminated. After this dumping of solid wastes started, the groundwater appears to have been contaminated all around the Perungudi.

2.2. Women's Perception

During Site visit, a Focus Group Discussion was conducted with the Self Help Group who are living near dumpsite. The reason for choose the women's group is based on IWRM third principle "Women play a central role in the provision of collecting, management and safeguarding of water". Women are worstly affected by the contaminated water. Most of them depend on the packaged water sources for the drinking purposes, the poor people consuming contaminated groundwater. Some of the people depend on tanker water for domestic purposes such as cooking, bathing etc. Due to presence of contaminants in ground water livelihood is affected in the Perungudi area.

2.3. Time Line Analysis

Time line is a Participatory Rural Appraisal tool which helps to identify the important past events. The inference obtained from timeline gives better information about the area and potential risk posses to the natural resources. From the Time line analysis, some of key findings are,

a. Municipal solid dumpsite was established at Perungudi before three decades.
b. Software companies and industrial buildings were constructed in the early period of 1990's.
c. Groundwater contamination is the main issue for past 15 years.
d. Peoples living near the dumpsite depends on packaged drinking water from 2000 onwards.

2.4. Key Informant Interview-Village Administrative Officer

The Municipal Solid Waste (M&H) Rules, 2000, require that the site chosen for the dumpsite should be suitable for the purpose. The site should be examined to make sure that it will meet certain criteria. The dumpsite in Perungudi fulfills only four out of seventeen requirement criteria in the Municipal Solid Waste (M&H) Rules, 2000. Due to lack of legislation and proposed management practices, waste are dumped improperly which leads to groundwater contamination. Segregation or treatment of waste is not being carried out. Many of the problems faced by the people due to non-engineered landfill.

2.5 SPQR (Situation Problem Query Response)

SPQR is acronyms of Situation Problem Query Response. It is used to analyses the situation and identification of the problem. It is used to set central and sub question which is help to attain the objectives of the

study. After the site visit and Focus Group discussion with women's group, Central question is derived. The Central question of the project is "what kind of remedial measures accepted by the local community"

To achieve the central question, some of the sub questions were prepared,

1. What is the people's perception about the groundwater contamination due to perungudi dumpsite?
2. What are problems faced by the people due to contaminated ground water?
3. What is the timeline of the dumpsite?
4. What is the level of knowledge about the up-gradation of the open dumpsite?
5. At what level public participate in up–gradation of the dumpsite, if proposal is accepted?.

3.DATA COLLECTION AND METHODOLOGY

3.1 Groundwater Quality data

The groundwater quality data in perungudi collected from the government agencies such as Institute for Water studies, Central Ground Water Board and Corporation of Chennai. The various studies have been conducted by the Central Ground Water Board from 2009 and they prepared reports. The report says that high concentration of cations and anions in ground water near dumpsites indicates deterioration of the quality of water.

Institute for Water Studies is monitoring a well present in Perungudi Area. The various data such as water level, water quality is recorded by the officials. Water level data is noted at every month from 1988. The water level is fluctuated and the water level is high during monsoon period of every year. Water quality data such as physical and chemical analysis are being carried out.

Water quality data is collected from the previous study and government agencies. The figure 1 shows the wells(C) location near the dumpsite. Totally sixteen wells samples were choosen and analyzed from June 2005 to Jan 2011. The parameter choosen for the study are pH, lead, TDS, TH and Chlorides.

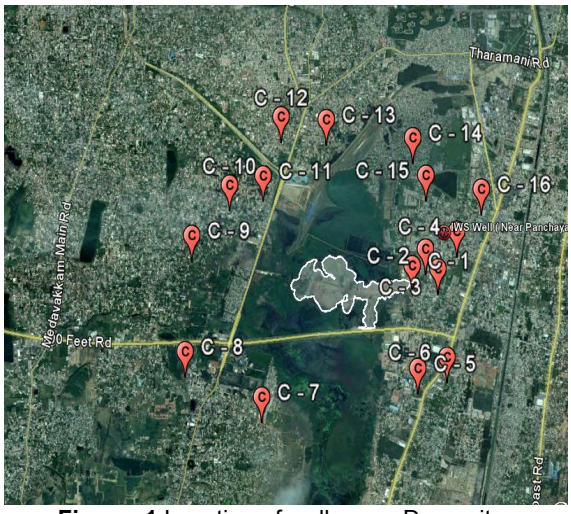

Figure .1 Location of wells near Dumpsite.

3.2. Methodology

After going through literature, thesis and reports it was realized that selected study area facing severe groundwater contamination due to solid waste dumping. A research methodology was carried out to achieve the objective of the study approach. The project aims to proceed in two stages which are

i. Groundwater quality analysis,
ii. Questionnaire Survey.

The results arrived from the two stages will be utilized to come out with suitable solution for the problem. For selection of the parameter and a questionnaire indicating the parameters identified based on literatures

4. RESULTS AND DISCUSSION

4.1. Data Analysis

The obtained groundwater quality data were analyzed, which is help to understand the various contaminations in the well in terms of distance. The Elevation of the dumpsite and sample location was studied (explained in Section 4.3). The table 1 shows the parameter concentration for various distance both post and pre monsoon periods.

