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INSIGHTS FROM THE FIELD

Legacy Waste Remediation in Karnataka: Field Assessments and the Promise of Biomining Technology

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1. INTRODUCTION

India's solid waste problems are compounding due to inadequate eco-friendly treatment. Many old dumpsites are releasing toxins that pose environmental and health risks. The Ministry of Housing and Urban Affairs (MoHUA) recognizes unlined dumpsites as sources of air and water pollution. The Swachh Bharat Mission has mandated small cities to clear old dumpsites by March 31, 2023, and larger cities by March 31, 2024 (MoHUA 2021). In 2020, it reported an annual loss of 1,250 hectares of land due to waste disposal (SBMU 2020). As per the Central Pollution Control Board (CPCB) report on solid waste management, India generates 1.6 lakh tons per day (TPD) of solid waste, with 1.52 lakh TPD of it collected at 95.4% efficiency. Of this, 50% (0.79 lakh TPD) is treated and 18.4% (0.3 lakh TPD) is landfilled. The number of dumpsites in India exceeds landfills. Further, several states lack landfill sites (CPCB 2020).

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2. SOLID WASTE MANAGEMENT (SWM) IN KARNATAKA

Karnataka has 316 urban local bodies (ULBs) and 66 Class I and Class II towns. Around 310 ULBs have a door-to-door collection system, wherein the segregation rate is 78%. The state has 221 landfill sites for waste disposal, of which 52 are operational, and 191 existing dumpsites. The total solid waste generation in the state is approximately 11,085 TPD, of which approximately 10,198 TPD is collected, 6,817 TPD is treated, 1,250 TPD is landfilled, and 3,018 TPD is unattended waste (Singh 2023). Moreover, 216 composting plants, 15 biogas, and 217 refuse-derived fuel (RDF)/pelletization plants have been set up in the state. Around 221 regional/individual landfill sites have been identified and 52 landfill sites have been constructed. House-to-house collection is carried out by ULBs, and the system has a 98% coverage percentage (CPCB 2020).

Many ULBs collect mixed waste and transport it to landfill sites or processing facilities. Many urban areas face two primary challenges in solid waste management (SWM): the management of daily waste generation and the handling of accumulated waste in locations originally distant from cities but now encroached upon due to urban expansion.

3. STATUS OF LEGACY WASTE IN KARNATAKA

Legacy waste—or historic waste—typically refers to old solid waste found in landfills or dumpsites. It includes a mixture of partly or fully decomposed biodegradable waste, plastics, textiles, metals, glass, and other materials. In Karnataka, ULBs have achieved significant success in door-to-door waste collection. However, many ULBs struggle with implementing waste segregation at the source. Additionally, ULBs lack the manpower and financial resources to operate composting facilities, which means fresh waste arrives at landfills and dumpsites as mixed waste. This complicates the process of on-site segregation and increases its cost. Due to insufficient investment in waste processing technologies and management of facilities, waste accumulates at these sites. ULBs are frequently confronted with the challenge of overflowing dumpsites. This dilemma compels them to make a crucial choice: either address the accumulated waste backlog by acquiring new land for dumping operations or continue using existing dumpsites despite reaching capacity. However, acquiring new land for waste disposal comes at a significant financial cost, deterring most ULBs from this option. Consequently, they are left with the unsustainable practice of dumping in their already brimming dumpsites. This reliance on outdated disposal sites has led to a widespread problem of land scarcity, further complicating the waste management crisis faced by ULBs. Waste burning is a prevalent occurrence at dumpsites, often attributed to either human activities or climate variations. This contributes to air pollution and diminishes the overall volume of waste. Figure 1 shows the burning of legacy waste at a dumpsite.

Figure 1: Burnt Legacy Waste at a Dumpsite

Source: Authors

While ULBs have allocated ample resources for waste collection and transportation, waste processing remains neglected. Most ULBs have made investments in essential infrastructure, such as composting sheds, weighbridges, and power and water connections for designated waste processing facilities. However, there is a noticeable lack of resources in terms of equipment, manpower, vehicles, and funding for the processing of fresh waste. Consequently, legacy waste has accumulated in dumpsites, with approximately 2.1 crore tonnes of legacy waste in the state occupying an estimated 2,000 acres of land. Of this, around 1.07 crore tonnes of legacy waste can be found in Bengaluru's dumpsites, with the remainder scattered across other ULBs. ULBs are obligated to address this legacy waste in accordance with National Green Tribunal guidelines. Thus far, they have prepared detailed project reports for managing this legacy waste, which have received state approval and are currently in the tendering stage. As of 2023, biomining operations have been initiated in cities such as Hosadurga, Mangaluru, and Shivamogga.

