International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 07 | July -2020 ISSN: 2582-3930

Impact Assessment of MSW Pirana Landfill Siteon Health, Environment and Groundwater Quality: A Review

Smruti Patel[1], S. M. Usman[2]

[1]*M. Tech Student, Department of Environmental Engineering, Swarrnim Institute of Technology, Swarrnim Startup & Innovation University, Gandhinagar, Gujarat, India*
[2]*Assistant Professor, Department of Environmental Engineering, Swarrnim Institute of Technology, Swarrnim Startup & Innovation University, Gandhinagar, Gujarat, India*

Abstract

An adverse impact of growing urbanization and rapid economic development of Ahmedabad is the increasing heaps of municipal solid waste in the Pirana landfill. The key reason behind water pollution around Pirana landfill site is uncontrolled dumping ofMunicipal Solid Waste, which is neglected in general. Degradation of wastes in landfill site results in the production of gases as well as leachate. These emissions are potential threatsto human health and to the quality of the environment. Leachate generated from landfill site affects groundwater quality in adjacent areas through percolation in the subsoil.Landfill gas consists mainly ofmethane and carbon dioxide, both important greenhouse gases.Nuisances suchas flies, odors, smoke and noise are frequently cited among the reasons why people do notwant to reside close to the landfill site.

Key words: Groundwater quality, Pirana landfill site, Health impacts, Environmental impacts, Municipal waste dumpsite

1. Introduction

With rapid industrialization and urbanizationcoupled with liberalization, globalization and ever increasing population of the world, billions of tons of municipal solid waste is generated per day worldwide. InIndia, the quantity of municipal solid waste (MSW) is expected to upraise significantly as India strives to attain an industrialized nation status. While taking into consideration the solely landfill site of Ahmedabad for a longtime, the Pirana landfill site is more than 40 years old and has accumulated more than 70 lakh metric tons of waste over the years. The landfill site has been spread across 84 acres of land.Garbage dumped here consists paper, plastic containers, bottles, cans and, at times, electronic goods.Open burning of this mixed waste is practiced on a daily basis – an inefficient combustion process that releases significant amounts of air pollutants, ash, and dense white or black smoke [1].

Also, the landfill has been identified as one of the major threats to groundwater resources. From various studies, it is observed thatin developing countries, where the waste is dumped directly in unscientific and uncontrolled manner, the waste can bedetrimental to the urban environment. Leachate generated from dumping of municipal solid waste contains variety of hazardous chemicals such as detergents,inorganic chemicals, complex organic chemicals and metals; which are prone detrimental to the environment and additionally uncontrolled microbial action may result in releaseof more toxic elements in a free or reactive form in the waste. Dueto rainwater infiltration, water already present in waste, or watergenerated by biodegradation, leachate tends to leave the dumping ground laterally or vertically andfind its way into groundwater thereby causing more contamination.In recent times, the impact of leachate on groundwater andother water resources has attracted a lot of attention because of its overwhelming environmentalsignificance [2]. Leachate migration from wastes sites or landfills and the release of pollutants fromsediments (under certain condition) pose a high risk to groundwater resource if not adequately addressed.

Apart from this, the landfill site has greatly impacted the health and well-being of migrant workers employed in factories in its vicinity. Official data from the Urban Health Centre (UHC) in Behrampura ward, where the landfill is located, show that 649 people were found to be suffering from tuberculosis between April 2017 and March 2018 within a total population of 1,65,731. These figures are shocking for the incidence of the disease in this ward is approximately 2.5 time that of the national average – which is 134 patients for a population of one lakh. “Patients identified with TB and other respiratory diseases are admitted or referred to the government hospitals where they are given proper medication, but once the patient goes back to the same polluted and unhygienic atmosphere, they fall prey to the same diseases and eventually succumb to them.” says Sanketbhai Gohil, who heads the TB eradication programme in Behrampura UHC.