Table 1 Water Quality Comparison of Pre – Monsoon and Post – Monsoon Period

Parameter	Distance (kilometer)	Pre Monsoon		Post Monsoon	
		Jun 2005	Jun 2010	Jan 2006	Jan 2011
pH	0.2	6.23	6.18	6.5	6.24
	0.45	6.78	7.23	7.10	6.90
	0.56	6.72	7.40	6.90	7.53
Total Hardness (mg/l)	0.2	980	3800	1030	3010
	0.45	450	1280	210	1010
	0.56	265	1280	310	1010
Chlorides (mg/l)	0.2	630	1200	700	990
	0.45	1085	1560	1321	602
	0.56	233	780	271	602
TDS (mg/l)	0.2	1550	6580	2120	5080
	0.45	1085	1560	1321	1441
	0.56	658	1277	734	1034
Lead (mg/l)	0.2	0.07	0.181	0.080	0.180
	0.45	0.08	0.100	0.100	0.110
	0.56	0.04	0.09	0.04	0.09

In pH, there is no observed variation in pH before and after monsoon which is also in the range of 6 to 8. Drastic change in the parameter of Total Hardness concentrations from 2005 to 2011. Total Hardness concentration increased in a well at distance of 0.2 kilometer compared to 0.45 kilometer in pre –monsoon period. Chlorides concentration level increased in post monsoon period due to accumulation of leachate from the dumpsite. TDS shows the concentration of TDS is within half a kilometer. Lead – No Change in intensity of Lead concentration in pre and post monsoon period

Table 1 illustrated the water quality changes during pre and post monsoon period. Groundwater flow in the area is generally towards east. The contamination level is found to be high within half a kilometer from the dumpsite indicating the spread of the contaminant plume towards the east of the dumpsite. The base of the deposited waste is mostly inundated and significant thickness of waste may be submerged during monsoon and hence the quantity of leachate released will be substantially high causing the contamination level increase in the surrounding area. Measured levels of contaminants are found to decrease progressively with increasing distance from site.

4.2. Groundwater Quality Analysis

Groundwater samples were collected (year of June 2012) from four wells various distances surrounding the dumping yard. The inference obtained is well water quality within one kilometer exceeds the Bureau of Indian standard limits. The principal threat to groundwater comes from inadequately controlled landfill where leachate generated from the dumpsite is allowed to escape to the surrounding and underlying ground.

Table 2 Groundwater Quality Analysis

Parameter	Concentration within one kilometer		Concentration beyond one kilometer		BIS	
	Sample 1 (0.34 km)	Sample 2 (0.7 km)	Sample 3 (1.1 km)	Sample 4 (1.5 km)	Desirable limits	Permissible limits
pH	6.92	7.85	6.10	6.20	6.5 – 8.5	9.2
TH(mg/l)	3800	1280	550	250	300	600
TDS(mg/l)	6780	1780	210	290	300	1500
Chlorides(mg/l)	1200	780	150.6	125	250	1000
Lead(mg/l)	0.1	0.09	0.01	0.00	0.1	0.1

4.3. Digital Elevation Model

DEM is created to the study area around two kilometers from the dumpsite. The figure 2 shows the DEM of the study area. DEM is created with help of SRTM data in ArcGIS package.