4. FIELD STUDY

The present study examined 20 dumpsites across the state of Karnataka, including those in major cities and towns. The average area of the dumpsites was recorded to be around 13.6 acres. These dumpsites have operated for 15 to 25 years on average, accumulating unprocessed mixed waste in substantial mounds. Physical analysis was conducted by sampling 100 kg at each site to determine the legacy waste composition. Results showed that the samples were composed of 65% bio soil/soil-like materials, 25% RDF, 9% inert, and less than 1% recyclables. The average volume and area of legacy waste across all 20 sites was estimated to be about 58,147 cubic meters and 6.42 acres, respectively. Thus, the legacy waste from all sites amounted to 11,04,798.84 cubic meters and covered an area of 129 acres. Figure 2 shows the legacy waste segregated during physical analysis.

Figure 2: Segregated Legacy Waste for Physical Analysis

Source: Authors

4.1 A CASE STUDY OF DODDABALLAPURA

Doddaballapura, which is a city located 40 km from the state capital Bengaluru and falls under the Doddaballapura City Municipal Council (CMC), underscores the current scenario in ULBs dumpsites. The city generates 36 TPD of municipal solid waste (MSW), mainly from 29,138 households; CMC collects 35 TPD, processes 9 TPD on-site, and dumps the remaining 27 TPD at its 16-acre dumpsite located 4 km away from the city. At the time of the field study, 4.16 acres of the dumpsite were filled with legacy waste.

The volume of the waste present at the site was estimated using drone technology by capturing 200–300 high-resolution images during multiple flights over the site. This data was then processed to create an ortho and elevation map to categorize waste into mounds or blocks. As per the drone survey conducted in August 2023, the dumpsite contained approximately 51,190 cubic meters of MSW, which is equivalent to 43,512 tonnes, with a density of 0.85 tonnes per cubic meter.

To understand the physical characteristics of the waste, a characterization study was conducted at the dumpsite by sampling 100 kg of waste from various locations and segregating it by type. The weights of the segregated materials were recorded, revealing that 64% of the waste was bio soil, 26.8% was RDF, 1.2% was recyclables, and 8% was inert, including 6.5% large stones. Additionally, a chemical analysis was performed by a National Accreditation Board for Testing and Calibration Laboratories (NABL)–accredited laboratory to determine the nitrogen, phosphorus, and potassium (NPK) content in bio soil samples and the calorific value of RDF material. The NPK values in the bio soil samples (1.2%:0.5%:0.6%) did meet fertilizer control order (FCO) standards for city compost (0.8%:0.4%:0.4%). The organic carbon content met the requirements, but it was observed that the samples had high moisture. The calorific value of the RDF material was measured to be 2,684 Kcal/kg.

In Doddaballapura, the quantity of waste collected and dumped at the sample dumpsite far exceeded its processing capacity, creating a crisis of rapid waste accumulation. This has created a situation of overflow, as the site does not have sufficient land for waste storage. ULBs such as the Doddaballapura CMC must address this crisis by either finding new dumping grounds or clearing the accumulated waste at the existing site through biomining. Procuring additional land is challenging due to high costs, including land prices and operational expenses, which strain the limited budgets of ULBs.

5. DUMPSITE REMEDIATION TECHNOLOGY

Bioremediation or biomining refers to the practice of excavating legacy waste dumped at the dumpsite and forming it into windrows for aerobic respiration, which takes place when biowaste is exposed to air. The windrows are also sprayed with bio-culture to make the process quicker and more effective. After the legacy waste has been stabilized, the materials are then passed through a screening process via screening machines such as Trommel sieves. Depending upon the material type and size, they are segregated into inert, recyclables, RDF, and bio soil or soil-like materials.