Need to Assess Groundwater Quality

The outdated, inefficient, shortage of working man-power, inadequate financial resources, improper choice of technologies, inadequate coverage of areas, poor short & long term waste management planning are few of the reasons why the MSW management system in India is lacking to the desired level [3]. The adverse effects on environment due to un-scientific management of waste

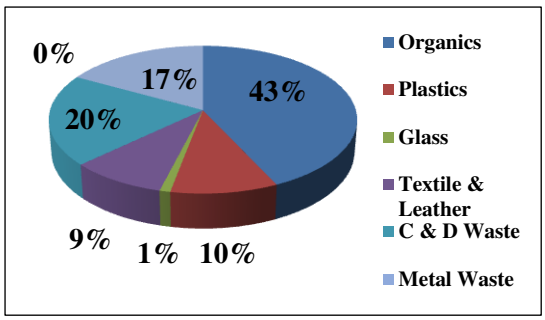

Fig. 1: Composition of municipal solid waste at Pirana dump site

disposal are well known however groundwater pollution needs to be studied for waste disposal, illegal dumping of such waste, and increase in acidity of soil near the garbage heaps. Besides there is a need to assess the quality of groundwater, also needs to be studied for extent to which pollution has happened [4].

Rate of Solid Waste Generation

Developing countries such as India, where economicgrowth and urbanization has become more rapid, arefaced with the severe problem of solid waste. As per thereport of Ministry of Environment in Japan in 2006, theamount of wastes generated in the year 2000 was about12.7 billion tons, which is estimated to increase to approximately 19 billion tons worldwide by 2025 and to approximately 27 billion tons by 2050 [6]. Moreover, in India the MSWgeneration was about 0.46 kg/person/day in the year 1995,whichwasestimatedtogrowto0.70kg/person/dayby2025. In Ahmedabad, approximately110,667 metric tons (MT) of solid waste is generated every month.Every month around 98% (106,000 to 110,000 MT) of waste is collected by AMCfrom various streams i.e.

- Door/gate to dump system (includes residences, institutes, commercial establishments, offices, etc.)
- Street sweeping
- Hotels' and restaurants' kitchen waste
- Construction & Demolition (C&D) waste
- Waste from special markets (including slaughter house, meat / fish / vegetable markets)
- Lifting of dead animals [5]

Composition of Municipal Solid Waste (MSW)

MSW differs significantly with respect to the composition, characteristics, and hazardous nature. The composition and characteristics of MSW is significantly influenced by various factors such as living standards, food habits, rituals, literacy rate, culture, economicdevelopment, and topographical conditions [6]. In India, MSW usually contains approximately 40% to 60% compostable waste, 30% to 50% inert waste, and 10% to 30% recyclable waste. Solid waste generation per head in Ahmedabad is about more than 600 grams per day. The Ahmedabad city corporation disposes of 3000 Metric tons of waste per day, including 300 Metric tons of construction & demolition debris. Further, composition of municipal solid waste dumped at Pirana landfill site of Ahmedabad city is given in the figure 1:

Handling of Solid Waste

Ahmedabad Municipal Corporation is having two processing plants, one is to convert waste into compost, whereas other is to produce Refuse Derived Fuel (RDF). Existing processing plants are of a cumulative capacity of 1000 MT per day, though another 1300 MT per day capacity of processing plants are being setup. Out of 110,667 MT of waste, only 10,000 MT waste is processed and remaining waste is dumped.At present, most of the waste, approximately 90%, is openly dumped at Pirana landfill site. While talking about remaining 10%, around 8% of waste is recovered, while 2% of inert waste is disposed at scientific landfill site at Gyaspur.

2. Study area

The information regarding Pirana MSW Dumpsite is summarized as below:
Pirana dumpsite is located at (22˚58'44.4" N - 72˚33'54.5" E) Chippkuva area near the old Octroi Naka & is adjacent to the main road National Highway No. 8, Ahmedabad.The landfill site is spread in an area of 84 acres. The site started operating from the year 1980. Due to Rapid Urbanization & Industrialization the site slowly & gradually was surrounded by numerous industries & residential areas. About 66.40 Acres of the site is filled completely with MSW & approximately more than 200 lakhs metric tonnes of MSW have been accumulated. Mainly there are three major dumps on the existing site. The largest & the oldest dump have a height of 36 – 42 meters.

