

Abstract

Similar to other developing countries, India is one of the world's fastest growing countries based on population, economic growth, urbanization, and industrialization. One huge problem that almost all developing countries have is the lack of proper solid waste management. Erode City, located in Tamil Nadu, India, has an estimated population of 150,000 people, and is estimated to generate 75 tons of waste daily (6). The current system generally disposes waste on the edges of the city, in areas with low altitude (near waterways) involving an unequal distribution of community bins which can lead to random dumping for convenience. The solid waste management system also involves unequipped vehicles for pickups and a huge lack of planning for landfill site locations. Landfills are usually old, un-engineered, and unlined causing leachate (liquid from rainfall that collects organic and inorganic compounds) to pollute soil and groundwater. In Erode City, a study was made to test the groundwater quality near landfill sites. The study tested three non-engineered and unlined landfill sites called Vendipalayam, Semur, and Vairapalayam. The observation study tested pH level, dissolved oxygen, salinity, and leachate. The results found high levels of total dissolved solids (TDS), Chloride (Cl^-), Sulfate (SO_4^{2-}), and other factors indicating unsafe drinking water. Also, leachate was found from high levels of Chloride (Cl^-), Nitrate (NO_3^-), and Ammonium (NH_4^+). It also showed that the closer the samples were taken to the landfill sites, the higher the contaminants. The samples reassert the fact that these landfills are polluting the groundwater. Tamil Nadu should focus on house to house collection instead of community bins, separation for recycling, uniform transportation vehicles, fencing around landfills, treatment for leachate and methane, and liners to prevent leakage.

Introduction

One of the biggest problems of the lack of solid waste management is its effect on groundwater. Water is the basis for life and development, and fresh water is already scarce in our world today. Some factors that show the dangers of leachate include high electrical conductivity (EC) and dissolved solids content which can cause gastro-intestinal problems (vomiting, diarrhea, gas, etc.). Also, leachate can be traced from compounds like Cl^- , NO_3^- and NH_4^+ . Heavy metals like iron (can be an indicator of iron and industrial metal) and Zinc (an indicator of battery waste) also show a relationship between leachate and its presence in groundwater. According to the Environmental Protection Agency, water with a TDS level higher than 500 mg/L is unsafe (U.S. has an average TDS level of 350 mg/L in drinking water), and levels of lead should be zero because lead or Pb can cause delays in development especially in children (11). All of these factors were observed and tested to show the dangerous effect that landfills and especially leachate can have on groundwater.

Materials/Methods



Figure 1
"Waste Management." Green India Drive. N.p., 15 June 2014. Web. 12 Oct. 2015.

Erode District, Tamil Nadu Study:

- Vendipalayam landfill: started in 1963 and still in use with 367 pits. Roughly 45 dumping's a day (6).
- Semur Landfill: started in 2001 and has about 15 to 20 dumping's a day (6).
- Vairapalayam landfill: built in 2001, located on the bank of Cauvery River. On average, 20 dumping's a day (6).

All three sites are non engineered and unlined and are located in the low lying regions of the cities. No separation other than from rag pickers is exercised.

- Samples from 43 observation wells were selected testing groundwater during February finding information on pH, salinity/dissolved oxygen, TDS, EC, and leachate was tested at each site (6).

Map of India



Figure 2: "POLITICAL+VECTOR+MAP+INDIA.jpg - Google Search." POLITICAL+VECTOR+MAP+INDIA.jpg - Google Search. N.p., n.d. Web. 12 Oct. 2015.

