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IMPACT OF SOLID WASTE EFFECT ON GROUND WATER, SOIL, NOISE AND AIR QUALITY NEARER TO BRAHMAPURAM SOLID WASTE LANDFILL SITE IN BRAHMAPURAM, KERALA, INDIA.

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Abstract:

In line with the above research works, the present study aims at evaluating the environmental impacts on ground water and soil quality associated with the operation of a common hazardous waste landfill facility (CHWLF). Soil and groundwater samples were collected nearer to Brahmapuram Solid waste landfill-site in Kerala to study the possible impact of solid waste effect on soil and ground water quality. The physical and chemical parameters such as temperature, pH, hardness, electrical conductivity, total dissolved solids(TDS), total suspended solids(TDS), alkalinity, calcium(Ca), magnesium(Mg), chloride, nitrate, sulphate, phosphate and the metals like sodium(Na), potassium, copper, manganese(Mn), lead(Pb), cadmium(Cd), chromium(Cr), nickel(Ni), palladium, antimony were studied using various analytical techniques. to find out the impact on the groundwater quality with the help of GIS tools and carry out real time monitoring to check the presence of any pollutants in the groundwater.It has *been found that most of the parameters of water are not in the acceptable limit in accordance with the IS10500 Drinking Water Quality Standards. To find out the impact on theair, Noise and soil quality to checks the presence of any pollutants nearer to the landfill area. It is concluded that the contamination is due to the solid waste materials that are dumped in the area.*

Keywords: Brahmapuram, water quality, ground water, solid waste

1. INTRODUCTION

Enormous amounts of solid waste produced in and around Chennai urban areas are dumped nearer to Brahmapuram, Kerala State solid waste landfill site. This municipal solid waste normally termed as “garbage” is an inevitable by product of human activity which is disposed through dumping. Solid waste land filling is the most common method of solid waste disposal. The landfill site nearer to Brahmapuram are open dumpsites, because the open dumpsites are low operating costs and lack of expertise and equipment provided no systems for leachate collections. Open dumps are unsightly, unsanitary, and generally smelly. They attract scavenging animals, rats, insects, pigs and other pests. Surface water percolating through the trash can dissolve out or leach harmful chemicals that are then carried away from the dumpsites in surface or subsurface runoff. Among these chemicals heavy metals are particularly insidious and lead to the phenomenon of bioaccumulation and biomagnifications. These heavy metals may constitute an environmental problem, if the leachate migrates into the ground water. The presence of bore well at the landfill sites to draw ground water threatens to contaminate the ground water**.**

Fig 1. Brahmapuram Solid wate Processing Site

A water pollutant is a chemical or physical substance present in it at the excessive levels capable of causing harm to living organisms. The physical hazards are the dissolved solids and suspended solids. The chemical hazards are the Copper, Manganese, lead,Chromium, Cadmium, Phosphate, Nitrate *etc*. As the public health concern, the ground water should be free from physical and chemical hazards. The people in and around the dumping site are depending upon the ground water for drinking and other domestic purposes. The soil pollution arises due to the leaching of wastes from landfills and the most common pollutant involved is the metals like Copper, Lead, Cadmium, Mercury etc., The Contamination of ground water and soil is the major environmental risk related to unsanitary land filling of solid waste.

Impacts of solid waste on health: The group at risk from the unscientific disposal of solid waste include – the population in areas where there is no proper waste disposal method, especially the pre-school children; waste workers; and workers in facilities producing toxic and infectious material. Other high-risk group includes population living close to a waste dump and those, whose water supply has become contaminated either due to waste dumping or leakage from landfill sites. Uncollected solid waste also increases risk of injury, and infection.

This study involves the water and soil quality analysis in the Brahmapuram solid waste dumpsite nearer area. The aim of the study is to understand how the soil , noise, air and water gets polluted due to the dumping of solid waste.

