

How to Cite:

Rao, C. N., & Sujatha, M. (2022). Landfills: A socket of wastes in the lap of the nature. *International Journal of Health Sciences*, 6(S3), 8749–8759.
<https://doi.org/10.53730/ijhs.v6nS3.8102>

Landfills: A socket of wastes in the lap of the nature

Chandana Narasimha Rao

Department of Engineering Chemistry, College of Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, AP, India

M. Sujatha

Associate Professor, Department of Engineering Chemistry, College of Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, AP, India

Abstract---Wastes generated in any part of the globe or in a country like India would definitely need to be understood about the waste and the impact that it brings to the environment or the human kind in its disposal. In this review more of the understanding is levied on the concept of waste and its purpose to reach the landfill as a final or the only option to non-degradable and non-recyclable waste materials. Strict adherence to the basic understanding of waste and its sorting and its disposal has to be on compliance with the environment and its safe keeping policy. It is necessary prospect to dispose the wastes only after careful sorting, distribution and disposal of wastes at landfills. Green technology is the ultimate need in approaching towards the feasible and safe approach to waste management disposal and its management of landfills is by seeking solutions which are environmentally and ecologically balanced system. Reducing, Reusing and Recycling are the core strategies to go technologically before placing these wastes in the modern and highly advanced landfills. Research is aimed to move towards a “zero-waste production” and “waste reduction” which aim at reduction of gaseous emissions, solid residues, and pollution which are contributing to the protection of climate and its environment.

Keywords---waste, landfills, novel approaches, hazardous.

Introduction

Wastes that's not recycled or that cannot be reused is need to disposed. Such unnecessary wastes are accumulated as landfills. Landfills are sites prepared in open land areas as empty sockets by quarrying for filling up of wastes into these

empty sockets. These landfills are processed to reclaim land. Landfills are existing in many parts of the world as waste filling grounds. In most of the under developed or developing countries these wastes are left to ground and are even piled up in uncontrolled positions. Most of the accumulated wastes are of household or commercial wastes and are even of the debris obtained from the civil construction demolitions. Consumption of wastes in human existence and living is non-avoidable. Countries like India alone generate around 62 million tons of waste each year. In this 12 Million tons is treated in various forms and the remaining wastes around 31 Million tons ends up in landfills.

Waste generated by humans in any country is unchangeable and it is destined for human to face till he exists. Most of the waste has come out from houses and commercial establishments. Few of these are organic and can be composted. Rest are non-degradable wastes. Mostly these type of wastes are generally termed as solid waste that are in municipal limits of habitation. These may include non-hazardous household and commercial wastes. Wastes that fill up the majority of the landfills like soil, concrete or brick rubbles are said to be inert wastes. These inert waste are just wastes that are safe in any landfill as they do not react with any of the other wastes and make it safe to be filled in any of the landfills. Any of the landfills that are filled with inert wastes and covered up then when its full can be reused or reclaim as a land for repurpose. Still some restrictions apply in reusing the inert waste filled landfills.

Landfills are meant to see that the contaminants do not the balance of environment or its water streams around. These waste store mines cannot be built in any sensitive locations of localities. At same time these landfill are equipped and monitored round the clock to check for any ground water contaminations or for landfill gas exposures. Landfill capacities can be varied based on the type of waste being filled and volume of the waste being landfilled can take upto years to reach its max capacity. Once the capacity is full a final layer of clay, cover material and vegetation is capped. This capped layer is one type of barrier on landfills and this layer keeps out the odours and rainwater. Basic purpose is to make a future restoration of land for light vegetation or recreation. Landfills are managed in a prospective means to make it as a part of integrated waste management. This is because landfills round the world are common grounds for solid waste disposal. Non-managed landfills can cause the land to become areas of land pollutions and uncontrolled building up of different kinds of solid wastes.

