United Nations | Department of Economic and Social Affairs

unosd.un.org

The Waste Crisis:

Accelerating National to Local Policy Action

Evidence-based strategies for sustainable solutions

The Waste Crisis:

Accelerating National to Local Policy Action

Evidence-based strategies for sustainable solutions

United Nations | Department of Economic and Social Affairs

This publication was developed as part of a new policy support initiative by the United Nations Office for Sustainable Development (UNOSD) under the Division for the Sustainable Development Goals of the United Nations Department of Economic and Social Affairs (UN DESA) to assist United Nations Member States in national policy, capacity and data for solid waste management and resource circularity.

Suggested citation: United Nations Department of Economic and Social Affairs (2024). The Waste Crisis: Accelerating National to Local Policy Action. Evidence-based strategies for sustainable solutions.

COVER PHOTOGRAPH: © Sara Castro-Hallgren
SWEDEN: A second life for plastics – A local plastic waste recycling facility sorts plastics into colours to ensure a value chain for reusing plastics and minimizing the waste footprint in Europe.

Acknowledgements

This report was prepared by Jeffrey Seadon, Environmental Scientist, with significant contributions from UNOSD-UNDESA: Sara Castro de Hallgren, Sustainable Development Officer, Emily Carroll, Policy Development and Coordination Expert and Chaela Shin, Policy Expert, with support from Wonju Kim, Team Assistant, under the overall guidance of Chun Kyoo Park, Head of Office. The authors wish to thank the following:

Reviewers

Listed in alphabetical order.

Global Alliance for Incinerator Alternatives (GAIA): Doun Moon, Policy and Research Officer (Expert Group Meeting (EGM) participant).

Global Green Growth Institute (GGGI): Dukwoo Jun, Circular Economy COP Lead and Trust Fund Coordinator (EGM participant).

Korea Environment Corporation (K-eco): Saerok Hong, Assistant Manager; Seunghoon Lee, Director; and Kanguk Seo, Junior Researcher (EGM participant) and Jungmok Yang, Director (EGM participant) – (Ecoplus Development and Research).

Ministry of Sanitation and Water Resources of Ghana: Godfred Fiifi Boadi, Senior Programmes Manager for Solid Waste (EGM participant).

Ministry of Natural Resource and Environment of Viet Nam: The Chinh Nguyen, Senior Environmental and Natural Resource Policy Consultant (EGM participant).

United Nations Department of Economic and Social Affairs (UNDESA): Amson Sibanda, Chief, National Strategies and Capacity Building Branch, Division for Sustainable Development Goals; Marcus Newbury, Statistician, and Reena Shah, Chief, Environment Statistics Section, United Nations Statistics Division.

United Nations Environment Programme (UNEP): Maria Hughes, Associate Expert on Circular Economy, Regional Office for Asia and the Pacific (EGM participant); Takehiro Nakamura, Head, and Daniel Ternald, Programme Officer, International Environmental Technology Centre.

United Nations Human Settlements Programme (UNHABITAT): Flavia Biri, Solid Waste Management Officer, and Francesca Calisesi, Associate Officer (Solid Waste) (EGM participant).

United Nations University Institute of Advanced Studies (UNU-IAS): Mahesti Okitasari, Consultant.

University of Utah: Nicole Codd, Graduate Program of Public Health.

World Bank: Junu Shrestha, Senior Environmental Specialist.

Expert Group Meeting (EGM) Participants

In November 2023, an Expert Group Meeting was held to contribute to designing improved research and policy support on strengthening circular approaches and zero-waste societies in target countries through a multi-year process. We are grateful to all participants as this publication benefited greatly from their knowledge and experience.

Note: Participants listed under the previous categories have not been listed again.

Federal Environment Protection Authority of Ethiopia: Kassahun Tsegaye Demessa, Senior Environmental Compliance Expert.

International Alliance of Waste Pickers: Kabir Arora, Asia Pacific Coordinator and Advocacy Lead.

Korea Environment Corporation (K-eco): Kyung Pyo Lee, K-eco, Assistant Manager.

Ministry of Environment of Cambodia: Sansreypov Ngan, Chief Officer; and Sokun Meas, Chief of Office.

Ministry of Energy Transition and Sustainable Development of Morocco: Bouchra Fari, Head of Foresight Service.

Ministry of National Development Planning of Indonesia: Asri Hadiyanti Giastuti, Planner; and Medrilzam Medrilzam, Director of Environment.

Institute of Strategy and Policy on Natural Resources and Environment of Viet Nam: Thi Hien Hoang, Researcher.

United Nations Centre for Regional Development (UNCRD): Choudhury Rudra Charan Mohanty, Environment Programme Coordinator.

United Nations Institute for Training and Research (UNITAR): Maya Valcheva, Programme Officer of Green and Circular Economy Learning.

United Nations Office for Sustainable Development (UNOSD): Livia Aurelia, Research Assistant; and Seung Gyo Kim, Research Assistant.

World Bank: Sojin Jung, Consultant.

Supporting Partners

This report would not have been possible without the support of the Korea Environment Corporation (K-eco), Ministry of Environment, Republic of Korea.

Contents

List of Tables

List of Figures

Acronyms and Abbreviations

EGM	Expert Group Meeting
EPR	Extended producer responsibility
GHG	Greenhouse Gas
IPLA	International Partnership for Expanding Waste Management Services of Local Authorities
ISWM	Integrated Solid Waste Management
MEA	Multilateral Environmental Agreement
MSW	Municipal Solid Waste
OECD	Organisation for Economic Co-operation and Development
POP	Persistent Organic Pollutant
PSS	Policy Support System
SDG	Sustainable Development Goal
USA	United States of America
USD	United States Dollar
UN	United Nations
UN DESA	United Nations Department of Economic and Social Affairs
WaCT	Waste Wise Cities Tool
WEEE	Waste from electrical and electronic equipment

Glossary

3R	Reduce, reuse and recycle
Compostable (materials)	Mixture of organic garbage and degradable trash with soil, in which bacteria in the soil break down the garbage and trash into organic fertilizer (UNSD 1997).
Composting	A biological process that submits biodegradable waste to anaerobic or aerobic decomposition, and that results in a product that is recovered and can be used to increase soil fertility (UNSD 2022).
Controlled Landfilling	Final placement of waste into or onto the land in a controlled landfill site (UNSD 2022).
Controlled Facilities	This term refers to Sustainable Development Goal indicator 11.6.1 on Municipal Solid Waste Managed in Controlled Facilities, which measures the proportion of municipal solid waste collected and managed in controlled facilities out of the total municipal waste generated. For a facility to be considered controlled, it needs to have reached at least an intermediate level. The level of control for a particular facility can be assessed using qualitative criteria including 1) degree of control over waste reception and general site management; 2) degree of control over waste treatment and disposal and 3) degree of monitoring and verification of environmental control. A score of at least 10 on each criterion is the threshold required to be considered as 'controlled'. International data collection efforts (e.g., UNSD/ United Nations Environment Programme Questionnaire on Environment Statistics-Waste Section) exclude waste from municipal sewage network and treatment, municipal construction and demolition waste from the definition of Municipal Solid Waste. Possible data collected for this SDG indicator, if allowed for disaggregation by these categories can enable reporting for both the SDG and for other international reporting (e.g., UNSD/ United Nations Environment Programme Questionnaire). For further information see: https://unstats.un.org/wiki/display/sdgehandbook/indicator+11.6.1
Design for Recycling	The process by which companies design their products and packaging to be recyclable (see Recycling) (UNEP 2024a).
Energy Recovery	Production of useful energy from waste through direct and controlled combustion or gasification (ISO 2023).
Environmental Impact Assessment	Analytical process that systematically examines the possible environmental consequences of the implementation of projects, programmes and policies (UNSD 1997).
Extended Producer Responsibility (EPR)	Environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. An EPR policy is characterized by a) the shifting of responsibility (physically and/or economically; fully or partially) upstream towards the producer and away from government or municipalities; and b) the provision of incentives to producers to take into account environmental considerations when designing their products. An EPR can be only financial or can be financial and operational depending on national laws (ISO 2022).

E-Waste	Electronic waste, or e-waste, refers to all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intent of re-use (UNSD 2022).
Food Waste	Food that is discarded along the food chain; The food waste that is generated along the foodchain from production, distribution, retail and consumption (ISO 2022).
Hazardous Waste	Hazardous waste refers to the categories of waste to be controlled according to the Basel Convention on the control of transboundary movements of hazardous waste and their disposal (UNSD 2022).
Household Waste	Waste material usually generated in the normal functioning of households (UNSD 2022).
Illegal Dumping	Disposal of waste without legal permission, in violation of national laws (ISO 2022).
Incineration	The controlled combustion of waste with or without energy recovery (UNSD 2022).
Incineration with Energy Recovery	Incineration in which evolving thermal energy is used for the production of steam, hot water or electric energy (UNSD 2022).
Informal Sector	Sector where workers and economic units are involved in solid waste collection, especially municipal solid waste collection, focused on recovery and recycling activities which are – in law or in practice – not covered or insufficiently covered by formal arrangements and public services (adapted from UNEP 2024a).
Integrated Solid Waste Management	Well planned and connected services including waste collection, storage, recycling, transfer, treatment and disposal activities resulting in a cost effective, efficient, functional and environmentally sound waste management system (ISO 2022).
International Agreements	Agreements concluded between states in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments, and whatever its particular designation. • **Multilateral Environmental Agreements (MEA)** Legally binding instruments between two or more nation States, dealing with environmental aspects. Most MEAs have been adopted after the 1972 United Nations Conference on the Human Environment (UNCHE). The United Nations Framework Convention on Climate Change (UNFCCC), Convention on Biological Diversity (CBD) and the Convention to Combat Desertification (UNCCD) are some of the most significant examples of MEAs at global level, forming the international legal basis for global efforts to address these environmental issues (UNEP 2024c).
Landfill	Final placement of waste in or on the land in a controlled or uncontrolled way according to different sanitary, environmental protection and other safety requirements (UNSD 1997).
Landfilling [e.g. controlled landfills and sanitary landfills]	Any final treatment or disposal different from recycling, incineration and landfilling. Examples include physical/chemical treatment, biological treatment, releasing into water bodies and permanent storage (UNSD 2022).

Leachate	Liquid that results from water trickling through wastes. Leaching may occur in farm areas, feedlots and landfills, and may result in hazardous substances entering surface water, groundwater or soil (UNSD 1997).
Marginal Social Value	The satisfaction society experiences associated with a specific good, plus or minus overall environmental and social costs or benefits
Municipal Solid Waste	Municipal waste, collected by or on behalf of municipalities, by public or private enterprises, includes waste originating from: households, commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings). It also includes bulky waste (e.g., white goods, old furniture, mattresses) and waste from selected municipal services, e.g., waste from park and garden maintenance, waste from street cleaning services (street sweepings, the content of litter containers, market cleansing waste), if managed as waste. The definition excludes waste from municipal sewage network and treatment, municipal construction and demolition waste (UNSD 2022).
Non-Recyclables	Waste that does not meet the definition of "recyclable" with current and available technology in the country or area
Open Burning	Outdoor burning of wastes such as lumber, scrapped cars, textiles, sawdust and so forth (UNSD 1997).
Organic Waste	Biological waste from plants or animals (ISO 2022).
Plastic Waste	Discarded material which contains as an essential ingredient a high polymer. Plastic waste can be recycled via mechanical recycling, chemical recycling and organic recycling and for energy recovery (ISO 2022).
Pollution Abatement (Pollution Control)	Technology applied to control pollution or measure taken to reduce pollution and/or its impacts on the environment. The most commonly used technologies are scrubbers, noise mufflers, filters, incinerators, and composting of wastes (UNSD 1997).
Polyethylene Terephthalate (PET)	Polymer made by the polycondensation of ethylene glycol and terephthalic acid or dimethyl terephthalate (ISO 2022).
Private Partnership Partnerships (PPPs)	A contractual agreement between a public agency (federal, state, or local) and a private sector entity. Through such an agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility (UNEP Glossary).
Private Sector	Part of a country's economy which consists of industries and commercial companies that are not owned or controlled by the government.
Public Policy	Actions taken by a government including regulatory, legal, and public programming, as well as national strategies or plans, to ensure a public outcome or goal is achieved.
Recyclable	Characteristic of a product or associated component that can be diverted from the waste stream through available processes and programmes and can be collected, processed and returned to use in the form of raw materials or products (ISO 2022).

Recycling	Any reprocessing of waste material in a production process that diverts it from the waste stream, except reuse as fuel. Both reprocessing as the same type of product, and for different purposes should be included. Recycling within industrial plants i.e., at the place of generation should be excluded (UNSD 2022).
Resource circularity (see also Circular Economy)	Economic system that systematically maintains a circular flow of resources, by regenerating, retaining or adding to their value while contributing to sustainable development (ISO 2022). Circular economy includes the circularity of resources such as water, waste, energy and other materials.
Safe Disposal	Ensuring that any waste that reaches its end-of-life is disposed of in a way that does not cause leakage of waste or chemicals into the environment, does not pose hazardous risks to human health and, in the case of landfills, is contained securely for the long-term (UNEP 2023a and Pew Charitable Trusts and Systemiq 2020).
Sanitary Landfill	An engineered facility for the disposal of solid waste on and in a controlled manner (UNEP 2024a).
Solid Waste (see also Municipal Solid Waste)	Useless and sometimes hazardous material with low liquid content. Solid wastes include municipal garbage, industrial and commercial waste, sewage, sludge, wastes resulting from agricultural and animal husbandry operations and other connected activities, demolition wastes and mining residues (UNSD 1997).
Stakeholder	Interested party; person or organization that can affect, be affected by, or perceive itself to be affected by a decision or an activity (ISO 2024).
Technosphere	Encompasses all of the technological objects manufactured by humans
Urban vs. Rural	The classification of urban versus rural is in alignment with the United Nations Statistics Division, which allows countries to use their own approaches for distinguishing urban and rural areas according to their individual circumstances (UNEP 2023 and The Pew Charitable Trusts and Systemiq 2020).
Ward data	Data that is obtained from a division or district of a city or town, and typically used for electoral or administrative purposes
Waste Management	Collection, transport, treatment and disposal of waste, including the after-care of disposal sites (UNSD 2022).
Waste Management Plan	Plan describing how to minimize, handle, treat, and offload waste (ISO 2022).
Waste Recovery	Retrieval or treatment of waste for reuse or recycling as another product (ISO 2022).
Waste Trafficking (Illegal Trade)	Any transboundary movement of hazardous wastes or other wastes: (a) without notification pursuant to the provisions of the Basel Convention to all States concerned; or (b) without the consent pursuant to the provisions of this Convention of a State concerned; or (c) with consent obtained from States concerned through falsification, misrepresentation or fraud; or (d) that does not conform in a material way with the documents; or (e) that results in deliberate disposal (e.g. dumping) of hazardous wastes or other wastes in contravention of the Basel Convention and of general principles of international law (InforMEA and the Basel Convention).

Executive Summary

Introduction

Growing levels of waste and pollution are jeopardizing our ecosystems and affecting human health globally. In 2022, UN Member States agreed on a resolution to create a legally binding agreement by 2024 to end plastic pollution, while also adopting a resolution proclaiming 30 March as the International Day of Zero Waste.[1] With an urgent call-to-action voiced by Member States during the first High-Level Meeting of the United Nations General Assembly on Zero Waste held on 30 March 2023, the international community recognized the pressing need to address the escalating crisis of poor and inadequate waste management that is affecting the health of people, ecosystems, and economies.

With 2 billion tons of municipal solid waste generated annually and projections indicating a potential doubling of this figure by 2050, the severity of the pollution crisis cannot be overstated. Stressing the necessity for immediate and concerted action, the United Nations can support Member States in developing comprehensive strategies to combat waste on multiple fronts given challenges and opportunities for ensuring sustainable waste management.

In this context, the United Nations Office for Sustainable Development (UNOSD), under the Division for Sustainable Development Goals of the United Nations Department for Economic and Social Affairs (UN DESA), is leading a policy support initiative for United Nations Member States to strengthen evidence-based policymaking, data, capacity and governance systems for integrated solid waste management and resource circularity. As a key step in orienting policy support, this report assesses the current and future state for solid waste management from national to local level. The report addresses the interlinkages between our current global production and consumption systems, which has led to a waste crisis requiring renewed attention on sustainable waste management policy and practice. Developed through a consultative process with inputs from experts drawn across Member States, the United Nations, and civil society, the report reviews current sustainable waste management policies and explores future policy scenarios to accelerate progress toward the Sustainable Development Goals (SDGs) and a zero-waste future.

Key statistics

- Humanity generates an estimated 2.3 billion tons of municipal solid waste (MSW) annually and waste generation could rise by more than 77 per cent by the end of 2050.[2]
- Only 62 per cent of MSW is managed in controlled facilities across the world.[3]
- Approximately, 90 per cent of waste in low-income countries is discarded in unregulated dumps or burned openly.[4]
- The waste sector contributes an estimated 20 per cent of human-caused methane emissions.[5]

These trends and statistics underscore an alarming situation that disproportionately affects poor and vulnerable communities, particularly women and children working informally in waste picking. Inadequate data potentially underestimates the waste crisis and limits the reach and impact of policy for these communities and the ability to address negative environmental externalities.

1 UN (2022).
2 UNEP (2024a).
3 Ibid.
4 World Bank (2019).
5 NASA (2022).

While waste is directly related to key targets under the 2030 Agenda's Sustainable Development Goals, waste management and resource circularity impacts all 17 SDGs. Improving national waste management is essential to confront the triple planetary crisis of pollution, biodiversity loss and climate change.

A focus on the informal sector needs to be a priority in developing countries to ensure the principles of Leaving No One Behind can be fully achieved. This sector operates primarily because there is economic benefit for the workers in collecting and separating waste and selling materials. Gender differences and the vulnerability of women and children is particularly apparent in the sector, which attracts women and youth unable to find decent work in the formal sector. This striking reality urgently calls for national governments to accelerate progress on formulating and implementing evidence-based policies for a waste to resources approach, including waste management, recovery, and recycling systems.

I. Background

Changing Waste Composition amid Development

Globally, organic waste from food and other sources comprises the largest component of waste, followed by paper, cardboard, and plastics. As households and economies increase their level of development, the composition of waste also changes. The rise in plastic waste is particularly alarming, with significant amounts entering aquatic ecosystems. In response to the plastic pollution crisis, UN Member States endorsed a resolution in 2022 to address the full life cycle of plastic and establish an international legally binding agreement by 2024 to end plastic pollution.

The life cycle of solid waste involves generation, collection, transport, sorting, recycling, recovery, treatment, and disposal. Effective management requires collaboration between local and national governments according to this waste hierarchy. Key lessons from multilateral engagements include:

- Adopting a whole value chain approach to view waste as a resource.
- Integrating resource efficiency into macro-economic policies.
- Promoting eco-industrial parks and regional infrastructure.
- Formulating policies for partnerships to expand markets for environmentally sound goods.
- Diverting waste from landfill to recycling and recovery facilities.
- Fostering a culture of science, innovation, and technology for policy development.
- Supporting research on statistical improvement, material flows, and resource productivity.
- Promoting local government cooperation for integrated production and consumption systems.
- Developing facilities to manage disaster waste in an environmentally sound manner.
- Advocating for a national approach to circular economic development.

The Waste System

Developing countries face significant challenges in waste management, including limited data, inadequate funding, and insufficient technology. Insufficient systems lead to adverse health outcomes, environmental damage, and substandard development pathways. Key barriers to effective waste management include complexity, lack of urgency, data deficiencies, underestimated climate impacts, lack of inclusion, undervalued informal sector, inadequate legislation, weak local enforcement, and insufficient funding mechanisms.

Globally, 16 per cent of MSW remains uncollected, with 39 per cent managed in uncontrolled facilities. The highest proportions of uncontrolled disposal occur in Sub-Saharan Africa, Central and South Asia, Central America, the Caribbean, and Oceania.

There are complex challenges for governments in improving waste management practices. Key challenges relate to data collection, financial mobilization, and behavioural change targeting different income levels and social norms.

The Importance of Waste Management Data

Acquisition of data is critical to provide information on the current state of the waste system as well as future trends and the successes of waste management programmes. However, an in-depth understanding of waste-related issues is hindered by the lack of relevant waste data, with particularly inadequate data collection in low- to middle-income countries. The United Nations and international community have made significant progress in developing tools especially for municipal-level data collection, but more national data with comprehensive policymaking and investment is required to tackle a fast-growing challenge.

Data from the United Nations Statistics Division's Country Files shows that higher income countries collect data on waste frequently, while data from low-income countries is approximately 15 years old. The importance of this data is that it enables informed decision-making, allows for trends to be identified and hence resource allocation. Robust data also contributes to an enabling environment to attract financial investment.

Limited data availability also poses significant challenges for the waste-related Sustainable Development Goal indicators - namely (11.6.1, 12.3.1, 12.4.1, 12.4.2, 12.5.1 and 14.1.1). SDG 11 (Sustainable Cities and Communities), which includes urban solid waste data, has the most insufficient data of all SDGs. For the other two SDGs principally related to waste: SDG 12 (Responsible Consumption and Production) shows progress, but an acceleration is needed especially to close gaps related to key targets on national recycling and resource efficiency. On the other hand, SDG 14 (Life Below Water) shows specific challenges related to indicator 14.1 on marine plastic debris density.

Financing a Waste to Resources Transition

The economic benefits of instituting an integrated waste management system extend across various facets of the economy. A variety of sources can provide means to fund waste management programmes, including international finance, private sector participation and community contributions. Investing in environmentally sound waste management will enable the creation or expansion of a formal waste industry with associated decent employment, environmental management, and advancement opportunities. Important aspects for financing waste management initiatives include full cost accounting, gaining the finance, and investigating financial incentives.

Development of a case for finance should include a full cost accounting approach to highlight the economic, social, and environmental costs and benefits. To move to a zero-waste society, a price component needs to be included at all stages of the life cycle, and a system of incentives and disincentives can be utilized to help guide people's choices. To consider the full cost of waste, accounting needs to start at the beginning of the life cycle, from the extraction of raw materials from the Earth (air, water, and land) that are then transformed through manufacturing, transportation, use, and finally reach the end-of-life stage.

II. Next Steps for Policymakers

Developed countries have made significant progress toward a circular economy, while many developing countries struggle with basic services. Effective waste management requires coordinated efforts across national and local levels, integrating waste as a resource throughout its life cycle. Involving the informal sector and addressing socio-economic differences are critical for successful waste management policies.

Limited data availability poses challenges for waste-related SDG indicators. A systems approach, focusing on the entire life cycle of waste and leveraging data for behavioural change, is essential.
To manage the waste crisis, policymakers should develop evidence-based public policies guiding the adoption of science, technology, and innovation, financing mechanisms, and data management capacity from national to local levels. Key actionable steps that can be taken include:

- Adopt a waste-to-resources mindset across government and society by adopting whole-of-government and whole-of-society approaches.
- Set integrated solid waste management as a national priority, including for growing sources of waste such
- as plastics and waste from electrical and electronic equipment (WEEE or e-waste).
- Assess the current state of solid waste management, through all stages of the life cycle, from national to local levels.
- Ascertain current capacity and needs for governance, science and technology, finance and data management at all levels.
- Engage stakeholders throughout the process, including the informal sector and vulnerable groups.
- Facilitate knowledge-sharing and peer learning opportunities among national and local governments facing similar waste management challenges.
- Define legislation and regulation needs, to support fulfilment of national priorities and international commitments.
- Prepare national budgets and explore funding mechanisms, including through innovative sources.
- Monitor and ensure compliance, including at local level, adopting innovative data sources and methods such as through the use of digital technologies and remote sensing.

The adoption and implementation of these measures will facilitate the transition to sustainable waste management and resource circularity, contributing to global environmental, economic, and social benefits. As data and public governance is strengthened globally, countries, communities and households will be able to truly measure the shift towards zero-waste mitigating humanity's footprint on the Earth for generations to come.