2. Study Area

The dumping started on the 30th of June with 25 lorries carrying municipal waste rolled into Brahmapuram with police protection. 53 families that make up the Chellipadam village initially took refuge at a school nearby. Some were admitted to the hospital citing headaches, nausea, and dizziness [4] [5]. They subsequently abandoned their homes due to the stench and health concerns that the site posed. Since then the people of neighboring villages have protested against the indiscriminate and unscientific handling and dumping of waste in the area. However, in 2007, the panchayat decided not to renew the NOC.

In the wake of continued protests, in 2008, the government acquired additional land from the residents in Chellipadam. This expanded the site area to 110 acres. A solid waste management (SWM) facility was commissioned in 2008 with a capacity to handle 200 tonnes of waste per day at Brahmapuram [6]. From the various waste management projects that have been proposed on this site has been riddled with issues and has posed various hazards to the people in the neighboring villages.

In 2011, the plant was found to be defunct. There was subsequently a proposal to create a plant with a capacity to process 500 tonnes of waste per day, while repair and maintenance were carried out in the old plant. This new proposal was firmly opposed by the people of the Vadavucode-Puthenkurish and Kunnathunad Panchayats, who refused to grant the required license [7].

Since 2012, municipal solid waste of 5 municipalities (Aluva, Angamaly, Kalamassery, Thrikkakara, and Tripunithura) and 2 panchayats (Cheranalloor and Vadavucode-Puthencruz) and the solid waste of Kochi corporation are handled by the Kochi Corporation and taken to Brahmapuram plant. The plant now receives 383 tonnes of waste every day. In 2016, the National Green Tribunal (NGT), Southern Zone pointed out that the dumping of the waste at Brahmapuram has been illegal since its authorization had expired 5 years ago[8]. It also pointed out the violation of the erstwhile Municipal Solid Waste (Management and Handling) Rules 2000 and suggested that remedial measures be taken to restore the facility. In 2018 the NGT slapped a 1 crore rupee fine on the corporation for the non-compliance to its 2016 order [9]. The Kerala Pollution Control Board has initiated action against the Kochi Corporation for the unscientific handling of waste at Brahmapuram citing the violation of SWM Rules, 2016, and Section 24 of the Water (Prevention and Control of) Pollution Act, 1974 [10].

High-level committee reports have consistently proven that the plant is in a dilapidated condition, many facilities including the refuse-derived fuel facility, plastic shredding, and bailing units are not working, and that there is an accumulation of leachate at various points [6]. There is also non-biodegradable legacy waste spread over an area of 16 acres which remains to be remediated.

Fig.2 Layout of Brahmapuram soild waste landfill site

The Chitrapuzha and Kadambrayar rivers around the site are the source of drinking water to 6 panchayats. The Central Pollution Control Board in its 2018 report on the rivers in India that do not meet water quality criterion mentions the particular stretch of Kadambrayar between Manckakadavu and Brahmapuram [11]. There have also been repeated allegations of the ill-maintained infrastructure- cracks on beams, sinking floor - posing a hazard to the workers in the facility. Collapsing river walls have also increased pollution in the Kadambrayar river [12].

3.METHODOLOGY

Sampling and Methodology **:** The Preliminary survey on the quality of ground water, soil and solid waste samples was conducted in the month of November 2020, because the ground water and soil get polluted due to solid waste dumping nearer to the location. The water samples and soil samples were collected along with three grab samples during first week of the month between 3.00 P.M. to 4.30 P.M.

Water**:** Water samples were collected from bore wells as well as wells that were dug and Handpumps, using clear acid-washed polyethylene bottles. Thirty seven groundwater samples were collected for analyzing the chemical parameters. Sample Collection, preservation and analysis were done as per the standard methods. Water samples were taken at each station. Three water samples were collected at different locations at Brahmapuram. The polyethylene sample containers cleaned by 1 mol/L of nitric acid and left it for 2 days followed by thorough rinsing of distilled water. Two litres of samples were collected for the analysis. The generally suitable techniques for the preservation of samples followed as per Indian standard methods. The pH, Electrical conductivity, Total alkanity, hardness and chloride test were done at the site. Total suspended solids. nitrate, phosphate and sulphate were analysed as soon as possible. The samples for trace metal analysis were acidified with concentration HNO_3 to bring pH<2.