Methodology

Pit like area and engineered to take solid wastes as layers over layers are laid to compact and cover for a final disposal. Pits are bottom lined to guard the ground water sources being polluted by the wastes or its leachate. Complete setup of the landfill consists of leachate monitoring vent and treatment system, monitoring system for ground water samples, extraction of gas and cap over the system. Planning of landfill sites capacity and the site is based on the risk assessment done on the location and its feasibility. Especially the landfills are designed to promote anaerobic type of biodegradable process from the organic waste to produce the biogas while conducting the inline monitoring of the oxygen levels

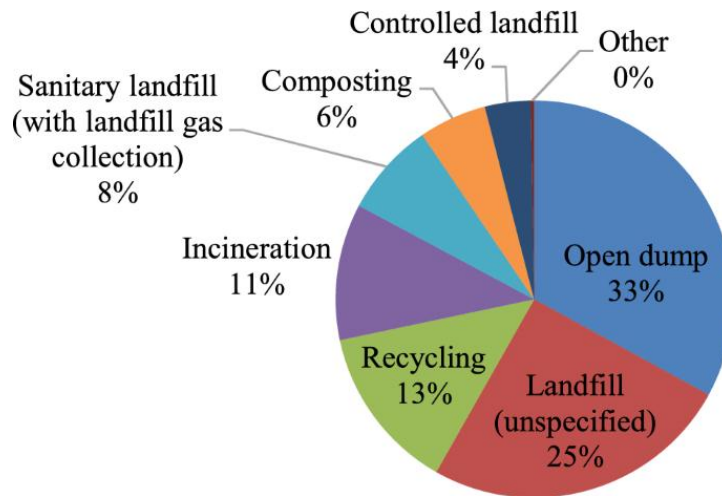
and its moisture content. Expertise management with skilled operations can provide a guaranteed functionality of the landfills as per the expected form of designs. In general collection of wastes from the urban locations they are sorted out and transported to designated areas of landfill wastes. Municipal solid waste would also receive other types of wastes related to non-hazardous, wastes, sludge, and industrial solid wastes. In general, the landfills are segregated in plain landfills into 3 types. , They are simply outlined as landfills, sanitary landfills and incineration pits.

Landfills or landfill sites

Landfills are in commonly located in or near urban areas with large quantities of wastes are being dumped in common areas of the locations. This type of landfill is not of open dump type but it has a pit dug into the ground. So the garbage after being dumped into the pit, it is then covered in a way to prevent the breeding sources of for rats and flies. On day to day process, at the end of day soil layers are scattered over the top and heavy machinery like earth movers to compress the garbage which on later becomes a cell form. Finally once the landfill is full thick layer of soil is filled and later handed over to develop a multi-function parking lot or park type land reclamation. Problems do occur in landfills. Water when seeps through this landfills it gets contaminated which in turn pollutes the surrounding water bodies. This process of contamination is called as leaching.

Sanitary type of landfills

Alternate type of landfills are designed to solve some complex issues like leaching in the sanitary landfilling process. This landfilling is quite hygienic in nature and methodical in manner of operations. Some impermeable wastes like plastics or clay are used as lining materials. This landfilling is later built over impermeable soil. Sanitary landfills are costlier construction works and have their own issues or problems in construction. Assumptions occur around plastic linings being cracked as time passes by which is considered to react with various other chemicals present in wastes. Sanitary landfills are having variable decomposition rates. As the garbage gets tight compression which later restricts the availability of oxygen for decomposition. Even some degradable materials do not decompose in a landfill. Major problem of methane gas generation occurs when little quantities of oxygen occurs due to anaerobic reaction. Methane generated in sanitary landfills is suitable for tapping and supply as commercial gas in piped deliveries.