1 The World We Have

MADAGASCAR : Andralanitra dumpsite, Antananarivo. © Emily Carroll

1.1 Background

The United Nations Office for Sustainable Development (UNOSD), serving as a technical arm of the United Nations Department of Economic and Social Affairs (UN DESA), aims to develop a Policy Support System (PSS) on Waste Management and Resource Circularity that can bridge data, technical and capacity gaps to advance resource circularity in solid waste management across developing countries and support waste management plans at the national and local levels.[6] This work builds on the engagement of UN DESA on zero-waste through the International Partnership for Expanding Waste Management Services of Local Authorities (IPLA) from 2011-2015 and responds to resolution A/RES/77/161 Promoting zero-waste initiatives to advance the 2030 Agenda for Sustainable Development.[7]

With the support of the Republic of Korea's Ministry of Environment and its Korea Environment Corporation (K-eco), an Expert Group Meeting on policies for resource circularity and solid waste management to accelerate national to local progress on the Sustainable Development Goals[8] was held in November 2023. The objective of this first meeting was to develop a consultative platform and coordinate a baseline research process to tailor future research and a policy support roadmap. The expert group meeting collected data on the present needs, challenges and accelerated solutions that can measurably improve evidence-based policymaking and data for national to local solid waste management and resource circularity in developing countries. This informs continued design of a policy support system that will allow Member States to self-assess progress on circular approaches to waste management in target countries through a multi-year and multi-stakeholder process. Expert consultations, research and partnerships will continue to inform the development of the system to measurably improve national to local solid waste management and resource circularity data and policy action.

6 Carroll *et al.* (2023).

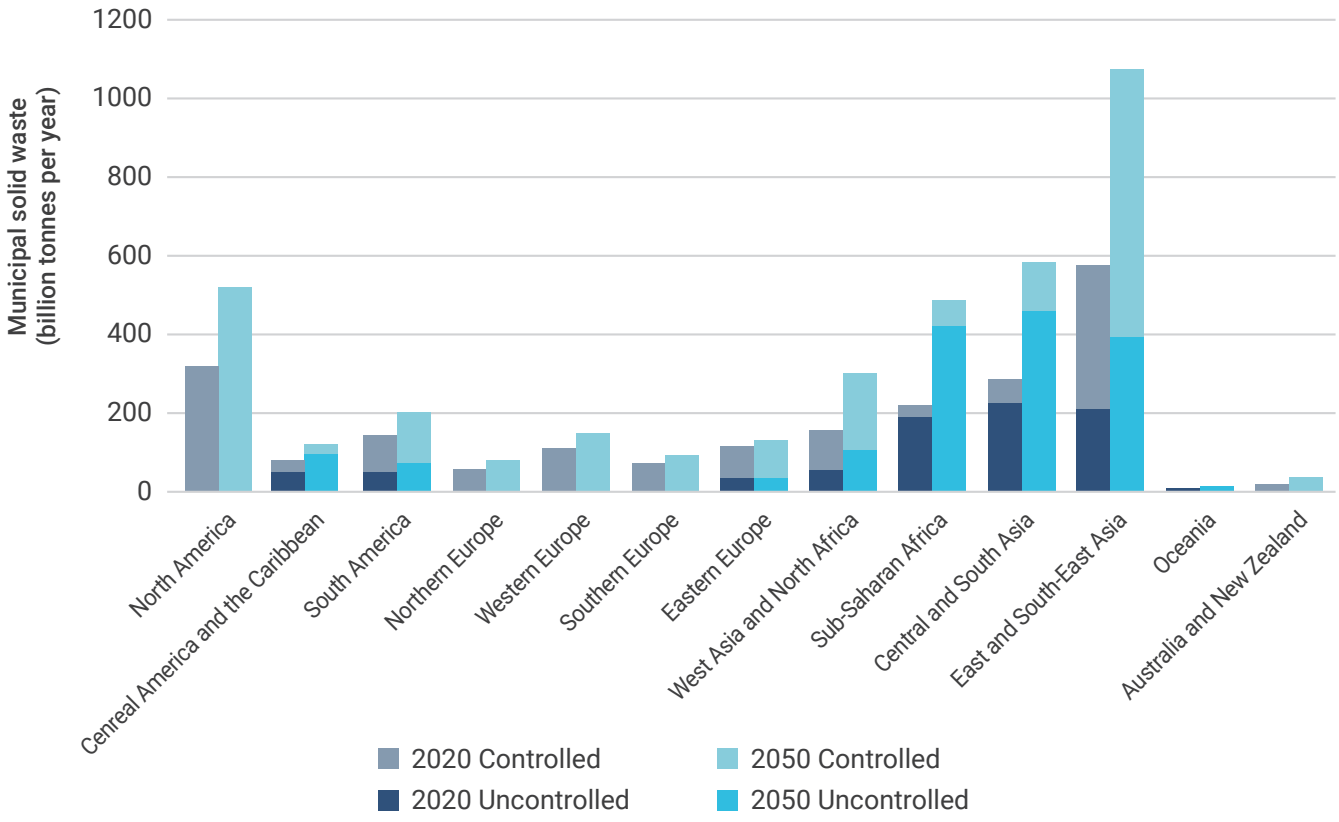
7 United Nations General Assembly (2022).

8 https://unosd.un.org/announcements/2023-expert-group-meeting-policies-resource-circularity-and-solid-waste-management

The objective of this publication, as an outcome of the EGM, is to present baseline evidence and data on current needs, challenges, and barriers for advancing resource circularity and a circular economy in solid waste management policy and governance. Throughout the publication, case study countries have been used to illustrate examples. These countries were chosen with a focus on priority regions and according to the expressed willingness to serve as Policy Support System hub countries for their regions, enabling accelerated action on national capacities to tackle the waste crisis.[9]

Overall waste generation differs markedly around the world depending on regions and income. Projections for 2050 demonstrate that all regions in the world are expected to experience increased waste generation, as shown in Figure 1. From 2020 to 2050, the East and South-East Asia region will continue to generate the greatest quantities of waste. It can also be seen that the capacity for controlled waste is predicted to increase significantly over this period.[10]

Figure 1: Waste projections and distribution by region



Source: UNEP (2024a).

East and South-East Asia is also the hub of the fastest growing economies. The lowest levels of MSW management are found in Sub-Saharan Africa and Central and South Asia. Projected estimates show that globally uncontrolled MSW management will increase slightly, from 38 per cent in 2020 to 41 per cent by 2050. This equates to doubling the current quantities.[11] This diversity and complexity requires regionally tailored and national policy support for governments to ensure effective action on the ground to address the growing solid waste crisis.

[9] Participant nations were chosen for their geographical spread and their receptiveness to enhancing municipal solid waste management.

[10] UNEP (2024a).

[11] UNEP (2024a).

1.2 Global Governance For Solid Waste and Sustainable Development

Waste can be seen as a marker of humanity's planetary impact. The amount of waste generated as countries and regions develop, serves as a data point on the inefficiency of production and consumption models, as well as on the ecological footprint of these. Sustainable development in its core definition compels humanity to ensure natural resources availability for future generations.

Natural resource use and material demand has increased globally since the Great Acceleration, the post-1950 acceleration of industrialization, population growth and other trends marking humanity's impact on the Earth System.[12] This accelerated has also resulted in increasing solid waste generation. Overall, annual global production of plastics increased from 234 to 460 million tons or 97 per cent between 2000 and 2019, while plastic waste increased from 158 to 353 million tons or 126 per cent over the same period. Plastic waste represented 30 per cent of all plastics produced over this period. The end-of-life for plastics showed that only 9 per cent was recycled, 19 per cent was incinerated and 50 per cent went to sanitary landfill. The residual 22 per cent was dumped into uncontrolled landfills, burned in open pits, or leaked into the environment, mainly into waterways.[13] More recently, the COVID-19 pandemic produced a spike in demand for single-use plastic products, which increased levels of plastic pollution.[14]

As key tools for global governance around solid waste and sustainable development, Multilateral Environmental Agreements (MEAs) are instruments that, among other things, enable countries and regions to provide a synchronized response to waste management priorities. Modern MEAs extend from the 1921 Convention concerning the Use of White Lead in Painting to, most recently, the 2017 Minamata Convention on Mercury. Some of the key agreements are shown in Annex 1.

It can be seen in Annex 1, that international conventions were usually agreed on following environmental disasters. A typical progression is shown in the development of the MEA for Prohibiting the Use of White Lead in Painting.[15] The industrial revolution produced a growing realization, starting in the 1830s, that lead poisoning had many effects including anaemia, lead colic, joint and muscle pain, chronic intestinal nephritis, miscarriages and stillbirths.[16] Increased industrialization also brought an epidemic of lead poisoning cases, followed by medical research resulting in a growing realization that lead exposure needed to be minimized.[17] The result was the 1921 Use of White Lead in Painting Agreement which was rapidly ratified by some European countries, although industry pressure in the USA meant that it only ratified the Agreement in 1972.[18]

12 Steffen, W. et al. (2015).
13 OECD (2022).
14 OECD (2022).
15 ILO (1921).
16 Hernberg (2000).
17 Hernberg (2000).
18 ILO (1921); and Hernberg (2000).

As can be seen from Annex 1, the 1970s produced three agreements countering marine pollution which came about following the Tory Canyon grounding in 1967.[19] The 1980s focused on the Earth's atmospheric ozone depletion through human-made chemicals, after it was found that increasingly large ozone holes were a global problem.[20] The same period also brought about a focus on the transboundary movement of toxic wastes that were discovered in Africa and other parts of the developing world.[21] The 1990s saw the development of a more holistic approach to the environment, including waste management, through the adoption of Agenda 21 with local agendas which often included detailed MSW management plans, and the Millennium Development Goals, advancing controls on Persistent Organic Pollutants (POPs), which continued into this century. The impact of climate change is a thread that has been running through the international community since the 1990s and the Kyoto Protocol (adopted in 1997) and Paris Agreement (adopted in 2015) have been significant drivers for waste reduction.

Table 1 below reviews key recent MEAs related to solid waste. Two key agreements are of special note. In March 2022, in response to the threat of growing plastic pollution, United Nations Member States endorsed a resolution, at the sixth session of United Nations Environment Assembly, to address the full life cycle of plastic from its production to end-of-life and to establish an international legally binding agreement by 2024 to end plastic pollution.[22]

Table 1. Recent United Nations multilateral agreements related to solid waste

Year	Agreement	Description
2012	The Future We Want	Prevents waste through innovative public-private partnerships, increased resource efficiency, sustainable management of waste through the 3Rs, environmentally sound chemicals and waste management, promotion of life cycle assessment, and increased waste to energy.
2015	2030 Agenda and The Sustainable Development Goals	While waste management is covered in Goals 11, 12 and 14, there are also many direct links throughout the Goals to accelerate global action on waste prevention, management and circularity as well as its adverse impacts.
2015 (entered into Force in November 2016)	Paris Agreement	Strengthens the global response to the threat of climate change.
2017	Minamata Agreement	Phases out mercury in products and processes; introduces control measures on emissions to air, land and water.
2022	Resolution 5/14	175 Member States at the UN Environment Assembly agree to develop a legally binding agreement to phase out plastic pollution.
2022	Resolution 77/161	Member States agree to promote zero-waste initiatives to advance the 2030 Agenda for Sustainable Development.
2023	High Seas Treaty	Framework for the conservation and sustainable use of marine areas outside of country jurisdiction.
2023	Global Framework on Chemicals - for a planet free of harm from chemicals and waste	Member States agree on a framework, including a roadmap for countries and stakeholders, to collaboratively address the life cycle of chemicals, including products and waste.

Sources: Author's elaboration – Minamata Convention on Mercury (2013); Paris Agreement (2015); United Nations General Assembly (2022); and United Nations (2012; 2023b).

19 International Maritime Organisation (2017).

20 UNEP (n.d. (a)).

21 UNEP (2011).

22 United Nations General Assembly (2022).

Furthermore, in June 2023, the UN High Seas Treaty was adopted, which aims to provide a framework for the conservation and sustainable use of marine areas that fall outside of country jurisdiction. It contains provisions based on the polluter-pays principle requiring countries to evaluate potential environmental impacts of any planned activities beyond their jurisdictions.[23]

1.3 Integrating Targets on Solid Waste across the Sustainable Development Goals

Recognition of the need to move towards a circular economy was seen through integration of the concept into the Sustainable Development Goals (SDGs) with their key economic, social and environmental targets. Waste management is well entrenched into the 17 SDGs as shown in Figure 2, with strong linkages to the other global challenges covered by the goals such as climate change, health, poverty eradication, security, and sustainable consumption and production.

Figure 2: How solid waste management can contribute to the Sustainable Development Goals

Graphic supplied with assistance from Zoë Lenkiewicz, WasteAid UK and contributor to Be Waste Wise.

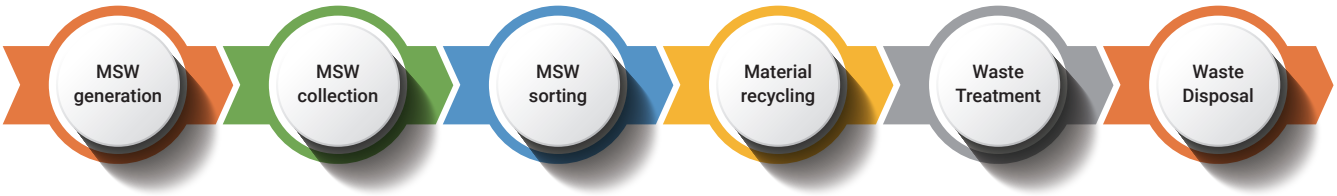
Source: UNEP (2019a).

[23] United Nations (2023b).

1.4 Policy Progress from National to Local

Zero waste policies aim to minimize waste generation and maximize resource efficiency through the application of the waste management hierarchy. The application of tools like extended producer responsibility (EPR), which puts the onus on manufacturers (or importers) to manage the entire life cycle of their products, provides incentives for them to design products that are reusable, easily repairable or recyclable. An integrated solid waste management (ISWM) approach is fundamental to achieve zero waste as it looks at the causes of the waste, and not just its production.[24] Figure 3 outlines the life cycle approach to solid waste management – with the design to use stages encapsulated in the generation phase – though it seems to be a linear approach, it is in fact cyclical, as recycling directs materials back into the manufacturing operation.

Figure 3: Life cycle approach to solid waste management



Source: White, Franke and Hindie (1995).

In Figure 3, it can be seen that the main stages in the life cycle of solid waste comprise generation (by households and industry), collection, sorting, material recycling, and treatment (biological, thermal and physical volume change or recovering materials or energy) and disposal (landfill or incineration).[25] All of these stages commonly concern local government, however, to undertake its roles, local government needs to engage meaningfully with national government.

Focusing on local implementation versus national policies has provided key lessons, based on an analysis of multilateral engagements (for example with the International Partnership for Expanding Waste Management Services of Local Authorities):

1. A whole of value chain approach is needed, where waste is seen as a resource to enable government design and implementation of effective circular economy plans and policies.
2. Integrating resource efficiency into macro-economic development policies can offer competitive solutions to many environmental issues.
3. Promoting innovation networks and innovation centres for resource efficiency, in addition to eco-industrial parks (clusters) and regional infrastructure to support resource optimization and efficiency in industries and small-to-medium enterprises is essential.
4. Formulating and implementing policies to promote partnerships (both multi-layer and public-private) can expand markets for environmentally sound goods and services.
5. Implement policies, especially segregation of waste at source, can divert waste from landfill to recycling and recovery facilities.
6. Initiating a science, innovation and technology-based culture for policy setting and development programmes is challenging but necessary.

[24] Seadon (2006).

[25] White, Franke and Hindie (1995).

7. Supporting government and international collaborative research on statistical improvement, material flows, waste accounting and resource productivity analysis is key.
8. Promoting research and development to address resource efficiency in all types of industry and across local governments and regions to integrate production and consumption.
9. Reuse and recycling facilities to manage disaster waste in an environmentally sound manner must be developed, especially in light of rising climate-related disasters.
10. Promoting a national whole-of-government approach to cooperation with local governments can advance the circular economy and localize sustainable development.

As countries shift from a disposal mentality to viewing waste as a resource, policies are being updated. The concepts of zero waste and a circular economy are replacing waste management. Along with that change, the waste management hierarchy is expanding to, for example, the circular economy hierarchy as shown in Figure 4.

Figure 4: The waste management and circular economy hierarchies

Sources: UNEP (2016a); and Kirchherr, Reike and Hekkert (2017).

There is no single Waste Management Hierarchy, nor a single Circular Economy Hierarchy. The hierarchies in Figure 4 represent one example of these hierarchies drawn from reputable sources, but many other valid hierarchies exist. Of note is that they all roughly follow the same pattern, with slight variations. It can be seen in Figure 4 that Refuse and Rethink are subsets of Prevention, while Reduce, Reuse, Remanufacture and Repurpose are subsets of Reduction. Recycle, Recover and Dispose translate straight across. Both hierarchies are a guide that can break down when outside factors are brought in (e.g. costs associated with processing).

Countries transitioning from a linear to a circular economy are primarily located within Europe, with some developing countries initiating programmes or projects at local level. Examples of this shift in thinking are shown in Table 2.

Table 2. National initiatives in selected countries advancing towards a circular economy

Territory	Year	Initiative	Comment
Brazil	2010	National Policy on Solid Waste (Law No. 12305)	Shared responsibility for product's life cycle among the value chain, and providers of public urban cleaning and solid waste management services.
	2022	National Solid Waste Plan (Decree No. 11043)	Aims to increase the national recycling rate by 14 per cent by 2024 and a total of 48 per cent by 2040.
European Union	2021	EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" (and annexes)	By 2030: • improve water quality by reducing waste, plastic litter at sea (by 50 per cent) and microplastics released into the environment (by 30 per cent); • reduce residual municipal waste by 50 per cent.
Morocco	2019	National Waste Recovery Programme (PNVD)	National programme recognizes natural resource constraints and increasing waste. Law on Extender Producer Responsibility. Planned legal, technical and financial reforms for a circular economy through waste reuse and recovery across cities.
Republic of Korea	2024 (2018)	Act on promotion of transition to circular economy and society (formerly, "Framework act on Resources Circulation")	A comprehensive national to local regulatory framework to promote resource circulation and build the foundation of circular economy and society.
Thailand	2021	Sufficiency Economy and Bio-Circular-Economy Model	Emphasis on applying science, technology and innovation to turn Thailand's comparative advantage in biological and cultural diversity into competitive advantage, focusing on agriculture and food; wellness and medicine; energy, materials and biochemicals; and tourism and creative economy.
Türkiye	2017	Establishment of zero-waste management systems across all 81 provinces	Helped recover 33 million tons of recyclable waste, including 20 million tons of paper and cardboard and 5 million tons of plastic, with gains of US$3.3 billion and savings in energy and water use and storage space.
United States of America	2023	Zero Waste Act (New York City)	Established zero-waste legislation at local level. Complements Washington, DC and many other local efforts across the country.

Sources: Author's elaboration – European Commission (2023); International Energy Agency (2023); Morocco, Ministry of Energy Transition and Sustainable Development (2023); National Science and Technology Development Agency (n.d.); New York City Council (2023); UNEP (2023c); United States of America, Department of Commerce, International Trade Administration (2023).

In addition to national policy actions as shown in Table 2, many civil society organizations are taking a lead in advocating for, and acting on, resource circularity and zero waste across the globe. Some examples are shown in Table 3.

Table 3: Selected civil society organizations involved in resource circularity and zero waste programmes

Country/ Region	Organization	Title	Description
Africa	Action sur l'Environnement et le Développement	Support global efforts to eliminate lead paint	To eliminate lead paint and the risks caused by lead paint specifically for vulnerable populations such as children and pregnant women. Participate in efforts to develop laws and regulations on this subject and collaborate with key stakeholders, such as government, industry, and the health sector for their establishment.
Argentina	Fundación para el Desarrollo Colaborativo	Beehive project	Citizen participation to recover and process urban waste in a distributed manner in the neighbourhoods of the cities, rewarding the citizen for their participation with the JellyCoin cryptocurrency of an economic model supported by the recovered material.
Benin	ONG La Grande Puissance de Dieu	Lead paint is banned in Benin	To eliminate lead paints and the risks posed by such paints, especially to vulnerable populations.
Brazil	Associação Brasileira de Empresas de Limpeza Pública E Resíduos Especiais (ABRELPE)	Integrated MSW Management Towards Mitigation of Short-Lived Climate Pollutants	Support the Brazilian government for public policies that stimulate clean treatment technologies for MSW systems such as composting and anaerobic digestion.
Cameroon	Centre de Recherche et D'Education Pour le Dévelopment (CREPD)	Working for the safe use of chemicals	Eliminate lead paint. Eliminate sources of exposure to lead (non-standard recycling of lead acid batteries). Eliminate sources of exposure to populations and ecosystems with mercury. Eliminate POPs. Prevent water pollution from plastic waste. Manage empty pesticide packaging.
Colombia	Colnodo	Eliminate lead from paints in Colombia	Inform manufacturers about health issues of lead in paint.
Colombia	Red de Desarrollo Sostenible Colnodo	Let's protect our children, it is necessary to ban lead in paint	Produce lead-free paint in Colombia.
Eurasian Economic Union	Eco-Accord	Supporting Global Efforts to Eliminate Lead Paint in the Organisation for Economic Co-operation and Development, Eastern Europe, Caucasus and Central Asia countries	To eliminate lead paints and the risks posed by such paints, especially to vulnerable populations.
European Union	European Environment Bureau	Beat pollution coming from waste	Promoting and improving the concept of Circular Economy, which covers the whole cycle of the product, substance or business model.
Finland	Sitra - The Finnish Innovation Fund	Finland's transition to low-carbon circular economy: Finland's national circular economy road map	Recycle nutrients in foods. New forestry commercial products, services, co-operation models and digital technology. Minimize use of virgin raw materials and maximise length of material and product life cycles. Transport will develop into a seamless, smart system that uses fossil-free fuels.
Georgia	NGO "Gamarjoba"	Supporting Global Efforts to Eliminate Lead Paint	To eliminate lead paints and the risks posed by such paints, especially to vulnerable populations.

Greece	Mediterranean SOS Network	Reduction of single use plastic bags in Skiathos island	Radically reducing single use plastic bags in Skiathos island. Based on an integrated, targeted and continuous raising awareness process.
Haiti	Haiti Cholera Research Funding Foundation Inc	Earthquake in Haiti creates cholera epidemic disease and potential economic disaster: why is it not curable?	Collaborate with Ministry of Environment for solid waste management.
Honduras	The Citizens Parliament (Bunge La Mwananchi)	Transforming society, toward clean pollution free world going green and clean	Become an advocate and whistleblower of factory waste and toxic chemicals that are dumped in waters.
International	Circle Economy	Circularity Gap Report	To create an economic system that ensures the planet, and all people can thrive.
International	Ellen MacArthur Foundation	Develop and promote the idea of a circular economy	To accelerate the transition to a circular economy that benefits people, business and the natural world.
International	International Council for Local Environmental Initiatives	ICLEI Circulars	Facilitates circular economy interventions at the local level.
International	International POPs Elimination Network	IPEN Commitment to continue to support Global Lead Paint Elimination	To eliminate lead paints and the risks posed by such paints, especially to vulnerable populations.
International	Tebtebba Foundation	Innovating on traditional indigenous territory management [specifically Forestry and Agriculture] among the Global Partnership in Forests and Sustainable Development, in pilot villages in 13 countries in Asia, Africa and Latin American	Advocate for sound waste management.
International	Thornley Wildlife Foundation	Global Education & Awareness of human household waste in our local environments.	Educational and networking platform that creates awareness of the many conservation, pollution, and related issues.
Kenya	Centre for Sustainable Development	Support global efforts to eliminate lead paint	Educational and networking platform that creates awareness of the many conservation, pollution, and related issues.
Kenya	E-Waste Initiative Kenya	Improving E-waste management in Kenya	Alternative e-waste collection. Formalize e-waste management practices in the informal sector. Reduce environmental impact by informal sector through training. Increase e-waste recycling levels through community participation and awareness. Develop cost effective methods of recycling and refurbishing e-waste for the informal sector.
Liberia	Youth Bridge	Promoting plastic free environment	Reduce plastic waste through advocacy, awareness and community service development.
Nigeria	Securcycle	Securecycle	Provide environmental education to children and youths in schools. Provide knowledge of how communities can properly segregate waste and work together to provide facilities that will aid proper waste management. Add value to waste, so it can be used back in the production line.
Philippines	Eco-Waste Coalition	Supporting Global Efforts to Eliminate Lead Paint	To eliminate lead paints and the risks posed by such paints, especially to vulnerable populations.

