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Hydrochemical Investigation on Ground Water Quality in and Around Solid Waste Dumping Site, Chennai City

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Abstract: The daily waste generation in Chennai city from each individual is expected to be 0.252Kg. Current waste generation in the city is 2,940 m^3/ day of which 80% is collected and disposed to dumping site every day. This open dumping site has neither liner system nor any other mechanism for groundwater pollution. Authors proposed to conduct an investigation on ground water quality in and around solid waste dumping site, Chennai city. A cross sectional study was conducted in Reppi solid waste dumping site from April 10 to 25 / 2011 to analyze associated risks to the groundwater and the public health in its vicinity. For groundwater leachate, nearby well water and far away spring water samples were collected based on the distance difference and for public health issue. Based on WHO standard sampling procedures 20 in the nearby community and 20 from the controlled group were used for the study. Extreme care was taken to avoid alteration of chemical composition of samples during sampling. The study parameters for leachate, and groundwater quality were determined in the laborataries of Central pollution control board, government of India. The parameters includes physicochemical parameters such as pH, chloride, total hardness, alkalinity, TDS, TSS, DO, BOD, COD, Nitrate, Ammonia, Phosphate and trace metals. Standard methods were used for the analysis of the samples. The public health parameters were collected using pre designed questionnaires. Physicochemical analysis of leachate and groundwater showed that more than 95% of parameters in nearby well water analysis is more than the far away spring water and much exceeded WHO drinking water quality standards. This may be due to contaminants transported from dumping site to ground water. More than 95% of the population around the dumping site face the risk of public health hazard. From this study we conclude that there is an increase in risk to ground water and public health that is reported near Reppi solid waste dumping site.
Key words: Ground water quality, Heavy metals, WQI, solid waste dumping site, spring water, Leachate, well water, Bore well water.

Introduction

Chennai is a center for modern economic and social activities because of the infrastructure services are found relatively in better condition than other cities of TamilNadu. It is the political capital of TamilNadu[1]. The covered area is 174 sq.km with total population is 46, 16,639. The longitude and latitude of the study area lays 13.08 to 13.5 N and 80.16 to 80.27 E. However, its development is too slow to meet the demands of the increasing population due to both natural growth and rural urban migration. In particular, the complete inadequacy of the solid waste management is major environmental hazard in Chennai. The daily waste

generation in Chennai city from each individual is expected to be 0.5Kg. Current waste generation in the city is 3000 tons/day of which 80% is collected and disposed on dumping site every day [1]. This open dumping site has no liner system and other groundwater pollution and public health risks control mechanism. We proposed to investigate hydrochemical on ground water quality in and around solid waste dumping site, Chennai city.

The remaining 20 per cent of waste is disposed off through informal means, except smaller percentage going to incineration, dumped on open sites, drainage channels, rivers and valleys as well as on the streets[1]. The rivers that cross the city, are widely used as disposal sites, although the hygiene and environmental sanitation regulation issued by the Chennai city administration prohibits people from disposing waste along roads, avenues, rivers, ponds, and other sites. Due to lack of proper means of discharging their day to day waste, it becomes difficult to implement the proclamation, directives and rules that result a continuous violation of regulation by the people. Solid waste dumping sites in Chennai are Ottivakkam, Madipakkam, Paliakaranai, Perundurai, Ambattur Industrial Estate and Ennoor. We chosen for the study is Ambattur Industrial area. In these above dumping sites, Ambattur Industrial area chosen for the impact study and health risk analysis is carried out for our project.

Figure 1: Outline map of study area Ambattur industrial area

Objectives of the investigation

In order to measure the quality of water and assess the risk contamination, attempts have been made with the following objectives:

- To evaluate the water status
- To identify the contamination element
- To create awareness on water quality, quantity and pollution

Materials and methods

Samples were collected in to cleaned high density polyethylene bottles using a peristaltic pump. Samples were filtered during collection through a 1.2 mm polypropylene filter cartridge. The use of a filter cartridge was preferred to membrane filters to minimize common filtration problems such as membrane clogging and reduction in effective pore size. Water pH, temperature, conductivity and dissolved oxygen were measured situ using adequate sensors14. Reagents used for the investigation were AR and GR grade chemicals and deionized double distilled water used for the preparing various standard solutions. Total hardness, total dissolved solids, chloride, calcium, magnesium, sulphate, bicarbonate alkalinity, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand, sodium, potassium, fluoride, nitrate and trace metals like chromium, cadmium, lead, mercury and arsenic content assessment were carried out by the standard methods[2-7] Sodium and potassium were measured by the flame photometer. The suitability of the water for potable purposes was analysed by using an indexing system called water quality index (WQI). [8-24]

Results and Discussion

Before samples were collected site selection for leachate sample and ground water samples was carried out. After sampling sites selected leachate sample was collected at the center of dumping site from shallow well and the color of leachate sample was found to be black and the ground water samples were collected from private owned well located in the southern direction at 300m from the boarder of dumping site. The well water table range from 1.8 to 4.5m in one full day, since the water was used for construction of building and the other purposes,controlled sample was collected from naturally occurring spring in east direction at distance 2km from dumping site. The color was bright yellow and colorless respectively as can be

seen.

