Engineering X

Founded by the Royal Academy of Engineering and Lloyd's Register Foundation

Data sets, new knowledge and analysis: a learning resource

Sam Barker, LR Foundation Impact Review, 2022

Royal Academy of Engineering

LR Foundation

DATA SETS, NEW KNOWLEDGE AND ANALYSIS

Thematic learning resource

THE CHALLENGE

Open burning of waste, responsible for around 11% of global carbon emissions, accelerates climate change and contributes to serious respiratory, dermatological, and developmental health issues. It is largely a symptom of inadequate waste management systems, leaving many communities with no option but to burn their waste. Other drivers include low awareness of health risks and misconception about the benefits of pest control or resource recovery. The practice deepens existing inequalities and disproportionately harms the most vulnerable, including informal waste workers, women, children, and people living in or near dumpsites. Despite these impacts, waste management is often deprioritised in national, municipal, and city budgets and received only an estimated 0.41% of overseas development finance between 2003 and 2021.

In 2022, Engineering X launched the first global grant scheme dedicated to addressing the open burning of waste. The projects successfully raised awareness, collected and shared critical data and information, delivered initiatives that generated tangible community-level impact and brought national and international stakeholders together.

THE GRANT PROJECTS

Mapping of Open Burning of Municipal Waste in Pakistan and Identification of Underlying Factors and Key Drivers

Project lead: Circular Plastics Institute at Karachi School of Business and Leadership

Open Burning of Municipal Solid Waste in Sri Lankan Harbours

Project lead: University of Central Lancashire

Upscaling Awareness and Waste Characterisation in Remote Bedouin Communities of Jordan

Project lead: Applied Sciences Private University

Evidence and impacts of open burning of cables in Brazil

Project lead: São Paulo State University

The Gendered Dimensions of Open Waste Burning

Project lead: ImpaXus

THE THEME

The lack of available data on where, what and how much waste is currently being burnt, means that the true scale of the problem is unknown. Collecting accurate data on the open burning of waste is challenging as the practice is informal, widespread, often short-lived and prohibited in many contexts. Waste fires are abrupt, occur over large areas and are rarely reported. In addition, current remote-sensing tools have limits that make detection difficult. Under the theme data sets, new knowledge and analysis, the projects began the difficult task of collecting new data, filling information gaps, and developing new approaches to analyse and present data to decision makers.

Dandora Dumpsite, 2023

DATA SETS, NEW KNOWLEDGE AND ANALYSIS

Thematic learning resource

PROJECT LEARNINGS AND INSIGHTS

Mapping open burning hotspots is essential, but approaches varied across projects. **Tools such as Geographic Information System and satellite imagery proved to be valuable in building a strong evidence base.** For example, geospatial analysis was used in Pakistan to detect previously undocumented burning hotspots in Lahore and Karachi. By comparing satellite imagery across different times and seasons, temporal and typological patterns in open burning were discovered. The project team was also able to segregate the data into household and neighbourhood levels, by observing two types of fire incidents: small or big. In the mapped area, the project team observed that small fires occurred more frequently and in areas where there are no waste management services at all and big fires are more likely to occur in neighbourhoods where waste management services exist but are inefficient. The limited data on the open burning of waste also means the true scale of its impact on people is unknown. However, by using GIS and satellites the project team was able to map the trajectories of pollution caused by the open burning of waste and identify which communities are most affected. This data is vital to inform more targeted interventions. **Pixel-level analysis offered a scalable way to infer the types of waste being burned, reducing reliance on time-intensive physical waste studies.** Pictures of the burning waste were taken, and each type of plastic, textile, and other waste was manually identified and counted. The data was extrapolated and further analysis was conducted to determine the waste composition, mirroring what would typically be produced during a physical audit. This could be a promising tool for future waste assessments, especially for municipalities or stakeholders with limited resources.

