



# Workshop Proceedings: Mapping of Open Burning of MSW in Pakistan & Identification of Underlying Factors & Key Drivers

Organized by: Circular Plastics Institute at KSBL, Engro Foundation in collaboration with the NED University, Indus Valley School of Art and Architecture, and COMSATS University Islamabad

## Acknowledgement

We would like to express our sincere gratitude to Engineering X and the Royal Academy of Engineering for their generous support and funding, which have been instrumental in the successful execution of this project. Their dedication to addressing the issue of open burning of waste has played a vital role in advancing sustainable waste management solutions.

We also extend our appreciation to the stakeholders, researchers, and experts whose valuable insights and collaboration have contributed to the project's progress. Their support has been essential in developing effective strategies to mitigate the environmental and health impacts of open burning.

This project reflects a collective commitment to fostering science-based interventions, and we hope it serves as a meaningful step toward cleaner and more sustainable waste management practices.

## Executive Summary

The Circular Plastics Institute (CPI) at KSBL, in collaboration with key academic and institutional partners, convened a workshop to address the critical issue of open burning of municipal solid waste (MSW) in Pakistan. The workshop presented findings from the project *Mapping of Open Burning of MSW in Pakistan & Identification of Underlying Factors & Key Drivers*, focusing on Karachi and Lahore as primary hotspots. The event brought together experts from diverse fields, including environmental science, urban planning, engineering, and public policy, to analyze the socio-economic, environmental, and infrastructural challenges driving open burning.

The discussions underscored the severe environmental and public health impacts of open burning, particularly the release of toxic pollutants from plastics, textile, and other waste materials. Key drivers identified include inefficient waste management systems, lack of public awareness, weak enforcement of regulations, and infrastructural deficits. The workshop concluded with a set of actionable recommendations aimed at fostering sustainable waste management practices, reducing open burning, and aligning Pakistan's waste governance with global sustainability goals.

These hotspots- key locations where waste burning is most prevalent were analysed to understand their environmental and health impacts, pollution transport trajectories, and the socio-economic factors contributing to open burning.

## Project Brief:

The Mapping of Open Burning of Municipal Waste in Pakistan project, led by Shiza Aslam at the Circular Plastics Institute (KSBL), aims to identify the key drivers and underlying factors contributing to open burning in the country. Pakistan generates approximately 30 million tons of municipal solid waste (MSW) daily, yet only 60% is collected, with a service coverage of just 43%. Uncollected waste is often openly burned or dumped, contributing to severe environmental and health hazards. Annually, 3,000 kilotons of plastic are consumed in Pakistan, but only 20% is recycled, exacerbating waste accumulation. Studies indicate that 7.9% of total MSW in developing countries is openly burned (World Bank, 2019). Open burning is widely practiced by reducing waste volume, create disposal space, minimize leachate, and recover recyclables due to inadequate waste collection services. This research aims to map high-risk areas, assess policy gaps, and propose sustainable interventions to mitigate open burning and improve waste management practices.



## Methodology:

### 1. Spatial Distribution and Pollutant Transport

Identifying hotspot areas for open burning is crucial for targeted mitigation strategies. Mapping efforts have revealed that waste burning is prevalent in densely populated urban neighbourhoods, informal settlements, and along major roadways. The burning of municipal solid waste (MSW), particularly plastic-based products, releases harmful pollutants, including dioxins, furans, and fine particulate matter (PM<sub>2.5</sub>), which can have severe respiratory and cardiovascular health effects. Pollution trajectory modelling further indicates that emissions from open burning are transported over considerable distances, exposing nearby and downwind communities to hazardous air quality conditions.

### 2. Remote Sensing and Satellite-Based Monitoring

Satellite-based monitoring has emerged as a critical tool in detecting and analyzing open burning events. High-resolution imaging, coupled with multispectral and thermal sensors, enables the identification of fire hotspots, burn scars, and smoke plumes. These advanced detection methods allow for continuous monitoring, capturing variations in burning activity across different seasons. Observations indicate a pronounced increase in open burning during winter months, likely driven by lower atmospheric dispersion rates and higher heating demand. In contrast, burning activities are reduced in the early mornings during summer but intensify during nighttime hours, highlighting the role of temperature inversions in pollution accumulation. Integrating satellite data with ground-based monitoring enhances the accuracy of open burning assessments and facilitates timely intervention strategies.

