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DISPOSAL OF MUNICIPAL SOLID WASTE AND ITS IMPACTS – A REVIEW

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ABSTRACT

Municipal solid waste (MSW) is commonly known as garbage, which consists of everyday items we use and throw away, such as food, paper, plastics, glass, wood, leather, metals, textiles, paints, cloth, batteries etc. This type of garbage comes from our houses, offices, educational institutions, hospitals, and businesses. India produces 277 million tons of MSW every year, according to a 2016 estimate. That's more than 80% of the 334 million tons of waste generated across the South. Whereas, in 2010, 250 million tons of MSW were generated in the United States. Globally, about 71 percent of MSW are disposed of in landfills (Aldriana & Elaine, 2003). Studies show that landfill is the most popular destination for solid waste, by a wide margin. The majority of landfills throughout the world send their trash/garbage to the dump. The testing of groundwater is important to determine whether waste materials have escaped from the landfill. The storage of any waste material in a landfill poses potential problems. One problem is the possible contamination of soil, groundwater and surface water that may occur as leachate produced by water or liquid wastes moving into, through and out of landfill. The purpose of this review paper is to focus on the adverse effect of dumping of municipal solid waste (MSW) at disposal sites on groundwater quality. The groundwater gets contaminated/polluted and causes certain water borne diseases.

KEYWORDS: *Waste, Landfill, Groundwater, Municipal, Pollution.*

INTRODUCTION

Groundwater occurs below the surface of Earth, where it occupies all or part of the void spaces in soils or geologic strata. It has extensively been used as one of the prime sources of the drinking water supplies in the developing world. It is generally considered as the safest water source as far as pollution is concerned. It was reported recently due to an increase in unplanned urbanization without any adequate provision for issues like waste generation and dumping problems which stress on the groundwater (Asef & Gupta, 2009). In India, the problem of uncollected solid waste obstructs storm water runoff, resulting in the forming of stagnant water bodies. Solid waste generation (SWG) is problematic and is an issue of concern everywhere in the world, particularly in all urban centers. Such SWG is considered one of the most challenging issues faced by most developing countries that suffer from severe environmental pollution problems caused by the large quantities of SWG (Khatib *et al.*, 2010). The waste dumped solid waste may cause contamination of the water body or the groundwater source. The water, which already presents in the waste, generates with the biodegradable waste or due to the infiltration of water by rainfall. This water which generates or occurs due to that process pours in the soil and causes contamination with groundwater (Nandwana & Chhipa, 2014). In India the major source of domestic, agricultural and industrial is the groundwater. Almost 61 percent of the needs are fulfilled with groundwater, 29 percent from canals, 5 percent other resources (Abbasi & Vinithan, 1999). The sources for groundwater supply mostly depend upon the rainfall and the resulting percolation of the water in the Earth, another important factor is the type and quality of the soil (Adoni & Joshi, 1987). Grzegorz (2019) findings show that the increased values of Cd, EC, and TOC may have a negative impact on the groundwater quality below the landfill. Many researchers have investigated the impact of landfill sites on the quality of groundwater (Dhere *et al.*, 2008). The risk of pollution of the groundwater by the contaminated liquid from the landfill sites is considered to be the most significant risk for the natural environment and human health related to the waste (Kjeldsen & Christophersen 2001; Deshmukh & Aher 2016).

Discussions

Landfilling is one of the oldest and common methods of municipal waste disposal throughout the world. This is most likely to remain the ultimate fate of solid waste since it appears to be one the cheapest ways (Britz *et al.*, 1990). Studies show that once disposed of in landfill, solid waste undergoes various physico-chemical and

biological changes. Landfill is one of the most popular and extensively used methods for the disposal of more than 90 percent of MSW (Idris *et al.*, 2016). It was also reported that there is a direct relation between the solid waste composition and the social activities in the community (Gidarakos *et al.*, 2005). Consequently, the degradation of the organic fraction of the wastes in combination with percolating rainwater leads to the generation of a highly contaminated liquid called leachate (Kurniawan *et al.*, 2006). Pushpendra *et al.*, (2012) reported, the groundwater from the landfill area shows fluctuating readings and the water was contaminated. Solid waste is an important environmental problem in both developing and developed countries. Management of Municipal Solid Waste (MSW) is one of the main modern environmental issues in municipal areas (Shuokr & Amin, 2016). The landfill leachate creates long-term impact on the surrounding environment and public health since it contains substantial amounts of dissolved organics, xenobiotic organic compound (XOCs), inorganic salts, ammonia, heavy metals and other toxicants (Ponznyak *et al.*, 2007).