| Table 3 Comparison of groundwater quality parameters with Indian (IS) and International (WHO) standards | | | | | | | | | |
|--|----------|---------|---------|-------------------|--------------------------|---------------------|--|---------------------------------|------------------------------|
| Parameters | Units | Minimum | Maximum | Average (SD) | IS Standard (BIS) (mg/L) | WHO Standard (mg/L) | Waste site, exceeding limit | As per BIS standard | As per WHO standards |
| pH | - | 7.1 | 8.2 | 7.63 ± 0.2134 | 6.5-8.5 | 6.5-8.5 | - | Nil | Nil |
| EC | µmhos/cm | 410 | 3830 | 1463.48 ± 830.656 | - | - | - | - | - |
| TDS | mg/L | 267 | 2345 | 862.27 ± 494.784 | 2000 | 1500 | 1, 9 | 1, 2.9, 15, 37 | Gastro-intestinal irritation |
| TH | mg/L | 170 | 1070 | 441.4 ± 208.396 | 600 | 500 | 1, 2, 6, 9, 10, 15 | 1, 2, 6, 9, 10, 15 | Scale formation |
| TA | mg/L | 155 | 675 | 383.6 ± 123.077 | 600 | 500 | 6, 32 | 2, 6, 9, 14, 15, 24, 32, 37, 39 | - |
| Na ⁺ | mg/L | 0 | 437 | 142.37 ± 118.281 | - | 200 | - | - | - |
| K ⁺ | mg/L | 4 | 76 | 26.76 ± 20.337 | - | 200 | - | - | - |
| Ca ²⁺ | mg/L | 28 | 188 | 84.74 ± 29.712 | 200 | 200 | Nil | Nil | Scale formation |
| Mg ²⁺ | mg/L | 5 | 209 | 55.72 ± 40.976 | 30 | 150 | 1, 12, 14-18, 20, 23-25, 31-39, 42, 43 | 9 | Scale formation |
| Cl ⁻ | mg/L | 28 | 759 | 201.76 ± 193.985 | 1000 | 600 | Nil | 1, 2, 9, 15 | Salty taste |
| HCO ₃ ⁻ | mg/L | 189 | 824 | 468.09 ± 150.209 | - | - | - | - | - |
| NO ₃ ⁻ | mg/L | 0 | 47 | 7.93 ± 10.452 | 45 | 45 | 1 | 1 | Blue baby |
| SO ₄ ²⁻ | mg/L | 12 | 300 | 81.74 ± 65.976 | 400 | 400 | Nil | Nil | Laxative effect |
| F ⁻ | mg/L | 0.14 | 1.5 | 0.80 ± 0.471 | 1.0 | 1.5 | 4, 8-10, 12-14, 16-20, 24, 32, 36-37 | Nil | Fluorosis |

Figure 3: Nagarajan et al. Iranian Journal of Environmental Health Science & Engineering 2012 9:35 (6)

Results of Leachate Samples

- Vendipalayam: The pH value was 6.9, TDS values at 25514 mg/L, Pb at 1.10 mg/L, Zn levels at 2.10, and Fe of 63.41 mg/L (6).
- Semur: The pH value was 6.7, TDS values at 22961 mg/L, Pb at 1.20 mg/L, Zn levels at 1.29, and Fe of 58.91 mg/L (6).
- Vairapalayam: The pH value was 6.7 TDS values at 24,123mg/L, Pb at 1. mg/L, Zn levels at 1.29, and Fe of 58.40 mg/L (6).

Conclusion

High physico-chemicals presence in the samples reasserts the dangers leachate can have on drinking water. With India's lack of investment for water treatment systems and the populations dependence on river water (which is commonly unsafe for drinking) it is dangerous to have landfills/dumpsites are located near rivers/waterways (especially the Vairapalayam site which is located on the Cauvery River, a major waterway on the edge of the Erode District). Contaminating these major rivers can effect the crops that farmers grow from using contaminated groundwater. It is necessary that pre-cautions be taken to prevent the dangers of leachate and the contamination of groundwater. The action plan lays out specifically the precautions that should be put in place to sustain clean and safe groundwater.

Action Plan

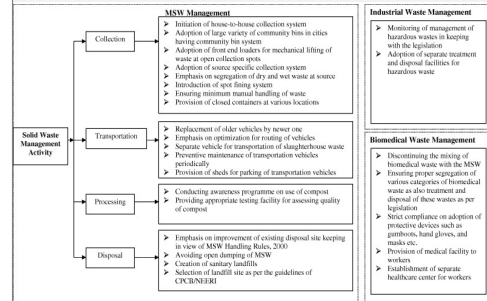


Figure 4: Flow diagram for indicative action plan for solid waste management. (8)

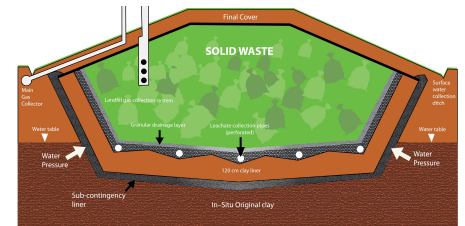


Figure 5:
Digital image. Halton Recycles. N.p., n.d. Web. 11 Oct. 2015.
<<https://haltonrecycles.files.wordpress.com/2012/09/hydraulictrap.jpg>>

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