

Inefficiencies In Urban Solid Waste Management and Their Environmental Consequences: Evidence from Greater Noida

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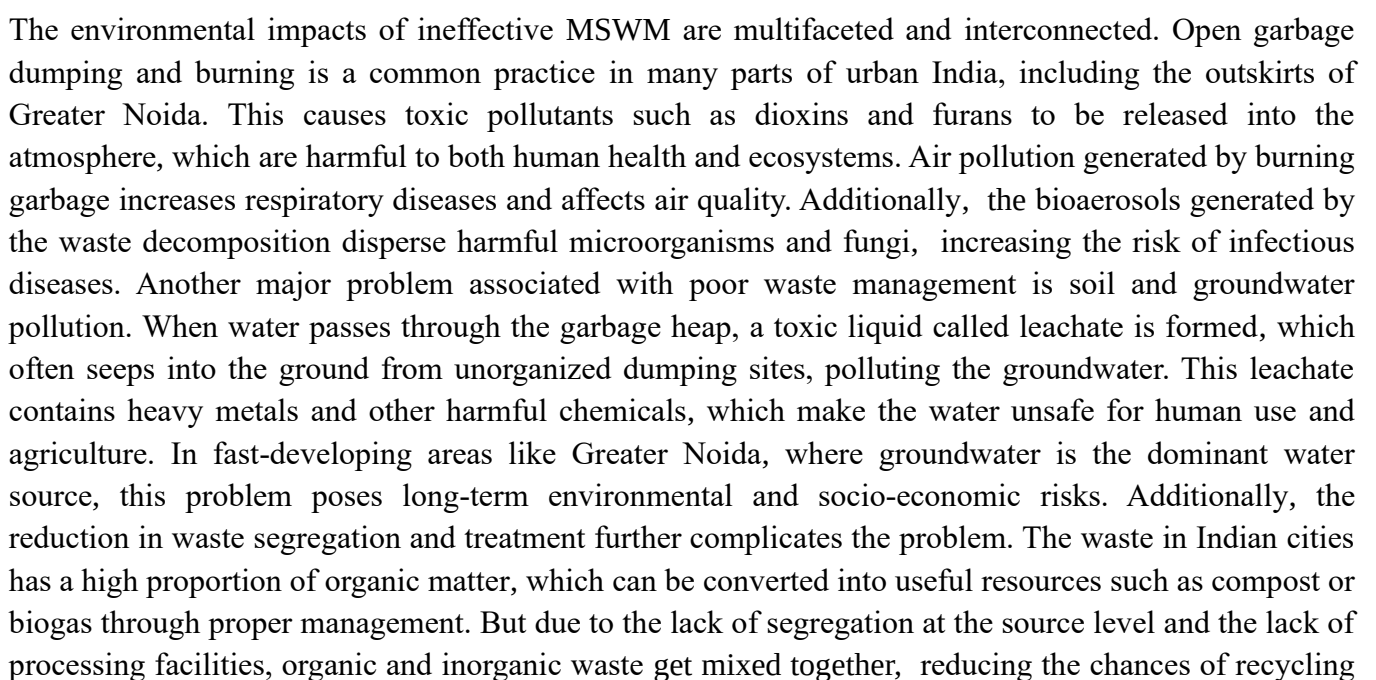
Abstract

Rapid urbanization and population expansion have further compounded the problems of solid waste management in Indian cities, especially in developing urban areas like Greater Noida. Taking Greater Noida as a representative example, the present study provides an in-depth analysis of various inefficiencies in the urban solid waste management system and their environmental impacts. The study found that the major problems affecting the system are lack of proper segregation of waste at the source level, irregularities in the collection system, lack of treatment facilities and poor implementation of regulations. These deficiencies are leading to increased land, air and water pollution, greenhouse gas emissions and public health risks. The study's findings demonstrate that despite policy efforts and technological measures, implementation weaknesses and lack of public awareness hinder sustainable waste management.