1. Current situation of dumping problem in Indian Cities

In recent years, India is facing the problem of exponential population growth, high density of urban areas, diverse culture, changing lifestyles, varying outlet solid wastes from Municipal corporation, Industries, Human communities etc., creating Sevier problem of dumping. Consequently, the municipalities have been facing many other issues related to the collection, treatment, and management of solid waste (Akhilesh & Avlokita, 2020). India, with a population of approximately 1210 million, the urban population is more than 377 million constituting 31.16 percent of its total population (Census of India, 2011). As per the World Bank estimates urban India produces approximately 100,000 MTs daily or approximately 35 million MTs of MSW annually by the year 2020 (Hanrahan *et al.*, 2006). The municipalities with such rapid rate of urbanization, facing an extra burden and environmental prospects owing to migration and depletion of natural resources (Gerdes & Gunsilius, 2010). In general, Indian MSW contains more organic material and less hazardous material than western countries like USA, Canada etc. (Gupta *et al.*, 1998). The quantity of plastics, rubber and leather contents are lower than paper. As per the central pollution control board (CPCB) of India, the per capita waste generation has increased at an exponential rate (0.26 kg/day to 0.85 kg/day) (CPCB India, 2018). Ahluwalia (2018), estimated that approximately 80 percent to 90 percent of the municipal solid waste is disposed-off in landfills without proper management practices (Ahluwalia & Patel, 2018). In India, approximately 143,449 MT of MSW is being generated daily, out of which around 111,0000 MTs collected, and about 35.602 MTs are treated (Kumar *et al.*, 2017). The typical rate of increase in MSW generation in Indian cities is estimated around 1.3 percent annually (Shekdhar, 1998). Imura et al., reported., that in developed countries generation of solid waste is more than developing countries. In the past years, these elements of waste management were often regarded only from an engineering and technical viewpoint. Management of MSW continues to remain one of the most neglected areas of urban development in India. Piles of garbage and wastes of all kinds littered everywhere have become visible in urban life (Dimpal, 2012). Most of the urban local bodies in India experienced that, solid waste is a major concern that has reached alarming proportions requiring management initiatives on a war-footing.

Fig. 1: ***Top 10 Indian cities generates MSW annually*****.**

2. Leachate interaction with hydrologic cycle

The leachate from Municipal Sewage Waste (MSW) landfills may leak into groundwater aquifers due to rainfalls, and spread into the adjacent river system by groundwater flow and pollute the surrounding environment. When MSW is dumped on land, it becomes part of the hydrological cycle. During rains and runoff of water from the surface of waste, the water infiltrates into the waste and numerous contaminants are taken from the waste to the adjacent areas as well as the strata below the waste by the action of the percolating water (Dutta & Gayanthri, 2011). However, this process is long term and does not stop even after the landfill activities have stopped receiving solid waste. The nature of landfill leachate depends on the MSW being dumped, landfill age, moisture content, seasonal weather variations, site hydrology, the stage of decomposition in the landfill and pH. Some of the problems associated with polluted environments include leachate, which contaminates both land and surface waters, with emission of methane (CH_4) and other gases. The adverse impacts of landfill leachates on adjacent surface and groundwater have prompted a great number of studies since 1980. The investigation of Zheng *et al.*, (1991) on the leachate intrusion in the groundwater showed pollution of groundwater. The generated leachate may be characterized as a composition of water-related solution of four groups of ingredient contaminants: dissolved organic matter (acids, aldehydes, alcohols, sugars etc.), inorganic macro components, heavy metals, and xenobiotic organic compounds such as halogenated organics (Wiszniowski *et al.*, 2006). The environmental pollution and

harmfulness of leachate are mainly due to *odor* (lot of carbohydrates & nitrogen compounds in leachate), *organic matters* (aerobic organic matter), *pathogenic microorganisms* (bacteria, viruses and pests, mosquito), *heavy metals* (Hg, Cd, Cr, Pb etc.). The municipal landfill leachate also contains significant quantities of hazardous chemicals (Zhao, 2018). Despina *et al.*, (1999) recorded high levels of TS, COD, NH3-N, PO4, SO4 2-, K+, Fe and Pb in landfill leachate samples.