Incineration or firing plants

Waste burning in large receptacle is termed as incineration. Recyclable materials are sorted out and the remaining material is burnt in these receptacles. Ash left in these containers after the complete burning process is filled with toxins like dioxins and other heavy type metals, Even fly ash is also obtained in this burning. Ash left in this burning procedure if dumped in landfills they leach down the area and cause a contamination of severe effect. Incineration procedure is not permissible as this procedure produces high toxin content of ash and it pollutes the water and air. There are chances that some of the materials that are burnt are recyclable or recoverable. So incineration is the final option after landfilling and it's mostly used for treating the waste that is infectious type. Landfill main purpose is to bury the waste deep down in an isolated way far away from reaching the ground water sources. In simple they keep it dry and do not let the material come in contact with air. They are designed to keep the trash away and do not allow it getting decomposed quickly. Landfills process is known but the brief information about its constructions and the components involved in being a part of the design are detailed below.

Basic parts of landfills are

- Bottom Liner Layer: Layer separating the leachate from ground water sources.
- Cells – Trash being stores in the landfills
- Rain Drainage system – Water collected during rains over landfill areas.
- Leachate layer - Water percolated all through the landfills area do contain the substances that are contaminated.
- Gas Collection System: Methane gas is collected while the breakdown of trash occurs.
- Cap Layer: Landfill top layer is been sealed by the covering.

Detailed outline of the parts in Landfills are

Bottom Liner Layer: One of the biggest challenges in landfills design and construction is contain the complete trash within the designed area. Basic purpose is to avoid trash creating any problem to environment. Bottom layer restricts the wastes getting in contact with the outside soil specifically with ground water sources. Layer is of durable material and puncture proof synthetic plastic. Usually they are ranging between 30 -100 mills thickness. Plastic lining also becomes a layer with compacted clay soil forming another layer with durability in resistance for tear. This enables to avoid any punctures occurring from gravels or rock.

Cells

Airspace availability in any landfills gives the life of usability in landfills. Increasing the air space could increase the usability life of landfills. So trash is getting compacted in areas as cells which accommodate the whole days trash collection. Heavy equipment are used to compress the trash. Cells arranged in rows or layers for adjoining cells. Along with compressing trash as cells or space is covered and excluded bulky wastes such as carpet, foam, yard waste and so on from the landfills.



Rain Drainage System

Landfills are needed to be put in dry condition to avoid leachates or reduce the amount. Condition to fulfil this prospect is to see that the solid waste remains dry. Tests are required to be done to solid wastes that are being for liquid before entering the sites of landfilling. Process is conducted by passing samples of waste through standardized paint filters. If liquid doesn't appear on the sample that comes after 10 min outside then the waste is acceptable to landfills area. Rain water needs to be out of the area. So landfill is built with rain water drainage system. In all this the water passes around the landfills in channels and gets ditched in the base. Water collected in ponds are used to check when the solid

particles settle down then the water is tested for leachate chemicals content. If water passes the test then it is allowed to flow out of the site.

Leachate Layer

Water that percolates in the landfills through the trash which picks up contact with organic / inorganic chemicals or metals that has dissolved contaminants and is collected as leachate in the leachate layer. Collection of leachate is done by the perforated pipes that run through the landfill. This leachate flows to the collection point of leachate layer. This leachate is tested for permitted to test for confirmation of the content and its margin levels. This treated leachate is treated like any other sewer waste water. This treatment occurs at site or out of site. Recirculation of leachate for later process of treatment increases the contamination but reduces the leachate volume.

Gas collection System

Anaerobic reaction occurs in landfills and breaks down the trash in absence of oxygen. This is because it is airtight. So the by-product is methane gas from this landfill. Along with methane Carbon Dioxide also gets generated along with nitrogen and oxygen. In order to decrease the explosions due to gas they are collected using pipes and supplied to suitable sources of methane sales operations. Similarly this trapped methane gas is also used to generate electricity on small or large scale. This is also another form of benefit from landfills.