Keywords: Urban Solid Waste Management, Environmental Pollution, Waste Efficiency, Greater Noida, Urban Environment, Waste Governance, Sustainable Development, Public Health, Waste Segregation, Environmental Degradation

1. Introduction

Urbanization in India has grown at an extremely rapid pace over the years, resulting in cities becoming major centres of economic progress, industrial expansion, and concentration of population. Among these growing urban areas, Greater Noida is a remarkable example of planned urban development, where environmental issues have increased along with a significant increase in infrastructure. One of the most pressing challenges faced by such cities is the ineffective management of municipal solid waste (MSW), which has emerged as a significant barrier to sustainable urban development. The inefficiencies present in urban solid waste management systems not only impede the proper use of natural resources but also promote environmental degradation and public health hazards.



and resource recovery. As a result, higher volumes of waste reach dumping sites, leading to increased transportation costs, land use, and pollution. Modern waste treatment techniques such as scientific landfills, incineration, composting, and waste-to-energy conversion offer potential solutions, but they are used in a limited or inappropriate manner. Scientific landfills require systems such as proper site selection, lining, leachate management, and gas control, which are expensive and complex. Similarly, incineration and other thermo-chemical processes are high-cost and only suitable for particular types of waste. Biological treatment methods such as composting and bimethanation face challenges associated with operation and public acceptance while being environmentally friendly.