Soil samples**:** Sample collection, preservation and analysis were done as per the standard methods. The representative soil samples were collected as per standard methods. The sampling of soil was done using manual hand augur. The augur was used to bore a hold to the desired depth and then withdrawn. The samples were collected directly from the augur. The sampling area first to be cleaned and first eight inches of surface soil was removed with the radius of 8 inches around the drilling location. Begin auguring, periodically removed and deposited accumulated soil onto the plastic sheet. After reaching the desired depth slowly and carefully removed the augur from the hole and the samples were directly from the augur. The composite samples collected and they were kept in the suitable labeled container. The collected soil samples were protected from sunlight to minimise any potential reaction. The dry soil samples for various tests were prepared as per the indian standard method**.** The received soil samples dried in sun or air and the pulverization was done. The pulverised soil was passed through the specified sieve and taken for various analysis.

Solid waste samples**:** 500g of representative solid waste samples were collected in the different places of Brahmapuram Landfill site on 5^{th} November 2020. The solid waste samples were collected as per the standard procedure.

Air: The ambient air quality has been assessed with respect to SPM, SO_2, NOx, and CO the sampling stations were carefully chosen based on the prevailing meteorological conditions during the study period using synoptic scale climatological normal and with the help of available screening air quality. HVS anf filter method is uded for SPM pollutants, Pros and aniline method is used to find out the SO_2 , Sulphaniliamide method is used to find out the Nox and Co-Direct reading detector is used to find out the CO.

Noise: A sound level meter, an instrument which has a microphone amplifier and weighting networks and an indicating meter that gives a reading in dB relative to 2 * 10-5 N/M2.

Laboratory analysis: The station-wise distributions of analytical parameters such as physical parameters and metals are shown in Tables 1, 2 and 3 and the analysis was done as per the standard methods.

Table: 1 Comparison of analytical results with International (WHO) and National standards (BIS)

Parameters	Max	Min	Mean	WHO Guideline value (2004)	BIS 2012
Electrical Conductivity (μS/cm)	8370	400	2584.32	1500	-
Ph	7.3	5.8	6.8	6.5 - 8.5	6.5 - 8.5
TDS (mg/l)	4191	212	1417.54	1500	500 - 2000
Calcium (mg/l)	384	34	129.02	200	75 - 200
Magnesium (mg/l)	316	19	63.27	150	30 - 100
Sodium (mg/l)	1051	12	314.45	200	200 - 400
Potassium (mg/l)	227	0	20.05	12	-
Carbonate (mg/l)	0	0	0	-	-
Bicarbonate (mg/l)	702	61	366.4	500	-
Chloride (mg/l)	2233	46	509.86	600	250 - 1000
Sulphate (mg/l)	702	14	193.43	250	200 - 400
Fluoride (mg/l)	1.7	0	0.36	1.5	1.0 - 1.5