If the bio soil meets the FCO requirements for city compost, it may be packaged and sold as compost for consumption. If not, it should be processed further to enhance its nutritional value before being sold. Currently, bio soil is typically used to fill low-lying areas. Since it contains heavy metals that can leach into the soil and contaminate the underlying strata, bio soil should be disposed of carefully. Materials such as low-grade plastics and rags can be baled into smaller compact portions that can be sent to cement factories that utilize these materials as RDF in their kilns. Inert materials such as rocks and stones may be utilized in filling up low-lying areas or may be landfilled. The recyclable portions, which consist of hard plastics and metal, may be sold as scrap.

All in all, most of the materials recovered from the bioremediation process are utilizable. By the end of the operations, if designed well and performed correctly, most of the legacy waste accumulated at the dumpsite is cleared off. Subsequently, additional fresh waste received by the dumpsite is processed as soon as it is received on-site, thus reducing the probability of waste accumulation at the dumpsite area.

As per Swachh Bharat Mission 2.0 guidelines, ULBs receive ₹ 550 per metric tonne of legacy waste from the central government, with states contributing two-thirds of the project funding. As per CPCB (2019), cleared legacy waste dumps cannot be inhabited for 15 years. Afterwards, settlements may be allowed, provided that emissions and leachate quality meet standards and the soil is stable.

6. CONCLUSION AND WAY FORWARD

Karnataka's legacy waste composition is approximately 65% bio soil or soil-like materials, 25% RDF, 9% inert, and less than 1% recyclable materials. Our chemical analysis found that most of the bio soil samples do not meet the FCO standards required for it to be utilized as city compost. To meet these standards, bio soil must be enriched through additives. ULBs such as the Doddaballapura CMC—whose dumpsites mostly receive mixed waste and are rapidly reaching dumping capacity limits—are common across the country. Waste is generally dumped at these sites without processing. Further, many dumpsites have a limited processing capability, which is inadequate to service the quantity of fresh waste received at the dumpsite per day. Bioremediation, while not a "cure-all" solution, may prove to be a viable option to reclaim land that is occupied by accumulated waste, which can vacate space for ULBs to set up waste processing units and process fresh waste as soon as it arrives. This will curtail the need to procure new land every time the dumpsite reaches its maximum capacity. This will also allow ULBs to recover a part of the operational costs through the sale of end products such as compost and recyclables.

To address the waste management challenges, the Swachh Bharat Mission 2.0 initiated by the Government of India aims to make all cities clean and garbage-free, emphasizing 100% scientific processing of municipal solid waste by adopting suitable technologies such as composting and biogas generation. This mission mandates "100% scientific waste management, including safe disposal in proper landfills" and the remediation and transformation of all existing dumpsites into green zones (SBMU 2021).

Across India, ULBs are obligated to adhere to the Solid Waste Management Rules of 2016, which mandate effective MSW management. These rules require ULBs to address open dumpsites by taking necessary actions for remediating legacy waste through bioremediation or biomining.

Ethics Statement: I hereby confirm that this study complies with the requirements of ethical approvals from the institutional ethics committee for the conduct of this research.

Data Availability Statement: The data used in this paper is available from the corresponding author on reasonable request**.**

Conflict of Interest Statement: No potential conflict of interest was reported by the author.

REFERENCES

Central Pollution Control Board (CPCB). 2019. *Guidelines for Disposal of Legacy Waste (Old Municipal Solid Waste)*. New Delhi: Ministry of Environment, Forest and Climate Change.

Central Pollution Control Board (CPCB). 2020. *Annual Report on Solid Waste Management (2020-21), CPCB, Delhi.* https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf

Ministry of Housing and Urban Affairs (MoHUA). 2021. *Swachh Bharat Mission, Urban (SBMU) 2.0: Making Cities Garbage Free*. 2021. New Delhi: Ministry of Housing and Urban Affairs.

Singh, Richa. 2023. *Methane Emissions from Open Dumpsites in India: Estimation and Mitigation Strategies*. New Delhi: Centre for Science and Environment.

Swachh Bharat Mission Urban (SBMU). 2020. *Guidance on Efficient collection and transportation of municipal solid waste*. Central Public Health and Environmental Engineering Organisation (CPHEEO). Accessed June 24, 2022. https://smmurban.com/uploads/files/cr3h4k6v_ywpnx5.pdf.

Swachh Bharat Mission Urban (SBMU). 2021. Operational Guidelines October 2021, Ministry of Housing and Urban Affairs, Government of India. Accessed May 11, 2022. https://sbmurban.org/.