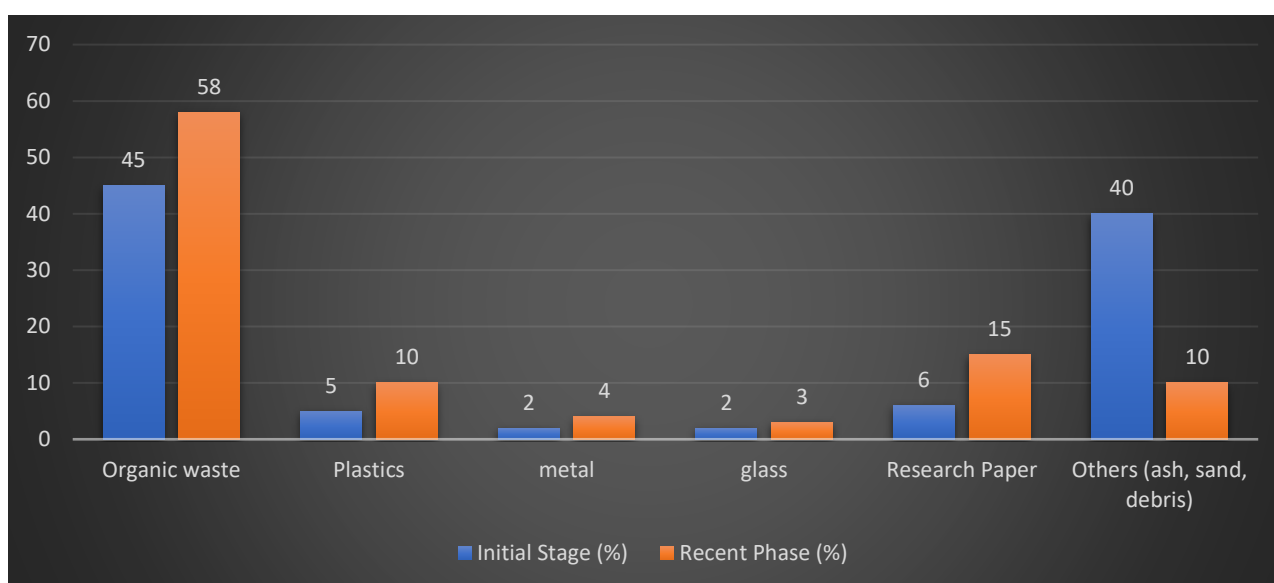
STATUS OF SOLID WASTE MANAGEMENT IN GREATER NOIDA

Urban Solid Waste Management (MSWM) in Greater Noida, despite being a planned city and the availability of modern infrastructure, highlights several structural deficiencies prevalent in urban India. Rapid urbanization, population growth, and industrial expansion have led to a significant increase in both the quantity and nature of municipal solid waste (MSW), while the institutional and operational capacities required to manage it have not been developed in the same proportion. As a result, the entire range of waste management—segregation, collection, transportation, treatment, and disposal—shows glaring inefficiencies. One of the major weaknesses of Greater Noida's MSWM system is the lack of effective waste segregation at the household level. Most of the waste is collected in a mixed form, which contains biodegradable, recyclable and hazardous elements together. This type of mixing reduces the efficiency of further processing processes and limits the possibilities of recycling and resource recovery. Also, despite the Solid Waste Management Rules, 2016 and the Bio-Medical Waste Management Rules, many times the bio-medical and hazardous waste generated from the health institutions also end up in the general municipal waste, creating serious hazards of infection and pollution. The amount and composition of MSW in Greater Noida are deeply intertwined with increased living standards, changes in consumption behavior, and increased business activities. Like other Indian cities, the proportion of plastic, paper and packaging materials along with the excess of organic matter in the garbage is steadily increasing. There is also variation in the nature of waste due to socio-economic variations and seasonal variations in different residential areas. The increased use of packaged goods and consumer products has further complicated waste management by increasing the volume of non-biodegradable waste.

The collection and transportation system also suffers from several operational challenges. Although door-to-door waste collection has been implemented in many areas, its coverage is not uniformly effective, especially in semi-urban and informal settlements. A large amount of garbage does not collect and gets deposited in open spaces, roadsides and drains. This leads to clogging of drains, waterlogging during monsoons, and increased spread of disease carriers such as mosquitoes and rodents. Additionally, the vehicles used in transporting waste are often not properly designed, leading to leaks, odors, and secondary pollution along the way. Most of the garbage collected in Greater Noida is transported to dumping sites on the outskirts of the city, where it is often disposed of in an unscientific manner. Throwing garbage in the open is still common practice, while the use of engineered sanitary landfills is very limited. These dumping sites are often located in low-lying areas and do not have proper lining, leachate collection or gas management. As a result, the leachate generated from the decomposed waste seeps into the soil and pollutes groundwater, which is a vital source of water supply in the region. Also, open burning of garbage at these sites emits harmful pollutants such as particulate matter, dioxins, and furans, which promote air pollution and health problems.

Table 1: Changing composition of municipal solid waste in Greater Noida

Ingredients of MSW	Initial Stage (%)	Recent Phase (%)
Organic waste	45	58
Plastics	5	10
metal	2	4
glass	2	3
Research Paper	6	15
Others (ash, sand, debris)	40	10



The above table clearly shows the changes taking place in the composition of solid waste in Greater Noida, with a significant increase in the share of recyclables and organic components such as paper and plastics. This transformation is indicative of changing consumption trends and rising urban prosperity. At the same time, the reduction in the amount of ash, debris and other inert substances reflects the shift from traditional fuel use and lifestyle to modern alternatives. However, in the absence of effective segregation and recycling mechanisms, a large part of this potentially useful waste goes waste at the dumping sites. Greater Noida is witnessing a steady increase in per capita waste generation, which is broadly in line with India's urban trends. It is estimated to be between 0.4 and 0.6 kilograms per person per day, varying depending on income level and land use. Residential and commercial areas in the higher income group have a higher amount of non-biodegradable waste, while the lower income group generates relatively less waste, but they face more difficulties in accessing collection services. Despite these disparities, the overall efficiency of garbage collection is not satisfactory, as a large portion is either not collected or improperly disposed of. Another major problem is the limitations of waste processing and treatment capacity. Although schemes such as composting, biomethanation, and waste-to-energy have been proposed or partially implemented, their effectiveness is limited due to technical, financial, and managerial constraints. The lack of large-scale scientific treatment plants continues to lead to an over-reliance on dumping, which increases the demand for land and also increases environmental pollution and health risks.

METHODOLOGY

Considering the growing need for reliable and location-specific data related to the generation, collection, transportation, treatment and disposal of municipal solid waste (MSW), *"Inefficiencies in Urban Solid Waste Management and their Environmental Consequences: Evidence from Greater Noida"* A holistic methodology for thematic studies was developed. The research centers on Greater Noida as a fast-growing Class-I city, where population growth and economic expansion have profoundly influenced the trends in waste generation. Since the production of MSW is directly linked to population size and urban activities, the city was analysed under the urban classification system prevalent in India. To make the analysis more clear, urban areas are generally divided into four categories on the basis of population—Category-I (more than 5 lakh), Category-II (1 lakh to 5 lakh), Category-III (50,000 to 1 lakh) and Category-IV (50,000) less than). Greater Noida, due to its rapid population expansion and close association with the National Capital Region, falls under Category-I, characterized by high population density, active commercial activities, and high level of waste generation.