Second dump is located behind Excel Industries, has a height which varies between 16 and 25 meters. The new dump has the height of 1 - 10 meters.

Due to disposal of waste in unscientific manner, i.e. absence of Liners, Leachate collection system, etc. leads to pollution & contamination of Groundwater.

Figure 1 Study area: Pirana landfill site

3. Leachate Generation

One important reason behind groundwater and surface water contamination at various places is inefficient solid waste management system and improper dumping of MSW employed for an open landfill. It is observed that landfills are generallybuilt without engineered liners, leachate collection systems, collection equipment, or landfill gas monitoring facility in most of the developing countries. Groundwater in landfill adjacent area is more prone to contamination in view of the fact that the potential pollution sourceof leachate originates from the nearby landfill site. Thereare number of studies on the negative impact of landfillleachate on the surface and groundwater as well [7].

The production of leachate is dependenton various factors such as types of waste disposed at the site, landfill age, and amount of rainfall. However, not only the quantity of leachate but also its composition and quality is determined by these factors. As thelayer of waste increases on a landfill site, more moisture within the waste will bereleased due to the rainfall that seeps into the layers, in addition of the weight ofdeposited waste layer.

Infiltration of Leachate

Leachate will flow downward until it reaches to the bottom of the landfill and if no liner is present,will continue to seep downward until it reaches the water table. Availability of aliner will minimize or attenuate the flow, and leachate collection pipeswill direct the flow to a designated area (leachate collection pond) prior to treatmentbefore discharge. However, few studies have also been carried out on the possibility of failure ofa liner system to prevent the infiltration of landfill leachate into the groundwater; which shows that even in an engineered landfill site, there are still possibilities of leakage due to designfaults or limitations or the exceeding of a liner's lifetime. Hence, an acceptableleakage limit typically considers the physical and attenuation properties of the liningsystem.

Soil Properties

Soil properties determines the permeability, porosity, and also the attenuationmechanism that would affect the movement of contaminants through the soil.Briefly, it plays an important role in determining the movements of leachate asit seeps out from the landfill layer and the fate of contaminants as it flows down thesubsoil into the groundwater below [8]. A subsoil may consist of different types of soils and thus have different properties at each layer. It is, however, difficult toquantify the porosity and permeability of the soil mixture.

4. Impacts due to landfill site

Health Impacts

Healthimpacts and handling, treatment, and disposal of waste is directly or indirectly correlated. It is found that different health issues such as common cough and cold,frequent diarrhea, and infections (both skin and respiratory); moreover, parasitic infections such as malaria anddengue have frequently occurred among local residentsnear the landfill as they used groundwater for domestic purposes [9].

According to the 2012 study report of Bhalaswa Lok Shakti Manch and Hazards Center ofNew Delhi, there was an increased concentration of contaminants in groundwater near the Bhalaswa landfill.The local residents suffered from a number of illnesses, especially gastro-intestinal diseases, musculoskeletal pain,skin and eye irritation, and respiratory problems. Of thesample population in Bhalaswa resettlement colony, 21.1%of women and 31.9% of men suffered from diarrhea andvomiting. This could indicate occurrence of fecal contamination of the drinking water. On the other hand, 62.6% ofpeople suffered from gas and ache problems. The percentage of people was also found to be significant; 20% of menand 18.2% of women in Bhalaswa resettlement colony hadskin problems such as itching and skin rash. This may bedue to regular contact with the polluted groundwater forthe domestic use such as bathing, washing utensils, andclothes.

Landfills pose a great risk to the health of nearby residents due air pollution from unscientific disposal sites. Continuous inhalation of particulate matters including dust,fumes, mist, and smoke is the key reason behind lungand respiratory problems. Dust releasedfrom different sources can cause a variety of diseases right fromcommon cold to deadly diseases like cancer. The highamount of RSPM (respirable suspended particulate matter) is found in either polluted or moderately pollutedcategory. The

higher concentration of particulatematter causes acute and chronic respiratory disorders andlung damage in humans. Population residing in thevicinity of polluted regions by high suspended particulatematter (SPM) was reported to have a higher risk of cardiovascular diseases [10].