Problems caused from leachate: After percolation from landfills leachate pollutes the nearby water sources unusable for consumption. Health effects could be from an acute/short exposure, or long-term chronic exposure to leachates from landfills. Medical literature reports that leachate contaminated water can range from *sweating, bleeding stomach disorders, to blood disorders, congenital disabilities* and even *cancer.*

3. Landfill's planning

The term landfilling is used to describe the process by which solid waste is placed in the landfill. Pursuant to MSW Rules 2000, the municipal authorities in India are required to construct sanitary landfills for the disposal of solid wastes (Da Zhu *et al*., 2008). Landfilling is one of the most common methods of waste disposal. It is also one of the most significant sources of groundwater contamination. Globally, about 71 percent of MSW are disposed of in landfills (Aldriana & Elaine, 2003). A landfill is a facility for the disposal of waste materials by burial and is the oldest form of waste treatment. According, Rules 2000 state that waste should be disposed of in engineered landfills and never in open or unsanitary dumps. Historically, landfills have been the most common methods of organized waste disposal and remain so in many places around the world (Dutta & Gayanthri, 2011). Landfills are well-engineered facilities that are located, designed, operated, and monitored to ensure compliance with federal regulations. Generally, landfills are classified into three classes: i) *Open dumps or unsanitary landfills* ii) *Semi-controlled or monitored landfills* and, iii) *Sanitary landfills*. The solid waste landfills must be designed to protect the environment from contaminants which may be present in the solid waste stream. The landfill siting plan prevents the siting of landfills in environmentally sensitive areas (Jay *et al*., 2016). The groundwater monitoring system at the site may play an important role to collect the potential information of groundwater contamination.

The aim is to avoid any contact between the waste and also the encompassing atmosphere, significantly the groundwater. Landfills are classified into 3 classes, which are:

i. Open dumps or unsanitary landfill, that may be low lying area or natural area where there is no measure has been taken for collection of leachates as well as gas emissions. Such landfills are present in maximum number in developing countries.
ii. Semi-controlled or monitored landfills, in these sites disposed wastes are compacted and waste dumps are covered by topsoil layer so as to reduce nuisance. Generally, all kind of wastes are dumped without segregation such as municipal, medical and industrial etc. Collection systems for leachates and gas emissions are also not present.

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iii. Sanitary landfills unicipal solid waste landfills (MSWLFs) receive household waste. MSWLFs can also receive non-hazardous sludge, industrial solid waste, and construction and demolition debris. Modern landfills are well-engineered facilities that are located, designed, operated, and monitored to ensure compliance with federal regulations.

Solid waste landfills must be designed to protect the environment from con-taminants which may be present in the solid waste stream. The landfill siting plan prevents the siting of landfills in environmentally-sensitive areas while on-site environmental monitoring systems monitor for any sign of groundwater con-tamination and for landfill gas, and provides additional safeguards. In addition, many new landfills collect

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4. Reduce, Reuse and Recycle

Developing countries, including Brazil, Russia, India, China and South Africa (BRICS), are implementing mitigation strategies for greenhouse gas (GHG) emissions in specific sectors, such as municipal solid wastes (MSW), to reduce the impacts of climate change. The key is to only purchase goods that we need and in the right amount (Fahzy, 2014). Each year, the trash is generated in the form of packaging, bottles, boxes, cans, furniture, clothing, and more. Significant energy and resources are consumed in production, transportation and disposal of this waste stream. We can reduce the amount of solid waste by following some basic principles of reducing the amount of waste.