On site measurement were conducted for the temperature, DO, conductivity and P^H of leachate and ground waters using standard devices and the result obtained from the measurement for leachate was 24.4^{O}C that is similar with the ambient temperature and the temperature of well water and spring samples were 24.3^{O}C and 24.7^{O}C respectively. The P^H value of the leachate, well water and spring water in the onsite were 9.23, 9.48 and 9.15 respectively.

Leachate in the dumping site and groundwater physicochemical characteristics nutrients and heavy metals were determined in Chennai city Environmental Protection Authority and in Indian Geological Survey Water Laboratory. (Tables- 1, 2, 3) displayed the physicochemical characteristics, nutrient concentration and some important trace heavy metals concentration with their respective samples and it is represented graphically in (Figure- 2, 3, 4, 5)

Table 1: Hydro chemical characteristics of leachate and groundwater samples

SL NO	WQP_s	Leachate	Well Water	Bore well Water	WHO Standard
1.	pH	9.23	9.45	9.15	6.5-8.0
2.	Suspended Solids	29	11	-	-
3.	Dissolved Solids	5658	2154	132	600-1000
4.	Alkalinity	5364	1465	173	200
5.	Chloride	520	256	186	250
6.	Sulfate	502	398	64	200
7.	Electrical Conductivity	2126	154	32	-
8.	Ammonia	0.4	0.1	0.02	-
9.	Nitrate	0.66	0.42	0.03	-
10.	BOD	160	20	30	7-14
11.	COD	210	54	67	-
12.	DO	NA	2.6	2.8	-
13.	Phosphate	6.0	2.0	-	-

Table.2: Trace metals composition of leachate, well and spring water samples

Sl No	Parameters	Leachate Conc.(mg/L)	Well water Conc.(mg/L)	Spring water Conc.((mg/L)	WHO standards (mg/L)
1.	Lead	0.090	0.0760	0. 060	0.010
2.	Nickel	0.070	0.04	0.010	0.020
3.	Copper	1.40	0.40	1.40	2.000
4.	Cadmium	0.13	0.10	Nil	.003
5.	Chromium	0.30	0.20	Nil	0.050

Table 3: Risk based drinking water criteria and nearby well concentration.

Sl No	Element	WHO	U.S.EPA	Well water Conc.((mg/L)
1.	Lead	0.010	0.015	0.09
2.	Nickel	0.020	0.100	0.04
3.	Copper	2.000	1.3000	0.4
4.	Cadmium	0.010	0.010	0.1
5.	Chromium	0.050	0.100	0.2