Romania	Entrul de Consultanta Ecologica, Galati Romania Eco Counselling Centre Galati, Romania	To free the planet from pollution and increase the public's awareness of the need to commit themselves to achieving this	To raise public awareness on the need to rethink our lifestyles to get better protection for the environment and secure better healthcare.
Senegal	PAN Sénégal	Removing lead from paint	To eliminate lead paints and the risks posed by such paints, especially to vulnerable populations.
Seychelles	The Ocean Project Seychelles	To educate the public on the issue of marine debris in general, and plastics in particular; and to engage the public to act against marine debris.	Stop debris entering the oceans through coastal clean ups and proper waste disposal. Switch to environmentally friendly, reusable alternatives to single-use plastics using anti-plastic straw and anti-plastic bottle campaigns.
Slovakia	Centre for Sustainable Alternatives (CEPTA)	Air pollution & waste prevention	Composting bio waste; prevention of one-way packaging where possible; food from local, seasonal, and low-chemical production; waste separation for the rest.
St Lucia	Greening the Caribbean	Greening the Caribbean	Expanding existing recycling programs. Implement a measurable litter prevention solution.
Uganda	Masupa Enterprises	Raising awareness on the negative environmental and health impacts of traditional cooking fuels, contributing to behavioural change	Stop cutting trees for charcoal and firewood and turn organic waste into briquettes for fuel.
United Arab Emirates	Emirates Environmental Group	Waste Management	Maximise waste management commitments to contribute to the local action of the UAE to achieve the Sustainable Development Goals. Collect 7 recycling materials. Members are corporates, academics and families, who actively participate in campaigns and deposit large quantities of waste materials.
Viet Nam	Research Centre for Gender, Family and Environment in Development	Supporting global efforts to eliminate lead paint	To eliminate lead paints and the risks posed by such paints, especially to vulnerable populations.

Source: Author's elaboration – Ellen MacArthur Foundation (n.d.); International Council for Local Environmental Initiatives (2024); and UNEP (n.d. (b)).

Analysis of the data in Table 3 shows that eight initiatives occurred in Africa, and Latin America and Caribbean, four in Eastern Europe, and three in the Asia-Pacific region and Western Europe and Other Group. Of the 30 initiatives, 12 focused on lead elimination, four on plastics and three on education. While many types of waste are covered by these programmes, there is an emphasis on information sharing and working with significant stakeholders.

Many of the approaches listed in Table 3 are already adopted in developing countries. For example, 11 of the programmes require separation of waste to some extent. In a 2012 case study, a source separation at the local community level was initiated in Battambang, Cambodia.[26] The case study showed that the 350–400 informal waste workers using pushcarts and motorized carts were able to process, on average, 2 tons of waste daily.[27] The waste was sent to 20 shops across Battambang, where it was collected, stored, packaged and transferred. The waste workers earned USD 5–10 per day while another 50 people scavenged at the city dumpsite earned USD 1–1.25 per day. A composting facility was built to facilitate source separation from three markets, of which one was judged a success and the other two were less successful. The reasons for lack of success were:[28]

- Market management and cleaners did not cooperate resulting in waste separated by vendors being remixed by cleaners during transportation to the collection point. The vendors observed this practice and quickly lost interest in participating in the scheme.
- Insufficient resources – only two workers were appointed at each market to collect separated waste.
- Market vendors demonstrated resistance because they already paid a waste collection fee and were not compensated for doing the extra task of source separation, hence there was little financial incentive to participate.
- Although separate bins were distributed for the organic waste, since the cleaners did not provide adequate collection of the separated waste, the bins were used for mixed waste.

Hence for a programme to work, incentives and disincentives need to be carefully worked out. Another factor to be considered is the pricing mechanism. For example, a waste to resource programme in Kon Tum, Viet Nam, processed an average of 650-680 kg of organic waste per day, producing approximately 1.3 tons of compost monthly.[29] Almost all the compost produced is sold to the local authorities for application in parks and other green spaces and rubber and coffee plantation owners are also clients. The uptake has been limited because waste collection fees in the town are among the lowest in the country and this cannot be matched by the organic waste collection fees.

Learning from the Kon Tum case, Quy Nhon, Viet Nam, a similar composting programme had considerable success. The municipal government instituted the following measures:[30]

- The contracted company had to transport a minimum of 21 tons of rejected waste per month to the landfill.
- Negotiating to obtain waste collection contracts with local establishments such as hospitals and educational institutions.
- Established jointly with stakeholders, a revolving fund to provide transport allowances to local communicators to offset their outreach expenses.
- Distributed communication materials, established an annual ‘recycling day’ and had ongoing communication activities to improve awareness by families, businesses and other stakeholders.

The measures above sought to make the scheme viable by accepting that contamination occurs (and must be managed), focusing on bulk generators and fully supporting a continuing education programme.

26 UNESCAP (n.d.a).
27 Ibid.
28 Ibid.
29 UNESCAP (n.d. b).
30 UNESCAP (n.d. b).

1.4.1 Governance and Policy Structures

For successful solid waste management there must exist policy structures that enable progress at the local level while retaining overall direction at the national level. Table 4 outlines some policy measures undertaken for solid waste management by a selection of developing countries. These countries were chosen for their geographical spread, their potential to become a regional hub country for the forthcoming PSS platform, and their receptiveness to enhancing MSW management.

Table 4: Policy measures for solid waste management

Country	Policy measures	Result
Cambodia	Clean cities competition	Evaluates cities on the basis of cleanliness, waste management, urban planning and public health and safety.
	Develop community-based 3R	Local NGOs; Communities; School or youth volunteers.
	Digitization of MSW management	National platform for data collection on waste quantities and billing. Public mobile app for collection scheduling and alerts, bill payment and reporting. Specific stakeholder mobile apps for MSW staff, local administration staff, truck drivers and MSW agency.
	Engage the private sector	Waste as fuel for a cement factory. Plastic waste as raw material for packaging. Reduce plastic packaging for mineral water facilities.
	Improve organic recycling	Promote composting and fertilizer at city and household levels. Introduce black soldier fly for composting.
	MSW management qualifications	Targeted at the village commune leaders.
	Reduce plastic consumption and waste	Minimum pricing for plastic bags at supermarkets and malls. Install public water fountains. Measures to reduce single use plastic products. Promote eco-friendly alternatives to plastics.
Ethiopia	Community participation in solid waste management action plans	Plans designed and implemented at local urban administrative levels.
	Cooperation between departments	Cooperation between MSW management and relevant environmental authorities to monitor and evaluate systems and ensure effectiveness of implementation.
	E-waste management and disposal	National regulation to minimize environmental and social impacts by reducing generation, refurbishing, reuse, recycling, and disposal.
	Environmental Impact Assessments	Required for waste disposal facilities, such as waste incineration and landfill sites before implementation.
	Urban administration responsibilities	Collection, transportation, recycling, treatment or safe disposal of municipal waste through the institution of an integrated municipal waste management system.
Fiji	Waste Pollution Control Unit	To provide overall waste coordination. It is situated in the Department of Environment of the Ministry of Waterways and Environment.
	Waste Pollution Control Officer	Has the authority to issue Waste Disposal Permits.
	Waste management services to citizens	Carried out by each municipality and is governed by the Department of Local Government of the Ministry of Local Government.
	Recycling facilities	In the capital, Suva, organics are collected and composted. A private company is collecting wastepaper and manufacturing recycled toilet paper. Collection of plastic bottles and aluminum cans.
	Reuse	Beer bottles are collected, washed and reused.

Ghana	Extended Producer Responsibility	For packaging materials with a focus on plastics.
	Local government responsibility	Metropolitan, municipal and district assemblies are responsible for the provision of waste management services.
	National Environmental Sanitation Strategy and Action Plan (2012)	Promotes material recovery through the concept of materials in transit, which sees waste as a secondary resource.
	Recovery and recycling facilities	Privately owned and centered in 3 main cities. Absence of advanced and commercially sustainable recycling businesses valorizing recyclables.
	Waste collection and transport	Delivered through private sector providers.
Honduras	Household waste collections	Well established with high rates of participation.
	Media Outreach and education campaigns	Local governments promote and arrange with governmental, non-governmental institutions and the private sector, launching media, outreach and educational campaigns for behavior change in solid waste.
	Municipal ordinances	Banned plastic bags, straws, and bottles.
Indonesia	Circular economy	Implementation from domestic sources (upstream).
	Waste handling	Optimization at waste facilities (downstream).
Madagascar	Urban solid waste management	A priority in the General State Policy (PGE: Politique Generale de l'Etat) and in the National Sanitation Policy and Strategy (PSNA).
	Urban waste collection and transport	Less informal dumping and litter.
Morocco	Close and/or rehabilitate dumpsites	Reduced environmental impacts of waste.
	Eco tax on tires and plastics	Improves recovery, treating, recycling and reuse.
	Focus on pilot projects	Enables wider roll out of successful projects.
	Increase coverage of waste collection	Less informal dumping.
	Increase rate of sanitary landfilling	Reduced environmental impacts of waste.
	Public-Private Partnerships	Sorting and recycling facilities enabled larger diversion of waste from landfills.
	Upskill local authorities	Carried out feasibility studies to prepare tender documents for projects.
Viet Nam	Extend recycling to rechargeable batteries, oil and lubricants, tires, electronics, and vehicles by 2027	Keep valuable materials in the technosphere.
	Households separate solid waste into recyclables, food and other	Food waste converted into fertilizer and animal feed.
	Extended Producer Responsibility (EPR) for recyclables	Organizations, individuals and importers are responsible for recycling. Either products recycled or financial contribution to Viet Nam Environmental Protection Fund to support recycling.
	Role of provincial government to deploy and implement national policy at the local level and organize and monitor for compliance	Reduce environmental impacts by keeping products and materials in the technosphere.

Sources: Author's elaboration based on data shared during Expert Group Meeting held in November 2023; CTI Engineering International Co., Ltd (2022); Secretariat of the Pacific Regional Environment Programme (2023); UN-Habitat (2010); and UNEP (2018a; 2021d).

It can be seen from Table 4 that there are 35 policy measures listed for solid waste management. Within those policies there is a significant recognition of the need for local government to work with local communities to inform and encourage them to participate in new waste minimization initiatives. At the fundamental end of the scale collections are targeted, while at the other end EPR is suggested for a diverse set of wastes including electronics, plastics and packaging. Recycling also features heavily for packaging and organics.

1.5 The Waste System

GHANA : Burning site at an electronics dump in Agbogbloshie. © Fairphone

An underlying contributing factor to the triple planetary crisis (climate change, biodiversity loss and pollution), is the generation of waste. Waste impacts all 17 Sustainable Development Goals and, on current trends, waste is expected to increase by 77 per cent by 2050 from 2.3 to 3.8 billion tons annually.[31] There is limited data available for quantities of waste produced and to achieve zero waste will require knowledge of the life cycle of waste, starting from its generation. Figure 5 shows a generic waste system for developing countries, and demonstrates that the life cycle of waste is not a linear or circular process but is an interconnected web. This suggests a systemic approach to waste management is required.

[31] UNEP (2019a); and UNEP (2024a).

Figure 5: The waste system for developing countries

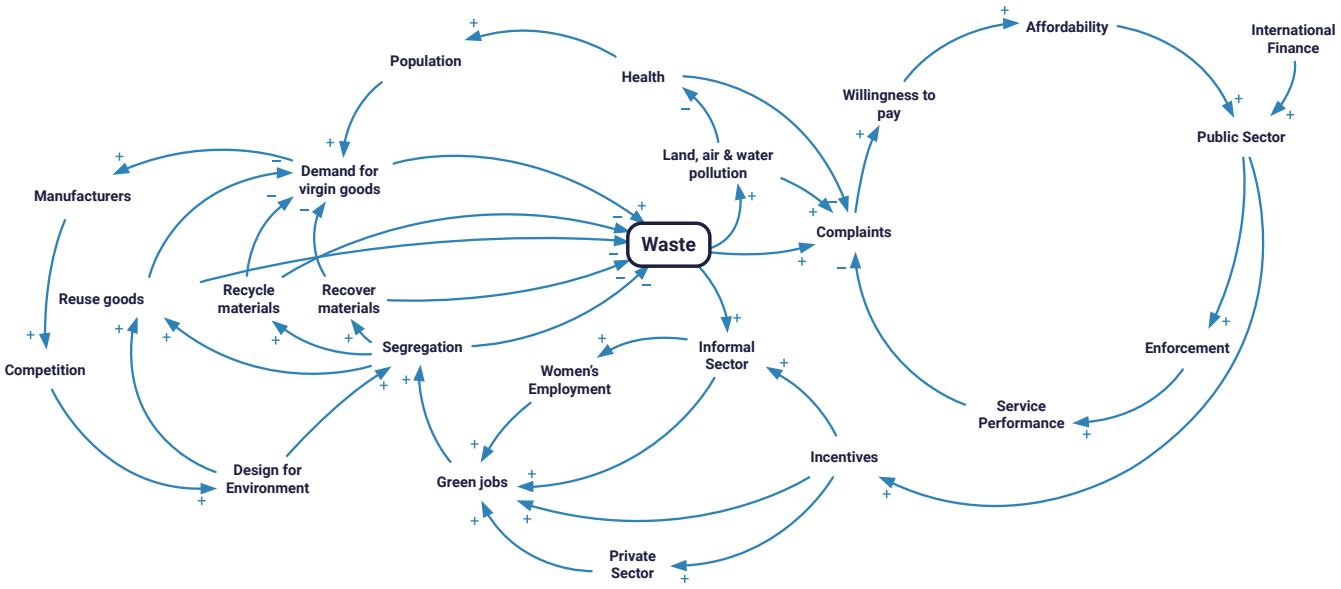


Figure 5 shows a variety of drivers that can either increase or decrease waste production in developing countries. Consideration of the 297 causal loops shows that there are a lot of interconnections, but some of the more notable ones are:

- **Population**: An increase in population causes an increase in the demand for virgin goods which increases waste generation. Waste increases lead to land, air and water pollution[32](which adversely affect health)[33] which will decrease the population.[34]
- **Public Sector Involvement**: A decrease in health or an increase in waste generation will cause an increase in complaints to authorities.[35] The more complaints there are, the more willingness there is to pay for a better service.[36] The more willingness to pay, the easier it is to afford a better service. The more affordable the service, the easier it is for the public sector to invest in it. Once invested, the public service wants to ensure it is maintained, which results in increased enforcement. The greater the enforcement, the better the service performance resulting in fewer complaints. There is then less willingness to pay for more services.
- **Public Sector Incentives**: The more the public sector sees that people are focused on waste, the more motivation there is to increase incentives (e.g. finance – which may be sourced locally or internationally – taxes, and subsidies). The more incentives there are to divert waste, the more the public, private, and informal sectors can become involved in generating green jobs.[37] The greater the number of green jobs there are, the more opportunity there is to segregate waste, which leads to diversion of waste through greater reuse of goods, recycling and recovery of materials. The more diversion of waste, the less waste per head of population is produced.
- **Private Sector**: The more incentives there are, the more the private sector can become involved, the more green jobs can be created, which increases segregation resulting in less waste produced.[38]

[32] European Commission (2023).
[33] World Health Organization (2020).
[34] Mataloni *et al*. (2016).
[35] Colmar, Evans and Shimshack (2023).
[36] Han *et al*. (2019).
[37] UNEP (2024a).
[38] UNDP (2023).

- **Informal Sector**: The more waste there is, the more opportunities there are for the informal sector. An increase in incentives will also increase opportunities for the informal sector. The more opportunities for the informal sector, the more green jobs and the more opportunities for women's employment.[39] The greater the number of green jobs, the greater the amount of segregation resulting in less waste generated.
- **Design for Environment**: In more developed countries there is potential to reduce waste generation by adopting design for environment principles. A side crescent to the population loop shows that a growing demand for virgin goods increases business opportunities which increases competition. Seeking to gain an advantage increases the potential for design for environment, which increases reuse and segregation at end-of-life stage.[40]
- **Segregation**: The more segregation that occurs, the more opportunity there is to reuse goods and recycle materials.[41] The more reuse, recycling, and recovery that occurs, the lower the waste quantities to landfill and the lower the demand for virgin goods, which also reduces the quantities of waste.
- **Health**: The greater the quantities of waste, the more the environment becomes polluted through land, air and water transmission. The more pollution that occurs, the more health is adversely affected resulting in lower population.[42] In addition, the greater pollution and negative health effects, the more complaints to the public sector from affected people. This then moves into the public sector involvement cycle.

An example of how health can affect waste management is the recent COVID-19 pandemic. The recovery from the pandemic compounded previously existing problems with further expansion in waste generation, particularly from health facilities.[43] The expansion of waste generation generally leads to increases in pollution which further adversely affects health.

Currently, an estimated 2.24 billion tons of MSW is generated worldwide annually, and it is estimated this could rise by more than 77 per cent in the next 25 years.[44] This growth rate is more than double the predicted population growth, which means that waste generation is anticipated to increase per head of population.[45] Globally, only 62 per cent of the waste generated annually is managed in controlled facilities.[46] In addition, it is estimated that MSW forms only about 10 per cent of the total waste generated, but little is known about the other wastes such as mining and construction and demolition.[47]

39 UNEP (2024a).
40 Canada, Ministry of Industry (2009).
41 UNEP (2024a).
42 Mataloni *et al*. (2016).
43 UNEP-IETC (2020).
44 UNEP (2024a).
45 World Bank (2018).
46 UNEP (2024a).
47 European Union (2024a).

The international waste trade forms a significant part of the waste system. This is a global phenomenon with countries in the global north exporting wastes such as used electronics, textiles and plastics to the global south.[48]

Globally, food and green waste forms the largest component of overall waste with an estimated 1,052 million tons of lost or wasted food annually, generated from household, food service and retail sources (representing 47 per cent of the total waste stream).[49] The other major sources of waste are paper and cardboard (17 per cent) and plastics (12 per cent).[50] This waste has an impact on the environment. For example, 14 million tons of plastic wastes enter aquatic ecosystems.[51] While that represents a very small percentage of plastic waste generated globally, its externalities of altering habitats and natural processes diminish ecosystems' ability to adapt to climate change. The results of changed habitats directly affect millions of people's livelihoods, food production capabilities and social well-being.[52]

Upstream actions represent an effective approach to reduce waste, however, most countries focus on downstream programmes. Key challenges that developing countries face for such programmes include lack of resources such as human capacity, and access to funding and technologies to manage rapidly increasing waste quantities in an environmentally sustainable manner. The result of substandard waste management systems is that 33 per cent of waste (about 790 million tons) is openly dumped or incinerated, accounting for over 90 per cent of waste in low-income countries.[53] The effects of substandard waste management include adverse health outcomes, environmental (including climate) and economic development outcomes.

Poor waste management has disproportionately adverse effects on low-income countries,[54] while contributing to two of the planetary crises – greenhouse gas emissions and plastic pollution. However, an in-depth understanding of related issues is hindered by the lack of relevant waste data, with particularly inadequate data collection in low- to middle-income countries.[55]

The lack of data presents significant issues for policymakers as they are not able to adequately plan for expansion of services, including waste management. Accessing and/or committing financial resources requires a business plan that adequately demonstrates the size of the problem, and ensures financial commitment that will adequately address the problem. National and local governments have many competing priorities for available funding, and without a solid business case, advances in waste management are minimal.

A major contributor to waste management in many developing countries is the informal sector. However, by its nature, this sector is hard to access, and it is frequently excluded from formal waste management strategies. Significant sections of the informal sector come from disadvantaged backgrounds and so formalized approaches that are used successfully for other sectors, do not necessarily work well, as there is a high degree of lack of trust towards 'the establishment'.

Small and medium-sized enterprises play crucial roles in waste management due to their low-tech capabilities. By implementing upstream measures focusing on waste reduction and contributing to downstream processes like EPR, they can fill a niche role to assist the sustainable development goals.

48 UNODC (2023).
49 UNEP (2024b).
50 World Bank (2018).
51 UNEP (2021b).
52 UNEP (2023a).
53 World Bank (2018).
54 UNEP (2015).
55 ibid.

With all the reasons for change demonstrated in this section, there are still significant barriers to overcome as outlined in Table 5.

Table 5: Barriers to change waste management practices

Barrier	Comment
Waste is a complex problem	Characterized by many dependencies, social dynamics and stakeholders as shown in Figure 5.
Lack of recognition of the urgency of the waste challenge	Many developing countries have not provided adequate waste management for all citizens allowing the build-up of waste.
Data on pollution and health risks is lacking	Inadequate waste management contributes to a rise in diseases and lowering fertility. Data on this is sporadic.
Climate impacts are underestimated, and mitigation opportunities are underexploited	Better waste management could. In addition, other externalities including human health and biodiversity loss are also underestimated.
Lack of inclusion	Non-expert or non-influential parts of the community are not considered in policy development.
Gendered aspects of waste are not recognised	Women's experiences with waste management are different to men's including as consumers, domestic waste managers, service users, informal waste workers, social hierarchies, health risks, sexual discrimination and harassment, policymaking, formalization, and professional roles.
The informal sector is undervalued	In countries with developing waste management systems more than 80 per cent of workers are in the informal sector.
Legislation is frequently inadequate and ineffective	Waste definitions vary between countries while recognition of waste's potential for further use within legislation would assist diversion from disposal sites.
Weak linkages between national and local levels	There is a gap between the national waste management plan and local waste management implementation.
Lack of an enabling environment	Overly bureaucratic processes can stifle working relationships and innovation between the public and private waste sectors. The lack of data sharing is a significant disabling factor.
Weak enforcement, sanctions and penalties	Waste mismanagement is heightened when there is weak enforcement and application of sanctions and penalties.
Technical barriers: Universal and contextual	Non-recyclable products and packaging are universal barriers to waste reduction while conditions like warm climates requiring more frequent food waste collections to avoid disease spread are contextual.
Persistent market and financial barriers	Barriers include growing waste quantities due to lack of private sector investment; lack of waste management services; insufficient financial incentives for source-separated waste collection; lack of access to capital and operating expenditures; rapid urbanization with waste management provisions as an afterthought; waste management systems designed to meet local population needs; unstable recycling markets; and waste-to-energy competing with recycling.
Financing mechanisms are not always fit-for-purpose	While the largest cost of waste management is collection, funding mainly focuses on processing and disposal facilities.
Polluters are not paying or changing	Waste externalities are borne by communities disproportionately affected by pollution and those vulnerable to climate change effects, which are generally not the high waste generators.
Waste trafficking	Disincentivises proper waste management.

Sources: Author's elaboration based on UNEP (2024a); UNODC (2023).

It can be seen from Table 5 that many of the barriers require solutions that are context specific. Hence, it is important to analyse and work at both the national and local level.

In addition to the above presented systemic issues with waste management and policy development, it might be pertinent to draw attention to a number of issues that make a systemic understanding of the waste cycle – or the 'rich picture' of the waste system – opaquer and are considered below when analysing real world problems.

1.5.1 International Data on Solid Waste

Data for MSW targets is found under the United Nations Statistics Division's Country Files.[56] Types of data collected from national governments, including national statistical offices, Environment Ministries, and other equivalent organizations are shown in Table 6.

Table 6: Selection of waste data collection by United Nations Statistics Division

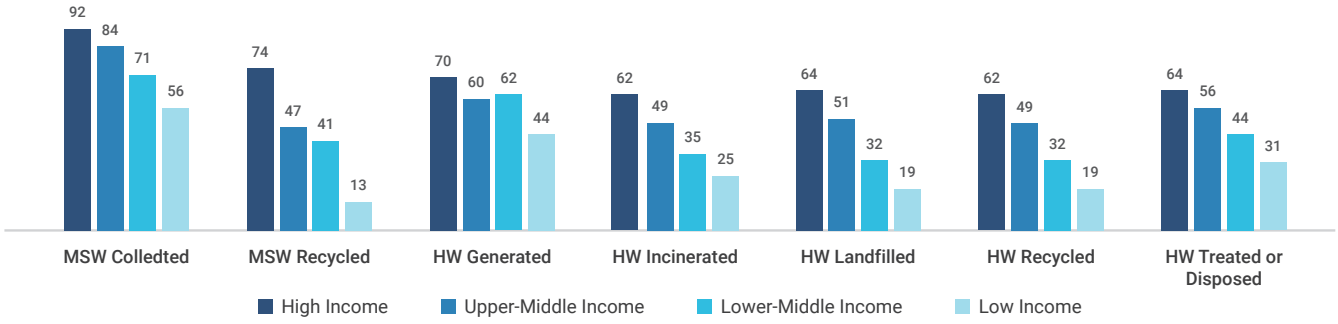
Data	Reporting Items	Type of Information Collected
Items	MSW Hazardous waste E-waste	Collection volume or amount Recycling rate Generation volume Incineration volume Landfill volume Recycling volume Treatment Disposal volume Amount generated Amount collected
Collection period	26 years	1990 1995 – 2021
Collection frequency	Biennial	1999 – 2022
Scope	148 countries	53 high-income 45 upper-middle income 34 lower-middle income 16 low-income

Source: Author's elaboration based on UN DESA Statistics Division data, 2024.

[56] UN Statistics Division (2023a).

Analysis of the data shows that the higher the income level, the more countries that reported, and conversely, the lower the income level the fewer the countries reported, as can be seen in Figure 6.