Reduce
✓ Use reusable bags instead of single-use plastic bags
✓ Select items with limited or no packaging
✓ Use a refillable container for water in place of bottle water
✓ Recycle paper and cardboard
✓ Set a goal for reducing the amount of trash

Reuse
✓ Use packaging materials & ways to reuse items
✓ Use of cloth napkins & plates instead of paper
✓ Use of compost fertilizer for garden plants
✓ Use remolding technology instead of new
✓ Use to re-construct technic instead of purchasing new

Recycle
✓ Make it habit to separate out all items that are recyclable
✓ Use old appliances for any repair
✓ Use own created compost pile instead of chemical fertilizers
✓ Buy recycled-content, equipment & tools

Fig. 2: *Principles of MSW reduction.*

A lot of the things that people trash can be recycled. Some prime examples include paper, newspaper, cardboard, aluminum, steel cans, glass plastic motor oil, organic waste, and scrap metals. Use of varied recycled and compost waste varieties soil surfaces might lead to eutrophication i.e., fulfilling the various nutrient demands such as nitrogen phosphorus saturation same as that fulfilled by fertilizers (Shobhit & Surinder, 2017).

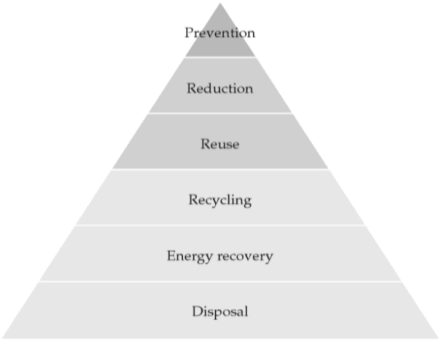

Fig. 3: *Waste Management Hierarchy* (Source: Sandec).

5. Public awareness methods

India, like most developing countries in the world, is faced with problems of solid waste management. Studies show that all kinds of wastes, regardless of their nature, simply dumped indiscriminately into depressions, at

different dumping/non-dumping sites, without due regards to the nuisance and harm caused to the environment. According, Ardoin *et al.*, (2020), environmental education is more than the unidirectional transfer of information, enhancing environmental attitudes, awareness, knowledge and skills for an affirmative environmental action. To sustain solid waste issues in developing countries, formal education for sustainable development is essential at all levels of education, able to trigger a whole societal transformation. For better environmental sustainability or waste management sustainability education, teachers with the right knowledge, attitude, skills, and innovation are required (Kofi *et al*., 2021). Da Zhu *et al*., mentioned many methods which can be used to generate awareness among the public are:

- ✓ *Door to door awareness and awareness programs*
- ✓ *Celebration of Rallies*
- ✓ *Street plays*
- ✓ *Cleanup drives*
- ✓ *Open forums*
- ✓ *School programs*

Extensive and continuous efforts by various stakeholders from the society to enhance awareness towards sustainable solid waste management in the developing countries (Mahmood *et al.*, 2019). Waste management policy is strengthened via working groups and community.

CONCLUSION

The present study is a comprehensive review summarizing the present situation of MSW management status and associated challenges and solutions. The unsorted solid waste from various sources creates severe problems of solid waste pollution. In the urban areas' landfills have historically been seen as the ultimate solution for storing wastes at minimum cost. Landfilling is one of the most common methods of waste disposal. It is also one of the most significant sources of groundwater contamination. Leachate from the landfills may leak into groundwater flow and pollute the surrounding environment and become part of the hydrological cycle. The leachate contaminant water may be responsible for congenital anomalies, and few types of cancers. Solid waste problems should be controlled by following some principles like reduce, reuse and recycle. If we implement these principles in daily life, it may show fruitful results in the future on the problem of MSW. To sustain solid waste issues, public participation is essential. For better environmental waste management sustainability education, awareness, teachers with the right knowledge, attitude, skills, and innovation are required. In India, population increase, rapid urbanization, booming economy, and the rise in the standard of living have greatly accelerated the rate, amount and quality of the MSW generation. Now, there is an urgent need for adequate treatment and recycling strategies required to be adopted as per Indian solid waste composition.

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