HIGH SCHOOL EDITION
Journal of Student Research
Volume 12 Issue 4 (2023)

Landfill Management: Challenges and Opportunities

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ABSTRACT

Landfill management is one of the most common techniques to manage the waste disposal process, perhaps this is the reason behind the current inefficiencies in the landfill management processes used by the Indian authorities and local municipalities. The increasing burden of safely managing and disposing the incoming waste is one of the most important reasons to reassess the landfill management techniques used in India. Therefore, this policy paper tries to examine the importance of sustainable management of landfills along with examining the general framework of rules and regulations surrounding the practice of landfill management in India.

Introduction

Landfills which mean a site of disposal of waste materials are one of the most commonly used methods of waste disposal. It is also the most suitable, preferred and the oldest method of disposing waste. Earlier, landfills were referred to as middens, where refuse was left in piles in certain areas. Ideally, landfills are somewhat similar to middens but have become more complicated for managing waste in a proper manner so that it doesn't leave any harmful residue which can affect our environment.

As the population of India is increasing, the amount of waste generated is also accelerating tremendously. Usually, the different types of waste that is being generated include solid waste like vegetable waste, household waste etc.; liquid waste from industries, power plants etc.; plastic waste; metal waste; and nuclear waste. These wastes can be then classified into biodegradable and non-biodegradable wastes.

The waste that can be easily decomposed by the action of microbes are called biodegradable wastes and the wastes which can't be broken down by the microbes are called non-biodegradable wastes. Overabundance of both these types of wastes exists which is causing environmental degradation and pollution. The overabundance of biodegradable wastes give a suitable environment for bacteria to grow, and the process of decomposition at a large scale leads to the release of the methane gas which gives out a foul smell. Methane, as we all know, is one of the main reasons for environmental degradation, global warming and climate change. The more non-biodegradable waste is produced, the more it gets accumulated and leads to pollution. Wastes like plastics and metals can't be decomposed by bacteria thus they have to be processed properly and recycled so that they don't produce harm to the environment. All these wastes are getting dumped in Indian landfills without any proper care (Aditee Das 2020).

Due to dumping of waste in landfills, a large amount of methane gas is being released from these landfills. According to the EIA report of 2003, "*The methane released from landfills has a great global warming potential which is 23 times greater than that of the same amount of carbon dioxide*" (Aditee Das 2020).

Harmful gases which are released from the landfills is causing different health problems to people who work there and also to the people who live around the landfill areas. Different health conditions like nausea, vomiting and memory loss can happen due to the inhalation of methane (Crown 2019). Along with that, respiratory problems also are very common by the inhalation of the carbon dioxide gas (Drechsler M 2023). A large amount of leachate is also released from landfill areas. Leachate is the liquid waste that gets penetrated into the soil and pollutes the groundwater. As such, it is important to develop a sustainable landfill management system to protect the environment and the citizens of India.

Types of Landfills

Landfill can be divided into three major types:

1. Municipal Solid Waste Landfills: These types of landfills are used to store domestic and commercial wastes such as food, paper, plastic and other materials. Their area can vary from 1 hectare in rural areas to over 120 hectares in urban areas. These landfills release a large amount of methane into the atmosphere which is very harmful and causes ozone layer depletion.
2. Hazardous Waste Landfills: These types of landfills are specially designed to handle harmful wastes and chemicals produced by hospitals or industries. Since such wastes are very hazardous and toxic they can be really harmful for the people living around such landfill. Leakage in these landfills can be very dangerous as it can cause environmental degradation and dangerous health consequences.
3. Industrial waste landfills: These types of landfill are designed to handle wastes generated by the industries. This waste may or may not be dangerous. Industrial waste includes chemicals, untreated sewage, concrete, gypsum, metal and many more.

