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Sustainable Solid Waste Management: A Geo-Environmental Perspective from Malegaon Municipal Area, Nashik Maharashtra

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ABSTRACT:

Solid Waste Management (SWM) is a crucial aspect of urban sustainability, especially in fast-growing and densely populated cities like Malegaon in Maharashtra. This study assesses the current status and geo-environmental impacts of SWM in the Malegaon Municipal Corporation (MMC) area. Through field data collection, stakeholder interviews, and environmental sampling, the study identifies significant shortcomings in the processes of waste collection, segregation, transportation, treatment, and final disposal. These inefficiencies contribute to environmental degradation and pose health risks. The research proposes sustainable and practical strategies to enhance SWM practices, aiming for a cleaner, healthier, and more environmentally responsible urban ecosystem in Malegaon.

Keywords: Solid Waste Management, Environmental Impact, Municipal Corporation, Urban Pollution

1. INTRODUCTION:

Rapid urbanization and population growth in India have placed immense pressure on municipal solid waste management systems. Malegaon, a densely populated and industrial city in Nashik district, faces serious challenges due to unscientific and inefficient waste disposal methods. These practices have led to significant environmental degradation and public health risks. This study examines the geo-environmental impacts of current waste management practices in the Malegaon Municipal Corporation area. It explores sustainable alternatives by integrating technological solutions and participatory governance. The research emphasizes the need for a comprehensive and community-inclusive approach to improve waste management efficiency and promote environmental sustainability in the region.

2. OBJECTIVES OF THE STUDY

- To evaluate current SWM practices in Malegaon.
- To assess the geo-environmental impacts of unregulated waste disposal.

- To propose actionable strategies for sustainable SWM.

3. METHODOLOGY:

3.1 Sources of Data Used in the Study:

• **Primary Sources:** The study relies heavily on direct fieldwork to gather firsthand information. Field surveys were conducted to assess ground realities of waste generation and management. Stakeholder interviews with municipal officials, sanitation workers, and local residents provided valuable insights into operational challenges and community perspectives. Waste audits were performed to analyze the composition and quantity of waste. Additionally, GPS tracking of collection vehicles was used to map routes and evaluate the efficiency of waste transportation systems.

• **Secondary Sources:** Relevant reports and data from the Malegaon Municipal Corporation (MMC) for the years 2020 to 2024 were analyzed to understand policy frameworks and infrastructural developments. Central Pollution Control Board (CPCB) and National Green Tribunal (NGT) documents offered regulatory guidelines and legal perspectives. Census 2011 data helped profile the demographic and urban characteristics of the study area. Peer-reviewed scientific journals were consulted for theoretical grounding and comparison with similar case studies.