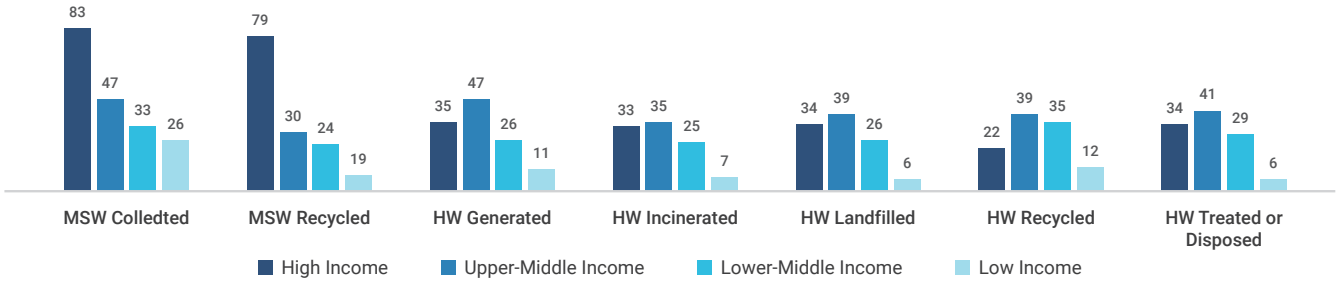
Figure 6: Reporting rate by income level (per cent)



Source: K-eco, Ministry of Environment of Korea - analysis based on UNSD 2023 data.

Similar trends are found when considering the reporting rate fulfilment, with higher income countries reporting a rate of about 80 per cent for MSW collected and recycled while end-of-life hazardous waste options are in the mid 30 per cent range for the same income group. Similar trends are shown for data collected over the 26-year reporting period as shown in Figure 7.

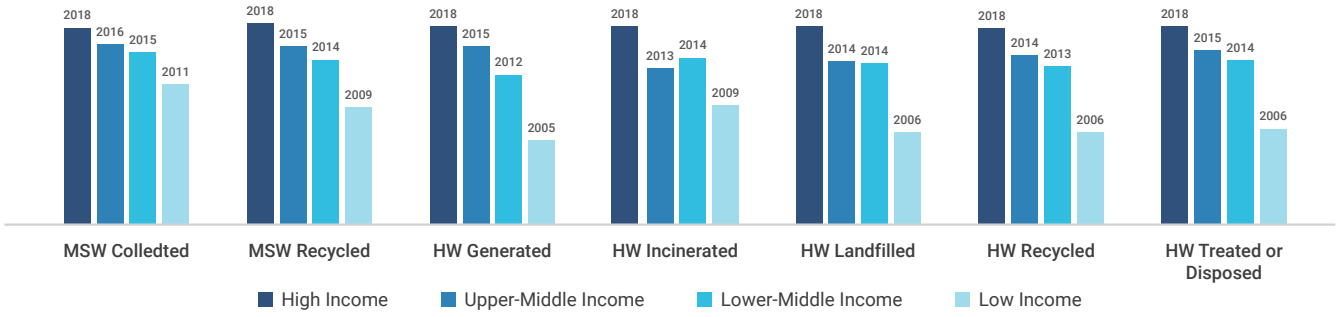
Figure 7: Reporting fulfilment rate by income level (per cent)



Source: K-eco, Ministry of Environment of Korea - analysis based on UNSD 2023 data.

Examination of data collection regularity shows that higher income countries collect data frequently, while data from low-income countries is approximately 15 years old, as shown in Figure 8.

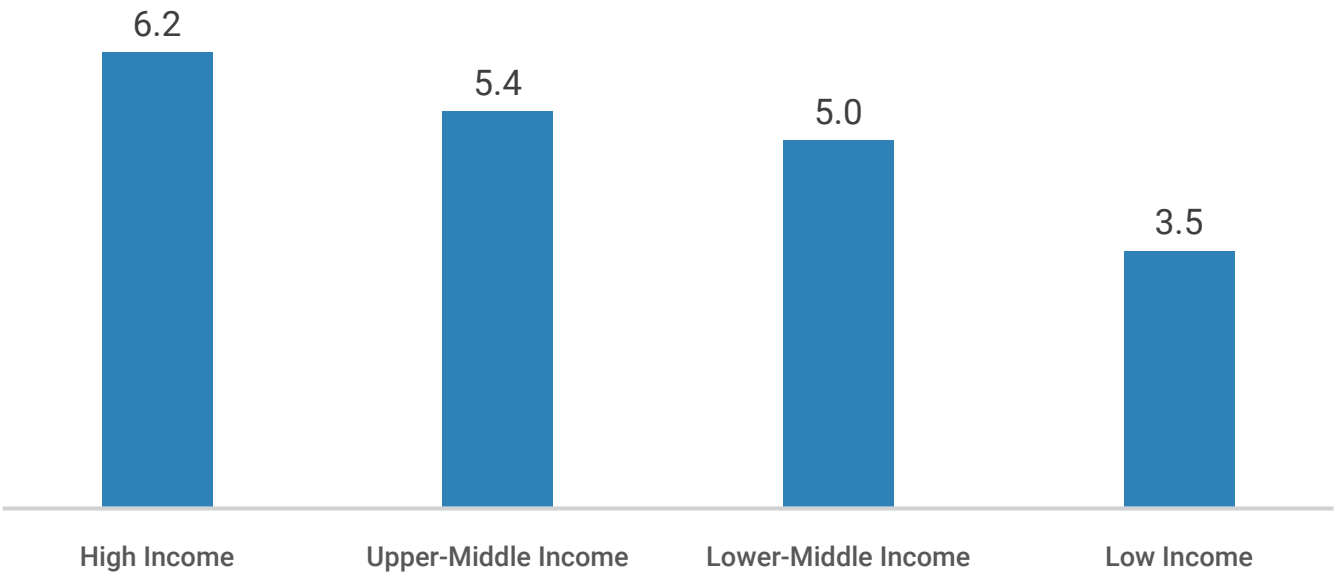
Figure 8: Waste data currency by income level (year)



Source: K-eco, Ministry of Environment of Korea - analysis based on UNSD 2023 data.

Following the trends of the earlier data, higher income countries report more data categories, while lower income countries report fewer as shown in Figure 9.

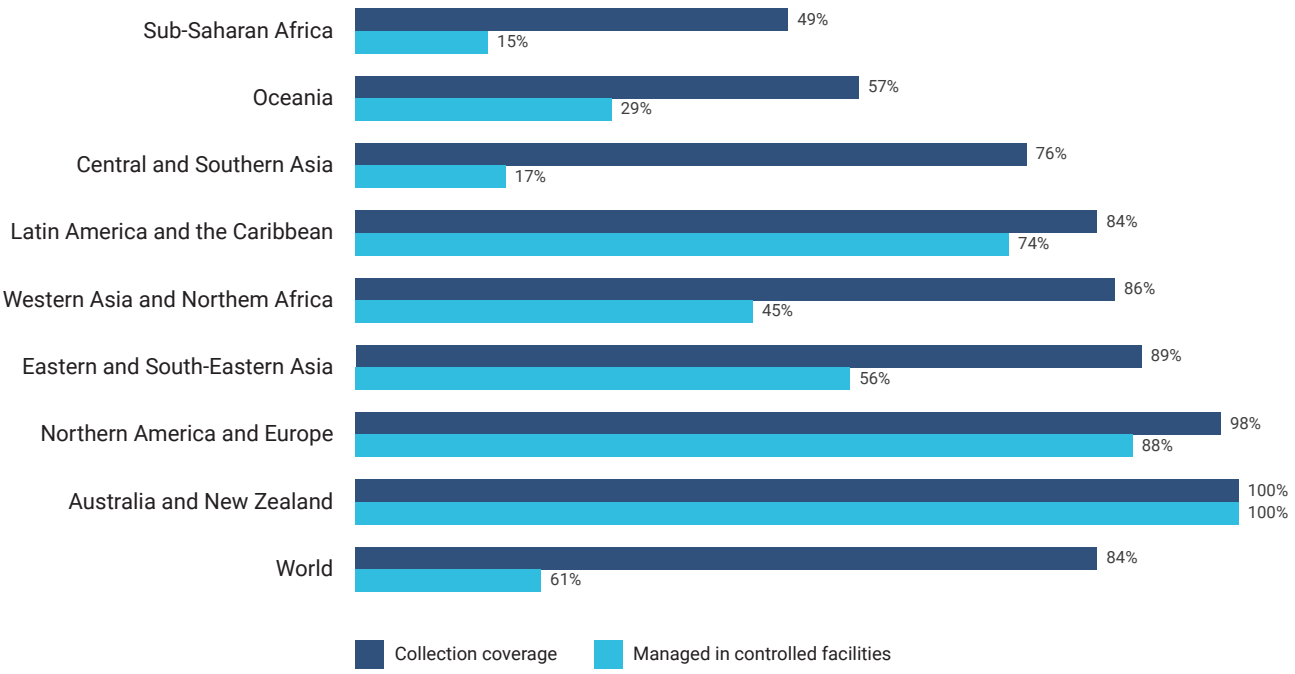
Figure 9: Average number of reported items by income level (categories)



Source: K-eco, Ministry of Environment of Korea - analysis based on UNSD 2023 data.

Work under SDG 11.6.1 provided the global estimate for waste collection compared to the portion that is managed in controlled facilities, which is shown in Figure 10.

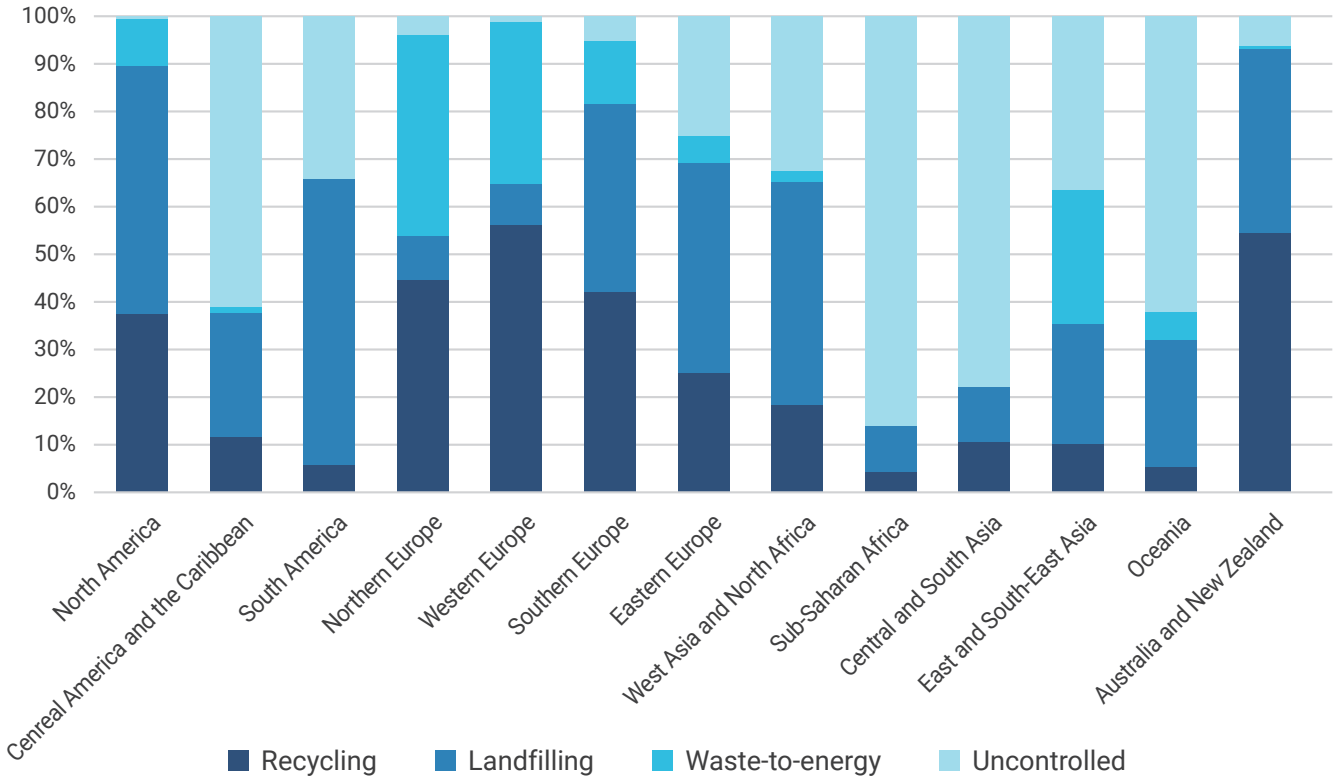
Figure 10: Municipal solid waste collection coverage and management in controlled facilities



Source: UN-Habitat (2023).

Figure 10 shows that globally, 16 per cent of MSW remains uncollected and 39 per cent is managed in uncontrolled facilities. Of the waste that is controlled, half of it (49 per cent) is landfilled, 21 per cent is sent to waste-to-energy plants and 30 per cent is recycled.[57] A regional breakdown of distribution of MSW destinations is shown in Figure 11.

Figure 11: Regional distribution of municipal solid waste destinations (2020)



Source: UNEP (2024a).

Figure 11 shows that the highest proportions of uncontrolled disposal occur in sub-Saharan Africa, Central and South Asia, Central America and the Caribbean, and Oceania. These are mainly developing countries in the early stages of development.

The highest rates of landfilling occur in North and South America, West Asia and North Africa, and Eastern Europe while the highest levels of waste-to-energy incineration are found in Northern and Western Europe, and East and South-East Asia. The European Union has an active programme to decrease disposal into landfills, which has encouraged waste-to-energy incineration. East and South-East Asia have significantly increased their waste generation in line with population and economic growth.

These trends show different approaches to reduce waste disposal at landfills through waste-to-energy incineration. It is worth noting, however, that landfill caps (e.g. European Union Landfill Directive sets a 10 per cent landfilling target for MSW to be achieved by 2035)[58] can merely encourage the increase of waste incineration when not accompanied by requirements to reduce overall quantities of generated waste or other residual waste treatments. This action will contradict the principles of a true circular economy. For this reason, there has been a call for a residual waste cap instead of a landfill cap at the European Union level.[59]

[57] UNEP (2024a).

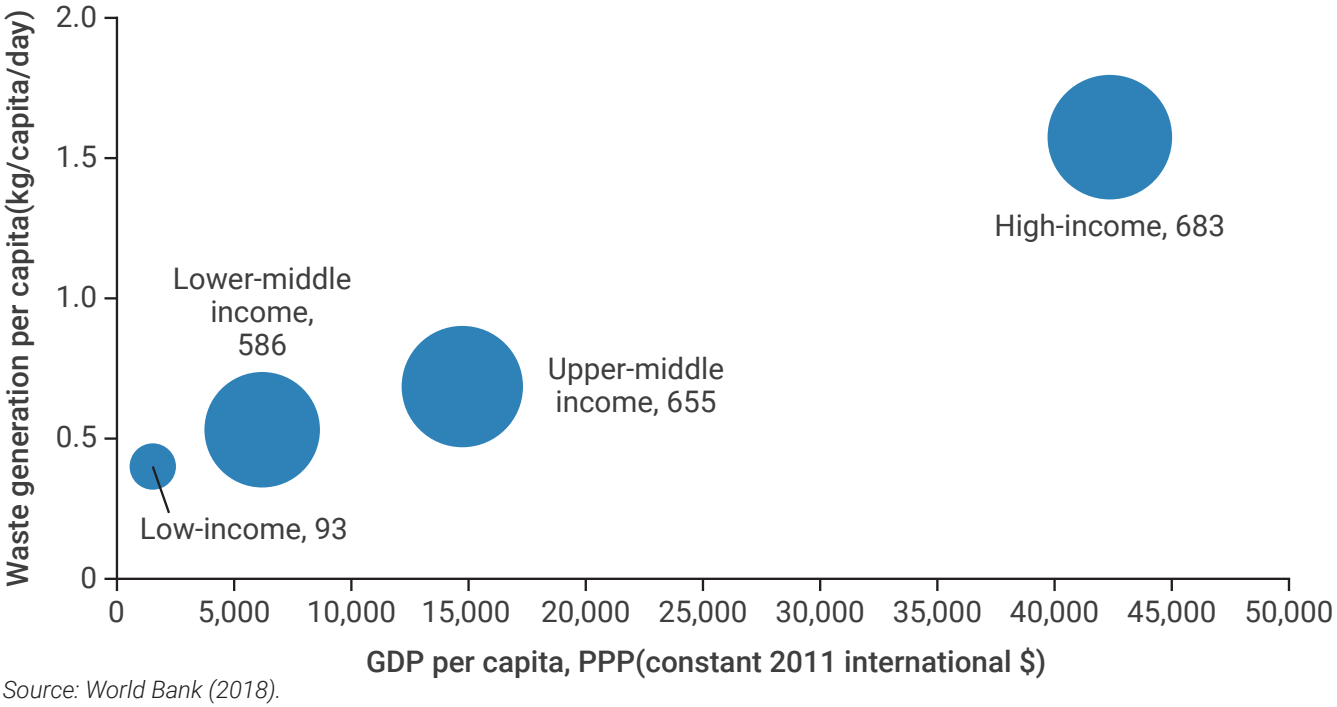
[58] European Commission (2018).

[59] Zero Waste Europe (2024).

The greatest levels of recycling are found in Northern and Western Europe, Australia and New Zealand, Southern Europe, and North America where the highest concentration of developed countries is found.

In addition to regional differences, waste generation is also dependent on income level as shown in Figure 12.

Figure 12: Waste generation versus Gross Domestic Product, by income group



Source: World Bank (2018).

Figure 12 shows that, as income levels rise waste generation also increases. While the high-income quartile countries generate 34 per cent of the world's waste, the low-income countries only generate 5 per cent of the world's waste.[60]

[60] World Bank (2018).

1.5.1.1 Defining waste

Conceptually, waste is easy to define. For example, the Cambridge Dictionary defines it as *"unwanted matter or material of any type, especially what is left after useful substances or parts have been removed"*.[61] Logically, household waste is then waste produced by households. However, an overlaying societal context often influences the definition of waste. For this reason, it is often not clearly defined in legislation. Consequently, many attempts to avoid defining waste in legislation have met with opposition from local government, industry and the waste industry as they all need clarity to enforce (or loopholes to benefit from) compliance.[62] An example of the influence of the overlaying societal context on definition and treatment of waste in different countries can be seen in the four cases presented in Table 7, which do not necessarily represent all classification systems in those countries. For example, the Republic of Korea does not include hazardous waste in its definition of the term, but information on hazardous waste is contained in the statute.

Table 7: Differences in terminology and classification for waste across countries

Term	Cambodia[63]	Republic of Korea[64]	Morocco[65]	Viet Nam[66]
Waste	Used things, materials, and products remaining or generated from human daily activities and livelihood which does not consist of toxic substances or hazardous wastes.	Garbage, burnt refuse, sludge, waste oil, waste acid, waste alkali, and animal carcasses, etc., which have become no longer useful for human life or business activities.	Residues coming from extraction, development, transformation, production, consumption, use, control or filtration processes, and in general, any abandoned object and material or any material that the holder must dispose of to avoid harming health, public hygiene, and the environment.	Any matter in a solid, liquid, gaseous state which is discharged from manufacturing, business, services or living activities or from other activities.
Classifications	Glossary Classification • Municipal Solid Waste • Industrial Waste • Hazardous Waste	Classification by legal provisions • Household Waste • Industrial Waste • Designated Waste (including medical waste)	Classification by Statutory Provisions • Household Waste • Household-like Waste • Industrial Waste • Medical and pharmaceutical waste • Hazardous Waste • Inert Waste • Agricultural Waste • End-of-life waste • Biodegradable waste	Classification by Statutory Provisions • Household Solid Waste • Industrial Solid Waste • Hazardous Waste
Waste Management Steps	Definition: None	Definition: Receiving, transporting, storing, treating, and disposing of waste, and all activities for this purpose (only for radioactive waste).	Definition: The collection, storage, sorting, transportation, landfilling, treatment, recovery, recycling, and disposal of waste.	Definition: None
	Scope: • Sorting • Disposal • Recycling • Reuse	Scope (only for radioactive waste): • Transportation • Storage • Treatment • Disposal	Scope: • Collection • Storage • Treatment • Disposal • Recovery	Scope: • Disposal • Reuse • Recycling

61 Cambridge Dictionary (n.d.).

62 United Nations Environment Programme (2016a).

63 No 113 ANKr.BK – Sub decree on Management of Garbage and Solid Waste of Downtowns.

64 Waste Control Act.

65 Law No. 28-00, on waste management and disposal.

66 Law on protection of the environment.

Treatment	Type: • None	Type: • Collection / Transportation • Storage • Recycling • Disposal	Type: • Physical • Chemical • Thermal • Biological	Type: • None
Disposal	Type: • None	Type: • Interim disposal (Incineration, neutralization, Fragmentation, Solidification) • Terminal Disposal (Landfill, Ocean Discharge)	Type: • Storage • Incineration • Dumping (Control) • Other operations	Type: • Abatement / Elimination • Separation/ Isolation • Incineration • Landfill

Source: Author's elaboration based on data shared during Expert Group Meeting held in November 2023.

Comparison of the scope of waste definitions in Table 7 shows that Cambodia is the only country that excludes hazardous substances while Republic of Korea specifically includes them, and Morocco and Viet Nam infer that hazardous substances are included. Morocco takes a life cycle approach and Viet Nam adopts an integrated approach across the life cycle and three media (solid, liquid and gas).

Classification of wastes in Table 7 shows that Morocco has the largest number of categories at nine, while Cambodia and Viet Nam only have three. All countries specify household waste (though Cambodia calls it 'municipal'), and industrial waste. The other three countries stipulate household waste and hazardous waste (though Republic of Korea terms it designated waste, which includes 'medical waste'). However, Morocco divides hazardous waste into hazardous and medical and pharmaceutical categories.

Definition of the waste management steps is silent in Cambodia and Viet Nam's legislation, while Republic of Korea only considers it for radioactive waste, and Morocco includes waste diversion. The scope of waste management in the Asian countries listed in Table 7, cover reuse, recycling and disposal, while Morocco includes the operations from collection to disposal.

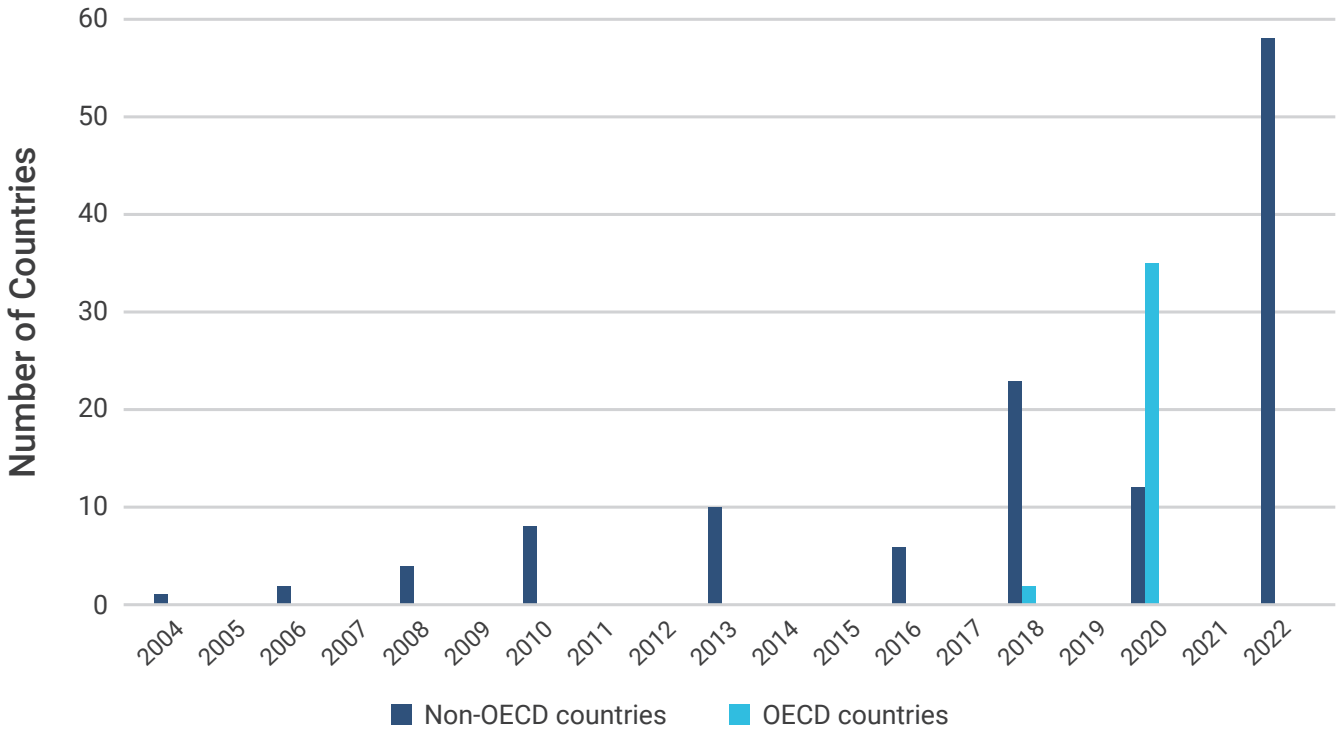
Definitions of treatment in Table 7, once again, produce a variety of responses. Cambodia and Viet Nam are silent, while Morocco categorizes the four different types of treatment and the Republic of Korea takes a more life cycle centred approach by including collection through to disposal under this category.

