International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 03 | Mar 2022 www.irjet.net p-ISSN: 2395-0072

Municipal Solid Waste Characterization and Management in Lucknow – Capital city of Uttar Pradesh, India

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Abstract - *Due to population growth, rapid economic growth, and rising living standards. The rate of change is accelerated by population growth, rapid economic growth, and the quality of life of the next generation of solid municipal waste (MSW) in Indian cities today they face a major problem of land and water pollution. The current study examines the current state of Municipal Solid Waste Management (MSWM) in the town of Lucknow, Uttar Pradesh (India). The findings of this study revealed that current MSWM methods have many flaws. The town of Lucknow is one of India's most populous, commercial, and urban areas. The city is also building new commercial centres and urban expansions, providing more housing and services to the growing population, leading to the development of a large number of MSW. Every day, the inhabitants of Lucknow produce about 1500 tons of MSW. As debris from landfills becomes an important source of groundwater pollution in the years following MSW dumping, such open dumping poses environmental and health risks.*

Key Words: *Lucknow Municipal Solid Waste (SWM), landfills, dumpsites, Lucknow Nagar Nigam (LNN), Waste generation.*

1. INTRODUCTION

Today there is a growing number and complexity of solid waste produced globally mainly due to growing economic development, urbanization, and improved living standards in cities where trainees are losing out on environmental costs. In any urban area the production of different types of solid waste depends on food habits, cultural traditions, lifestyle, and income. Separation of solid waste from urban areas is also an important problem. The total value of Municipal Solid Waste (MSW) is reported as 800 tons / day, and the average production of Solid Waste is 0.65 kg / capita / day. The town of Lucknow cleaning and collection process includes a solid waste collection from the road with a barrow and then dumped at depots (52 depots). Solid waste is then loaded onto trucks, which transport waste to various landfills each year and LMC spends an average of 21% of its total waste management budget. Waste disposal and management can be helpful in reducing land use in the vicinity of the city.

2. STUDY AREA

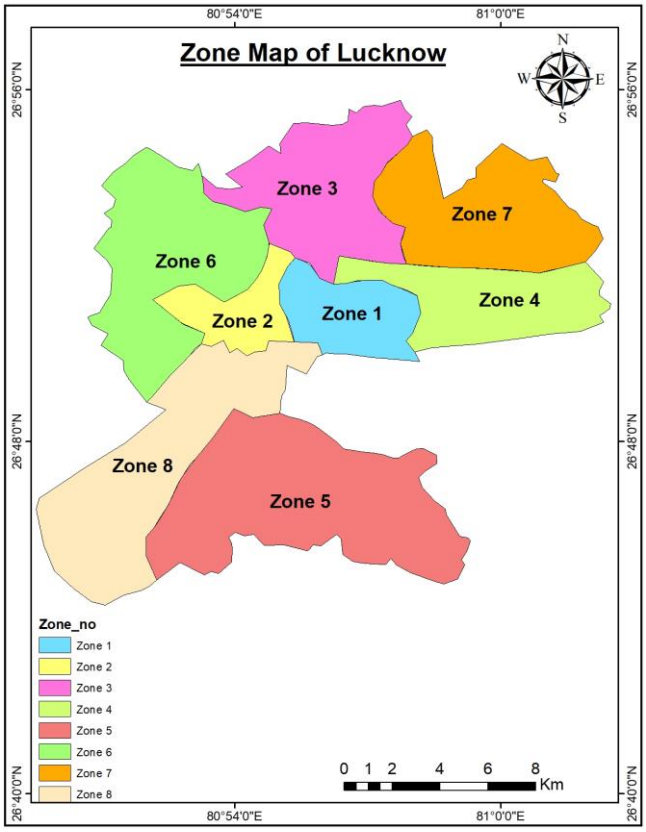

Figure1: ArcGIS map of 8 Zones of Lucknow city

Lucknow city is situated at a height of around 123 meres (404 feet) above sea level. Lucknow city covered an area of about 402 square km till December 2019. It lies between 26°55‘ North latitude and 80°59' East longitude. The city is divided into **8 zones** as per the master plan 2021. It is divided for the better management of services served by the administration to its citizen. Till 2011 master plan only 6 zonal divisions were there but due to management issues in the city boundary it was further divided into 8 zones.

3. MUNICIPAL SOLID WASTE OVERVIEW

The composition of the waste depends on many factors such as dietary habits, culture, lifestyle, climate, income, and so on. These represent residential, commercial, market, and

diverse industries. In this way, 800 Kg representing MSW was collected from dumping sites, mixed thoroughly, and divided into four equal parts. Two diagonal facing sections were retained for analysis and the other two were discarded. The stored parts are also well mixed and divided into four equal parts. The exercise continued, a 200 kg sample was taken for physical analysis.