The report of Bhalaswa Lok Shakti Manch and hazards center of New Delhi in 2012 indicated that landfillleachate can have volatile organic chemicals such as benzene, chloroform, ethylbenzene, toluene etc., which cancause eyes and skin irritation. Pigmentation, dry skin,ringworm infection, skin allergy, and rash were also observed. Bathing and contact of eyes with contaminated water can lead to eye problems such as pink eyesetc. Additionally, gases that are released from landfillssuch as ammonia, acrylonitrile, carbonyl sulphide, methylethyl ketone etc. have negative impacts on eyes and causeproblems such as burning sensation, watering, and eye irritation.

Socio-economic Impacts

In addition to the health issues, landfills create considerable impacts on land value, landdegradation and land availability. Various researches conclude that landfills likely have anadverse negative impact upon housing values depending upon the actual distance from thelandfill. Potential hazards such as flies, odor, smoke, noise and threat to watersupplies are cited as reasons why the public do not want to reside close to the landfills.

Environmental Impacts

As with any waste management activity, landfilling is also a potential threat to the quality ofthe environment due to its gaseous and leachate emissions as well as wind-blown litter anddust. There are also substantial environmental effects associated with waste transport andcollection.Three major categories of environmental impacts are considered:

1. Impact of landfill construction

Site selection of waste management facilities can be a major issue as all infrastructuralprojects have the capacity to damage the ecology of the site on which they are developed,causing landscape changes, loss of habitats and displacement of fauna. Such impacts aregenerally site specific and need to be assessed on a case by case basis.The soils on selected sites tend to suffer from high levels of disturbances and their chemicaland physical properties differ from those of the surrounding areas due to the general removalof topsoil as well as specific process related changes. Soil is an important resource whichsupports a variety of ecological, economic and cultural functions. The factors like porosity,density, water holding capacity and aggregate strength that operates the soil quality are bestdeveloped in the top soil fraction, subsoil being more poorly developed and having a lowerability to support plant growth. This quality can be disturbed during the constructionactivities. The movements of heavy machinery can lead to excessive compaction of topsoiland subsoil, and in deeper soil this may only be reversible over relatively longer time periods.There is a considerable impact on flora and fauna during the construction phase of landfillsdue to the removal of existing vegetation. But this damage could be recovered after theclosing phase of the landfills. The studies have shown that landfills are capable of supportinga rich and varied fauna including exotic species during the operational and closing phase oflandfills.

2. Impact of landfill gas

The environmental impact of gaseous emission from landfills, which are of global or regionalsignificance, can be mainly grouped as contribution to the greenhouse effect and damage tothe eco system. Apart from that, risk of explosion and odor problem due to some trace gasescan also be identified as significant impacts.

CO_2 and CH_4 are the primary constituents ofenvironmental importance in landfill gas. They act as greenhouse gases of global significance,with CH_4 being the most active but CO_2 being produced in the greatest quantities. TheLCA modeling performed by Damgaard, Manfredi et al. shows that landfills are maincontributors for global warming and photochemical and stratospheric ozone formation.

Gaseous pollutants have significant effects on plants, animals and entire eco systems. Thelateral migration of gas through soil beyond landfill boundaries causes the displacement ofoxygen from soil. This results in a decline in soil faunal populations and burrowing animalsand causes vegetation dieback. Mainly the vegetation around the landfill and the newlyplanted vegetation on a closed landfill can be damaged due to the suppression of air aroundthe roots by migrated landfill gas [11] The acidic gaseous constituents contribute to thephenomenon of acid rains and its secondary effects on the acidification of soils andecosystems. Ammonia is a major acidic constituent which can be found in the landfill gas. Itis a secondary acidifying agent following its atmospheric oxidation to nitric acid. It haseffects on plants, causing a loss of stomatal control, a reduction in photosynthesis, enzymeinhibition, changes in synthetic pathways and depressed growth and yield. Hydrogen sulfideis also having a considerable impact on ecosystem. It is an extremely bio toxic gas, effective ata few parts per billion in mammals. Plants are far less sensitive to direct toxicity effects but have a threshold of 1µg/g. The most severe impact on plants is inhibition anddestruction of root growth and vegetation cover due to the anaerobic soil conditions createdby high concentration of sulfides which laterally seepage from landfill sites. VOCs play asignificant role in formation of ground level ozone. High concentrations of ground levelozone tend to inhibit the photosynthesis, reduce growth and depress the agricultural yields [12].