Outcomes from improper landfill management

As a matter of fact, only 3 landfills in Delhi namely Bhalswa, Okhla and Gazipur have cost more than 450 crore rupees in environmental degradation (Gandhiok J 2022). This highlights the fact that improper usage of landfills as a waste management technique can have dangerous outcomes. Some of such outcomes are as follows:

1. Groundwater contamination: Landfills which are not designed properly, can leach some contaminants into the groundwater. This can contaminate the groundwater drinking supplies and harm aquatic ecosystems. In fact, the level of nitrates in the groundwater in around 50% of districts in India have exceeded the permissible limits (Mohan V 2018).
2. Air pollution: Landfills release high levels of methane every year which is a very dangerous gas. Further, landfills also give out an unpleasant odour and volatile organic compounds which harm the environment. Landfill gases are the gases released by the landfill areas after the decomposition of organic wastes. These gases include methane, carbon dioxide, hydrogen sulphide, ammonia and volatile organic compounds.
3. Public Health Impacts: Constant exposure to the contaminants released by the landfill areas, can cause several harmful diseases like cancer, birth defects and neurological disorders. The health impact on people doesn't happen in a month or two, it takes at least a constant exposure to the toxic gas which leads to different diseases. The communities living nearby the landfill areas are most affected.

Key controversies around landfill waste management

Landfills are a traditional way of waste managing, however, over the years there are several ethical debates surrounding. Some of it are as follows:

1. Location of the landfill: Landfills in India are usually built away from the urban areas, in low-income areas, which lead to injustice with the economically weaker areas of the societies. First of all, these low-income areas don't get proper facilities like hospitals, schools etc, and when a landfill is built in these areas, it worsens the situation. Instead of the development of these areas, landfill establishment results in release of harmful gases which affects the people living here.
2. Waste of resources: In today's world, everybody talks about saving our resources and sustainable use of them. However, what questions the sustainability of landfills is that a large amount of substance which is

dumped into the landfills contain useful resources and when this is dumped into the landfills, the said resources are wasted.

3. Expensive: Landfills are expensive to construct and maintain. When it isn't properly maintained, it starts harming the environment by releasing landfill gases and by producing leachate. This raises questions about the cost effectiveness of landfills and the necessity to find an alternate proper solution for waste management.

Policy Framework

In India, there are several landfill management regulations laid down by the government. Different regulations cover different aspects of landfill management like air pollution control, water pollution control and managing the hazardous waste in the landfills. Some of the regulations which cover various aspects of landfills in India are as follows:

1. Solid Waste Management Rules, 2016: These Rules are applicable to every municipal body to regulate, segregate, store, transport, process and dispose of municipal solid waste. These rules require landfill sites to be designed in such a way to minimise environmental impacts and ensure public health and safety.
2. Environmental Impact Assessment Notification, 2006: This Notifications notifies any project, including landfill sites, which are likely to have significant environmental impacts to go through an environmental impact assessment before they can be approved. This assessment evaluates the potential social and environmental impacts of the project and the ways through which these impacts will be reduced.
3. The Water Act, 1974: This Act provides for prevention and control of water pollution, including the contamination of ground water by landfill leachates. It requires landfills to be designed in such a way to reduce the contamination of groundwater.
4. The Air Act, 1991: This Act provides for controlling and preventing the air pollution in the country, including the harmful emissions from the landfill sites. This Act requires landfills to be designed in such a way that it minimises the release of harmful gases, odour and other pollutants.
5. The Hazardous Waste Rules, 2016: These Rules provide guidelines to manage and handle the hazardous and harmful wastes, including the disposal of hazardous wastes in landfill sites. It requires landfills to design in such a way that minimises environmental and health impacts.

In India, despite the existence of many laws and regulations related to landfill site management, there still are many challenges that need to be addressed. There has been some progress in this area but there are some significant challenges to ensure their successful implementation.

Challenges in landfill management

There are several problems and issues associated with landfill management. Some of them are as follows:

1. Improper enforcement: One of the major problems with these laws is the improper enforcement of them. There are many landfill sites which operate without proper permits and violate environmental regulations. The local authorities often lack the resources, capability and political will to take any action against them. A study conducted by the Indian Institute of Science (IISc) has revealed that 10 to 15 per cent of the total three lakh tonnes of waste generated daily goes to illegal dumping sites on the outskirts of the Bangalore city (DH News Service 2014).
2. Lack of public awareness: Another important issue is the lack of public awareness and education related to the landfill sites. People living in communities near the landfill sites are unaware of the potential health and environment risks associated with improper landfill management practices.