3.2 Techniques Used

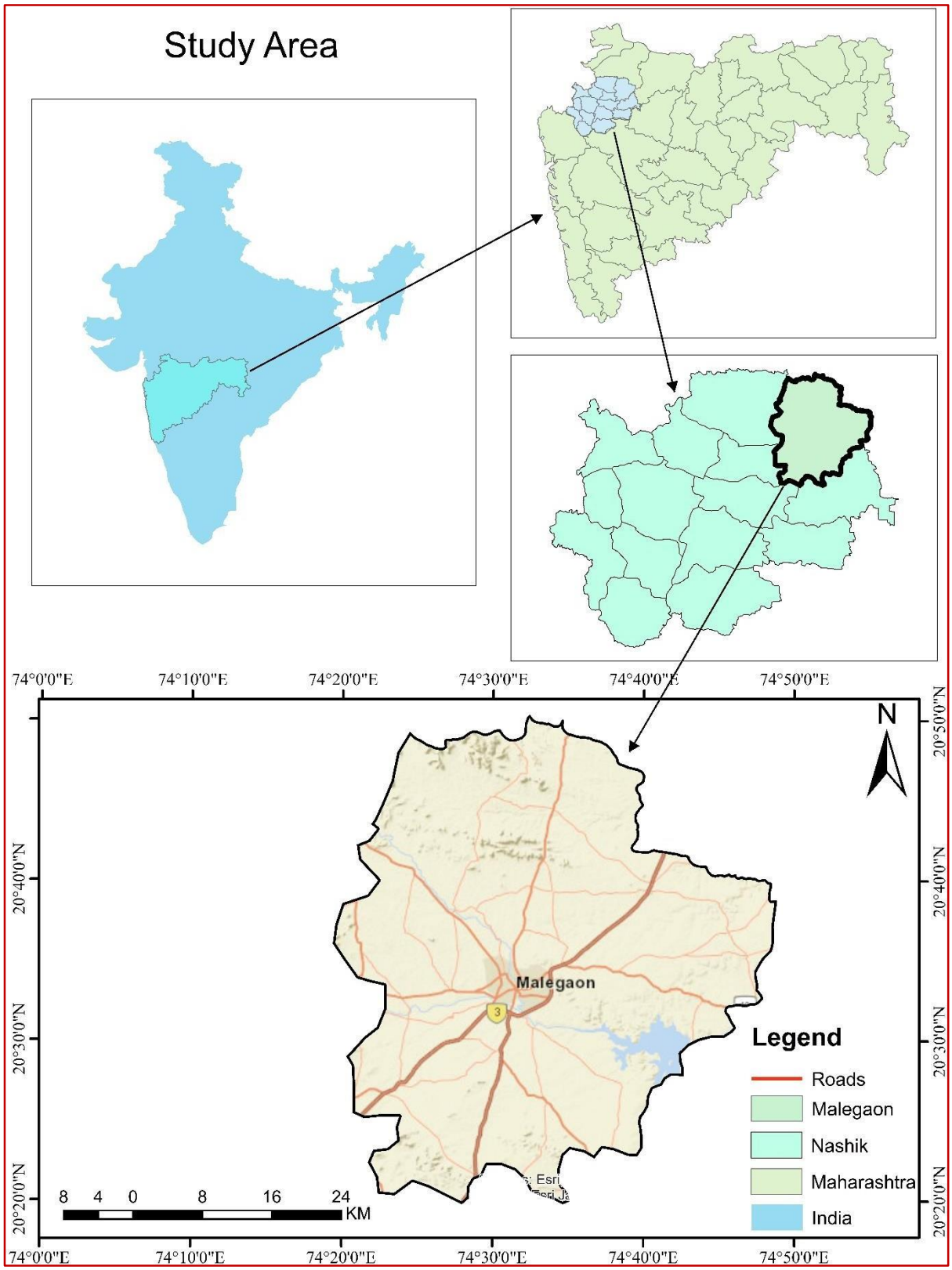
• **Environmental Sampling:** Soil and water samples were collected from areas surrounding landfill and waste disposal sites to assess contamination levels. Parameters such as pH, heavy metals, and organic content were analyzed to understand the environmental impact of current waste management practices.

• **Qualitative Analysis:** Interviews and discussions with local residents, municipal workers, and officials were conducted to gather insights on community perceptions, operational issues, and challenges faced by the solid waste management (SWM) workforce. This helped identify gaps in awareness, participation, and system efficiency.

4. Study Area: Malegaon

Malegaon, covering an area of 34 sq.km, has a population of 731,493 (2021), with a literacy rate of 87.61% and a sex ratio of 973 females per 1000 males. Rapid urbanization and industrial growth have led to significant environmental pressure, with the city generating approximately 170 metric tons of solid waste daily, posing serious management challenges.

Study Area Map: India, Maharashtra, Nashik District and Malegaon city



5. RESULTS AND DISCUSSION:

5.1 Waste Generation & Composition: Malegaon generates approximately 184 grams of waste per person per day. With its growing population, the total annual municipal solid waste (MSW) production is estimated at around 51,100 tons. The composition of this waste is diverse, with organic waste forming the largest portion, followed by significant amounts of plastic and paper. Additionally, biomedical and construction waste are also present, contributing to the complexity of waste management. The high proportion of biodegradable and recyclable materials highlights both the potential for resource recovery and the pressing need for systematic segregation and treatment at the source.