Sam Barker, LR Foundation Impact Review, 2022

However, the use of aerial technology is not always possible. For example, when mapping the burning of fishing waste in Sri Lankan harbours, another project team planned to use drones but were prevented from doing so due to government restrictions and instead had to survey the harbour on foot. **Generating reliable data in dynamic environments requires flexible, adaptive methods rather than rigid tools such as fixed questionnaires.** Through collaboration with experienced academics, motivated students and autonomous data collectors, the project's team shifted toward **informal interviews and context-based conversations, which produced richer and more accurate data**. For example, the team found that fisherfolk were more comfortable talking on their boats rather than on land. Meeting people in spaces where they felt comfortable made a big difference. **Cultural expectations and trust in officials also played a big role**. In some places, simple suggestions, such as placing plastic in a designated area, was met with resistance because it was assumed authorities would use it as an excuse to impose fees. Door-to-door questionnaires also proved effective for collecting data in a project focused on remote Bedouin communities in Jordan, though not without significant challenges. Conducting research in these areas required the team to navigate sensitive cultural norms, obtain permission from local leaders, and build trust through partnerships with local non-governmental organisations. In such remote settings, **meaningful engagement demands a deeper level of communication and cultural understanding than is typically required in standard field studies.**

> *"To our knowledge, this was the first project to investigate the social impacts of open cable burning in Brazil, and it led us to a much broader investigation than initially expected. Personally, the project had a profound impact on me: direct contact with people living in social vulnerability, often desperately seeking some form of support, was difficult to witness but also became a strong motivation to keep producing knowledge and pursuing solutions that may help improve their lives."*
>
> - Antonio Carlos Varela Saraiva, Awardee, São Paulo State University

DATA SETS, NEW KNOWLEDGE AND ANALYSIS

Thematic learning resource

Partnering with an established local organisation that is already active in the sector can help mitigate cultural and contextual barriers to data collection. However, even with such partnerships in place, **researchers may still need to balance ambition with feasibility and accept that only a limited dataset can sometimes be obtained.** For example, a project in São Paulo, Brazil found that gathering data on the open burning of electrical cables was particularly challenging. The practice is largely informal, sometimes associated with copper theft, and involves vulnerable individuals who may be distrustful of research activities and, in some cases, present safety concerns for interviewers. Collaboration with a local environmental organisation helped to address some of these challenges however, data collection remained constrained.

The adverse effects of the open burning of waste disproportionately affect women, yet so little data is disaggregated by gender. Addressing this gender-blind spot is critical to prevent the practice in both household waste management and the informal waste sector, two domains where women play a significant role. There is a need for gender-disaggregated data that accurately reflects reality and informs effective policy-making while supporting holistic development. The projects found that **gender-disaggregated data provided behavioural insight**, showing how motivations for burning differ between men and women and highlighting opportunities for more tailored community engagement. For example, a project in the Dominican Republic used ethnographic interviews, focus group discussions, and Trials of Improved Practices, a participatory method for testing and refining new behaviours in real world settings, to better understand gender differentiated waste management needs. Through this process, the team discovered that anecdotal evidence showed that the open burning of waste is often shaped by women's concerns about modesty and privacy.

KEY LEARNINGS

- Technology can efficiently map open-burning hotspots and help build a robust evidence base through tools such as Geographic Information Systems, satellite imagery, and pixel-level analysis.
- Generating reliable data in dynamic environments requires flexible, adaptive methods rather than rigid tools such as fixed questionnaires. Informal interviews and context-based conversations can produce richer and more accurate data.
- Cultural expectations and trust play a big role in data collection. Meaningful engagement demands a deeper level of communication and cultural understanding.
- Partnering with an established local organisation can help mitigate cultural and contextual barriers, particularly when engaging with hard-to-reach stakeholders such as waste pickers and waste collectors.
- Researchers may need to balance ambition with feasibility and accept that only a limited dataset can sometimes be obtained.
- Gender-disaggregated data provides behavioural insight, showing how motivations for burning differ between men and women and highlighting opportunities for more tailored community engagement.

SOURCES:

These key learnings were prepared using information from interviews with the project team, documents supplied by the Academy including reports, and additional online resources.

Learn more about the grant projects and their impact:

ASPU: Project website

FUNDUNESP: The scenario of copper smelting in Brazil: evidence and impacts of open-air burning of cables for copper wire extraction

ImpaXus: The gendered dimensions of open waste burning: A case study of Samaná Province, Dominican Republic, and USAID's Clean Cities, Blue Ocean program

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

Engineering X is a growing collaboration founded by the Royal Academy of Engineering and Lloyd's Register Foundation.

Royal Academy of Engineering
Prince Philip House, 3 Carlton House Terrace, London SW1Y 5DG
For more information: https://engineeringx.raeng.org.uk/seel