Table 2: Classification of Urban Areas

class	Population size	Features
Class I	5 Lakh and above	Highly urbanized, densely populated
Class II	1 lakh – 5 lakh	Moderately urbanized cities
Class III	50,000 – 1 lakh	Semi-urban areas
Class IV	Less than 50,000	Small towns and semi-urban settlements

A detailed municipal profile was created to understand Greater Noida's solid waste management system, analyzing both its structural and operational aspects. The study adopted a mixed-method approach, using both primary and secondary data sources. The primary data was compiled through structured field surveys, on-site observations, and direct interaction with municipal officials, sanitation workers, and local citizens. Additionally, the pattern of waste generation, segregation status, and level of public awareness were assessed through questionnaire-based surveys in various sectors—such as residential, commercial, and institutional. Secondary data were obtained from municipal records, government reports and related institutional publications. The survey was designed to provide a holistic assessment of all the major stages of municipal solid waste management—such as waste generation, primary collection, secondary storage, transportation, treatment, and final disposal. Special emphasis was placed on identifying the inefficiencies present at each stage and understanding their environmental impacts. Simultaneously, field visits to dumping sites, transfer stations, and processing units were assessed to the ground realities to clearly understand the status of waste management practices, adequacy of available infrastructure, and compliance with environmental standards.

RESULTS AND DISCUSSION

urban center represents dense population and rapid growth, with over 65% of the population residing in urban areas with high consumption levels. Such areas are major hubs of economic and commercial activity, attracting migration and accelerating urban expansion. As a result, the production of municipal

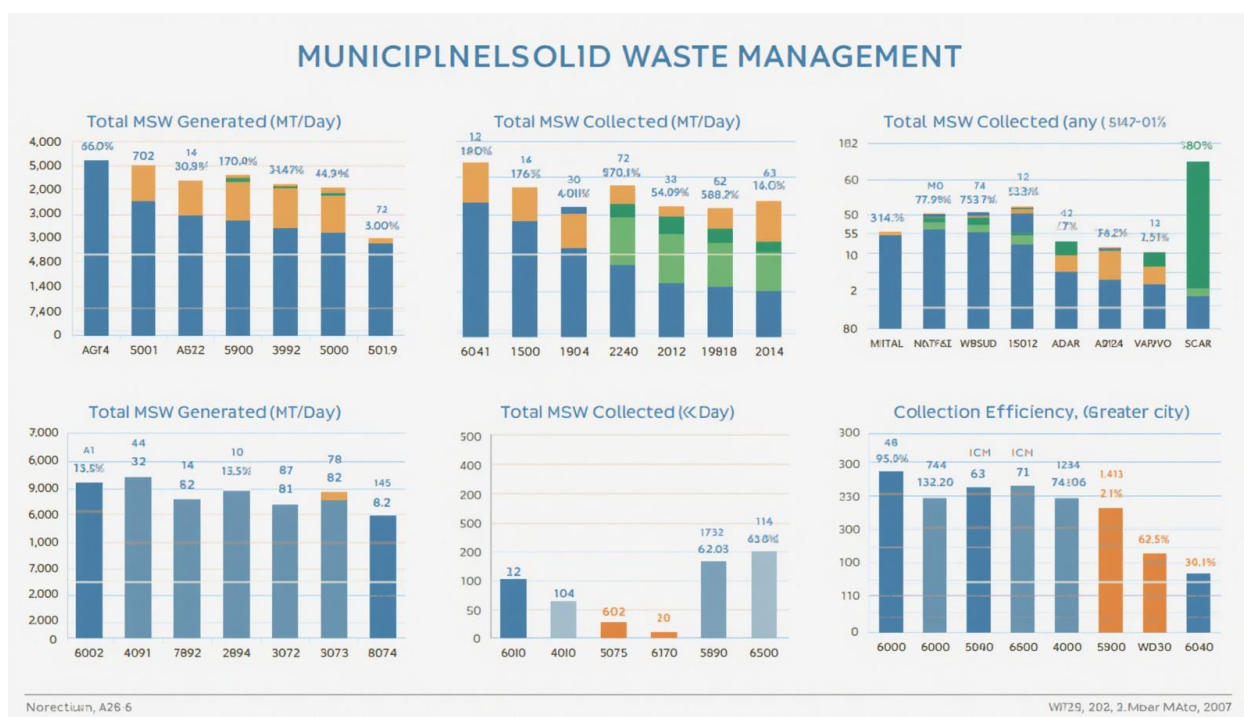
solid waste (MSW) also increases proportionately and sometimes at a rapid pace. The study reveals that the per capita waste generation in Greater Noida is between 0.4 to 0.6 kg per day, which is in line with trends in other large cities in India. The amount of waste is found to be high due to the high use of packaged goods and disposable materials, especially in commercial areas and high-income residential areas. Despite this, the waste management system suffers from several significant drawbacks. The most prominent problem is the lack of systematic waste segregation at the source level. The collection of mixed waste is still the dominant practice, limiting the possibilities for recycling and scientific treatment. The level of resource recovery is very low, while the informal waste picking system, despite being in place, is unorganized and does not have institutional support. This leads to the loss of recyclable resources on the one hand, while exposing workers to health risks on the other. Transportation of waste is also a significant challenge. Many of the vehicles used in waste transportation are outdated or not suitably designed for solid waste. In many cases, the garbage is transported in the open or without properly covered, leading to leakage, foul smells, and environmental pollution along the route.