### 3. Waste Management and Urban Infrastructure Constraints

The persistence of open burning is closely linked to systemic weaknesses in urban waste management. Infrastructural challenges, such as congested road networks, high-rise buildings with limited waste disposal mechanisms, and distant landfill sites, exacerbate inefficiencies in waste transportation. The lack of appropriately sized waste collection equipment, including trolleys with insufficient capacity, further contributes to the accumulation of waste in public spaces, increasing the likelihood of open burning as an alternative disposal method. Additionally, insufficient coordination among municipal authorities and the limited integration of informal waste collectors into formal waste management structures hinder the adoption of sustainable waste treatment solutions.

## 4. Socio-Economic and Behavioural Drivers

Economic constraints and governance shortcomings play a critical role in perpetuating open burning. In many cases, waste collectors and local residents' resort to burning as a cost-effective means of reducing waste volume, particularly in areas with inadequate collection services. Trust in municipal waste management systems remains low, leading to resistance against policy interventions and formalized waste disposal mechanisms. Seasonal variations further influence burning practices, with increased waste incineration observed during colder months when alternative disposal options are less accessible. Additionally, employment instability and the absence of structured incentives for recycling contribute to the continued reliance on open burning, underscoring the need for targeted socio-economic interventions.

### Key Workshop Discussions:

#### A Perspective from the Space Above:

Presenter: Dr. Muhammad Imran Shahzad, Head of Department, COMSATS University Islamabad

Dr. Muhammad Imran Shahzad presented "A perspective from the Space Above", where he focused on mapping open burning of municipal solid waste (MSW) in Lahore and Karachi using satellite data and remote sensing techniques. Satellites equipped with advanced sensors detect various environmental parameters, enabling wide area coverage for monitoring large geographic regions, including remote areas. High-resolution imaging captures detailed images of the Earth's surface, revealing visible signs of open burning such as smoke plumes, burn scars, and fire hotspots. Multispectral and thermal sensors detect specific wavelengths of light and heat, identifying thermal anomalies associated with open burning, even though cloud cover or at night. The study analyzed fire events across seasons, categorizing them into low, nominal, and high confidence events, and conducted hotspot analysis to distinguish between day and night occurrences. Continuous and frequent observations highlighted seasonal variations in open burning activities, with reduced burning in the morning and increased burning at night during summer, and an extreme increase in open burning throughout the day and night during winter. Advanced data analysis techniques, such as machine learning and image processing, were used to identify patterns and trends, while integration with ground-based data enhanced the accuracy and reliability of findings. The research identified key drivers of open burning, including inefficient waste management systems, which lead to waste accumulation and burning as a disposal method, seasonal agricultural practices like crop residue burning, and urban expansion and industrialization, which increase waste generation and pressure on disposal methods. Additionally, lack of public awareness and weak enforcement of environmental regulations were highlighted as contributing factors. These drivers collectively **emphasize the need for targeted interventions, such as improved waste management infrastructure, stricter regulations, and public awareness campaigns, to mitigate the environmental and health impacts of open burning.** Dr. Imran's work, supported by real-time monitoring capabilities for timely detection and intervention, provided valuable insights into the spatial and temporal dynamics of MSW burning, offering a data-driven perspective for addressing this critical issue in Pakistan.

#### Socio-Economic and Infrastructural Challenges

Presenter: Dr. Suneela Ahmad, Head of Department Architecture, Indus Valley School of Art Design and Architecture

Dr Ahmed examined the socio-economic dimensions of open burning, emphasizing that while communities acknowledge immediate health risks (e.g., respiratory diseases, irritations, cough, asthma), long-term effects such as carcinogenic exposure are less understood. Infrastructural shortcomings—including distant disposal sites, irregular waste collection, and high-density urban settings—further compound the issue. Such that residents opt to burn waste as way of managing waste and to avoid disease spread specific to mosquitoes and rodents **She advocated for integrated urban planning, public-private partnerships, and decentralized waste management solutions.**

## Waste Composition Analysis of Open Burning

**Presenter:** Shiza Aslam, Research Head, Circular Plastic Institute (CPI) at KSBL

Shiza presented empirical data and provided a detailed analysis of waste composition in open burning incidents. The study revealed that plastics, particularly food wrappers and bags, dominated the waste stream, with food wrappers reaching counts as high as 76 and 62 in certain instances, and plastic bags exceeding 100 counts in multiple samples. Together, food wrappers and bags accounted for the majority of plastic waste, with bags contributing 66.66%. Fabric waste, such as textile fragments, rags, and clothing, was the second most common category, with occurrences ranging from 2 to 18. Paper and cardboard were observed in lower frequencies, with counts of up to 8, while rubber fragments were rarely observed, with frequencies of up to 2. No significant quantities of metal or glass waste were detected. **The session highlighted the urgent need for improved waste management systems and community awareness to address the environmental and health impacts of open burning, particularly given the dominance of plastics in the waste stream.**