Cap Layer

Cell cover that is covered daily as compacted soil is layered by heavy machinery compaction. This avoids the pests intruding into the trash compacted cells. Once the capacity is full a final layer of clay, cover material and vegetation is capped. This capped layer is one type of barrier on landfills and this layer keeps out the odours and rainwater. Basic purpose is to make a future restoration of land for light vegetation or recreation. Usually vegetation of small herbs type are allowed for growing over the layers. There are some rare chances of leachate seepage through the weaker points of the coverings. So suitable repair works enable to excavate the area around seepage and fill back with compacted soils on the surface. Ground Water monitoring process: Places around the landfills are distinguished for monitoring the water quality in these places. Suitable pipe channels are run to ground water sources. Water from these pipes are tested for quality and contamination of leachates. They are calculated based on temperature and leachate leaking.

Limitations

Landfills as a final waste disposal system in India or in any part of the globe do have few limitations that are considered before choosing for waste disposal. In brief the limitations are detailed as below.

- Landfills are a cause for soil pollution.
- Landfills lead to ground water pollution due to leachate

- Natural habitation decrease or destruction of habitable environment
- Endangerment of the ecosystem or its species
- Pollution of air
- Toxic fumes and the odour around the landfill area.
- Landfills are the breeding grounds for bacteria or any such microorganisms.
- Deforestation.

Discussion

Serious Causes of Landfills

- **Solid waste**

Solid Waste is foremost a contributor of landfill wastes as a disposal daily. Various habitations and commercials are the contributors or wastes generation that are generated at great deal in quantities daily. Most of these as disposal end piling up in the landfills. Solid wastes like wood, paper broken furniture, glass, electronic products and many such end up in landfills. These as non-degradable wastes lie as heaps in landfills for years. Improperly managed wastes disposal processes damage the land and the environment around.

- **Agricultural waste**

Agricultural disposal that's generated from the animal manure, farm leftovers and crops. All these collected wastes are dumped in landfills which are of high toxic levels and have the potential to contaminate land or water sources. These wastes in landfills for years can impact the quality levels of soil and the land.

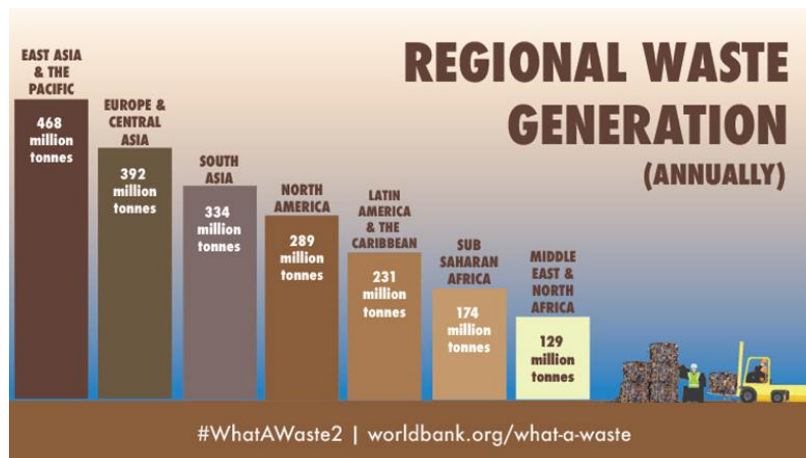
- **Industry, manufacturing, and construction waste**

- **Industrial wastes** such as the by-products obtained from constructions, power plants and industrial process. Most of the dominant products are disposed from oil refineries, civil works, pharma process units, power plants and other agricultural product manufacturers. All these are directly dumped into landfill sites.

Petroleum and hydrocarbon byproducts from oil refinery units, construction firms dispose wood, plastics and other metal wastes. Manufacturing and power generation companies have a regulated work still the wastes disposed from these companies are being piled up in the landfills.

- **Urbanization and population growth**

Increasing in population and the urbanization of the countries there is an ever growing requirement for products and the need for materials do increase as population grows. With this increase in consumption there is lot of disposal of solid waste by this increased demand. Among the disposed wastes the plastic pollution is of major contribution in wastes and they simply get piled up in landfills. Plastic has been of nearly 80% of the wastes collected by municipalities in India.