Finally, from Table 7, disposal is not defined by Cambodia, whilst Morocco includes storage with its disposal operations, Republic of Korea includes some treatment processes within the disposal definition and Viet Nam includes some prevention and sorting activities under this category. Comparisons of these few countries, which are not outliers on the world scale, shows that it can be difficult to achieve commonality between countries, and much less regions, for waste management terms defined in legislation.

1.5.1.2 Measuring what we waste

Acquisition of data is critical to provide information on the current state of the waste system as well as future trends and the successes of waste management programmes. Data availability can be very sporadic and what and how components are measured is often unclear. An example of the sporadic nature of data collection is shown for 125 non-OECD countries in Figure 13.

Figure 13: Most recent year for available waste data



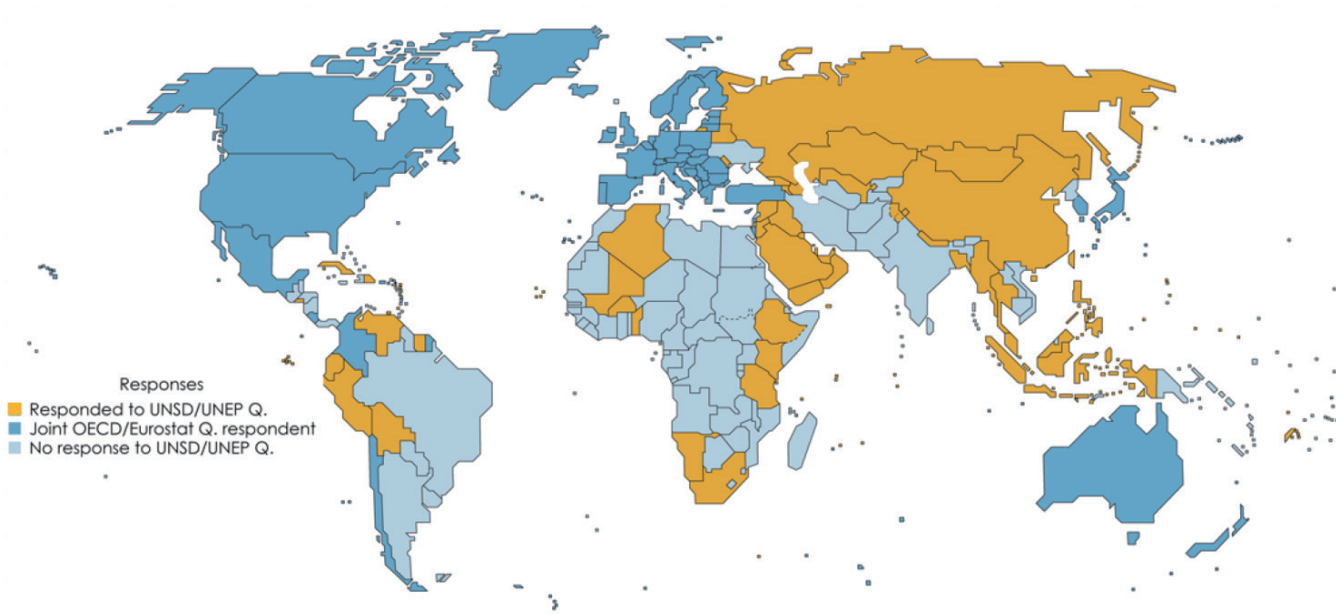
Source: UNSD (2023a) and OECD (2024).

It can be seen from Figure 13 that only 46 per cent of the non-OECD countries surveyed have waste data that is less than one year old and 56 per cent less than three years old, while 12 per cent have their most recent data older than ten years ago.[67] This lack of current data demonstrates that either many countries are making waste management decisions based on outdated data or they are not progressing waste management as a priority. For the OECD countries, 90 per cent have data recorded for 2020, while 5 per cent have data up till 2018 and 5 per cent (Albania and Switzerland) have not reported data.[68] Thus, Figure 13 shows that more developed countries, which are members of the OECD, generally have better tracking and data granularity than developing countries.

Waste data reporting worldwide is quite sporadic as shown in Figure 14.

[67] UN Statistics Division (2023a).
[68] OECD (2024).

Figure 14: Responses to United Nations Statistics Division / United Nations Environment Programme Environment Statistics Questionnaire (2022) – Waste Section



Source: UN Statistics Division (2023b).

It can be seen from Figure 14 that there are significant gaps in reporting waste statistics. The United Nations Statistics Division has considered ways of improving reporting rates for their questionnaire and has conducted trials on:[69]

- Multilateral calls conducted as information sessions on environmental statistics with, for example, UN-Habitat, World Health Organization, United Nations Environment Programme and regional commissions in 2021 and 2022. Fifteen to 50 participants attended each call.
- Bilateral calls in 2023 with countries wishing to discuss the questionnaire which boosted response rates and data quality.

A further idea to increase participation is to align requests for reporting with policy demands such as the Sustainable Development Goals and the Paris Agreement. This is an ongoing process.

The eight case study countries in this report have the latest data as shown in Table 8:

[69] UN Statistics Division (2023b).

Table 8: Latest data for the case study countries

Country	Year	MSW Collection per capita (kg) per annum
Cambodia	2012	31
Ethiopia[70]	2005	106
Fiji	2021	182
Ghana	2017	164
Honduras	2013	179
Indonesia[71]	2017	258
Madagascar[72]	2009	207
Morocco[73]	2014	395
Viet Nam[74]	2017	484

Source: Author's elaboration based on available data from United Nations Statistics Division (2023a).

Examination of the source data in Table 8 shows that the average age of the data reported was ten years old. For those countries that separately report their municipalities, only the largest cities are covered. It can be seen from Table 8 that data reported as household waste collected varies from 31 to 484 kilograms per capita per annum, with Viet Nam noting that their data is estimated.

Data collection can be further complicated by countries with waste responsibilities split across ministries. In these cases, communication between ministries has potential to be difficult as responsibilities often overlap, and people tend to be extremely focused on their particular areas. Examples of countries with split responsibilities for solid waste management include:

- **Ghana**: The Ministry of Sanitation and Water Resources is the primary line Ministry in charge of strategic direction and policy development within the solid waste management sector, while environmental compliance is regulated by the Environmental Protection Authority. In addition, day-to-day oversight and monitoring of service delivery is provided by metro, municipal and district authorities.
- **Madagascar**: A national action plan to address gaps, priorities and needs to more effectively prevent and reduce Sea-Based Marine Plastic Litter involved the Ministry of Fisheries and Blue Economy (Ministère de la Pêche et de l'Economie Bleue – MPEB) with the contribution of the Ministry of Transport and Meteorology (Ministère des Transports et de la Météorologie – MTM), Ministry of the Environment and Sustainable Development (Ministère de l'Environnement et du Développement Durable – MEDD).[75]
- **Morocco**: The Department of Sustainable Development laid the foundations for developing waste management channels through the National Waste Recovery Programme while the partnership for an ecotax on used lubricant oils involved the ministries of Energy, Transition and Sustainable Development; and Industry, Trade, Investment, and the Digital Economy.

[70] Addis Ababa only with 68 per cent of the city covered by collections.

[71] Bandung, Jakarta and Surabaya cities only.

[72] Antananarivo city only.

[73] Rabat and Casablanca cities only.

[74] Haiphong, Ho Chi Minh and Hanoi cities only.

[75] International Maritime Organization (n.d.).

In addition to the availability of data, data quality is a factor that needs consideration.

An examination of recent regional waste management outlooks such as for Asia[76] and Small Island Developing States,[77] identifies the following 14 main data gaps in waste and resource management:

- **Accuracy**. In many cases it is not known whether the data being reported is estimated or measured, and if it is measured, the accuracy of the measurements and whether they are repeatable.
- **Classifications**. Common classifications of waste remain an issue.
- **Full cost accounting**. The cost of disposal is often only a small part of the cost of waste.
- **Indicators**. When data is published, it is often at the macro level like total tons disposed.
- **Informal sector**. The informal sector represents a significant part of the waste sector, but due to its nature of growing organically and working by word of mouth, it often does not feature in official data, and hence its contribution is not recognized.
- **Information management systems**. Recording and updating data in information management systems often has a considerable lag time.
- **Geospatial or remote sensing data**. Data collected using more innovative methods such as through satellite or Earth sensing can identify significant methane (CH_4) plume emissions from space providing longitudinal and precise data, at high spatial resolution, on the anthropogenic emissions sources from waste, including in controlled and uncontrolled sites.[78]
- **Longitudinal data**. Data over a period of time is most useful when looking at trends that can inform interventions to reduce waste.
- **Monitoring and reporting**. Quantity and quality of data is often unknown. Often countries do not have sufficiently sophisticated systems to enable them to generate data[79] so a system of monitoring and reporting data is needed.
- **Standard definitions**. Along with classifications, standard definitions remain an issue. Waste is a generic term, and countries often adopt definitions to suit their needs.
- **Ward level data**. Data at a level that is more granular than citywide is often absent, even though such data would enable more tailored interventions to be implemented.
- **Waste collection emissions**. Greenhouse gas emissions due to motorized waste collections are generally classified under transport emissions, rather than due to waste.
- **Waste destination**. Whether waste is dumped (legally or illegally), incinerated (with or without energy recovery), sent to landfill or diverted back into the circular economy through, for example, composting, all have important ramifications when considering programmes for waste reduction.
- **Waste other than MSW**. The focus is typically on MSW, particularly from households.

Progress towards sustainable waste management can only be effective when gaps noted above are filled.

76 UNEP (2017).

77 UNEP (2019a).

78 NASA Jet Propulsion Laboratory (2024) For more information see: https://methane.jpl.nasa.gov/

79 UNEP (2019a).

1.5.1.3 Cost of waste

Globally, the direct costs for MSW management were USD 252.3 billion, of which 59 per cent were collection costs, 14 per cent landfill, 12 per cent waste-to-energy, 8 per cent recycling and 7 per cent dumping costs.[80] In addition to the direct costs, the indirect costs (externalities representing impacts of waste) of MSW management comprising the environmental price of the marginal social value of preventing emissions (or activities like land use change), were calculated to be USD 243.3 billion.[81] Thus, the direct costs only represented 51 per cent of the total cost. These costs were offset by gains due to recycling of USD 134.6 billion,[82] leaving a net total of USD 361 billion, or USD 44.5 per person per year.[83]

1.5.1.4 Sustainable Development Goals waste indicators and data

Data collection for the Sustainable Development Goals waste indicators from 202 countries (67 high income, 54 upper-middle income, 53 lower-middle income, and 28 low income) shows that responses are variable, as tabulated in Table 9.

Table 9: Data information by Sustainable Development Goal indicator

Indicator	Data Collection Dates	Number of Countries covered	Reporting Items
11.6.1	2001-18	109	• MSW collection coverage by city (per cent)
12.1.1	2017	25	• Number of countries mainstreaming sustainable consumption and production policies • Countries with sustainable consumption and production policy instruments • Number of policies, instruments and mechanisms in place for sustainable consumption production
12.3.1	2019	202	• Food waste volume • Food waste per capita
12.4.1	2015~2019	193	• Parties to Basel Convention obligations • Parties to the Minamata Convention • Parties to the Montreal Convention obligations • Parties to the Rotterdam Convention • Parties to Stockholm Convention obligations

80 UNEP (2024a).

81 UNEP (2024a).

82 UNEP (2024a).

83 World population taken as 8.104 billion people.

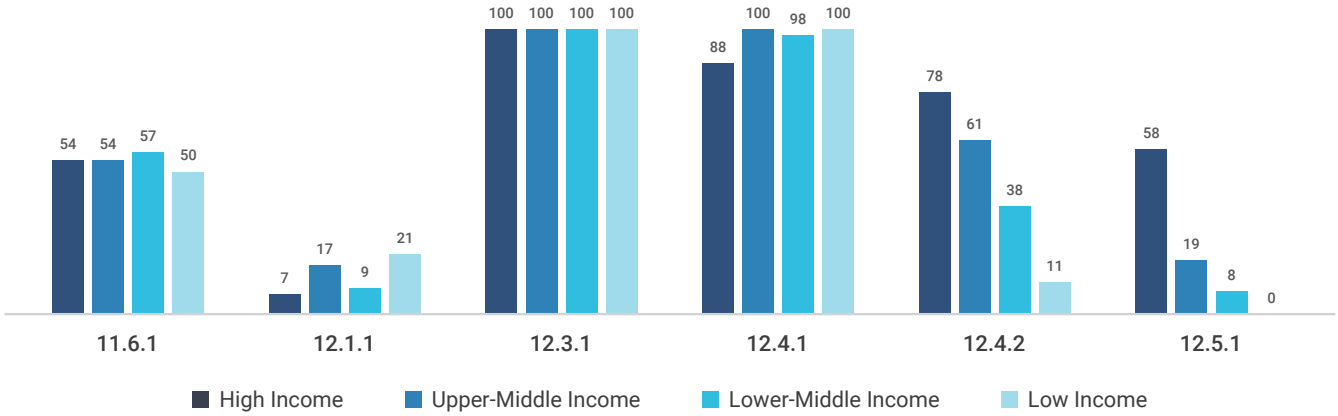
12.4.2	2016, 2019~2020	108	• E-waste collected (kg per capita) • E-waste collection rate (per cent) • E-waste collected (tons) • E-waste generated (kg per capita) • E-waste generated (tons) • Hazardous Waste Exported (tons) • Hazardous waste generated per GDP (Kg per US$ in 2015) • Hazardous waste generated (tons) • Hazardous waste imported (tons) • Hazardous waste generated per capita (Kg) • Hazardous waste treated by treatment type (tons) • Percentage of hazardous waste treated or processed (per cent) • Hazardous waste treated or disposed of (tons) • Urban waste collected (tons) • Urban waste generated (tons) • Disposed of municipal waste by treatment type (per cent) • Total waste generated by activity (tons)
12.5.1	2016, 2019	53	• E-waste recycled (tons) • E-waste recycled per capita (kg) • Urban waste recycled (tons)

Source: UN Statistics Division (2023c).

From Table 9 it can be seen that all countries surveyed reported on food waste (target 12.3.1) and (those that had signed) waste-related multilateral environmental agreements (target 12.4.1), while 54 per cent reported on MSW collections (target 11.6.1), and hazardous and other types of waste (target 12.4.2). National recycling rates (target 12.5.1) were reported by 26 per cent and sustainable consumption and production policies (target 12.1.1) by only 12 per cent of countries. These results support the notion that countries are on a spectrum from dumping societies to circular economies, with those wastes that have more harmful effects on the population, for example, waste causing ill health receiving the greatest attention.

Reporting rates of Sustainable Development Goals waste indicators by country according to income levels are shown in Figure 15.

Figure 15: Sustainable Development Goal waste indicators reporting rates by income levels (per cent)

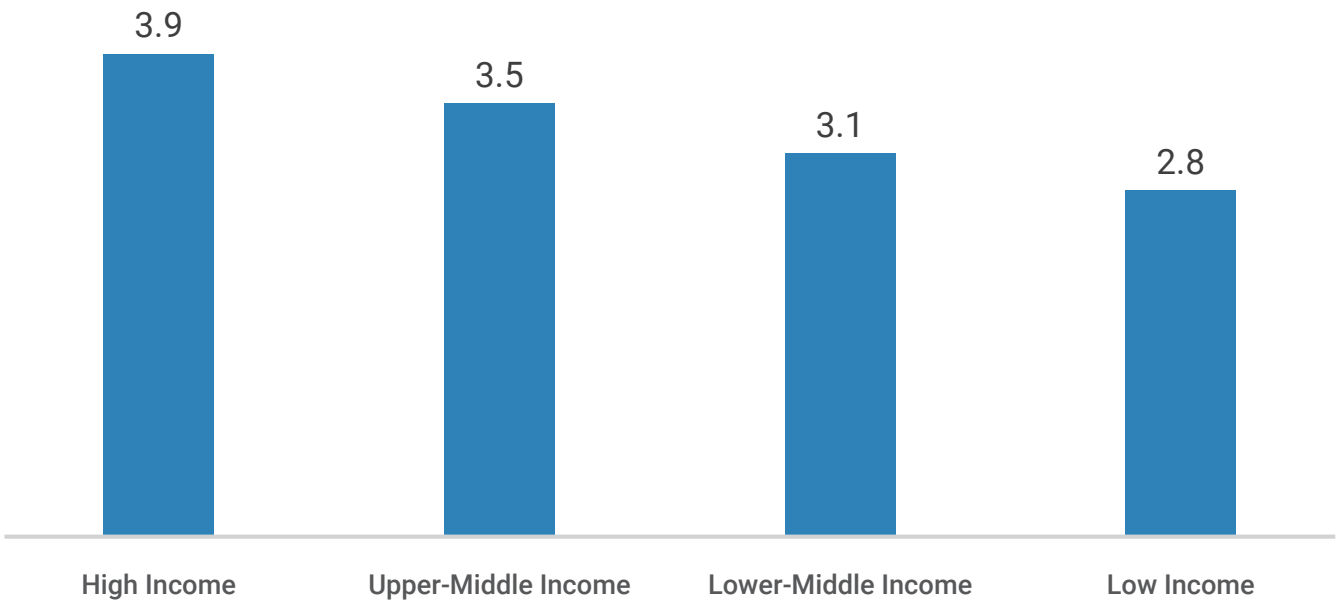


Source: K-eco, Ministry of Environment of Korea analysis based on UNSD 2023 data.

From Figure 15 it can be seen that for rates of reporting for MSW collections (target 11.6.1), food waste (target 12.3.1) and waste-related multilateral environmental agreements (target 12.4.1) there was no significant difference according to income level. For hazardous and other types of waste (target 12.4.2) and national recycling rates (target 12.5.1), there is a progression from high reporting rates by high-income countries to low reporting rates for low-income ones. The final category, reporting on sustainable consumption and production policies (target 12.1.1), shows that overall, there is a low reporting rate, but lower income countries tend to have a higher rate of reporting. The reason for this apparent anomaly is unknown.

Analysis of the average number of Sustainable Development Goals waste indicators reported is shown in Figure 16.

Figure 16: Average number of sustainable development goal waste indicators reported by income level

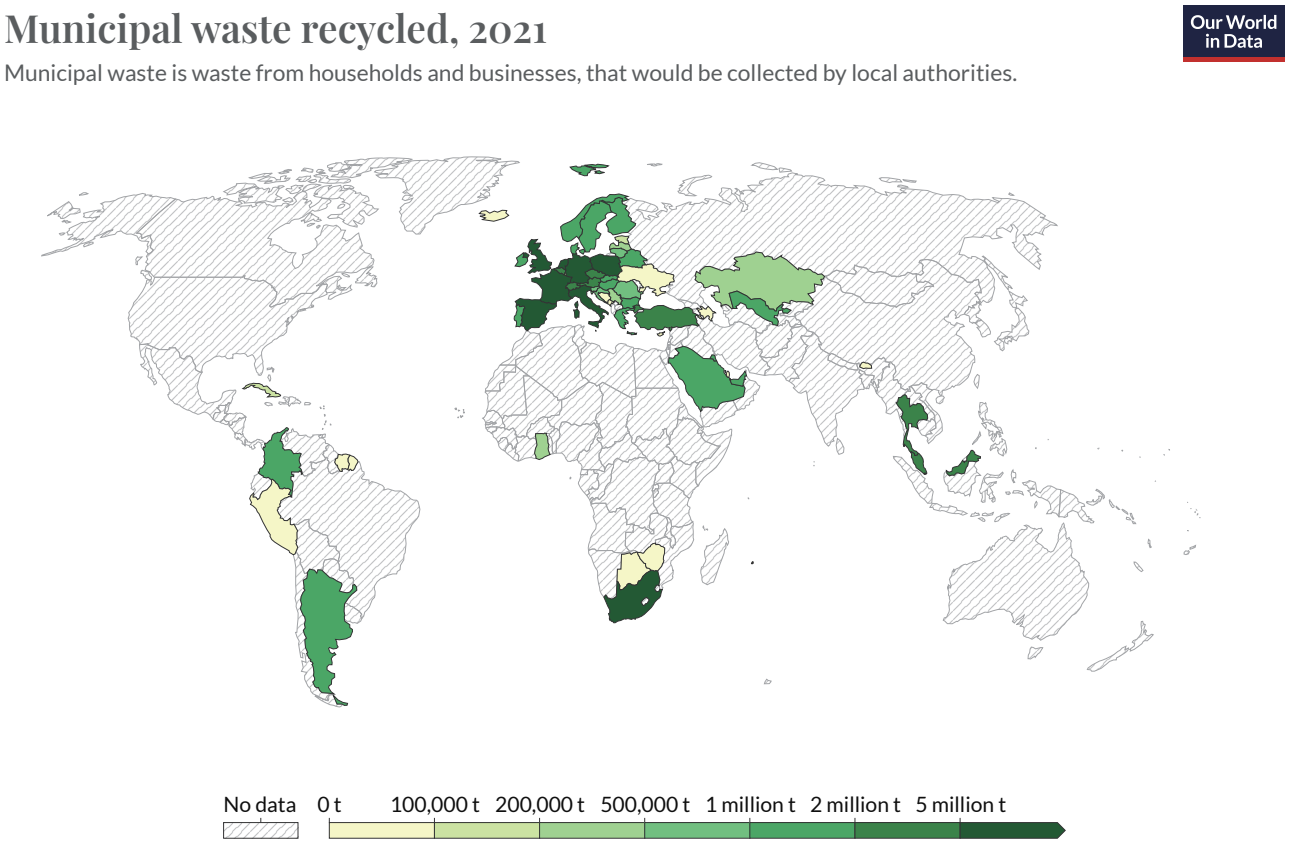


Source: K-eco, Ministry of Environment of Korea, analysis based on UNSD 2023 data.

It can be seen that, in Figure 16, there is a 30 per cent drop in the number of indicators reported as income levels decline and even the high-income countries only report on two-thirds of waste indicators.

Sustainable Development Goal target 12.5 focuses on decreasing waste generation through prevention, reduction, recycling, and reuse. The indicator for this goal is 12.5.1 which tracks national recycling rates, which, as shown in Figure 15, shows a decrease in reporting as income levels decrease from 29 per cent in high-income countries to zero in low-income ones. In most countries recycling is the responsibility of local government and thus, a lack of data means that effective programmes cannot be implemented to assist countries to move towards achieving the Sustainable Development Goal target 12.5. Figure 17 below shows clearly that it is mainly European, along with a few developing countries, that report on recycling rates. It can be seen that most of the developed countries outside Europe do not report on recycling rates.

Figure 17: Municipal waste recycled (million tons)



Source: Our World in Data, based on UN Statistic Division data (2021a).