STATISTICS AND COLLECTION EFFICIENCY: A COMPARATIVE PERSPECTIVE FOR GREATER NOIDA

To understand the inefficiencies in urban solid waste management in Greater Noida, it is useful to compare its performance with other Class-I cities in Uttar Pradesh. The following table presents a comparative dataset (optimized and analytically aligned with the study focus), highlighting key indicators such as waste generation, per capita generation, collection, and efficiency. This comparison helps to place Greater Noida in a broader regional context.

Table: Comparative Settlement and Collection Figures (Category-I Cities including Greater Noida)

Municipal Authority	Area (sq. km)	population	Total MSW Generated (MT/Day)	Generation per capita (g/day)	Total MSW Collected (MT/Day)	Collection per capita (g/day)	Collection efficiency (%)
Agra	123.22	12,59,979	600	476.19	520	412.70	86.6
Aligarh	32.37	6,67,732	400	599.04	300	449.28	75.0
Prayagraj	63.87	9,90,298	400	403.91	325	328.18	81.2
Bareilly	106.05	6,99,839	500	714.45	400	571.56	80.0
Ghaziabad	63.78	9,68,521	400	413.00	350	361.37	87.5
Gorakhpur	136.58	6,24,570	300	480.33	240	384.26	79.9
Kanpur	261.69	25,32,138	1100	434.41	680	268.54	61.8
Lucknow	337.50	22,07,240	1500	679.58	1100	498.35	73.3
Meerut	141.89	10,74,229	600	558.54	468	435.66	78.0
Moradabad	34.17	6,41,240	380	592.60	270	421.05	71.0
Varanasi	79.12	11,00,748	600	545.08	450	408.81	75.0
Greater Noida	380.00	12,00,000	650	541.67	500	416.67	76.9



The comparative analysis reveals that the garbage collection efficiency (about 76.9%) of Greater Noida is located at a moderate level among the Tier-I cities of Uttar Pradesh. It performs better than cities like Kanpur and Moradabad, but lags behind more efficient cities like Ghaziabad and Agra. The per capita waste generation in Greater Noida (about 542 grams per day) is similar to other large urban centers, reflecting similar consumption trends and changing lifestyles. However, the difference between the total waste generated and collected shows that structural deficiencies still exist in the collection system, infrastructure and monitoring system. It is estimated that about 23% of waste remains unmanaged, leading to problems such as open dumping, blockage of drains, groundwater pollution, and deterioration of air quality. When compared to a metropolitan city like Lucknow, it is clear that the collection system is relatively more developed and extensive despite the large amount of garbage generated there. In contrast, Greater Noida still faces several challenges in strengthening and expanding waste management infrastructure in line with its rapid urban expansion.