Figure 2: Chloride and Sulfate Vs Sampling Sources

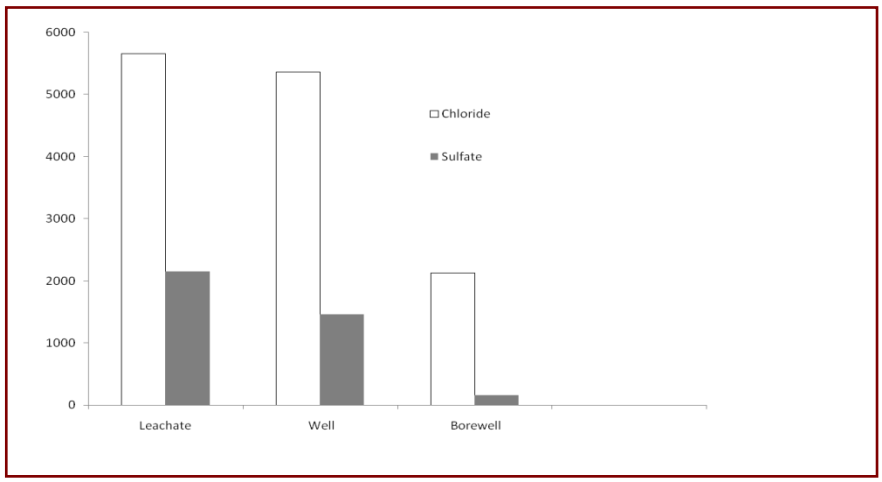


Figure 3: Tds, Ta and Ec Vs Sampling Sources

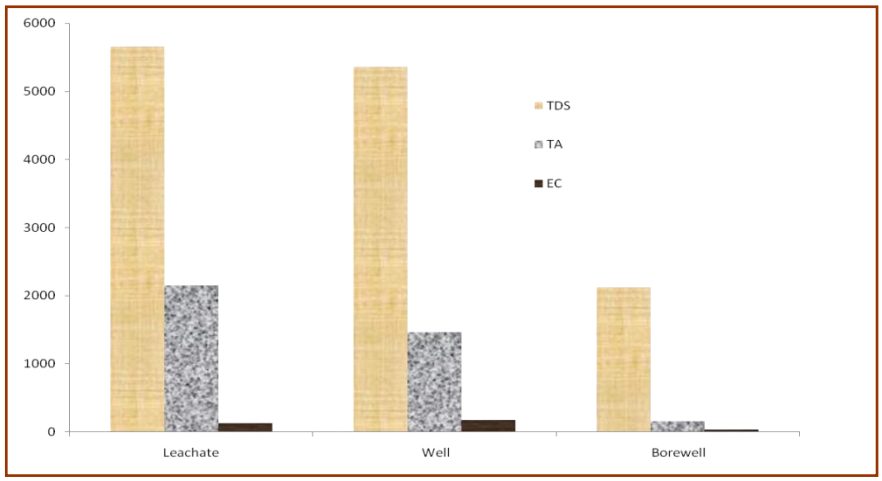


Figure 4:Samples Vs Pb, Ni, Cu, Cd, Cr

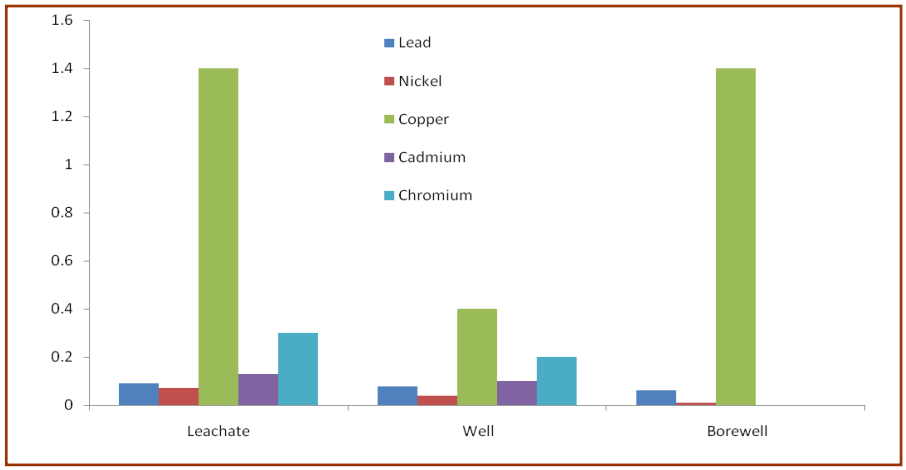


Figure 5: Samples Vs TDS, Alkalinity, Chloride

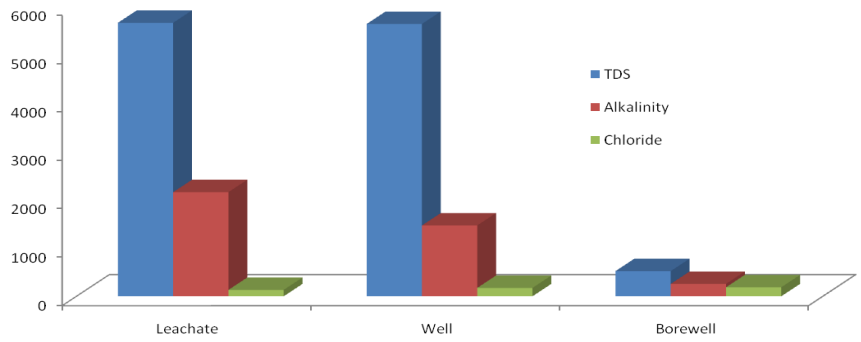
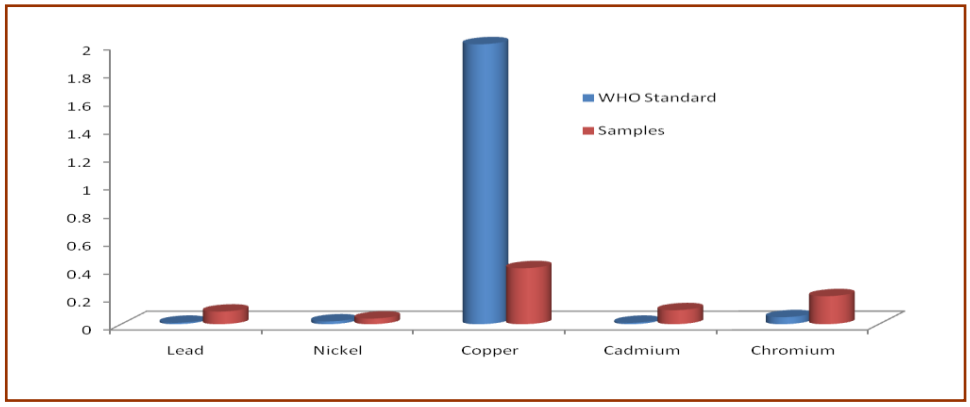