1.5.2 Waste and Public Health

As can be seen from Figure 5, health issues are a major concern that lead to government action on waste. Poor, or no waste collection systems, coupled with waste dumping are a concern in many developing countries as it has direct health impacts on residents, particularly the vulnerable ones like children and older persons. Waste builds up around drains in the community which allows flies, rodents, and other pests to thrive and infectious diseases like cholera, malaria, diarrhoea, and dengue fever to spread.[84] Likewise, uncontrolled dumpsites can result in disease spreading through adjacent settlements. Stormwater runoff can also carry waste into rivers and lakes which can result in sources of disease and cause public health issues. Leachate runoff into soils and waterways can get into the food chain which can cause negative health impacts for humans.[85]

Uncontrolled waste incineration causes air pollution, with smoke impacting people in the vicinity of fires, causing severe effects on their health. The most common reported impacts were dysentery, diarrhea, pulmonary diseases, asthma and allergies.[86] The smoke can also carry persistent organic pollutants from disposal of pesticides, which contaminates freshwater and has adverse effects on human health such as increased cancer risk, reproductive disorders, alteration of the immune system, neurobehavioral impairment, endocrine disruption, genotoxicity and increased birth defects[87], surrounding ecosystems, biodiversity and agricultural production. Another source of air pollution causing significant health effects is from firewood used for cooking, lighting and heating in, for example, Madagascar where 95 per cent of households use biomass. Such levels of pollution can exacerbate respiratory symptoms.[88]

1.5.3 Waste and Climate Change

Climate change is a major concern for urgent action by governments worldwide. Greenhouse gases (GHG), as part of air emissions from waste as shown in Figure 18, contribute to climate change, increasing as waste quantities increase. Due to unsustainable production and consumption patterns. GHG emissions have more than doubled over the last 50 years to 43 billion tons in 2020.[89]

The regional contribution of GHG emissions has changed from North America and Europe being the largest emitters to the Asia-Pacific region being responsible for more than half of the emissions. The largest emitters by income group have also changed from high income in the 1970s to upper-middle income in 2020.[90]

Landfills can be potent sources of methane emissions. Methane (CH_4) is up to 80 times more powerful at trapping heat than carbon dioxide (CO_2) and remains in the atmosphere for almost a decade, where carbon dioxide remains for centuries.[91]

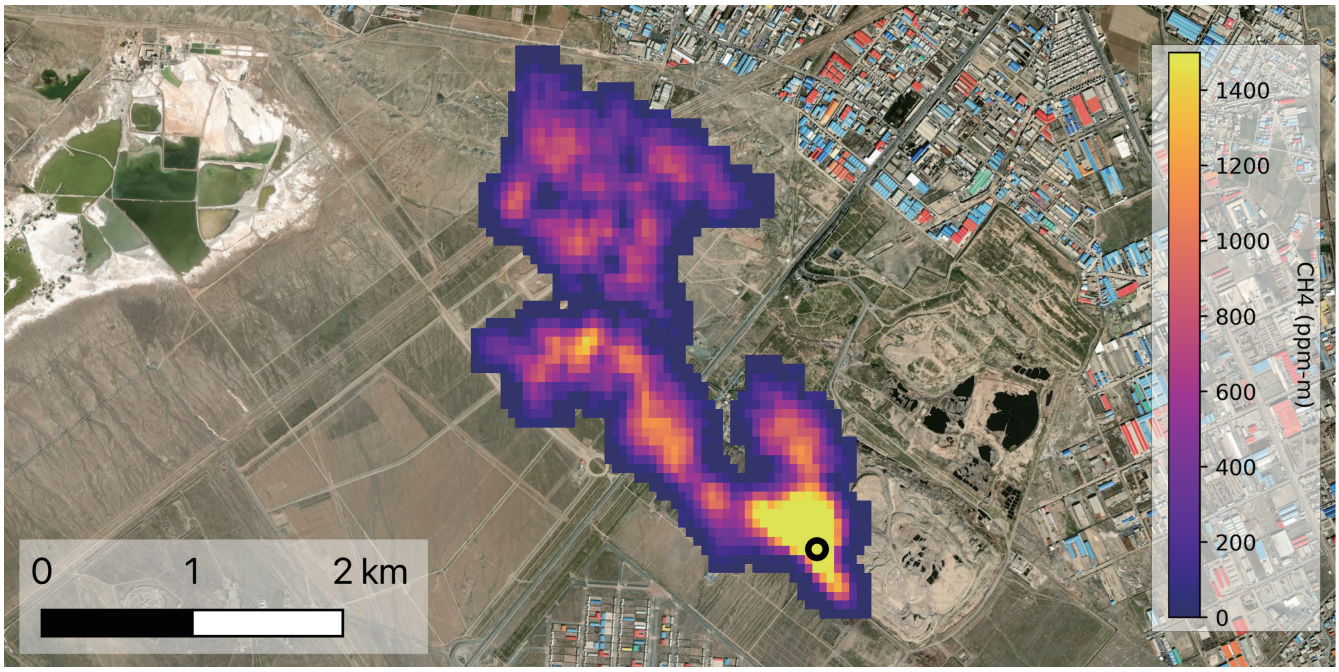
Globally, waste management improvements throughout the life cycle of products can contribute 15 to 20 per cent of greenhouse gas emission reductions across the economy. While most developing countries have low greenhouse gas emissions on a world scale, these countries are often ones most affected by climate change impacts such as the increasing frequency and magnitude of disasters and sea level rise.

84 Omang *et al.* (2021).
85 Kamboj *et al.* (2020).
86 Shammi *et al*. (2023).
87 World Health Organization. (2020).
88 Jeston-Guyon et al. (2022).
89 UNEP (2024c).
90 UNEP (2024c).
91 NASA Jet Propulsion Laboratory (2023). For further details on GHG emissions and tracking methane emissions specifically see https://carbonmapper.org/

Reducing the quantities of greenhouse gas emissions throughout the life cycle of products will also contribute to reducing climate change effects. By taking a more environmentally sound approach to waste management, fewer emissions of short-lived climate pollutants, such as methane and black carbon from open burning and dumping, will also help to mitigate climate change.

It is also important to note that today anthropogenic emissions from methane can be tracked with Earth remote sensing using instruments like the EMIT imaging spectrometer onboard the International Space Station, which provide high spatial resolution data on emission sources from waste. This data shows that certain regions and countries are contributing to largescale methane emissions due to uncontrolled waste dumping and "super emitter events".[92] There is increased research and available data in this regard for national governments to more effectively quantify and address methane and carbon dioxide emissions for targeted improvements at waste management sites.[93] This data can also help map uncontrolled landfills globally, to better understand waste related methane emissions in countries with limited resources.

Figure 18: Methane (CH_4) plumes observed with EMIT satellite and International Space Station from a landfill site in Iran.



Source: NASA JPL (2024).

[92] NASA Jet Propulsion Laboratory (2023). For further information on EMIT and super emitters of CH_4 see: https://www.nasa.gov/centers-and-facilities/jpl/methane-super-emitters-mapped-by-nasas-new-earth-space-mission/

[93] The data is freely available here https://earth.jpl.nasa.gov/emit/data/data-portal/Greenhouse-Gases/ and through the US Greenhouse Gas Center https://earth.gov/ghgcenter/data-catalog/emit-ch4plume-v1

1.5.4 Waste and Job Creation

Unemployment is a major challenge facing many countries, hence the imperative for governments to prioritize job creation. The waste sector provides a significant driver for job creation in both the formal (public and private) and informal sectors as shown in Figure 5. The formal sector's failure to institute comprehensive waste management systems encouraged the rise of the informal sector, which provided opportunities to divert waste among the least wealthy portions of the population from landfills and dumpsites. In the informal sector, the workers are mainly displaced and dispossessed people and it is a family occupation, including children.[94]

TIMOR LESTE : Women and children search a garbage dump for cans to sell. ©UN Photo/Martine Perret.

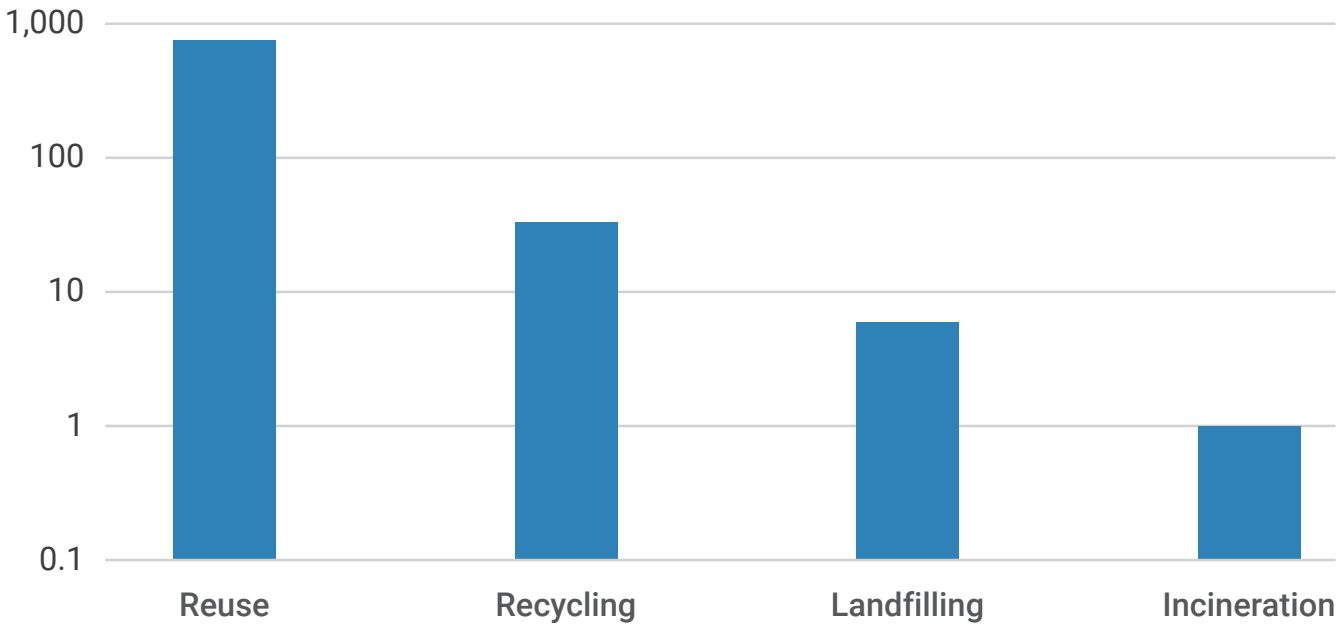
Formalization of waste management activities provides economic opportunities which can enable informal sector operators, who would otherwise work in hazardous conditions.[95] Decentralized waste processing provides an opportunity for greater employment opportunities. It is also less capital intensive, which enables easier access to finance. For example, an informal sector worker without any equipment can collect about 15 kg of material per day. If waste collection is done using a vehicle, this can increase ten-fold.[96]

One approach that has been found to work with the informal sector is to team-up with people, often from social agencies, who have gained the trust of the workers as a conduit to gain access and build a rapport that can result in a working relationship with the informal sector.[97] For example, in Fiji, data collectors go along with counsellors to gather data.[98] Tools like the Waste Wise Cities Tool can be used to engage with the informal sector and thus build a more inclusive picture of waste trends and management practices.[99]

94 Arora (2023).
95 UNEP (2017).
96 Arora (2023).
97 Arora (2023).
98 Arora (2023).
99 UN-Habitat (2021).

An example of job creation opportunities in the waste management domain is shown in Figure 19.

Figure 19: Job creation from waste diversion (per 10,000 tons)



Source: United States Environmental Protection Agency (2001).

It can be seen from Figure 19 that activities that are higher up the waste management hierarchy provides significantly more opportunities to create jobs. It should also be noted that, although landfilling and incineration are both classed as disposal activities, the difference in job opportunities is a factor of six.

1.6 TAKING STOCK OF GLOBAL POLICY SUPPORT AND MOVING FORWARD

A comprehensive analysis of United Nations publications showed that solid waste research at the United Nations level has fluctuated. The period 2010–2018 was a very active period for this type of research, but after 2019, global studies and the creation of global datasets diminished. There has been a gradual move towards thinking along the lines of waste to resources, resource efficiency, circular economy and zero waste. As described in sections above, there are multiple government entities and stakeholders from the private sector to the informal sector that need to be engaged to tackle the waste crisis. This movement needs to be accelerated with national strategies adopting a whole-of-government and whole-of-society approach for waste management that includes circular economy, resource efficiency, zero waste as comprehensive and integrated approaches for action on the ground.

Considering that within the 17 SDGs, there are three goals that have indicators directly focused on waste as shown in Table 10, it is paramount to advance waste management practices.

Table 10: Sustainable development targets and indicators that directly focus on waste

Sustainable Development Goal	Goal	Indicator
11 Make cities and human settlements inclusive, safe, resilient and sustainable.	**11.6** By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.	**11.6.1** Proportion of MSW collected and managed in controlled facilities out of total MSW generated, by the city.
12 Ensure sustainable consumption and production patterns.	**12.3** By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.	**12.3.1 (a)** Global food loss index. **12.3.1 (b)** Global Food Waste Index.
	12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.	**12.4.1** Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement.
		12.4.2 Hazardous waste generated per capita, proportion of hazardous waste treated and by type of treatment.
	12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.	**12.5.1** National recycling rate, tons of material recycled.
14 Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.	**14.1** By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	**14.1.1 (b)** Floating plastic debris density.

Source: Author's elaboration based on United Nations resolution A/RES/70/1 on The 2030 Agenda for Sustainable Development.

The Global Waste Management Outlook also concluded that waste management needs to be a priority to facilitate progress on the SDGs.[100] Moreover, from a life cycle perspective, addressing the problem at the design stage of a product or service (designing out waste) to prevent or reduce waste at other parts of the life cycle, will produce the greatest dividends. Thus, the circular economy concept is a powerful idea to enhance the notion that depletion of resources can only be decreased by using minimum virgin material and keeping resources in the technosphere. Circular economy is a broad concept that can also be applied to energy, water or resources use overall closing the loop for more resource efficiency.

[100] UNEP (2024a).

1.6.1 An International Partnership for Expanding the Waste Management Services of Local Authorities

Much of the work needed to achieve the goals listed in Table 10 needs to be undertaken by local authorities as most legislation mandates them to manage waste in their jurisdictions. At the international level, the United Nations Department of Economic and Social Affairs (UNDESA) inaugurated an International Partnership for Expanding Waste Management Services of Local Authorities (IPLA) in 2010 with the aim of supporting and promoting sustainable waste management practices at the local level.[101] IPLA achieves this transition through facilitating knowledge exchange, capacity building and partnerships between governments, businesses, the financial sector and civil society. Since its inception, IPLA has formulated five international declarations as shown in Table 11.

Table 11: International Partnership for Expanding Waste Management Services of Local Authorities (IPLA) declarations

Declaration	Date and Place	Description
Moscow IPLA Declaration on Regional Cooperation for Waste Exchange and Resource Recovery towards Circular Economic Development	6-8 October 2015, Moscow, Russian Federation	This declaration recognized the importance of exchanging practical experiences and ideas in 3R and waste management areas among different regions to foster a circular economy.
São Paulo Declaration of Municipalities and Local Authorities for Scaling up of National and International Public-Private Partnerships in Waste Sector for Achieving Sustainable and Resilient Cities	8-10 September 2014, São Paulo, Brazil	By capitalizing on the expertise and resources of both public and private sectors, this declaration aimed to strengthen waste management systems, promote sustainable practices, and enhance overall urban resilience.
Borås Declaration of the Private Sector on Moving Towards Resource Efficient and Zero Waste Societies	9-11 September 2013, Borås, Sweden	This declaration recognized that the private sector has a crucial role in driving change and catalyzing sustainable development.
Marrakech declaration towards "Greening" the Waste Sector	15 to 17 May 2012 Marrakech, Morocco	This declaration recognized the urgent need to address the environmental and social impacts of waste management.
Declaration for Moving towards Zero Waste through IPLA	18 October 2011, Daegu, Republic of Korea	This declaration acknowledged the critical role of local authorities in addressing waste management challenges and aimed to encourage collaboration between governments, communities, and relevant stakeholders.

Source: UNCRD (2023b).

The five Declarations moved from a position of recognizing the central role of local government in waste management to considering environmental and social impacts of waste management, through to the need to work with all stakeholders at the local and international levels to foster progress towards zero waste. Local government initiatives happen and are supported by the broader United Nations initiatives such as those discussed in the following two sections.

[101] UNCRD (2023a).

1.6.2 Promoting Zero-waste Initiatives to Advance the 2030 Agenda for Sustainable Development

In its resolution A/RES/77/161, the United Nations General Assembly[102] seeks to promote zero waste initiatives to advance the 2030 Agenda for Sustainable Development.[103] The zero waste initiatives are part of the transition to a more sustainable and circular economy. Member States are encouraged to adopt and implement policies that promote waste reduction, recycling and resource recovery in all sectors. The role of innovation, technology transfer and capacity building will be needed to drive the shift towards zero waste, requiring the waste management systems to be efficient, equitable and environmentally sound.[104] Alignment of zero-waste initiatives with the 2030 Agenda aims to contribute to sustainable consumption and production patterns, protect ecosystems, mitigate climate change, and promote inclusive and sustainable economic growth. The resolution anticipates that international cooperation, partnerships, and knowledge sharing will accelerate the adoption of zero-waste practices worldwide. Thus, the resolution seeks to emphasize collaboration between governments, civil society, private sector, non-government organizations and other stakeholders.

The resolution further acknowledges the work already done by Member States to develop and implement innovative solid waste management solutions and technologies to foster environmentally sound waste management, reduction and prevention. Key to the success of the programme is knowledge transfer to drive sound waste management through promotion of local and national zero waste initiatives and dissemination of best practices and success stories. This work is further augmented by the work of relevant existing regional and global platforms, including by the United Nations Environment Programme and the United Nations Human Settlements Programme (UN-Habitat). In addition, the United Nations General Assembly, in its resolution A/RES/77/161 designated March 30 as the International Day of Zero Waste.[105] This day provides an annual opportunity to raise global awareness of the global waste crisis, through education and information sharing, and operating as an advocacy platform.

1.6.3 Global Outreach and Support

The United Nations has divided custodial responsibilities for Indicators across its various agencies. For sustainable development targets that are directly related to waste, as shown in Table 10, the responsible custodial agencies are shown in Table 12.

Table 12: Custodial agencies for waste indicators

Indicator	Custodial Agencies
11.6.1 Proportion of MSW collected and managed in controlled facilities out of total MSW generated, by the city	UN-Habitat; UN Department of Economic and Social Affairs Statistics Division
12.3.1 (a) Global food loss index	Food and Agriculture Organization
12.3.1 (b) Global Food Waste Index	United Nations Environment Programme

102 United Nations General Assembly (2022).
103 UNDESA (2016).
104 United Nations General Assembly (2022).
105 United Nations General Assembly (2022).

12.4.1 Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement	United Nations Environment Programme
12.4.2 Hazardous waste generated per capita, proportion of hazardous waste treated and by type of treatment	United Nations Environment Programme; Department of Economic and Social Affairs Statistics Division
12.5.1 National recycling rate, tons of material recycled	United Nations Environment Programme; Department of Economic and Social Affairs Statistics Division
14.1.1 (b) Floating plastic debris density	United Nations Environment Programme

Source: UN Statistics Division (2023a).

Recent progress from the United Nations Environment Programme waste work involved developments in plastics, food, and chemicals. As part of that work, the 5th United Nations Environment Assembly in 2022 resolved to establish a binding international agreement to combat plastic pollution by 2024.[106] In December 2022, the Kunming-Montreal Global Biodiversity Framework was officially adopted, with a global target to halve food waste and reduce overconsumption and waste generation by 2030 as well as preventing, reducing and working towards plastic pollution elimination.[107]

At the 5th International Conference on Chemicals Management in 2023, hosted by the United Nations Environment Programme, to support a planet free of harm from chemicals and waste, Member States adopted the Global Framework on Chemicals. The Framework constitutes a roadmap for countries and stakeholders to collaboratively address the life cycle of chemicals, including products and waste. In addition to the Global Framework on Chemicals, participants adopted the Bonn Declaration, where they committed to "prevent exposure to harmful chemicals, and phase out the most harmful ones, where appropriate, and enhance the safe management of such chemicals where they are needed" also incorporating a United Nations Environment Programme Administered Global Framework on Chemicals Fund.[108]

The United Nations Human Settlements Programme (UN-Habitat) supports local governments to address the increasing MSW quantities and promote a circular economy. The resultant "Waste Wise Cities" campaign provides a platform for sharing experiences and best practices in waste management at the local level.[109] UN-Habitat also developed a sustainable solid waste management framework to improve municipal waste management and resource efficiency by generating waste data, monitoring, training and outreach, and project funding, as well as financing feasibility assistance for project proposals.

106 UNEP (2022a).
107 UNEP (2022b).
108 UNEP (2023b).
109 UN-Habitat (2023).

One of the roles of the Statistics Division of the United Nations Department of Economic and Social Affairs (UN DESA) is to conduct biennial environment statistics questionnaires of Member States to collect data on waste and water. The Statistics Division cooperates with the United Nations Environment Programme for a joint questionnaire. The European Union[110], and the OECD[111] member countries and candidate countries for accession are not part of the data collection, and instead respond to the OECD/Eurostat Joint Questionnaire on environment statistics, complementing the UN DESA Statistics Division/UNEP questionnaire. The latest data from the questionnaire was the 10th in the series and covered 163 countries including a wide range of data such as:[112]

- environmental indicators;
- country files;
- country snapshots;
- waste generation;
- collection;
- recycling data by type of waste (hazardous, municipal solids, and, as a result of a collaboration with United Nations Institute for Training and Research, e-waste);[113]
- industrial waste.[114]

The Food and Agriculture Organization of the United Nations (FAO) focuses on the agriculture sector to support data-driven food security policy formation. The policy roadmap for food loss and waste reduction throughout the food supply chain from farm to the consumer was launched in 2021.[115] Capacity building for statistics is conducted by workshops and e-learning courses by the FAO as well as providing training on calculation methods to manage the Food Loss Index. The calculations provide data on the progress of SDG 12.3.1: Global Food Loss and Waste. In addition, food loss analyses are conducted on selected food supply chains using case study methodology which identifies wastage points and strategy development to reduce these wastes.

The fourth key international organization, the World Trade Organization, which oversees trade rules between nations, focuses on plastics in the waste context. The 2023 Dialogue on Plastics Pollution and Environmentally Sustainable Plastics Trade produced a draft statement on shared principles and concrete actions regarding reducing plastics pollution through trade. It is anticipated that the draft statement will form an official statement at 2024 World Trade Organization ministerial conference.[116] It is hoped that environmentally sustainable plastics trade can drive innovation to create economic opportunities and contribute to the achievement of the Sustainable Development Goals.

110 European Union (2024b).
111 OECD (n.d. (a)).
112 UN Statistics Division (2023b).
113 UNITAR (2024).
114 UNIDO (2023).
115 FAO (2021).
116 World Trade Organization (2023).

2 Learning From National Priorities and Strategies

MADAGASCAR : Empty collection skips, Andralanitra dumpsite, Antananarivo. © Emily Carroll

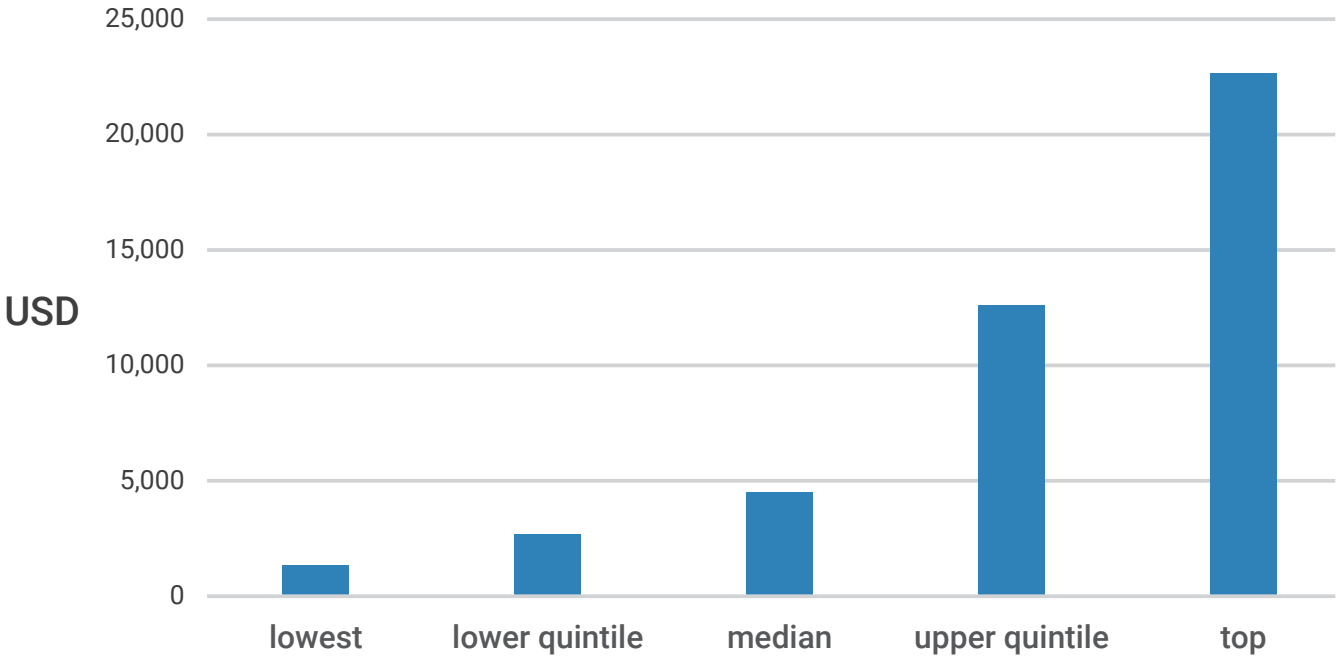
This section examines the national priorities and strategies that countries are using to provide better integrated solid waste management. The section starts with a look at the disconnections between the aspirations at the national level and the reality at the local level. It also looks at the gaps and challenges countries have identified, either in Voluntary National Review reports or through the process of the Expert Meeting held in November 2023 by UNOSD under UN DESA.