3. Impact of leachate

The leachate production decreases very slowly and some parameters might be ofenvironmental relevance for many decades to centuries. Leachate can migrate through the soil togroundwater or even to surface water due to the absence of proper liner system or damages ofthe liners and this results a serious problem as aquifers require extensive time periods forrehabilitation. Moreover, soil can retain the constituents of the leachate like metals andnutrients and can cause adverse impacts on the eco system [13].

The metals retained by the soil may uptake by plants and thereby provide a key route for entry ofmetals into the food chain. Deposition of trace metals in the plants can affect crop growth andproductivity and also pose a greater threat to animal health. Those metals such as lead, zincand cadmium show differential mobility through the vegetation and invertebrate trophic levelsand must be assessed by case by case basis. Uptake by plants is affected by soil pH andsalinity and also cadmium and lead uptake is enhanced by the chloride complexation of themetals present in the leachate. Eutrophication is the most extensive threat when theleachate is mixed with the surface water with higher concentrations of nitrate and phosphates. Eutrophic conditions invariably cause excessive production of planktonic algae andcyanobacteria in the open sectors of the lakes. This excessive production of algae resultsadverse impacts on fish species in the lake by limiting the light penetration into the lake.Ammonia generated from leachate within landfills will migrate through the soil horizonswhere it is progressively nitrified to nitrite and nitrate and cause eutrophication problem. Anumber of chemicals can disrupt the reproductive behavior in a range of species by acting asoestrogen mimics.

4. Remedial Measures for the Groundwater Pollution

It is clear from the study that the leachate generated from the landfill site is affecting the groundwater quality in the adjacent areas through percolation in the subsoil and hence some remedial measures are required to prevent further contamination. This can be achieved by the effective management of the leachate generated within the landfill. It can be achieved through adequate control of leachate generation, its treatment and subsequent recycling throughout the waste.

Engineered landfill sites are facilitated with impermeable liner and drainage system at the base of the landfill, which will stop leachate to percolate into subsoil. Leachate accumulated at the base of the landfill can be collected for recycling or treatment, also this collected leachate can be distributed throughout the waste by means of spraying the leachate across the landfill surface. Ultimately some of the water may be lost through evaporation and therefore leading to reduction in the volume of the leachate for ultimate treatment.

Landfill sites should be chosen after carrying out the Techno economic feasibility studies. Retrofitting techniques for the existing, old sites would be cumbersome and expensive. At and around these sites water supply drawn from safe, distant sources should be the first option. Remedial measures should be considered by taking this into account [14].

5. Conclusion

In general, most of the landfill sites are not equipped with appropriate bottom liner or leachate collection system scientifically and hence it impacts the ground water aquifers. The environment of surrounding area of Pirana landfill site is affected in several ways due uncontrolled disposal of municipal solid waste andthe main environmental problem due to landfill is the generation ofleachate from landfill sites. The leachate problem is also getting worse every day due to enormous generation of municipal solid wasteand its immense divergence of characteristic and composition with economic progress of the society. The upsurge of heavy metals in ground water, which can cause severe health disorders and environmental impacts represented by toxicityand groundwater contamination must be taken in consideration.

Numerous studies have been conducted on this topicwhich shows thepotential adverse health effects of the landfill site. Researchers havefocused on the healthof the general population, particularly those living near the disposal site. Thepresence of heavy metals such as Cd, As, Cr, and Ni has beenconsidered to be carcinogenic and has caused an increasing concern. In addition to carcinogenicity, many of thesesubstances can produce other toxic health effects (depending on exposure level and duration) on the central nervoussystem, liver, kidneys, heart, lungs, skin, and reproduction.