5.2 Collection & Transportation: In Malegaon, approximately 87% of the municipal solid waste is collected with some degree of segregation at the source. However, despite this relatively high collection efficiency, the city lacks a well-organized transportation network and adequate scientific infrastructure for processing and disposing of the waste. The transportation system is often irregular and poorly monitored, leading to delays and inefficiencies. Additionally, biomedical waste is frequently mixed with general municipal waste due to inadequate handling and oversight, posing serious health hazards through potential cross-contamination and environmental pollution. This highlights the urgent need for improvements in both logistics and regulatory compliance.

5.3 Disposal Practices: In Malegaon, the disposal of municipal solid waste is primarily carried out through open dumping. Waste is often discarded in low-lying areas and along riverbanks, which not only degrades the landscape but also leads to serious environmental and public health concerns. These open dumping sites lack any form of containment or treatment, allowing leachate to seep into the soil and nearby water bodies, potentially contaminating groundwater and surface water resources.

The city does not have any scientifically designed or engineered landfills that comply with environmental safety standards. Existing dumping grounds are poorly maintained and unmanaged, with no lining systems, leachate collection, or gas management mechanisms in place. This contributes to foul odors, pest infestations, and the risk of fire hazards, particularly during the summer months.

The situation is even more critical when it comes to biomedical waste. Its disposal remains largely unregulated, and in many cases, such waste is mixed with regular municipal waste. This poses a serious threat of cross-contamination, disease transmission, and exposure to hazardous materials for both sanitation workers and the general public. The lack of a separate collection and treatment system for biomedical waste underscores the need for urgent policy enforcement and infrastructure development in Malegaon's waste disposal system.

5.4 Geo-Environmental Impacts:

Land pollution: The improper disposal and management of solid waste in Malegaon have resulted in significant geo-environmental impacts affecting land, water, air, and public health. One of the primary concerns is land pollution caused by leachate infiltration. Leachate, a toxic liquid formed when rainwater percolates through waste dumps, seeps into the soil, degrading its quality and contaminating the surrounding land. This contamination reduces soil fertility and can harm local vegetation and agriculture.

Water contamination: Water pollution is another critical issue, particularly affecting the Girna River and the groundwater sources in and around Malegaon. The leachate and untreated waste runoff enter these water bodies, introducing harmful chemicals, heavy metals, and pathogens. This contamination threatens aquatic life, reduces water quality, and poses severe risks to communities relying on these sources for drinking, irrigation, and other uses.

Air pollution: Air pollution also arises from the open burning and natural decomposition of waste at dumping sites. Burning solid waste releases toxic gases and particulate matter into the atmosphere, contributing to poor air quality and the formation of smog. Decomposition emits foul odors and greenhouse gases such as methane, which contribute to climate change.

Health risks: These environmental hazards translate into serious public health risks for Malegaon's residents. Exposure to polluted air can lead to respiratory problems, including asthma and bronchitis. Moreover, the accumulation of waste provides breeding grounds for disease-carrying vectors like mosquitoes and rodents, increasing the incidence of vector-borne illnesses such as malaria and dengue fever. Overall, the geo-environmental consequences of inadequate solid waste management in Malegaon highlight the urgent need for sustainable and scientifically sound waste disposal solutions.

6. CHALLENGES IDENTIFIED:

1. Lack of Scientific Landfills and Composting Facilities: Malegaon currently does not have engineered landfills designed to safely contain and treat municipal solid waste. The absence of proper landfill infrastructure leads to open dumping, causing environmental pollution and health hazards. Additionally, there are no adequate composting facilities to manage the large quantity of organic waste generated daily, resulting in the loss of potential resources and increased burden on landfill sites.

2. Biomedical Waste Mismanagement: Biomedical waste in Malegaon is often mixed with general municipal waste due to ineffective segregation and handling practices. This improper management poses serious risks of infection and contamination for both sanitation workers and the public. Lack of dedicated treatment and disposal mechanisms further exacerbates the problem, increasing the chances of disease spread.