## Institutional Challenges in Waste Management

**Presenter:** Shiza Aslam, Research Head, Circular Plastic Institute (CPI) at KSBL

Dr. Saeeduddin highlighted various reasons for open burning, focusing on the attempt to reduce the volume of municipal solid waste (MSW) by sanitary workers and residents. In Karachi, he identified three major ways to reduce MSW outside of planned municipal operations: washing it away through rainwater, rivers, or nullahs; open burning; and taking away recyclable waste. He also discussed the challenges faced by human resources (HR) involved in MSW management, particularly within government entities like KMC (Karachi Municipal Corporation) and SSWMB (Sindh Solid Waste Management Board). These challenges include aging HR with old appointees and new hires on contract, lack of appropriate equipment like low-capacity trolleys, and faraway designated sites located 1 km or more. Additionally, he pointed out difficulties such as city infrastructure issues, traffic congestion, increasing housing density, and cumbersome vertical movement in high-rise buildings, all of which complicate waste collection and disposal efforts.

## Global Perspectives & Collaborative Solutions

**Presenter:** Charlie Fenn,

Engineering X, represented by **Charlie Fenn** and **Dr. Mansoor Ali**, shared valuable insights on addressing open burning of waste through global collaboration and local solutions. Their discussions highlighted the challenges, opportunities, and strategies needed to tackle this pressing environmental issue.

- **Charlie** highlighted Engineering X's role in supporting 16 ground projects, including this initiative, to address open burning of waste. The organization is focused on building an international community to deeply understand the problem and find lasting solutions. Additionally, two climate champions are raising the issue at the United Nations, collecting evidence of open burning to drive global awareness and action. Charlie **emphasized the importance of collaboration and evidence-based approaches to tackle this pressing environmental challenge.**
- **Dr. Mansoor** pointed out the lack of awareness among governments and the public, as well as poor decision-making and employment crises, as key factors exacerbating the issue of open burning. He stressed the need to open minds to all problems and opportunities and explore all possible solutions. Dr. Mansoor also noted that distrust in the system and resistance to change are significant barriers. He identified seasonal changes and garbage collectors burning waste instead of proper disposal as two major reasons for open burning. To address this, **he suggested monitoring small areas to assess the impact of open burning and using media and publications to raise awareness and drive behavioral change.**

## Activity

As part of the session, participants engaged in a group activity to define the government's role in addressing open burning, proposing policy measures, enforcement strategies, and ways to improve waste collection and community participation.

### GROUP A

**Group A** focused on what has remained the same and what has changed in waste management. They highlighted persistent issues such as inadequate planning and coordination, the continued use of dumpsters till dumpsites, and the restriction on GTS (Garbage Transfer Stations). However, they noted positive changes, including the introduction of GTD (Garbage Transfer Depots), SSWMB (Sindh Solid Waste Management Board), and the SSWB Act. The group emphasized the need for revising existing acts, incentivizing small technical remote recycling facilities, and exploring the potential of recycling and reusing materials to address open burning effectively.

### GROUP B

**Group B** stressed the importance of integrating the informal recycling system into the formal system and acknowledged that while monitoring and awareness have improved, they are not yet widespread. The group highlighted the need for establishing a proper collection system, implementing structural changes, and launching awareness programs. They also emphasized integrating laws and regulations with a sense of ownership, providing proper equipment and air quality monitors, ensuring waste burning occurs away from communities, and promoting training and behavioural changes to tackle open burning.

### GROUP C

**Group C** discussed strategies to improve waste management, including reducing transportation costs, enhancing sweeping practices, and allocating human and technological resources. They emphasized the importance of fostering public-private collaborations, ensuring financial transparency, and protecting the informal sector. The group also highlighted the need to engage political and religious entities, incorporate waste management into educational curricula, and mandate PEMRA to include awareness initiatives. They stressed the urgent need to address open burning practices through community engagement, government accountability, and enhanced waste management systems.