Figure 6: Who Standard Vs Metals Concentration in Well Water



Public Health Results

Due to uncertainty in quantifying dumping site emission, uncontrolled type of disposal practice and lack of facilities in the site, it is difficult to estimate the health risks on the nearby residents of the dumping site. Although there is conflicting findings on health effects of solid waste dumping site , this section display some important public health findings.

Based on the data collected from the nearby community and controlled site community combined respiratory tract, dermatological and sight problems were assessed and the finding was 91.5%, 75.6% and 84.8% respectively for exposed population and unexposed group findings were below 10%. In the study population there were no significant abortion and congenital problems. -

Conclusion

Since there is no design information obtained from the Ambattur Solid Waste Dumping Site, Reppi, the concentration of organic compound, nutrients, Temperature, P^H, Alkalinity, trace metals and hardness were determined based on American Public Health Association standard methods for the examination of water and wastewater. However, as can be deduced from (Tables- 1, 2, & 3) the maximum concentration of the stated materials are most likely found in the leachate and nearby ground water.

The characteristics of leachate and ground water are shown in (Tables- 1, 2, 3) and it is representen graphically in (Figure- 2,3,4,5,6). High concentration of pollutants prevailed in leachate and well water except copper. Leachate and well water produced during sampling higher concentration of pollutant particularly of conductivity, SS, TDS, Alkalinity, Phosphate, lead were found this may be due to the emission from mixed waste but BOD and COD of spring water were greater than nearby well water this may be due to contaminant of waste from its catchments area and due to its stagnation. This could be attributed to groundwater and surface water ingress from the dumping site that promote volatilization of pollutants from active decomposition of waste mass in to leachate emanated from disposal site to the nearby ground water source.

Table 4: Comparison of public health problems to those who live in the nearby dumping site and controlled group

Sl no	Conditions of events	Comparison group (N=316)	No of events	Percentage of problem
1.	Combined respiratory problems	Near site residents	289	91
		Control group	28	8.8
2.	Combined skin problems	Near site residents	239	75.6
		Control group	16	5.1
3.	Red itchy eyes	Near site residents	268	84.8
		Control group	22	6.9

Table 5: Prevalence of disease vectors with in the vicinity of dumping site and controlled site

Sl No	Vectors	Near landfill site (N=316)		Far landfill site (N=316)	
		No	percentage	No	percentage
1.	Dogs	313	99	29	9.2
2.	Canines except dogs	302	95.6	6	1.9
3.	Flies	316	100	28	9
4.	Cockroach	304	96.2	23	7.3
5.	Mosquito	303	95.9	None	0
6.	Rats	316	100	13	4.1
7.	Scavengers	299	94.6	None	0

However, background levels as can be seen from the (Tables- 4,5) more than 95% of the population living near the dumping area are found to be infested as well as canine animals around the dumping site .This is due to the fact that stray dogs and other similar canines are scavengers for leftover food and other wastes. This infestation will be big problem for the transmission of hydrophobia (rabid disease). And more than 96% of the residents were infested by flies and cockroach. This infestation revealed that those who live near the dumping site are in danger for eco-oral disease transmission with relative risk of 12 as compared with population far away from the dumping site. In addition to that almost 96% of nearby community are well exposed for the occurrence of malaria due to the mosquitoes breeding. The last but not the list, rat infestation is pronounced problem in nearby community (100% exposure rate). This revealed that the community in the site is exposed to communicable diseases such as Hantavirus Pulmonary Syndrome (HPS), Murine Typhus, Rat-bite fever (RBF), Salmonella enterica serovar, Typhimurium, Leptospirosis, and Eosinophilic Meningitis.

The presence of large quantities of mixtures of potentially hazardous chemicals in solid waste dumping sites close to residential area has increasingly caused some significant groundwater and public health concerns.Concerns have led to a substantial number of studies on groundwater and public health effects associated with solid waste dumping sites. From this study we can conclude that there is an increase in risk to ground water and public health that is reported near Reppi solid waste dumping site. Although biases and confounding factors cannot be excluded as explanations for this finding, the finding revealed that high risks are associated with groundwater pollution and public health near the dumping sites.

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