Section 2 then moves on to look at how development of better solid waste management can broadly contribute to 2030 Agenda for Sustainable Development and its Sustainable Development Goals. Following on from these wider perspectives, the issue of capacity building is examined and what developing countries need to advance this area. The section then concludes with a look at the data gaps and innovations needed to provide a better understanding of the integrated solid waste management activities in the countries under study.

2.1 Disconnects

While countries are generally presented as being in certain income level brackets, in reality, there is a distribution of income within countries and even inside different wards, within population centres. For example, the distribution of income for Ghana, a lower-middle income country, is shown in Figure 20.[117]

Figure 20: Income distribution by quintile in Ghana



Source: Author's elaboration based on World Salaries (2023).

Figure 20 shows that the income is unevenly distributed, with the median income approximately 36 per cent of the upper quartile income and 20 per cent of the top income. In Accra, the capital city of Ghana, districts can have markedly different average income levels as shown in Table 13.

Table 13 Districts and income levels in Accra, Ghana

Districts	Income Level
Municipal Areas	
Ablekuma Central	Middle
Ablekuma North	Middle
Ablekuma West	Middle
Ayawaso Central	Middle
Ayawaso East	Low
Ayawaso North	Low
Ayawaso West	High
Korley Klottey	Middle
La-Dadekotopon	High
Okaikoi North	Middle

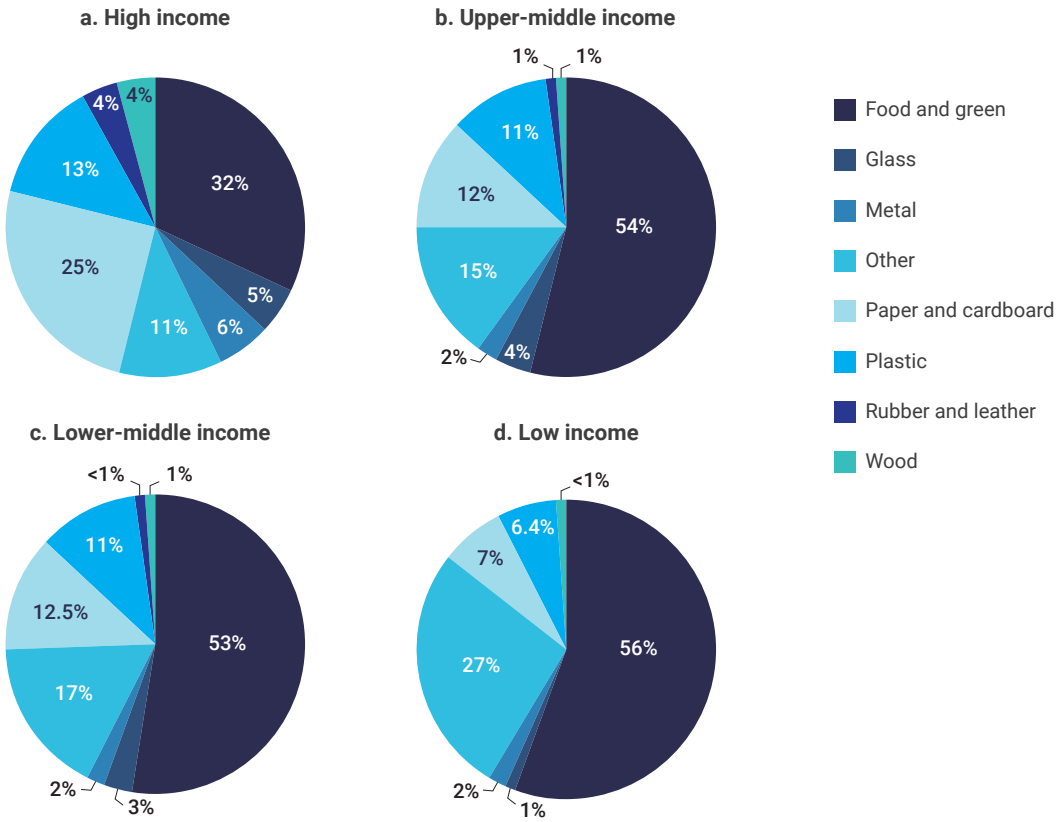
[117] World Bank (2023).

Sub-Metropolitan Areas	
Ablekuma South	Low
Ashiedu Keteke	Low
Okaikoi South	Middle

Source: Author's elaboration based on Amegah Y., et al. (2023).

From Table 13, it can be seen that there is a wide variation in income levels, with some areas (for example Ablekuma) being homogenous and others (for example Ayawaso) quite heterogenous[118].

Figure 21: Waste composition by income level



Source: World Bank (2018).

From Figure 21, it can be seen that, as the income level changes so does the waste composition. For example, low-income areas show 75 per cent more organic waste than high income areas, whereas high-income area waste composition has 250 per cent more paper and cardboard than low-income areas.[119] Therefore, when designing behaviour change programmes, one of the criteria needs to be targeting appropriate messaging to income levels at a granular scale.

To get a better understanding of waste flows and provide information on the performance of a city MSW management system, hence policy, finance and infrastructure gaps, development, the Waste Wise Cities Tool (WaCT) was developed by UN-Habitat based on the definition of SDG indicator 11.6.1. The tool is used to assist planning interventions that address policy, infrastructure, and finance gaps in MSW management systems.

118 Amegah , Yeboah, Owusu, Afriyie, Kyere-Gyeabour, Appiah, Osei-Kufuor, Annim, Agyei-Mensah, Mudu (2023).

119 World Bank (2018).

Firstly, WaCT assesses MSW generated, collected and managed in controlled and uncontrolled disposal facilities.[120] This measurement enables determination of the percentage of waste that flows into controlled facilities, out of the total MSW generated by the city.

WaCT also enables identification of the MSW recovery chain and its actors which forms an important part of the tool, as this exercise engages the participants in an inclusive and participatory manner to identify interventions and implement solutions. Data and evidence-based planning coupled with participatory and inclusive design of future MSW help establish better waste and resource management strategies that can generate business and employment opportunities, while addressing environmental challenges. A major feature of WaCT is the ability to generate data for MSW management infrastructure investment business cases for municipalities, waste stakeholders and investors.[121] This data can then be used for project development and funds mobilization. Finally, WaCT can be used as a monitoring and evaluation tool, to assess the effectiveness of interventions put in place. Training for the use of WaCT is through an online course which is available in several languages on the UN-Habitat Waste Wise Academy.[122]

Another avenue for obtaining waste data is through reports in the Voluntary National Reviews. Challenges for obtaining national waste management data for selected developing countries are shown in Table 14.

Table 14: Data on national waste management challenges as reported in Voluntary National Reviews

Country	Challenges
Cambodia	· Absence of governmental agency to treat hazardous substances. · Inefficiencies due to different ministries responsible for the implementation, measurement, reporting, and verification of hazardous waste reduction plans. · Lack of personnel to conduct research and weak enforcement level. · Limited awareness of environmental protection among stakeholders and citizens. · Need for technical support to collect data on sources of pollution, including solid wastes and liquid wastes, and the management and monitoring of industrial wastes.
Ethiopia	· Insufficient information to assess the progress of the implementation in waste and resource management strategies.
Fiji	· Prioritising the upgrading and maintenance of waste management systems. · High food wastage. · Providing waste management services outside municipal boundaries. · Plastic waste originating from land ending up in the ocean. · Source separation of waste and a pathway for recycling.
Ghana	· Low recycling levels. · Public dumping. · Urban-rural disparity in waste disposal methods.
Honduras	· Making waste management a priority. · Reliance on international finance for development opportunities.
Indonesia	· Decentralization and financing of waste management. · Lack of integrated waste management infrastructure. · Lack of waste transportation and geographical accessibility issues. · Open system operation of existing landfills.
Morocco	· Unsanitary areas due to rapid urbanization and very low recycling rate.
Viet Nam	· While Sustainable Development Goal monitoring, evaluation roadmap, and indicator systems have been developed to manage data, data in the waste sector is still missing.

Sources: Author's elaboration based on data reported in Voluntary National Reviews; Cambodia (2019); Ethiopia (2022); Fiji (2023); Ghana (2022); Honduras (2020); Indonesia (2021); Morocco (2020); Viet Nam (2023).

120 UN-Habitat (2023a).

121 UN-Habitat (2023a).

122 UN-HABITAT Waste Wise Academy can be accessed here: https://unhabitat.org/waste-wise-academy

The Voluntary National Reviews summarised in Table 15 help to provide a better understanding of the country's waste management practices. While COVID-19 was a factor for some countries which reported after 2019, the most common challenges stated were low resource recovery, a lack of data, capacity, and integrated national governance on waste.

A more recent update from other sources for some of the countries listed in Table 14 is shown below in Table 15.

Table 15: Gaps and challenges among planning and policy tools

Country	Gap	Comment
Cambodia	Baseline data	Lack of data on MSW.
	Lack of infrastructure and investment	Particularly for recycling.
	Limited public awareness	Public largely unaware of what can be diverted from landfill and recycled.
	MSW management	Limited resources to carry this out.
	Technologies and innovation	Limited access to these.
Ethiopia	Collection rate	Only 40-50 per cent of waste produced is collected.
	Financial deficiencies	Lack of finance; Poor waste budget planning and management.
	Low rate of diversion activities	Covers waste prevention, reduction, reuse, recycling, and energy recovery. Mainly focused on collection, transport, and disposal of solid waste.
	Institutional shortfalls	Lack of capacity, logistics, knowledge, and skills. Weak sectorial linkage from federal to local level. Weak collaboration between government and private institutions.
	Low waste diversion rates	Only 5 per cent of waste such as plastics, paper, glass, metals, and organic is currently recycled.
	Non-integrated collection systems	In urban areas micro and small enterprises collect waste door-to-door and accumulate in temporary storage sites. Municipalities transport the waste from temporary facilities to disposal points. Private companies also collect and dispose of waste. Qurales (Informal groups of street boys and scavengers) collect recyclable solid waste from households, temporary waste containers, and open dumpsites.
	Partially operational waste-to-energy plant	Lack of sophisticated technology, skilled labor, sorting of raw materials and lack of financial resources.
	Policy shortfalls	Inadequate guidelines and weak enforcement.
	Political challenges	Political interference; Weak managerial commitment.
	Social gaps	Law awareness; Willingness to pay for waste services.
	Technical inadequacies	Weak source waste separation; Low waste collection coverage; Irregular waste collection system; Inadequate waste transportation system; Lack of sufficient and environmentally sound waste disposal; Lack of formal waste recycling.

Fiji	Waste management law and development of regulatory authorities and jurisdictions	No waste management law. No centralized supervised authority. Partial overlap in roles and responsibilities in different agencies.
Ghana	Absence of behaviour change communications	There are no clear, coordinated, or coherent behaviour change strategies for solid waste management.
	Increased waste burning	This has tripled between 2000 and 2020.
	Institutional arrangements	Governance structure for solid waste management is complex and layered, with different responsibilities across several national- and sub-national level institutions.
	Lack of household knowledge	This results in behaviours that are not conducive or aligned to recycling principles.
	Lack of incentives for recycling	The recycling sector is not commercially attractive to the private sector.
	Low status of the informal sector	The result is that existing recycling activities come with substantial health and safety risks.
	Service Performance	Insufficient supervision of service performance of primary collection. Most solid waste management contracts do not specify key performance indicators or stipulate minimum service-level requirements. A large proportion of final waste disposal sites in the country are not managed in a safe, secure, or effective manner. Open burning occurs at dumpsites, and landfills are often prone to fire outbreaks.
	Service Procurement	Low level of competition in formalized solid waste management service delivery. Metropolitan, municipal and district assemblies have little or no control over the awarding of sanitation improvement package contracts.
	System knowledge	Metropolitan, municipal and district assemblies have inadequate knowledge within the changing national policy environment. Capacity varies widely between metro, municipal and district authorities.
Honduras	Capacity of local governments	Lack of capacity for local governments to manage solid waste. Local governments have very few environmental powers, thus they are not empowered to perform all the roles required to handle solid wastes in their field of action.
	Capacity of ministries	Lack of capacity for the Ministry of the Environment, Ministry of Health to manage solid waste. Ministry of Environment lacks powers to inter-institutionally lead and coordinate management in the framework of the General Environmental Law.
	Inadequate disposal	In dumpsites or controlled sites this is still predominant.
	Revenue collection	The main revenue for solid waste management is through property taxes, which do not discriminate between high and low waste producers.
Indonesia	Downstream burdens	Landfill fires; Landfills slide into rivers.
	Suboptimal waste management upstream	Unsorted waste; Suboptimal intermediary waste facilities; Limited waste transportation infrastructure.

Madagascar	Strengthen integrated waste management policy	Urban solid waste management is a priority in the General State Policy (PGE: Politique Generale de l'Etat). Improve equipment for waste collection, transportation, intermediate treatment, and improvement/life extension of existing landfill site.
	Pollution-related deaths that stem from the mismanagement of chemicals	Misuse of pesticides in the agricultural sector. Gold mining involves the uncontrolled use of mercury. Thermal power stations discharge used oil into the sewage system.
	Waste Electrical and Electronic Equipment Centre	Started in 2018. Create innovative practices for waste management related to urban mining and stimulate greater awareness among the public for the need to safely manage electronic waste.
	Resources	Lack of financial capital; Lack of personnel working in the waste industry. Gap between sorting workforce and collected waste.
	Legal framework for waste management	Private sector is not investing in waste diversion from landfill.
Morocco	Collect leachate at landfills	Treatment reduced environmental impacts.
	Ecotax on used lubricant oils	Initial work completed. Implementation still to be considered.
	Flare biogas	Produce electricity to replace non-renewables.
	Plastic waste	There are no secondary markets for plastic waste.
Viet Nam	Limited Resources	Finance, human and facilities.
	Low Awareness	Understanding of policies for implementation by governments at all levels, and people.
	Low, outdated infrastructure	Including waste collection, transportation and treatment.
	Low waste service charge	Cost for treatment is insufficient for MSW treatment facilities.
	Suitable policies	Different conditions, culture and status for each region and locality.
	Suitable technologies	Many technologies are not suitable for developing countries.

Sources: Author's elaboration based on inputs shared during Expert Group Meeting held in November 2023; USAID (2022); CTI Engineering International Co., Ltd (2022); Global Recycling (2022); Secretariat of the Pacific Regional Environmental Programme (2023); UNEP (2018a; 2021c; 2023d).

It can be seen from Table 15 that there are many gaps and challenges for developing countries to improve their solid waste management practices. One of the more significant ones is getting data to build a business case to progress programmes, and then finding the funding to implement them. Waste data, when it is available, is often very sparse and may only cover a very small part of the country, which makes scaling it up problematic. This then translates into difficulties in getting financial buy-in from international agencies.

Comparison of the results in Table 14 and Table 15, shows that there is considerable overlap between gaps/challenges that exist in these countries, with lack of capacity and skills at the local level being high on the list. This results in waste management systems that are rudimentary and very inefficient.

It is noted that the lack of capacity runs across the spectrum from national governments to local governments and industry. Without the right skills, any new programmes or infrastructure introduced will be, at best, sub-optimal, and, at worst, a complete failure. Skills development is a vital part of moving towards a circular economy.

2.2 A Critical Need for Capacity Development

As noted in Section 2.1, there is a critical need for capacity development. There have been advancements and plans to partially address this situation. Table 16 summarizes these national advancements.

Table 16: National advancements or plans to remedy challenges and gaps

Country	Advancement or plan	Comment
Cambodia	Circular Strategy implementation	Foster the implementation of this strategy.
	Legal framework development	Promotes MSW management, 3R implementation and the circular economy.
	Promote collection system	Promote the MSW collection system nationwide with implementation of the National Plan for solid waste management.
	Source separation	Set up measures to improve waste separation at source.
	Zero Waste Cities	Promote Zero Waste Cities initiative implementation.
Ethiopia	Encourage public-private partnerships	Spread the financial load and encourage job creation.
	Enhance service standards	Develop operational guidelines and monitoring and evaluation systems including standardized data collection, recording, and retaining.
	Establish strong financial mechanism	Source adequate pricing and finance from various sources.
	Formulate pilot and capacity building programmes	Encourages scale up and experience sharing.
	Increase community awareness	Education and communication programmes.
	Institutionalize integrated solid waste management systems	Include in policy and strategy documents.
	Promote circular systems	Contributes to achievements of sustainable development goals.
Fiji	National waste management strategy	Has been in draft form for several years.
	Container Deposit scheme	Opposition has come from the private sector. Wide recognition of the need for one.
	Services and financial resources	Needed for citizens outside the municipalities. There is a national policy to provide waste management services to all citizens. Some findings have been provided to suburban and rural areas but there are challenges in terms of sustainability.
Ghana	Comprehensive behaviour changes communication strategy and campaign	Develop and roll out over time.
	Create a platform for coordination	This covers Inter-ministerial and Inter-metro, municipal and district authorities' coordination.
	Develop a framework for data harmonization	To enable comparisons between entities and assist business cases for improvement.
	Develop incentives for private sector engagement	Use tax relief or similar.
	Establish and resource waste management districts	Create incrementally in municipal and district assemblies.
	Establish and resource waste management departments in municipal and district assemblies	Incrementally establish and resource waste management departments, starting with municipal to district assemblies.
	Formalize public-private partnerships	Develop appropriate guidelines and procedures for this in waste management.
	Incentivize metro, municipal and district authorities	Provision of financial rewards.

Honduras	Ban on other problem plastics	Styrofoam, for example has been discussed.
	Creating safer communities	Run a program of solid waste management. Development of educational strategies for community training in solid waste management.
	Plastic bag ban	Individual local governments banned it in some municipalities. Accompanied by an awareness-raising campaign.
Indonesia	Collaboration to achieve sustainable waste management	Government ensures planning and implementation, provides financial support and coordinates stakeholders. Private sector implements circular economy businesses. Non-government organizations oversee policy implementation and assist communities. Academics develop innovation in technology, provide input on waste management plans and develop sustainable waste management curricula.
	Establish competency standards and tiered capacity building	Increased stakeholder capacity.
	Farm to fork strategy	Empower farmers' groups to become solid business partners and implement climate friendly practices. Connect farmers with innovators in the food industry to explore new ways of doing business. Enable mechanisms to encourage trust and transparency throughout the food sector, enabling consumers to make future proof choices.
	Implementation of circular business models	Operational cost savings. Job creation. Emissions, energy, water and waste reductions.
	Improve waste management data management	Update national standards and data integration for waste sector.
	Integration of waste management system planning	Improve quality of planning and stakeholder participation.
	Stakeholder binding mechanism	Establishment of a Waste Management Task Force. Waste institutions are integrated with regional regulations. Workload suitability
Madagascar	Management of chemicals	Develop a national framework to prevent threats related to the misuse of chemicals in relevant sectors such as agriculture, health, industry, and customs. Not fully compliant with Basel, Stockholm, Rotterdam and Minamata Conventions because of a lack of national standards and policies the whole government should adhere to. Securing medical equipment to respond to and analyse chemical events.
	Waste Electrical and Electronic Equipment Centre	Started in 2018. Create innovative practices for waste management related to urban mining and stimulate greater awareness among the public for the need to safely manage electronic waste.
Morocco	National programme for waste recovery	Promote integrated and sustainable waste management. Organize waste recycling and recovery channels. Reduce wastage of natural resources. Minimize impact of industrial activities and upgrade national industry to a green economy. Promote investment and creating jobs by organizing the informal sector.

Viet Nam	Circular economy	National Action Plan for Implementation.
	Develop the carbon market	Greenhouse gas emissions cap and carbon credits.
	Greenhouse gas control	Greenhouse gas reduction and sequestration, Greenhouse gas inventory.
	Incentives mechanism	Specify investment incentive policies (e.g., green taxonomy, preferential loan interest rates).
	Waste segregation at source	Allows recovery of materials to reduce need for virgin resources.

Source: Author's elaboration based on data shared during Expert Group Meeting held in November 2023; CTI Engineering International Co., Ltd (2022); Honduras (2018); Secretariat of the Pacific Regional Environmental Programme (2023); and UNEP (2018b; 2023d).

Table 16 shows that the developing countries listed above have made advancements to address data gaps or challenges. There is a realization amongst several developing countries that public-private partnerships can be a pathway to improved solid waste management. Public-private partnerships can be challenging to establish but might present opportunities for infrastructure planning and improvements. However, whatever is chosen, there must be clear win-win outcomes for the recipients and the finance providers. A good starting point is the estimate that waste reduction can save municipalities between USD 35 and USD 400 per tonne, depending on the location and the waste management technologies used.[123] There is no single model for public-private partnerships, but they tend to entail more operational and collaborative relationships than conventional contracting. Of particular importance is getting the appropriate governance structures in place.

Further examination of Table 16 shows that source segregation, plastics, and recycling feature prominently. For these to be successful there need to be stable markets for the products, as well as an economic model that enables the circular economy model to be viable. In addition, the infrastructure needs to operate within the capabilities of those who are going to use it.

[123] UNEP (2019a).

2.3 Data Gaps and Innovations Needed in the Collection of Baseline Information

Data is one of the key elements to progress towards sustainable development. As already mentioned, a key obstacle in waste management at the local, national and international scales is limited data availability. Limited availability poses significant challenges for the waste-related Sustainable Development Goal indicators. The importance of the data is that it enables informed decision-making, allows for trends to be identified and hence resource allocation. Robust data also contributes to an enabling environment to attract financial investment.

Consideration of the waste-related SDG Indicators reveals that it is mainly Tier II level data, thus it is not produced regularly by countries.[124] Progress assessment for the 17 SDGs based on assessed targets for 2023, or the latest data is shown in Figure 22.

Figure 22: Available data for progress assessment on the SDGs

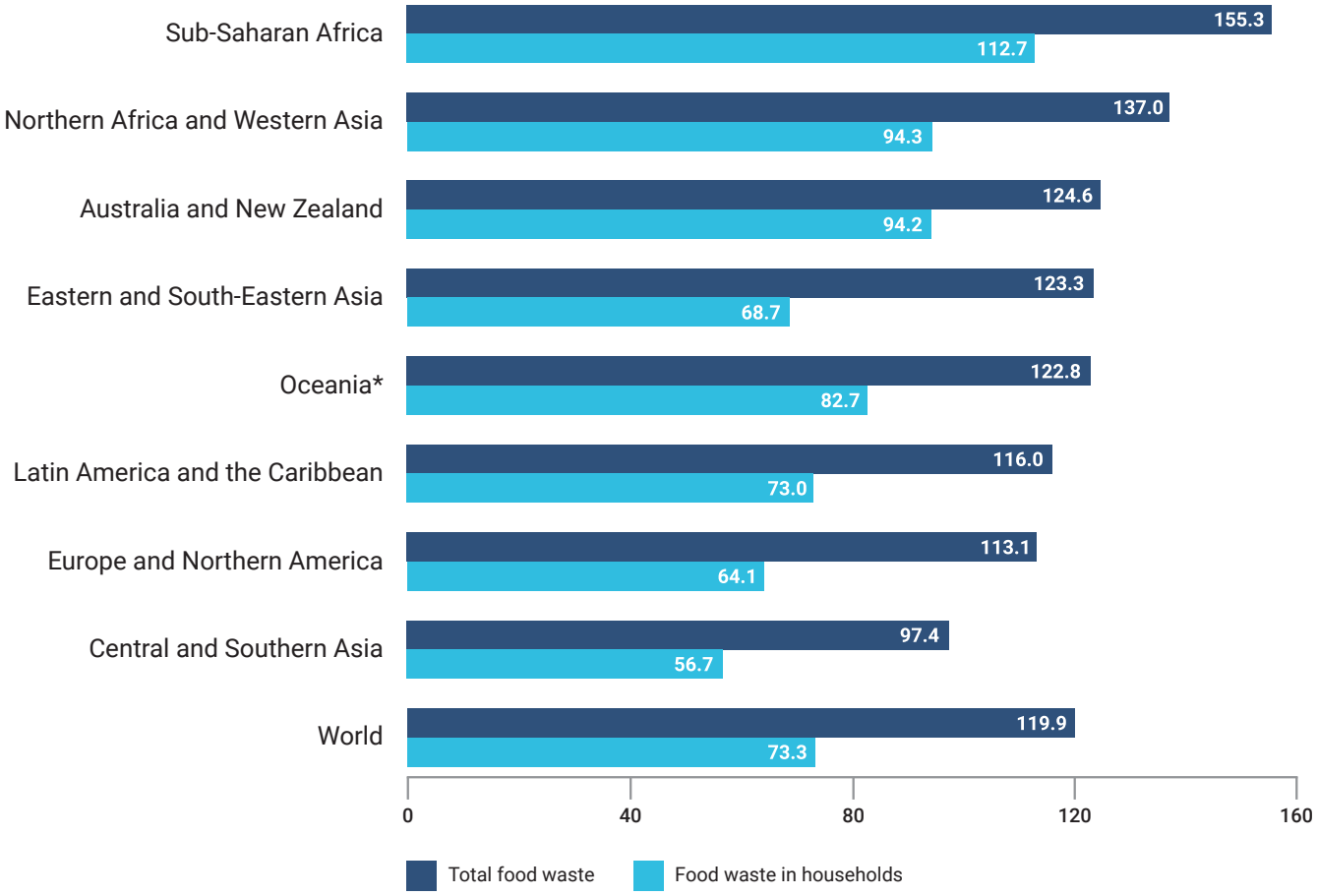
Source: UN (2023c).