Along with gas and contaminated water, wind-blown litter and dust are also emitted through the landfill site.Quality of environment is potentially threatened by landfill although the full extent of thisthreat has not always been scientifically validated. Major impacts of landfill are due to emission of gas and leachate. Both are highly complex mixtures and vary from site to site andwith waste composition and age of the landfill.Nonetheless, a number of studies shows that the landfills createsignificant impacts on global warming, eco system, ground and surface water, human health,land value and land availability. Hence, to minimize the potential risk and environmentalburden of landfills and also to re-introduce the buried resources to the materialcycle the scientific landfill concepts should be made operational in the future

REFERENCE

1. Mor, S., Khaiwal, R., Dahiya, R., Chandra, A.: Leachate Characterization and Assessment of Groundwater Pollution near Municipal Solid Waste Landfill Site, Delhi: Environmental

Monitoring and Assessment, Volume 118, Issue 1 - 3, (July 2006)435 - 456
2. Bhalla, G., Swamee, P.K., Kumar, A., Bansal, A.: Assessment of groundwater quality near municipal solid waste landfill: International Journal of Environmental Sciences, Volume 2, No. 2, (February 2012) 1492 - 1503
3. Bundela, P., Sharma, A., Pandey, A., Pandey, P., Awasthi, A.: Physicochemical Analysis of Ground Water near Municipal Solid Waste Dumping Sites in Jabalpur: International Journal of Plant, Animal and Environmental Sciences, Volume 2, Issue 1, (Jan - March 2012)217 - 222
4. Rathod, M., Mishra, H., Karmakar, S.: Leachate Characterization and Assessment of Water Pollution near Municipal Solid Waste Landfill Site: International Journal of Chemical and Physical Sciences, Volume 2, Special Issue, (March 2013) 186 - 199
5. Shaikh, A., Malek, A., Gajjar, H., Gandhi, N., Patel, D.: Qualitative Assessment of Groundwater Around the Municipal Solid Waste Landfill Site at Pirana in Ahmedabad City: International Journal for Scientific Research & Development, Volume 2, Issue 3, (2014) 1203 – 1205
6. Patil, C., Narayanakar, S., Virupakshi, A.: Assessment of Groundwater Quality Around Solid Waste Landfill Area - A Case Study: International Journal of Innovative Research in Science, Engineering and Technology, Volume 2, Issue 7, (July 2013)3131 - 3136
7. Bhalla, B., Saini, M., Jha, M.: Assessment of Soil Contamination near Unlined Municipal Solid Waste Landfill: International Journal of Current Engineering and Technology, Volume 4, No. 4, (August 2014) 2678 – 2683
8. Venkata Ramaiah, G., Krishnaiah, S., Naik, M., Shankara: Leachate Characterization and Assessment of Ground Water Pollution near MSW Dumpsite of Mavallipura, Bangalore: Int. Journal of Engineering Research and Applications, Volume 4, Issue 1 (Version 2), (January 2014) 267 - 271
9. Sidhardhan, S., Kumar, A.: Assessment of Ground Water Quality at Municipal Solid Waste Dumping Site – Valampurivillai, Nagercoil: International Journal of Research in Engineering and Technology, Volume 3, Special Issue 11, (June 2014) 173 – 178
10. Nandwana, R., Chhipa, R.: Impact of Solid Waste Disposal on Ground Water Quality in Different Disposal Site at Jaipur, India: International Journal of Engineering Sciences & Research Technology, 3(8), (August 2014) 93 – 101
11. Kumari, P., Gupta, N., and Kaur, A.: A Review of Groundwater Pollution Potential Threats from MunicipalSolid Waste Landfill Sites: Assessing the Impact on Human Health: Avicenna J Environ Health Eng. (June 2017)
12. Hamidi, A., Zahari, S., Bashir, J., Hung, Y.: Groundwater Contamination at Landfill Site
13. Danthurebandara, M., Van Passel, S., Nelen, D., Tielemans, Y., Van Acker, K.: Environmental and Socio-Economic Impacts of Landfills: Linnaeus ECO-TECH (November 26-28, 2012)
14. https://thewire.in/labour/ahmedabad-garbage-air-pollution-migrant-workers