3. Inadequate Funding and Weak Enforcement of SWM Rules, 2016: The implementation of the Solid Waste Management Rules, 2016, faces challenges due to insufficient financial resources and poor regulatory enforcement. Limited budget allocations restrict the development of necessary infrastructure and procurement of modern equipment. Furthermore, weak monitoring and lack of stringent penalties lead to non-compliance by waste generators and handlers.

4. Low Community Involvement despite High Literacy: Although Malegaon has a relatively high literacy rate, community participation in waste segregation, reduction, and proper disposal remains low. Awareness programs and behaviour change campaigns have not effectively engaged the public, leading to persistent challenges in achieving waste management goals. This gap highlights the need for more inclusive and sustained community outreach efforts.

5. Growing Population Putting Strain on Current Infrastructure: The city's rapid population growth and urbanization have increased the volume of waste generated, placing additional pressure on an already inadequate waste management system. Existing collection, transportation, and disposal infrastructure struggle to keep pace with this growth, resulting in inefficiencies and environmental degradation. Without timely upgrades and expansion, the problem is likely to worsen.

7. RECOMMENDATIONS:

Strategy and Action Plan: The strategy focuses on promoting waste segregation at the household level through awareness campaigns and providing color-coded bins. Infrastructure upgrades like composting units, material recovery facilities, and engineered landfills are essential for effective waste processing and disposal. Strengthening policy enforcement and encouraging community participation through education and incentives will ensure sustainable solid waste management.

1. Segregation at Source: To improve waste segregation, it is essential to focus on awareness and practical support at the household level. This can be achieved through targeted campaigns that educate residents about the importance of separating biodegradable, recyclable, and hazardous waste before disposal. The distribution of color-coded bins to households will make segregation easier and more systematic, encouraging consistent participation. Such measures not only reduce the volume of waste sent to landfills but also enhance recycling and composting efficiency.

2. Infrastructure Upgrade: Upgrading waste management infrastructure is critical for handling the increasing volume and complexity of waste. Establishing composting units will enable the processing of organic waste locally, reducing landfill pressure and producing valuable compost for agricultural use. Material Recovery Facilities (MRFs) will help in sorting and processing recyclable materials efficiently, promoting resource recovery and reducing environmental pollution. Additionally, developing scientifically engineered landfills with proper liners, leachate collection, and gas management systems will ensure safer and more sustainable waste disposal.

3. Policy & Regulation: Strict enforcement of the Solid Waste Management Rules, 2016, is necessary to ensure compliance from all stakeholders. This includes imposing penalties on individuals, businesses, and agencies that violate waste segregation, disposal, and treatment norms. Strengthening monitoring mechanisms and capacity building within municipal bodies will improve regulatory oversight. Clear guidelines and accountability will foster a culture of responsibility and improve overall waste management outcomes.

4. Community Participation: Engaging the community is vital for the long-term success of any waste management strategy. Public education campaigns using various media platforms can raise awareness about the environmental and health impacts of improper waste disposal. Incentivizing recycling behaviour, such as offering rewards or subsidies for segregated waste and recyclable materials, can motivate residents to adopt sustainable practices. Encouraging local involvement, such as neighbourhood clean-up drives and volunteer groups, will foster a sense of ownership and collective responsibility toward a cleaner environment.

8. CONCLUSION:

The current solid waste management (SWM) system in Malegaon is inadequate and poses significant environmental hazards. Unregulated waste disposal has led to serious contamination of soil, water, and air, threatening both public health and the local ecosystem. Integrating Geographic Information Systems (GIS) can improve waste monitoring and route optimization, while community-based strategies can enhance public participation and awareness. To address these challenges, urgent modernization of waste processing infrastructure, strict enforcement of SWM regulations, and active citizen involvement are essential. Such comprehensive measures will help ensure sustainable waste management, protect environmental quality, and promote the well-being of Malegaon's residents.

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