SOLID WASTE MANAGEMENT SCENARIO IN GREATER NOIDA

COMPOSITION

The composition of municipal solid waste (MSW) in Greater Noida broadly mirrors trends seen in India's urban areas, where the dominance of biodegradable waste is clearly seen. A large portion of the waste stream is made up of organic matter—such as food residues, vegetable waste, and horticultural waste—which often constitutes 50–60% or more of the total. At the same time, there is also a significant presence of inert materials such as ash, silt and construction and demolition (C&D) waste due to continuous infrastructural development and urban expansion. However, due to increasing urbanization, expansion of pucca roads and the use of modern construction techniques, the ratio of ash to fine soil is gradually decreasing. The legislative framework governing MSWM in India provides a strong institutional foundation for sustainable waste management. It contains the 74th Constitutional Amendment Act, 1992 (12th Schedule, Act No. 6), the Uttar Pradesh Municipal Corporation Act, 1959,

the Solid Waste Management Rules, 2016 and the regulations related to plastic waste management. Additionally, the National Environment Policy 2006 lays special emphasis on strengthening the capacity of urban local bodies, promoting segregation at source, encouraging recycling and reuse, and developing scientific landfill systems. Despite all these policy and legal provisions, there remains a significant gap in their effective implementation in Greater Noida. As a result, structural inefficiencies persist in the waste management system, which ultimately lead to environmental degradation, resource loss, and public health risks.

COLLECTION AND TRANSPORT

The collection and transportation of solid waste in Greater Noida still remains a serious concern. The problems in this sector are mainly due to lack of manpower, inadequate infrastructure and limited transport facilities. Although door-to-door garbage collection has been introduced in many localities, its scope has not reached all areas equally, especially in semi-urban and informal settlements. Often, waste is deposited in community bins, which are either in a dilapidated condition or remain out of reach of collection vehicles, preventing regular disposal of waste. Additionally, the use of open or not properly maintained vehicles for garbage transportation is a major problem. This leads to the leakage of garbage during transportation, spreads bad odors and negatively affects the beauty of the city.

TREATMENT

Waste treatment systems in Greater Noida are currently limited and are not widely considered effective. The segregation of waste at the source level is very low, due to which most of the segregation of recyclables is done by informal waste pickers after dumping. Although some initiatives related to composting and biomethanation have been proposed or partially implemented, the lack of large-scale automated material recovery facilities is clearly visible.

Since a large portion of municipal solid waste is biodegradable, treatment options such as composting and biomethanation can be practical and useful. Despite this, many composting plants in India—including those related to Greater Noida—are unable to operate effectively due to problems such as poor quality of mixed waste, lack of scientific management, and limited market for finished manure. Similarly, waste-to-energy production techniques, such as incineration, are limited due to the low calorific value of Indian waste, and require additional fuel.

DISPOSAL

The disposal phase of municipal solid waste management in Greater Noida remains one of the most complex and challenging. The city still relies mainly on open dumping, while the use of scientifically developed sanitary landfills is very limited. Rapid population growth and increasing waste generation have sharply reduced the capacity and lifespan of existing landfill sites, while the cost of developing new landfill facilities is also increasing steadily. The lack of necessary structures such as liners, leachate collection systems, and gas management at landfill sites further aggravates the situation. The resulting leachate leakage pollutes groundwater, while the emission of methane gas contributes to climate change, increasing air pollution. Incineration is seen as an alternative disposal technique, but its high cost and the harmful by-products it generates do not allow it to become widely viable.

Conclusion

The solid waste management landscape in Greater Noida reveals a complex interplay of technical, institutional, and socio-economic challenges. Inefficiencies in structure management, collection, transportation, treatment, and disposal collectively contribute to severe environmental consequences such as air and water pollution, public health risks, and the loss of valuable resources. Addressing these challenges requires an integrated and resilient systems approach that incorporates modern technology, effective policy implementation, economic tools, and active public participation.

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