Drastic Effects of Landfills

Air pollution and atmospheric effects

Increased landfills have created diverse effects like increased temperatures in urban and global wide. Apart from gas like Methane there are products from household and other agricultural chemicals have been disposed to landfills that resulted in generating the toxic gases by the bleach and ammonias impact in landfills. Non-Chemical fumes, particulate matter and dust could be contaminating the quality of air and atmosphere within the vicinity of the landfills.

Ground water pollution

Leaches is the main issue in contaminating the ground water sources around the landfills. Large quantities of hazardous wastes would have been piled into the landfills and these would be the unavoidable cause for the natural reason in deteriorating the quality of the ground water source around. Products that are the reasons for toxicity are the industrial solvents or household cleaners. Apart from these there are wastes that generate heavy metals like lead, cadmium or mercury from the electronic wastes. High probability of these toxins can infiltrate the soil in reaching the sources of fresh water, with a possibility of reaching our households and our foods by leachate to water ways. These are efficient in polluting the animals and the plant life. Most of the studies or survey state that near 82% of the landfills have leaks and dominant leachate impact.

Health effects

Vast studies related to the impact of landfills on the lives of people inhabiting around or near the landfill areas are facing severe implications in health such as defects at birth, low weight during birth and certain types of cancers. Carcinogen type of element which is the resultant of landfill leachate is being reported in these studies. Also other symptoms like dizziness, headaches and fatigue is observed in these people. Effects that are observed in the people are due to the toxic impact of chemicals that are available in landfills waste. Contamination of

air with such harmful gases and also same with water sources. Outcome of these is quite adverse in health effects. These are also related to the lungs and heart diseases as well.

Soil and land pollution

Ecosystem around the landfills is disturbed due to the negative impact of wastes leachate and toxic chemicals effect on the soil surrounded which spread overtime to nearby land areas. Soil fertility and the plant life activity is disturbed due to damaging effect on the soil by the landfills wastes. Landfills even deteriorate the quality of the soil and nature around the landfills and its surroundings

Economic costs

Management of the landfills is highly cost elevating process. Managing the operations of gas trapping process onwards to water sources contamination control management with a safety compliance with the environmental control policies. All this process would drain lot of capital out of the municipality tax payers money in the name of waste management. Nearly In these landfills most of the wastes dumped would take nearly millions of years just to decompose. So to devise new and effective strategies for managing landfills would require high amounts of investments in relation to the processes of recycling opportunities.

Landfill fires

Landfills are a source of highly flammable gas that can go out of control if not handled cautiously. It's a major challenge to put out these fires and they could further damage the air by pollution. These fires are a threat to the people living around the landfills and its reachable neighbourhoods. Methane a by-product from these landfills is combustible gaseous substance and is of a great threat once the gas catches fire. Higher volumes of methane in any of the landfills pose a danger that cannot be contained easily if the gas is not channelled out of the landfills trap.

Impressive Solutions of Landfills

Design and implementation of integrated waste management

Landfills construction in modern times with advanced technologies and a planned disposing facilities would significantly reduce the impact of landfills on soil, air and water. Landfills are designed and planned to be operated with compliance to environment preservation and to keep the environment free of contaminants. Design or construction of landfills are placed in locations that are not environmental sensitive and are under round the clock monitoring system. The monitoring system on landfill sites would be on high alert for possible detection of groundwater contamination and any such variations can be detected.

Reduce, Re-use and Recycle

New initiatives should be used to recover old products instead of piling up new products in landfills. Landfills will surely be a major environmental issue unless

and until the communities take up roles to reduce, reuse and recycle the wastes in every possible way. Demand increase of plastics by humans has placed more load on landfills and their costs in maintaining them. In this context of consideration the wastes have can be reduce the effective accumulation in landfills. Reduce the demand for manufacturing new products and accepting the concept of reusing can do a great favour of reducing the volumes of waste and toxicity ending up in landfill. Favoring the art of using the manufactured products till the life span of the product would mean a lot to the burden of landfills. These can be detailed into the following simple options:

- **Think before consuming:** Purchase the things only after doing a quick thinking, Consider to do the buy only if the need is unavoidable and use it wisely without hindering the nature and its greenness.
- **Limit Wastage:** Avoiding the unwanted expenditure would put a break on our draining wallets. Spend on what is needed and on that which saves the nature and preserves the environment. This conscious mind in considering the environment and its nature would establish a meaningful manufacture of products and its distribution. This would do a clean work of reducing the demand for new productions.
- **Reuse of products:** Reuse products which we already have in possession which reduces old wastes reaching landfills. Consider buying used items from any possible sources that offer second hand materials in affordable prices and do the favour to nature by donation of the materials that are of no use to the users.
- **Recycling of materials:** Recycling is the most favourable solution to avoid wastes reaching landfill or its management. Materials like plastics, paper, cans, and glass can be recycled.

Future Scope

Modern technologies with consideration of nature and its safekeeping would give rise to a conscious mind-set in humans to think before buying any new products but enable the desire to reach the reusable product. Initiatives to consider or adapt policies that allow reduction , reusing and recycling the waste instead of disposing the waste to landfills.. Insulation of the landfills and its pits would stop all processes in landfill. Membranes of these landfills that have a life span of 50years and these could even sustain a life upto 500years. Any disruptions or failures in the landfills would result in starting the emission generating process once again leaving the potential emissions to future generations. Sustainability can be received by exploring and implying safe solutions. It details the concept in a society that desires or allows a sustainable development which need long term sustainable landfill. On long term time horizon, landfilling could transform a troubling share from waste to a short time span of gas generation and unending supply of carbon. Even the aftercare of landfills would promote the green vegetation which in return adds to new horizon lot of opportunities that would include the betterment conditions for new opportunities.

Conclusion

Based on the discussion or consideration, we can opinionate that most countries are considering landfilling as most dominating method in municipal waste managements, Landfills in procedures is considered to be the main methods in disposal. Monitoring round the clock in identifying and detailing the hazards associated in landfills. This review show the necessity of knowing the knowledge gaps and also establish suitable bases in developing the landfill analysis. In respect to the ongoing conditions and the lifestyles where a rich type standard that are adopted by reducing the wastes , proposal to reuse and also recycling the wastes in which some waste materials is always routed to the disposal of wastes in Landfills. Finally the concept in sustainable landfills are needed to implemented, as a true sustainable landfill of which the waste materials are slowly and securely assimilated to environment around.

References

- Australia, S. (n.d.). *Environment Protection Authority Environmental management of landfill facilities Solid waste disposal*.
https://www.epa.sa.gov.au/files/4771343_guide_landfill.pdf
- Kumar, S., Smith, S. R., Fowler, G., Velis, C., Kumar, S. J., Arya, S., Rena, Kumar, R., & Cheeseman, C. (2017). Challenges and opportunities associated with waste management in India. *Royal Society Open Science*, 4(3), 160764.
<https://doi.org/10.1098/rsos.160764>
- Municipal Solid Waste Landfills Economic Impact Analysis for the Proposed New Subpart to the New Source Performance Standards*. (2014).
https://www3.epa.gov/ttnecas1/docs/eia_ip/solid-waste_eia_nsps_proposal_07-2014.pdf
- Ozbay, G., Jones, M., Gadde, M., Isah, S., & Attarwala, T. (2021). Design and Operation of Effective Landfills with Minimal Effects on the Environment and Human Health. *Journal of Environmental and Public Health*, 2021, 1–13.
<https://doi.org/10.1155/2021/6921607>
- The World Bank. (2018, September 20). *What a Waste: An Updated Look into the Future of Solid Waste Management*. World Bank.
<https://www.worldbank.org/en/news/immersive-story/2018/09/20/what-a-waste-an-updated-look-into-the-future-of-solid-waste-management>
- Vaverková, M. D. (2019). Landfill Impacts on the Environment— Review. *Geosciences*, 9(10), 431. <https://doi.org/10.3390/geosciences9100431>