3. Insufficient monitoring: The monitoring of landfill sites in India is often inadequate, which leads to violations of environmental regulations going undetected. This creates concerns for the environment, public health and safety.
4. Poor infrastructure: Many landfill sites in India lack the proper infrastructure required to manage waste. This leads to many issues such as burning of the waste in the open which contributes to air pollution.
5. Lack of an alternative: Landfills have been traditionally used for managing wastes, but they have never been used properly and their improper use leads to many environmental effects.

Overall, while there have been some positive developments, the implementation of landfill laws and policies in India has been challenging, and there is still a long way to go in ensuring sustainable use and management of landfills. Greater enforcement of regulations, public education and participation, and the promotion of alternative waste management strategies will be critical to achieving more sustainable landfill management practices in India.

Alternative Solutions

It is very important to find sustainable alternatives for landfills which are economically accessible, technologically feasible and accepted by the culture. Some alternatives which can be of assistance in the reducing the problems generated by the landfill sites are as follows:

1. Landfill mining: Landfill mining is the process of excavating wastes from existing landfill sites to use it for recycling or generating energy. It is helpful in reducing the amount of waste loaded in the landfill sites. Reduction in waste leads to the reduction in air pollutants released or the leachate produced. There are several stages for landfill mining. Firstly, the landfill sites have to be surveyed properly to identify areas in landfills where one can find valuable items like metals, plastic etc. Secondly, the waste is excavated using heavy machinery and transported to a sorting facility. Then in the sorting facility, the waste is segregated into different categories like plastic, metals, and organic matter, which can further be recycled or used to make energy. At an ashfill, by the process of landfill mining, 34,352 Mt of ferrous and non-ferrous metals were recovered and sent for recycling. These metals were then sold for $158 per Mt (Wagner, T. P., & Raymond, T. 2015).
2. Waste to energy: Waste to energy refers to the production of energy by the combustion of wastes. The waste used in this process can come from a variety of sources like municipal solid waste, industrial waste, and agricultural waste. The process of waste to energy involves various steps. Firstly, the waste is collected from the landfill sites and sent to the waste to energy facilities. Then at the facility, the waste is sorted into combustible and non-combustible substances like metals, glass and ceramics. The remaining waste is then combusted to produce heat energy. This heat is used to produce steam, which moves the turbines to produce electricity. This energy can be used to power houses and businesses. This method also helps reduce the amount of waste at landfill sites which increase its shelf life and reduces the need of making new landfills. At present, there are around 12 functional wastes to energy units in India (Balakrishnan C 2023).
3. Landfill gas capture and utilisation: This is the process of capturing landfill gases, like methane and converting it into usable forms like energy. This energy can be used as a fuel for vehicles. The process involves digging into the landfill site to capture the gas which is then refined to remove impurities and get the pure form. This gas can be used to move turbines to produce electricity, this electricity can be used to power houses and businesses. Methane can also be used to fuel vehicles which operate on compact natural gas. Landfill gas capture and utilisation has the potential to be an effective way to produce energy from landfill sites along with reducing the air pollutants released from these areas. In the city of Tianjin in China, landfill gas capture project was set up to capture the landfill gases and use it to produce electricity (ESMAP 2009).

Policy Recommendations

The current policies related to landfill management are good, but it is necessary to make its enforcement strict and also amending them to improve the condition of landfill sites in India. Some policy recommendations which can be considered are as follows:

1. Increasing the number of wastes to energy plants in India: Even though they are a bit expensive, using them properly and efficiently can help solve the issue properly. The government may consider encouraging waste to energy units as they are sustainable and help in the reduction of waste and convert harmful wastes into usable energy. Increasing the process of waste to energy can eventually help the environment by decreasing methane emissions.
2. Banning the use of plastic: Plastic has been used by the world since decades, but not only does it gets decomposed for 1000 years but also produces toxic gases when burnt in open air. There are several laws related to the ban of plastic, but their enforcement is not proper. The government may consider enhancing the enforcement towards banning the use of plastics.
3. Proper Mining Machines: For mining landfills, we need proper mining technology which will mine the waste in such a way that resources can still be extracted from it. The government may consider giving contracts to private companies for supplying this technology to the government. Along with mining technology, a proper segregation technology is also very important. To remove magnetic wastes like iron and nickel, powerful electromagnets can be used.
4. Landfill gas capture and utilisation: The government may consider encouraging landfill gas capture project which are established to capture the landfill gases and use it to produce electricity. This will reduce environmental degradation.
5. Public awareness: The government may consider working towards creating public awareness and education related to the landfill sites. This will create public education and result into enhanced participation by the community in this issue to ensure that community concerns are taken into account. Further, people living near the landfill sites should be made aware of possible risks so that they can make their choices properly and take proper protective measures.

Conclusion

Improper landfill management can cause environmental degradation which includes groundwater contamination and ozone layer depletion. Methane is a prominent gas which is released from landfill sites and this gas causes air pollution tremendously. The contaminated water from the landfills, known as leachate, seeps down the soil to reach the water table and contaminates the groundwater. It is thus very necessary to get an alternative of landfills or establish a proper system of landfill management in India. Landfill gases like methane can be captured using technology and converted into usable forms to supply fuels for vehicles. The waste from the landfill areas can be mined to reduce the high levels of waste in the landfills which will increase its shelf life. This waste can be segregated, and some waste can be used to generate energy, which can be used to supply power in nearby areas. This paper lists some suggestions which can be used to solve the issue, but it is important that work towards landfill management is expedited to solve this problem and for stopping further environmental degradation which will eventually save our environment.

References

1. Aditee Das. (2020, September 5). Indian landfill: The Ultimate Trash Kingdom. . Times of India Blog. https://timesofindia.indiatimes.com/readersblog/environmental/indian-landfill-the-ultimate-trash-kingdom-25565/
2. Balakrishnan, C. (2023, May 8). The Failed Ideas of Waste to Energy Plants in India - Centre for Public Policy Research (CPPR). Centre for Public Policy Research (CPPR). https://www.cppr.in/articles/the-failed-ideas-of-waste-to-energy-plants-in-india#:~:text=At%20present%2C%20there%20are%2012,report%20of%20CPCB%20(2021)
3. Crown. (2019). Methane General Information. United Kingdom: Crown. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769766/Methane_PHE_general_information__070119.pdf
4. DH News Service. (2014, July 9). Illegal dumping sites thriving in City: Study. Deccan Herald. https://www.deccanherald.com/content/418865/illegal-dumping-sites-thriving-city.html
5. Drechsler, M. (2023b, January 9). Carbon Dioxide Narcosis. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK551620/#:~:text=Carbon%20dioxide%20(CO2)%20narcosis%20is,%2C%20hypoventilation%2C%20or%20environmental%20exposure
6. ESMAP (2009). Good Practices In City Energy Efficiency: Tianjin, China - Landfill Gas Capture For Electricity Generation. Washington DC: Energy Sector Management Assistance Program. https://www.esmap.org/sites/default/files/esmap-files/Tianjin_Case_Study_033011_coverpage.pdf
7. Gandhiok, J. (2022, April 28). 3 landfills have cost Delhi ₹450 cr in environmental damages: Study. Hindustan Times. https://www.hindustantimes.com/cities/delhi-news/3-landfills-have-cost-delhi-450-cr-in-environmental-damages-study-101651172851899.html
8. Mohan, V. (2018, July 31). Across India, high levels of toxins in groundwater. The Times of India. https://timesofindia.indiatimes.com/india/govt-body-finds-high-levels-of-groundwater-contamination-across-india/articleshow/65204273.cms
9. Wagner, T. P., & Raymond, T. (2015). Landfill mining: Case study of a successful metals recovery project. Waste Management, 45, 448–457. https://doi.org/10.1016/j.wasman.2015.06.034