Results and Discussion

Water Quality Monitoring

Chemical Characteristics: pH of water samples varies from 5.24 to 6.59. The acceptable limit for the drinking water standard is 6.5–8.5. Since W2 does not lie in the limit, it is not suitable for drinking. The pH of soil varies from 6.3 to 7.0 and the solid waste sample varies from 6.4 to 7.3. Total alkalinity values vary from 40mg/L to 260mg/L. The desirable limit for total alkalinity is 200mg/L and the permissible limit in the absence of alternate source is 600mg/L. The total alkalinity value of water sample S2 is very lower as compared to the standard. Hardness of water sample varies from the 450mg/L to 669mg/L. The desirable limit for hardness is 300mg/L and the permissible limit in the absence of alternate source is 600mg/L. The calcium concentration varies from 107 mg/L to 169mg/L and the magnesium concentration varies from 22.5 to 60.1 mg/L. The desirable limit for calcium is 75 mg/L and the permissible limit in the absence of alternate source is 200 mg/L. The desirable limit for magnesium is 30 mg/L and the permissible limit in the absence of alternate source is 100 mg/L. Chlorides are not usually harmful to people; however, the sodium part of table salt has been linked to heart and kidney disease. Sodium chloride may impart a salty taste at 250 mg/L; however, calcium or magnesium chlorides are not usually detected by taste until levels of 1000 mg/L are reached. The desirable limit for chloride is 250 mg/L and the permissible limit in the absence of alternate source is 1000 mg/L. All the water samples fall within the limit.

TDS is generally considered not as a primary pollutant, but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants. The values for the present water samples vary from 1622 mg/L to 1809 mg/L. The desirable limit for TDS is 500 mg/L and the permissible limit in the absence of alternate source is 2000 mg/L. The TDS levels of the water come within the limit. Total Suspended Solids (TSS) (measure of the mass of fine inorganic particles suspended in the water values) are in between 24 and 42 mg/L.

Nitrate is one of the most common groundwater contaminant. The excess levels can cause methemoglobinemia, or "Blue Baby" disease. Although nitrate levels that affect infants do not pose a direct threat to older children and adults, they do indicate the possible presence of other more serious residential or agricultural contaminants, such as bacteria or pesticides. Nitrate in groundwater originates primarily from fertilizers, septic systems, and manure storage or spreading operations. The permissible limit for the nitrate is 45 mg/L. The water samples are in the range of 22.35 to 26.37 mg/L. All the samples are within the permissible range.

Sulfate can be found in almost all natural water. The origin of most sulfate compounds is the oxidation of sulfite ores, the presence of shales, or the industrial wastes. Sulfate is one of the major dissolved components of rain. High concentrations of sulfate in the water, drinking water can have a laxative effect when combined with calcium(Ca) and magnesium(Mg), the two most common constituents of hardness. The sample contains the sulphate concentration in the range of 351 to 487 mg/L. The desirable limit for sulphate is 200 mg/L and the permissible limit in the absence of alternate source is 400 mg/L. The samples W2 and W3 are not suitable for drinking. Phosphorus is usually present in natural water as phosphates (orthophosphates, polyphosphates, and organically bound phosphates). Sources of phosphorus include human and animal wastes (i.e., sewage), industrial wastes, soil erosion, and fertilizers. Excess phosphorus causes extensive algal growth called "blooms," which are a classic symptom of cultural eutrophication and lead to decreased oxygen levels in creek water. The water samples contain 0.11 to 0.16 mg/L of phosphate.

Sodium is an essential nutrient. The Food and Nutrition Board of the National Research Council recommends that most healthy adults need to consume at least 500 mg/day, and that sodium intake be limited to no more than 2400 mg/day. This low level of concern is compounded by the legitimate criticisms of EPA's 20mg/L [Drinking Water Equivalency Level (DWEL) or guidance level] for sodium. The maximum permissible level of sodium is 200mg/L as per WHO guidelines. The present water is having higher concentration as compared to DWEL Level. The sodium level of water is ranging from 449.8 mg/L to 482.2 mg/L.

Metals

***Copper*:** The desirable limit for copper is 0.05 mg/L and the permissible limit in the absence of alternate source is 1.5 mg/L. The undesirable effect beyond the desirable limit is astringent taste, discoloration and corrosion of pipes, fittings and utensils will be caused. The present water samples are having copper ranging from 0.221 mg/L to 0.478 mg/L. Hence, all water samples are contaminated due to copper and not suitable for drinking.