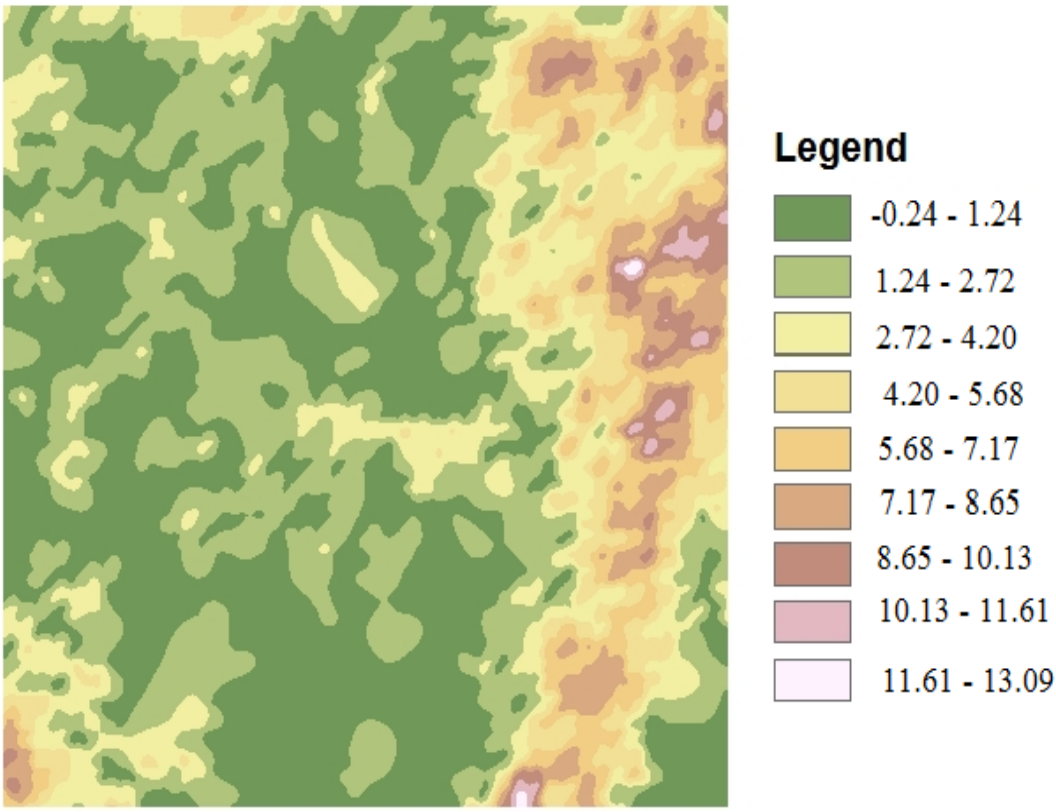

Figure 2 Digital Elevation Model – Perungudi.

A digital elevation model is stored terrain elevation data for the earth's surface which can be used to create digital models and representations of that surface such as elevation maps or 3-D models. The general area of terrain is plain with an average altitude of 5m above the mean sea level. Dumpsite is placed on Marshy land, leachate leaking is high and its contaminate groundwater

4.4. Analysis of Questionnaire Survey

From survey it is inferred that low income people is living very close to the dumpsite and were badly affected because of its presence. Due to the development of Information Technology and industry, people preferred to purchase flats at Perungudi. The land rate is cheap when compared to other metropolitan places. Leachates (solution percolating from a solid material) from tones of accumulated waste polluted the ground water for almost three decades and the residents of Sai Nagar, Telephone Nagar and MC Nagar have been getting water unfit for consumption.

4.4.1. Water sources and well detail

Almost Eighty five percent depends for packaged water for their drinking water. People spend 200 to 250 rupees per month for purchasing drinking water. Table 3 presents the detail of source of water at the Perungudi from the thirty respondent. Six out of thirty household depends on well water as their source of drinking water, that the six household near the dumpsite, low income groups

Table 3 Sources of water

Sources of water	**Packaged**	**Metro**	**Well**	**Other**
Drinking	20	4	6	0
Cooking	0	9	21	0
Bathing	0	9	21	0
Washing	0	9	21	0
Flushing	0	9	21	0
Gardening	0	2	12	0

Twenty one respondent depends on well water for their domestic purpose like cooking, bathing , washing and flushing.

4.4.2. Dumpsite and Evironmental Issues

Area of dumpsite is progressively increasing. Nearly 100 to 120 Lorries trip at Perungudi dumping site which receives about 1500 tons of wastes per day when compared to fifteen years back only 400 tons of waste were dumped per day. Previously groundwater was fit for drinking purposes but now the water is contaminated, so the local people depends on packaged drinking water. In some places, the colour of water is found to be yellowish due to leachate contamination. Health is affected because of existing dumpsite near the residential area like fever, cold and diahrrea. So many environmental issues arise due to Perungudi dumpsite, like air pollution, burning of wastes, groundwater contamination etc. The reason for the environmental issues were

i. Dumpsite is placed on marshy land.
ii. No proper maintenance.
iii. Absence of Solid Waste management practices.

4.4.3. Public awareness and Action

Sri Sai Nagar Residents Association and others filed case at High Court. It has appointed an Expert Committee to give its opinion as to whether Chennai Corporation is right in dumping the garbage in the marsh in the light of the Technical/Legal aspects prevailing today. So many awareness programs were conducted at Perungudi by Non Government Organisation. Nearly ten percent of people used boiling water as precautionary measure.

4.4.4. Remedial measure

Most of the people (28 out of 30) want to stop the waste dumping in the Perungudi dumping yard. Only two respondent preferred leachate management as a remedial measure.

5. CONCLUSION

The problem identification of study area is done with the help of Focus Group Discussion with women's group, key informant interview with VAO. The present condition of Perungudi was obtained from Situation Problem Query and Response tool and Timeline analysis. From the data analysis, the groundwater concentration has its own cyclic response of monsoon and non monsoon period. The concentrations are increase in June of the year and decrease in the January due to the monsoon behavior.

Groundwater flow in the study area is generally towards the east (well 1 and 2). The flow direction explains the larger contamination in the well in the east part of the dumpsite. It is observed that the contamination in groundwater within half a kilometer from the dumpsite.

The inferred from groundwater analysis and Questionnaire survey conducted among the local community are groundwater deteriorate due to presence of dumpsite. Even though a kilometer gets contamination but the intensity of the concentration is very high. Proper management practices need to control the groundwater contamination and to arrest the movement of leachate from the dumpsite.

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