## Recommendations for Enhancing Waste Management in Karachi

- 1. Policy and Legislative Reforms:** The persistence of inadequate planning and coordination necessitates a comprehensive revision of existing waste management policies and regulatory frameworks. While the establishment of the GTD, SSWMB, and the SSWB Act represents a policy advancement, these mechanisms require further refinement to enhance enforcement and operational effectiveness. Additionally, integrating the informal recycling sector into the formal waste management system is essential for improving material recovery rates, ensuring labor protections, and enhancing economic opportunities for marginalized waste workers.
- 2. Infrastructure Development and Operational Efficiency: Addressing deficiencies in waste collection and disposal** infrastructure is fundamental to mitigating open dumping and burning. The formalization and expansion of Garbage Transfer Stations (GTS) can significantly improve logistical efficiency, facilitating structured waste transportation to designated disposal sites. Furthermore, decentralized small-scale recycling facilities should be incentivized, particularly in remote areas, to promote localized material processing and circular economy initiatives. Investment in technological and human resources, including the deployment of air quality monitoring systems and provision of protective equipment for waste workers, is necessary to enhance system resilience and occupational health.
- 3. Public Engagement and Behavioural Change:** Sustainable waste management requires active public participation and awareness. Incorporating waste management education into school curricula can instil responsible consumption and disposal behaviours from an early age. In addition, the Pakistan Electronic Media Regulatory Authority (PEMRA) should mandate the integration of environmental awareness campaigns into television and radio programming to reach a wider audience. Training programs tailored for informal waste workers and low-income communities can further reinforce behavioural shifts toward responsible waste handling practices.
- 4. Environmental and Health Safeguards:** Given the severe health and environmental implications of open waste burning, regulatory enforcement must be strengthened to prohibit burning in densely populated areas and ensure compliance with designated waste treatment methods. Enhancing waste segregation at the source and improving mechanized street sweeping practices can reduce the volume of combustible waste in urban areas. Additionally, deploying real-time air quality monitoring stations in high-risk locations can support evidence-based policy interventions aimed at mitigating pollution-related health risks.
- 5. Environmental and Health Safeguards:** Effective governance mechanisms are critical for ensuring an equitable and transparent waste management system. Strengthening financial oversight and accountability in municipal waste management operations can prevent resource misallocation and enhance service delivery. Public-private partnerships should be encouraged to leverage financial and technical expertise in waste management innovation. Moreover, engaging political and religious institutions can facilitate community mobilization and foster a shared sense of responsibility in waste reduction and environmental protection efforts.

The findings underscore the necessity of an integrated, multi-sectoral approach to waste governance in Karachi. By implementing these recommendations, policymakers can improve waste management efficiency, reduce environmental and public health hazards, and establish a resilient framework that aligns with principles of sustainable urban development.



## Annexures

### Annex A- Speakers Profile

#### **Shiza Aslam**

##### ***Research Head, Karachi School of Business & Leadership***

Shiza Aslam is an industrial ecology expert with over five years of experience in material accounting, assessments, and just transition. Currently, she serves as the Research Head at the Circular Plastic Institute at Karachi School of Business and Leadership, a partner at Ouroboros Waste Management, and a doctoral researcher at Leiden University.

#### **Dr. Muhammad Imran Shahzad**

##### ***Chairman and Head, Earth & Atmospheric Remote Sensing Lab (EARL)***

Dr. Muhammad Imran Shahzad is an accomplished academic and researcher specializing in Earth and Atmospheric Remote Sensing and Geographic Information Systems (GIS). He serves as an Associate Professor and Head of the Department of Meteorology at COMSATS University Islamabad, with over a decade of experience advancing geospatial technologies.

#### **Dr. Suneela Ahmed**

##### ***Architect, Indus Valley School of Art and Architecture***

Dr. Suneela Ahmed is an architect, urbanist, and academic based in Karachi, Pakistan. Her work focuses on how communities in the Global South adapt architectural, urban, and rural spaces, exploring the impacts of globalization, localization, and informalization. She holds a PhD from Oxford Brookes University and currently heads the Department of Architecture at Indus Valley School of Art and Architecture.

#### **Charlie Fenn**

##### ***Programme Manager, Open Burning, Engineering X, Royal Academy of Engineering***

Charlie Fenn has over five years of experience in managing international programs addressing global challenges. Currently, he works at Engineering X on a programme tackling open burning of waste, advocating for policy changes, engaging stakeholders, and supporting global projects through a grant scheme aimed at building evidence, raising awareness, and driving impact.

#### **Dr. Mansoor Ali**

##### ***Theme Lead, Waste Burning Programme, Royal Academy of Engineering***

Dr. Mansoor Ali is the Theme Lead for the Waste Burning Programme at the Royal Academy of Engineering, UK. He is currently leading the UK government (FCDO) funded 'Dar es Salaam Urban Resilience Project.' With over 40 years of experience in research, training, and project implementation, his work focuses on improving waste management in developing countries.

# Annex B- Workshop Pictures