Municipal waste includes natural waste, sludge, road sweeping, recycled and mixed waste. No separation of source waste occurs. More than 3000 rag pickers are involved in segmentation activities. Control Room The Nagar Nigam Lucknow Department of Lucknow Municipal Corporation (LMC) and the Department of Health are responsible for street sweeping. Sweeping is done once a day in the morning and sweeping is done once a day at night. Garbage is collected from the cart and is dumped on dhalaos which is eventually taken to an open garbage dump.

4. STATUS OF MUNICIPAL SOLID WASTE

Lucknow city is at the forefront of the industry with its emerging biotechnology, having numerous small, medium-scale industries and plantations. Lucknow district covering an area of about 2528 square kilometers, the stretch ranging from 26°30' to 27°10' North latitude and 80°30' to 81°13' East longitude. On the banks of the Gomti River, Lucknow is bound by Barabanki District on the East, Unnao on the West, Raebareli on the South, and Sitapur and Hardoi districts on the North, respectively. Lucknow District's population constitutes 2.30 percent of the total Uttar Pradesh population (Census of India, 2011). Around 1,550,737 people are living in rural areas and 3,037,718 in urban areas. In Lucknow, the generation of waste quantity is approximately 1500 Metric/day Lucknow Nagar Nigam (LNN), 2011. The city area is spread over an area of about 247.7 square km. The Lucknow Nagar Nigam divided the whole city is into 110 election wards and 8 zones for solid waste management and it is responsible for the collection and transportation, treatment, and disposal of Municipal Solid Waste (MSW) generated in the municipal city of Lucknow.

4.1 Existing Situation

Total Waste generation 1365 TPD, Per capita waste generation: 480gm Door to door waste collection: 57 wards by a private concessionaire, Rest of the 53 wards: no door to door collection, Segregation of waste: no happening, Waste dumping at the open dumpsite (LMC, 2015).

Table1: Sources of Municipal Solid Waste (Source: LMC, 2015)

Percentage Households	Percentage (%)
Restaurants	42
Street sweeping	28
Market	6.8
Shops	8.3
workshop	7.5
Offices	4.2
Hospitals	1.7
Hotels	1.5
Total	**100**

5. SOLID WASTE CHARACTERIZATION

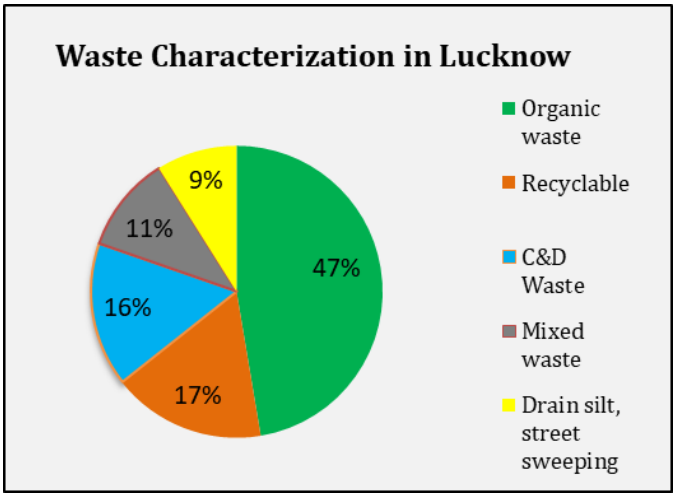

Figure2: Source Composition of Municipal Solid Waste in the Lucknow (U P Jal Nigam, Lucknow, 2010)

The composition of waste depends on a wide range of factors such as food habit, cultural traditions, lifestyle, climate, and income. They are represented by a variety of residential, commercial, market and industrial sectors. Using this method, 800 kg of representative Municipal solid Waste (MSW) from a landfill was collected, thoroughly mixed and divided into quarters. Two opposing parts were left for analysis and the other two were discarded. The rest was thoroughly mixed again and divided into quarters. The movement continued. A sample of 200 Kg was taken for physical analysis.