***Manganese*:** The desirable limit for manganese is 0.1 mg/L and the permissible limit in the absence of alternate source is 0.3 mg/L. Beyond this limit taste and appearance are affected and has the adverse effect on domestic uses and water supply structures. The present water samples are ranging from the 0.142 to 2.360 mg/L.

***Cadmium*:** The permissible limit for cadmium is 0.01mg/L. Beyond this the water becomes toxic. The samples are in the range 0.010 to 0.014mg/L, slightly more to the permissible limit.

***Nickel*:** The desirable limit for nickel is 0.07mg/L as per the WHO guidelines for drinking water quality, 2006. The samples are in between 0.029 to 0.154mg/L. S2 is beyond the limit.

***Lead*:** The permissible limit for lead is 0.05mg/L. The water sample has no appreciable concentration of lead and it is found to be below the detection level. The detection level is 0.01mg/L.

***Chromium*:** The permissible limit for chromium is 0.05mg/L. The water sample has no appreciable concentration of chromium and it is found to be below detection level. The detection level is 0.03mg/L.

***Mercury*:** The permissible limit for mercury is 0.001mg/L. The water sample W1 has the concentration of 0.00087mg/L and the other two water samples have no mercury content. Modernization and progress has had its share of disadvantages and one of the main aspects of concern is the pollution it is causing to the earth – be it land, air, and water. With increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. This waste is ultimately thrown into municipal waste collection centers from where it is collected by the area municipalities to be further thrown into the landfills and dumps. However, either due to resource crunch or inefficient infrastructure, not all of this waste gets collected and transported to the final dumpsites. If at this stage the management and disposal is improperly done, it can cause serious impacts on health and problems to the surrounding environment.

Air Quality Monitoring

Air quality in Chennai and pollutant dispersion was relatively good. Nitrogen Oxide (NOx) SO2 and fine particulate matter (SPM) are now the threat to the quality of air in Brahmapuram. A major source of these pollutants is transport, however the relative contribution of transporting hazardous waste is not known but heavy vehicles contribute to ambient Nox concentrations through exhaust emissions and SPM concentrations through exhaust emissions. Air pollution data collected from the high volume sampler for SPM, SO2 and Nox were reported in table XX.

Noise Monitoring

Noise levels in the area range from 30db(A) to 59db(A) which are within prescribed limits There are several noise measurement scales that are used to describe noise at a particular location. The most common is the A-weighted sound level or decibel (dBA). This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive.

Waste that is not properly managed, especially excreta and other liquid and solid waste from households and the community, are a serious health hazard and lead to the spread of infectious diseases. Unattended waste lying around attracts flies, rats, and other creatures that in turn spread disease. Normally it is the wet waste that decomposes and releases a bad odour. This leads to unhygienic conditions and thereby to a rise in the health problems. The plague outbreaks in Surat is a good example of a city suffering due to the callous attitude of the local body in maintaining cleanliness in the city. Plastic waste is another cause for ill health. Thus, excessive solid waste that is generated should be controlled by taking certain preventive measures.

Preventive measures: Proper methods of waste disposal have to be undertaken to ensure that it does not affect the environment around the area or cause health hazards to the people living there. At the household-level proper segregation of waste has to be done and it should be ensured that all organic matter is kept aside for composting, which is undoubtedly the best method for the correct disposal of this segment of the waste. In fact, the organic part of the waste that is generated decomposes more easily, attracts insects and causes disease. Organic waste can be composted and then used as a fertilizer.

Conclusion

Environment assessment of landfill study site is located at Brahmapuram of Kerala. The same site was used as agriculture land for the past few decades. Hazardous landfill site was seem to be a secured landfill site considering the prevailing environment observations on air, soil, water and noise has been within permissible limits during the course of this investigations. Wider use of alternative technologies was likely, including advanced thermal treatment, such as gasification and pyrolysis, mechanical and biological processes should be through to treat waste before disposal in the near future.

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