Table2: Quantity and characterization in MSW in Lucknow city (Lucknow Nagar Nigam (LNN), 2011)

Waste Characteristics	Quantity per day/ metric per day	Percentage of total waste
Recyclables(paper, rubber, glass and metals, etc.)	230.77	17.7
Organic	597.87	45.99
Construction debris	230.77	17.75
Mixed waste and drain silts & street sweeping	247.86	19.06
Total	1307.27	100

Table3: Source: Lucknow Nagar Nigam (LNN), 2011 and UP Jal Nigam, 2009

Categories	Percent of the total population	Approx per capita waste generation (gram/day)	Waste generation (in %)
High-income group	17	221.21	40
Middle-income group	38	162.67	32
Low-income group	30	172.89	27

6. METHODOLOGY

The research work is based on primary and secondary data collection to respond to the research questions of the study. The secondary data was gathered directly from the Control War Nagar Nigam office, research institutions such as universities, and non-governmental organizations (NGOs) that work on solid waste management issues. Secondary data is derived from a variety of electronic and printed sources, including official websites of Lucknow Municipal Corporation, published books, research papers, journals, and articles. The next work is ground truth and field survey and also we can use Google Earth Pro for timeline research.

7. MUNICIPAL SOLID WASTE COLLECTION AND TRANSPORTATION SOURCE: LUCKNOW MUNICIPAL CORPORATION (LMC, 2015)

7.1 Primary Collection (Door to Door)

Through rickshaw trolleys, hand carts. In the first phase, 57 wards out of 110 are taken up and garbage is sent to the dhalaos. In the remaining 53 wards, people throw waste into the nearby dhalaos and road bins.

7.2 Waste Collection from community containers/bins

The City of Lucknow separates waste from a variety of sources, such as residential, buildings, street sweeps, gardens, parks, offices, and shopping malls. Waste from homes and hospital is mixed with Solid waste in storage. The collection was performed in two steps. In the first stage, waste is collected door to door by private operators at multiple locations. Gomti Nagar, Indira Nagar are transported to bins, dhalao and open landfill. In other parts of the city, along with street sweeps, garbage collected from small heaps goes to a secondary collection point in front of Nagar Nigam households. In the second stage, the container filled with waste is replaced with an empty container using a dump truck. Secondary collection: Waste is being done by Department of Lucknow Municipal Corporation (LMC) in the whole of the city from dhalaos located at various locations in the city.

Figure 3: Vehicle for door to door waste collection, Dustbin at Aliganj, image capture during field survey, 2022

7.3 Transportation of MSW

MSW is transported by their vehicle; private vehicles are not being used. LNN has a large number of vehicles for transportation. Presently Lucknow Nagar Nigam (LNN) uses 22-23 dumpers, 6-10 tractors, 48-54 trucks, and 100 Chota Haathi, etc. vehicles for assembling and transferal of the waste from primary and secondary waste collection point to the landfills.

7.4 Processing and Disposal of waste

No processing of waste is being done by Lucknow Municipal Corporation (LMC) or private concessionaire. The dumpsites are traditional dumpsites without any lining at the bottom.

MSW is being relocated to more landfills near Gomti Nagar fun shopping mall, Telibagh Bhattha Maidan, Ghaila (Dubbga) Hardoi-Kanpur Ring Road, and Ramdaskheda, with the exception of landfills and other secure and dumping sites.

Figure4: Dumpsite, Ghaila Dubagga (source: site visit, 2022)

7.5 Scientific Landfill site and MSW Processing Plant

Processing plant at Shivari with a total area of 19 Hectare, scientific landfill site with a total area of 21 hectares in Phalenda Village (LMC, 2015)

Figure5: Processing Plant, Shivari Mohan Road (source: site visit, 2022)

8. MSW Issues

Lack of sanitary landfill site: lead to groundwater and soil pollution, vector nuisance, etc. The inappropriate primary collection of solid waste: waste is discharged by establishments (residential and non-residential) into open ploys, open drains, etc. Transportation of solid waste in open vehicles: Transportation in open trucks, three-wheelers, and trolleys, littering on roads during transportation, manual loading, and unloading. Inappropriate collection and disposal of construction waste. Mixing of house waste with MSW, an insufficient number of dustbins in city and area, Lack of community involvement, Low recovery of user charges.

9. RESULT AND DISCUSSION

The quantity and nature of trash are crucial factors in deciding which energy recovery technologies to use. The quantity of solid waste is more important than the composition since it is difficult to recoup capital costs as well as maintain and run a waste-to-energy system cost-effectively without enough waste (Tatarniuk, 2007). The amount of waste generated in each of Lucknow's nine towns is calculated by multiplying the 0.67 and 0.9 common factors with each town's increasing population trends in 2009 and 2012, respectively. In 2009, the predicted total amount of garbage was 5245 tons per day, while in 2012; it was 5890 tons per day.

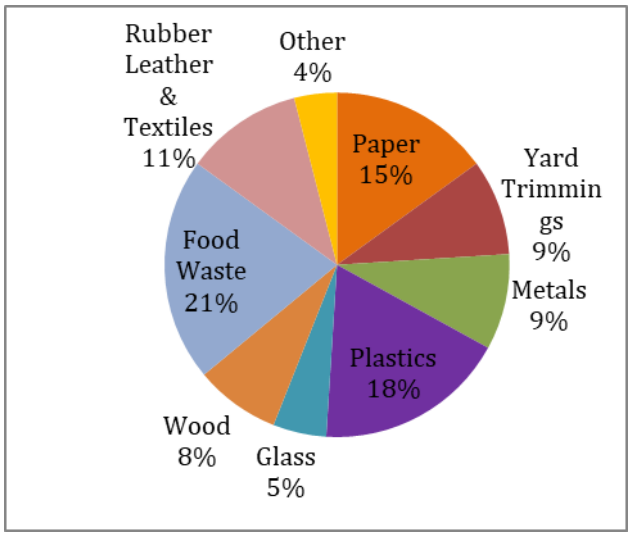

Figure6: Estimated Average composition of solid waste (Source- Lucknow Municipal Corporation, 2011)

Lucknow Data Analysis**:** Generation rate kg/capita/day = Quantity of solid waste kg/day Population Capital.

Table4: Total operational cost (source: LNN, Control Room, 2022)

1	Total wet waste collected of the city(Ton)	17392
2	Total dry waste collected of the city(Ton)	12348.79
3	Total mixed waste collected of the city(Ton)	30040.85
4	Total domestic hazardous waste collected(Ton)	948.66
5	Number of households in residential/commercial (mixed) building where user charges is collected	25260
6	Number of commercial, institutional and industrial establishments in the city where user charges is collected (in Rupees)	17526

7	Total amount of user charges collected directly or through property tax under SWM (in Rupees)	45566000
	Total operational cost (in Rupees)	**36708000**

10. CONCLUSION AND RECOMMENDATION

Segregation of trash at the source, as well as promotion of recycling or reuse of segregated materials, reduces waste volume and landfill burdens while also providing raw materials for manufacturers. Composting is an effective approach for treating and producing soil amendment since solid waste contains largely organic matter (45.3 percent). The significant increase in solid waste volumes, along with the inability to offer daily collection service, creates a nuisance as well as health risks. The report covers the current Municipal Solid Waste Management (MSWM) situation, which will aid in raising public awareness.

According to the report, current policies and infrastructure are unable to deal with the massive amount of MSW created in the city. After thorough recycling and composting, this segregated garbage should be delivered to authorized dumping sites. The extraction, updating, and visualization of the essential information is handled using Municipal Solid Waste Management (MSWM) data received from Arc GIS maps. Lucknow Nagar Nigam (LNN), environmental engineers, and decision-makers may use the data-rich maps to learn more about the current Municipal Solid Waste Management (MSWM) system, which is necessary for improving it and preparing for the future. The Non-governmental organization (NGO) and Lucknow Nagar Nigam LNN should collect livestock excrement from all of the city's cattle shelters/colonies.

Separation of waste from the well, as well as promoting recycling or recycling of waste materials, reduces waste and waste disposal loads while providing materials for manufacturers. Composting is an effective way to treat and produce soil supplementation as Municipal Solid Waste (MSW) is highly biologically active (45.3 percent). The significant increase in Municipal Solid Waste (MSW) volumes, as well as the inability to provide a daily collection service, creates stress and health risks. The report includes the current state of Municipal Solid Waste Management (MSWM), which will help raise public awareness.

According to the report, current policies and infrastructure cannot address the huge number of Municipal Solid Waste (MSW) created in the city. The city's Municipal Solid Waste Management (MSWM) is inadequate, and it needs immediate attention. The waste management system will also require significant community participation in resource allocation in residential areas. In the formulation of waste management policy, co-operation is required not only for policy formulation but also for active participation in waste collection and transportation until waste is disposed of in landfills. In some parts of the city, the Non-governmental organization (NGO) began collecting garbage from door to door. After complete recycling and composting, the separated waste must be delivered to authorized dumping sites. Releases, reviews, and display of important information are managed using MSWM data obtained from Arc GIS maps. Lucknow Nagar Nigam (LNN), environmental engineers, and decision makers may use rich data maps to learn more about the current MSWM system, which is needed to improve and prepare for the future.

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