From Figure 22, it can be seen that SDG 11, which includes urban solid waste data, has the most insufficient data of all SDGs. For the other two SDGs principally related to waste, SDG 12 primarily shows fair progress, but an acceleration is needed, and SDG 14 predominantly shows stagnation or regression. Overall, reported waste data internationally varies depending on national capacities.

[124] UNSD (2021).

Food waste and marine plastic pollution have been two focal points for SDGs 12 and 14 respectively.[125] Total food waste compared to food waste in households is shown in Figure 23.

Figure 23: Estimated total food waste and food waste in households per person, 2019 (kilograms)



*Excluding Austrailia and New Zealand

Source: UN (2023c).

Data shows that 13.2 per cent of the world's food was lost post-harvest along the food chain before it reached the customer and an additional 17 per cent is lost at the house, hospitality, or retail level.[126] From Figure 23 it can be determined that worldwide, 61 per cent of food waste occurs in households. The highest losses occur in Sub-Saharan Africa (20 per cent) compared to Europe and North America (9 per cent).[127] Comparing household generation with total food waste reveals that three regions are below 60 per cent (Eastern and South-Eastern Asia (56 per cent), Europe and North America (57 per cent) and Central and Southern Asia (58 per cent), while two regions are above 70 per cent (Sub-Saharan Africa (73 per cent) and Australia and New Zealand (76 per cent). It can be seen from Figure 23 that regions with the highest proportion of household food waste are also in the top part of the figure while two of the lowest percentages are at the bottom of the scale.

Highlights in the 2023 SDG Report for marine plastic pollution (SDG 14) only focus on monitoring carried out as part of citizen science initiatives worldwide, hence it provides little information for this report.[128]

125 Ibid.
126 UN (2023c).
127 Ibid.
128 Ibid.

However, data on its own is a very weak motivator for behavioural change. Since waste is part of a system, it is useful to take a systems approach to understand what is happening in the system and then consider potential levers to assist desired behaviour changes. A hierarchy has been developed as a guide to effectiveness of interventions that different types of levers can have as shown in Figure 24.[129]

Figure 24: Effectiveness of interventions for different types of levers

Source: Meadows (1999).

In Figure 24, the interventions at the top (for example, the paradigm change (exemplified by the 'old' thinking of flame, flush and fling being replaced by reduce, reuse, recycle and recover) are more effective than those lower down (for example, regulating negative feedback loops exemplified by liability costs for generating waste). Data appears twice within the hierarchy in Figure 24, as parameters (for example, waste quantities) and information flows where data goes to new destinations (for example, public reporting of hazardous waste generated by individual companies). Within the nine levels of the hierarchy, information flows are 5th most effective, and parameters are at the bottom.[130] Thus, the purpose to which the data will be put is more important than merely collecting the data and publishing it on a website.

This chapter has identified a number of significant challenges to accelerating national to local policy actions to address the waste crisis. A summary of the main challenges is provided in Table 17.

[129] Meadows (1999).
[130] Ibid.

Table 17: Summary of significant challenges to accelerating national to local policy actions to address the waste crisis

Challenge	Section
Coordination between different ministries responsible for waste management	2.1
Developing waste management systems outside main centres	2.1
Dumping of waste	2.1
Enforcement of waste management policies and legislation	2.1
Lack of capacity and skills at national and local level to deliver change	2.1
Lack of consumer knowledge	2.1
Lack of incentives	2.1, 2.2
Lack of financial capital	2.1
Limited data availability	2.1, 2.3
Legal frameworks at national and local levels	2.1
Low recycling rates	2.1
Low waste charges	2.1
Markets for recyclables	2.2
Plastics waste management	2.1
Provide win-win outcomes for recipient and funding providers	2.2
Source waste segregation	2.2
Status of the informal sector	2.1
Uneven income distribution between city, municipality and rural producing different waste profiles	2.1
Uneven income distribution within city wards producing different waste profiles	2.1
Unsuitable technologies	2.1

To achieve circularity and resource efficiency for waste systems, a transition must occur that takes nations from dumping waste to reducing waste in all its forms – solid, liquid and gas. This transition must include all stages in the life cycle of products since waste is an indicator of inefficiency in material life cycles. To that effect, the following chapters focus on the end-of-life stages and empowerment of national government so that they can build capacity for local government and private sector to manage waste generated in their areas.

3 The World We Want

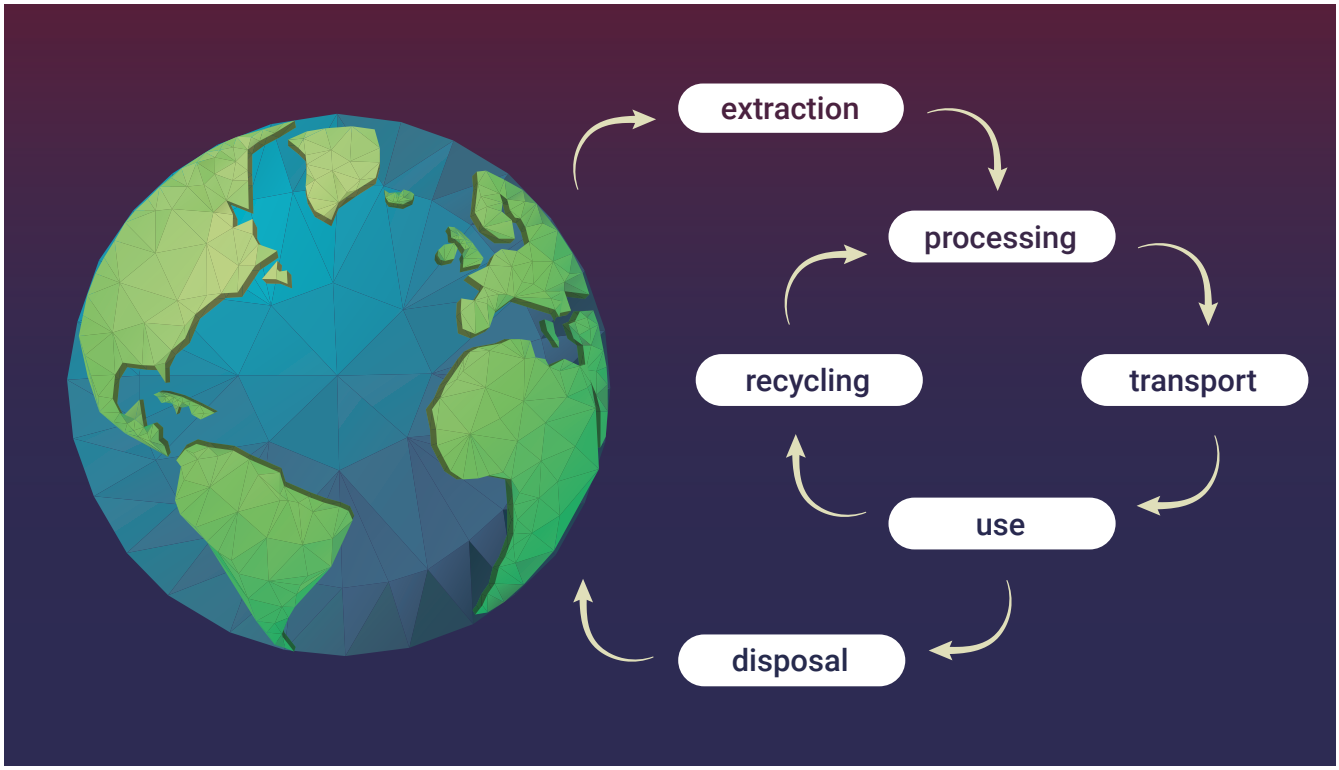
SWEDEN: An entrepreneur at his waste recycling facility views plastic waste sorted into colours and types for potential resale, providing a second life for plastics. © Sara Castro-Hallgren

The current trajectory of waste in the world shows continuing increases. A long-term outcome of this trajectory is depletion of the planet's resources, to the extent that humankind will run out of resources at the current rate of development. Coupled with resource depletion is the assimilative capacity of the planet for waste. Waste is an indicator of inefficiency in the life cycle of a product and in the economy overall.

In the previous chapters the current state of waste management practices in developing countries was analysed against best practice in life cycle management, and gaps on the road to an effective life cycle approach identified. The chapters also discussed a raft of solutions introduced by countries to address gaps and improve practice. In the following chapters some forward looking solutions are suggested to further improve life cycle management in developing countries and minimize, if not eliminate, waste from the global system. In particular, this chapter looks at tools to bridge the gap between the current situation in developing countries and a world heading towards zero-waste.

As the first step for a life cycle approach to work, the waste generation stage in the roadmap in Figure 3 needs to be further expanded to include more stages of a product's life cycle, as shown in the life cycle scheme in Figure 25.

Figure 25: A typical product life cycle



As mentioned earlier, waste is generated at each stage of the life cycle shown in Figure 25, starting from extraction from the Earth (land, water or air), processing, manufacturing and on until the post use stage. The effective reduction of waste requires tools to adequately assess the problem and then to implement appropriate solutions at all stages of the life cycle, and within the waste system as a whole. A key component of the path towards zero waste for policymakers is the identification and application of appropriate tools.

It has to be stressed that the waste system is a complex web (refer to Figure 5) and there is no single way of arriving at 'the' waste solution. The same applies to approaches to reduce waste disposal. Effective waste management requires integrated thinking that is suitable to the local context. There are several approaches to this problem. The three considered in this report are the systems approach, integrated design, and behavioural thinking. These approaches can all be applied to strengthen policymaking and planning for effective waste minimization and resource efficiency. Explanations of these three innovations for policymakers that can assist problem analysis are contained in Annex 2.

One of the key impediments to bridging the gap is the lack of capacity within national and local governments, as well as the industry sector. Strengthening these sectors is fundamental to making progress. The crucial role of information has been a recurring theme throughout this report, as well as formulating policies at the national level that support work at the local level. Building a business case to seek funding for appropriate resources is another fundamental step to improved waste management. Determining the right technologies that are affordable, the right scale and manageable within the context they are being implemented in, is a very important step in the process leading to successful execution. Part of the business case is gathering scientific evidence using tools like life cycle assessment and full cost accounting to give a holistic picture of the situation. Following the business case, funding mechanisms can be sought and applied from a variety of sources, spanning international to local and public to private. Each has its place.

Environmental responsibilities of national and local governments play an indispensable role in waste management. In addition to environmental regulation, fundamental activities like research and environmental assessments, as well as preparing for disasters and managing risk are principal components to protect the environment.

Central to all the activities mentioned above is development of sector engagement and public oversight. It is incumbent on the national government to first identify, and then work with, key stakeholders. These stakeholders provide valuable input towards what is feasible in the local situation.

3.1 Determining Current Status

Determining the current status of waste management requires quantitative data on the life cycle of waste from collection to disposal. Frequently, developing countries have significant data gaps and the following sections elaborate on gaps that have been identified in Section 1.5.1.2.

3.1.1 Classifications

While there is a Globally Harmonized System of Classification and Labelling of Chemicals,[131] there is no accepted classification across all countries for other types and categories of waste. This lack of common classification means that inter-boundary comparisons are difficult to achieve. Therefore, there is a need to focus on uniformity of data and data collection methods.

3.1.2 Indicators

Indicators for getting more granular data are either absent or not widely used. For example, building and construction, commercial and infrastructure wastes tend to have a different profile than household waste (which is a common focus for countries). Separating wastes into source types enables tailored interventions that can divert waste more effectively from landfill. In addition, socio-economic, health and environmental indicators are not generally considered. Environmental and socio-economic indicators need to include indicators relevant to waste management as well.

3.1.3 Standard Definitions

Without standard definitions it becomes difficult to compare quantities and methods between countries to see what is working and what is not. The lack of comparability means that a business case for international finance to introduce interventions to reduce waste is much harder to compile. Along with standard definitions, methodologies for measurement are also not standardized, making comparison between districts, countries and sub-regions difficult. This further emphasizes the need to standardize data and definitions across countries. UN-Habitat attempted to define some standard definitions e.g. MSW, collection, generation etc. to fill this gap.[132] Another source of standard definitions includes the United Nations Statistics Division and United Nations Environment Programme Questionnaire 2022 on Environmental Statistics.[133]

131 UNECE (2023).

132 UN-Habitat (2023a).

133 UNSD and UNEP (2022).

3.1.4 Ward Level Data

Ward level data can be very useful in providing composition data for differing socio-economic groups (as found in the Global Waste Management Outlook[134]) that are rarely taken below the national level, even though different socio-economic neighbourhoods at the sub-city level can show similar waste composition to those in the Outlook.[135] Collection of data at all levels and support for local data collection should be one of the priorities in waste management.

3.1.5 Waste Destination

Without the knowledge of where the waste is going (landfill, dumpsite, incinerator, open burning, illegal dumping or composting facility), it is difficult to assess which technologies, and at what scale, can be implemented successfully. Often there are multiple options that can be applied to the same waste stream, but an appropriate scale is a determinant of success or failure of the technologies. Understanding the whole life cycle, including the end state, is crucial to managing the life cycle system, as already mentioned.

3.1.6 Waste Other Than Municipal Solid Waste

While household waste is often profiled, waste streams like commercial and industrial, e-waste, plastics, trends and quantities of marine litter, hazardous waste quantities are often sparsely reported. In addition, waste from activities like construction and demolition, which form a significant waste stream (globally about 35 per cent of many countries streams[136]) and mining waste (up to 65 billion tons per year[137]) are not covered. A shift towards focusing on the spectrum of waste rather than on single streams is required.

3.1.7 Building Capacity

A staple feature of the gaps in effective waste management, as identified by various countries and United Nations organizations, is the lack of capacity at government level, both nationally and locally, to progress an integrated solid waste management system that forms part of a circular economy. Specific capacity gaps identified by several developing countries at local government level include:[138]

- Technical capacity to enforce hazardous waste regulations;
- Regulations implementation and guidelines development;
- Understanding each party's rights and responsibilities in managing waste through public-private-partnerships;
- Developing plastic recycling facilities or infrastructure to practice waste collection; and
- Inadequate knowledge within the changing national policy environment.

134 UNEP (2015).
135 Kala, Bolia and Sushil (2020).
136 UNEP (2022c).
137 Kalisz et al. (2022).
138 UNEP IETC (n.d).

3.1.8 Governance

Governance issues feature strongly in the ability of developing countries to implement a waste legislative framework. Many countries have legislative instruments that have enforcement and monitoring provisions, but they are often poorly administered. The absence of enforcement is often due to deficiencies in the capacity of national and local government to supply services or manage stakeholders in the private and community sectors including non-government organizations. Capacity-building in monitoring and enforcement at the national and local levels is often needed to improve legislative compliance to improve solid waste management practices which will require adequate funding.

In addition, there are different delivery models ranging from national or local government taking control, to industry stakeholders or community groups, churches and civil society organizations undertaking waste management actions. This is coupled with low levels of expertise of operators and competing priorities of government officials and departments which impede progress.[139]

Adding to this problem is the lack of capacity and incentives in the private sector in developing countries to introduce appropriate programmes and technologies to implement a transition to a circular economy.

These issues can be addressed by investing in inter-generational education activities through schools and tertiary education that can embed programmes such as 3R (reduce, reuse, recycle) at an early age and provide long term benefits. This has proven successful in many contexts (for example, Dominica's 3Rs Awareness for Schools[140]) and could be considered more widely to build capacity and ensure continued improvements in moving towards a circular economy.

Internationally, assistance is available to support national governments to assist local governments to build capacity. For example, the UN facilitates knowledge exchange, capacity-building, and partnerships between local governments, relevant stakeholders, and international organizations to address waste management challenges and zero waste practices at the local level. International organizations operate workshops and e-learning courses to develop statistical capacity on Sustainable Development Goals monitoring and indicator measurement including waste management.

3.1.9 Technology Transfer

Several of the targets within the Sustainable Development Goals refer to technology transfer as one of the means of implementation, including Target 12.a (Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production).[141] One of the barriers for effective solid waste management in developing countries is the lack of infrastructure, outdated technology, or inadequate processing materials. Appropriate handling of waste can both prevent serious environmental damage and recover valuable materials.

139 Carroll *et al*. (2023).

140 Dominica (2013).

141 UNDESA (2024).

Waste technologies can vary from a bicycle for waste collections through to automated plants for large scale separation of recyclable materials. Technologies also span from waste collections through to diversion and disposal. The more complex technologies are often marketed by companies in developed countries which have the capacity to operate them. However, there are advanced technologies in development that do not necessarily need significant infrastructure such as the use of the Black Soldier Fly, as an example of nature-based units, for organic waste processing which is under consideration in Cambodia.[142] In another example, Carbios in France, which are known for enzyme-based chemical treatment, is building a plant that will produce recycled polyethylene terephthalate using biotechnology.[143] It is anticipated that the environmental impact of the process will be lower than traditional recycling but can be inserted into most current recycling plants for polyethylene terephthalate. All of this means that national and local governments need to have the capacity to assess the appropriateness of potential technologies, based on scale of operation envisaged, skills needed to operate and maintain the technology, markets for the end products and affordability.

Movement from a linear society to a circular economy will require significant technological interventions. Essential factors to be considered for technology transfer include:

- A sound policy and regulatory framework at the national level especially for Public Private Partnerships.
- Vertical cooperation between national and local governments.
- Government incentives such as tax breaks, subsidies, preferential financing, or expedited regulatory approval.
- Financing requirements as there are limited financing capacities in developing countries, especially at the local level where communities may lack adequate waste management services and existing infrastructure may be deteriorating due to poor maintenance.
- Capacity building across national and local governments and the private sector.
- A strong science-policy-business interface which can drive a technology-oriented or R&D oriented culture and infrastructure.

Part of the assessment of appropriate technologies is to evaluate whether they are environmentally sound whereby they have capability to significantly upgrade environmental performance relative to other technologies.[144] For example, one of the more advocated technologies by companies is Waste-to-Energy with more than 200 plants under construction in the Asia-Pacific region, including in China, Thailand, the Philippines, Indonesia, Myanmar, Malaysia, Maldives, and Viet Nam. At the planning stage, these plants are often disputed by communities and scientists for their adverse environmental and social harm. They are more carbon intensive than coal powered plants, a leading source of dioxins and furans, and have high capital and operational expenses. In established markets like the United States or European Union, there is a movement away from incineration and Waste-to-Energy due to the environmental effects listed above, plus they are often built in areas with low-income households and groups in vulnerable situations.[145] On the other hand, while these Waste-to-Energy plants mainly use MSW as their energy source, there are also opportunities to use biomass to generate biogas for energy. Developing countries have much higher organic waste percentages than developed countries, so this opens an opportunity to beneficially use waste biomass.[146] As biogas generation relies on anaerobic digestion, the remaining organic matter can still be used for composting and cycling nutrients back into soil. The advantage of using biomass is that it is renewable. Therefore, it is necessary to adequately evaluate technologies, as appropriate for the country in question.

142 Dortmans, Diener, Verstappen and Zurbrügg (2017).
143 Carbios (2023).
144 UNEP (n.d (c)).
145 Ibid.
146 UNEP (2024a).

Technologies encompass individual equipment through to systems that include knowledge, procedures, goods and services, and equipment, as well as organizational and managerial procedures. To effect technology transfer at the enterprise level, there is a need to develop capacity in companies in developing countries to successfully explore opportunities in global markets. Other key challenges to enable technology transfer include access to finance, shortages of skilled labour to provide services related to the design, installation, and maintenance.[147] Table 18 provides a summary of some high and low technology solutions that can be utilized by developing countries to improve their waste management practices.

Table 18: Environmentally sustainable high and low technology solutions

Low Technology Solutions	High Technology Solutions
Animal feed production from biomass	Incineration for MSW*
Biogas digesters	Incineration with energy recovery*
Co-combustion in an industrial facility	Landfills: Sanitary
Composting biomass: Home composting	Material Recovery Facilities (clean)
Composting biomass: Windrow systems	Mechanical Biological Treatment
Controlled dumps	Sorter: Optical for material separation
Gasification for biomass	Sorter: Pneumatic for material separation
Hazardous waste: separation into hazard classes	
Hazardous waste: takeback systems	
Incineration: high-temperature, small-scale for medical waste	
Landfill gas capture systems	
Landfills: semi-aerobic systems (Fukuoka)	
Landfills: Inert substances	
Leachate management systems	
Material Recovery Facilities (dirty)	
Pyrolizer for wood	
Recyclables: Collection bins	
Recyclables: compactors	
Recyclables: grinders	
Sorter: Mechanical for material separation	
Sorter: Gravimetric for material separation	
Sorter: Magnetic for material separation	
Waste collection vehicles	
Waste Bins: Community	
Waste Bins: Individual households	
Waste Separation: Tipping floor	

**Note: Though these are not environmentally sustainable solutions, they can form a transitional solution that is better than some others, such as open dumping of waste.*

Source: UNEP (2015; 2018b; 2018c; 2019a).

147 UNEP (2018c).

3.1.10 Data Management

Monitoring, data synthesis and sharing are crucial tools to achieve public buy-in and generate evidence to build business cases to seek funding for projects. To build those business cases data gaps need to be addressed, as noted in Section 1.5.1.2. Those are considered in more detail below.

3.1.10.1 Accuracy

The infrastructure needed to generate data is often not present at disposal sites. This infrastructure includes weighbridges and countries do not often have volume-to-weight conversions for different sorts of waste (e.g. construction and demolition) nor for different vehicle types (e.g., car boot or small truck). Even simple factors like vehicle movements to and from disposal sites are not recorded. Gaining accuracy is an important factor, for not only is it necessary to obtain a base line, but progress over time resulting from interventions needs to be assessed.[148] Thus, data collection should be one of the standard practices at disposal sites.

3.1.10.2 Information Management Systems

Without an information management system, it is very difficult to apply for funding for projects as there is insufficient data to build a case.[149] A process needs to be found so that data is released in a timely fashion so that planned interventions can use the most up to date data that allows for the greatest success.

3.2 Formulating Policy

Policy is a crucial tool for accelerating solutions to the waste crisis. Policy at the national level needs to align between ministries and departments with different waste management responsibilities. These tools also need to align with those at the local level. Policymakers have a variety of tools available including:[150]

- Data and information collection for analysis and dissemination that can influence behaviours and decision making (Sections 2.3 and 3.1);
- Economic instruments (development and application) (Section 3.3);
- Education and training of the producers, consumers, the general public and others (Section 3.5);
- Executive decision making;
- Harnessing the commitment of the community and the non-government sector (Section 3.5);
- Regulation and enforcement (Section 3.5); and
- Voluntary agreements (with industry groups and the industrial sector).

The effectiveness of these tools is greatest when used in combinations that are appropriate to the context, culture and socio-economic conditions of the country under consideration. Discussion on most of the tools is covered in other sections as noted above, with executive decision making and voluntary agreements covered below.

148 Carroll *et al*. 2023.

149 UNEP (2019a).

150 UNEP and UNITAR (2013).

While executive decision making seems to be the quickest tool to implement, for it to be effective, it needs to be contemplated after effective consultation with affected parties. Ministers and senior policymakers are often presented with seemingly good ideas that turn out to be detrimental to important parts of the waste sector. For example, Waste-to-Energy is often presented as a great opportunity to significantly reduce waste to landfill while producing sustainable energy.[151] While this appears to be a win all around, consultation with the informal sector would reveal that they can be significantly adversely affected by, for example, diversion from recycling of profitable materials with high calorific values to the waste-to-energy plant.[152] In addition, consultation with local residents has also revealed that incineration can produce adverse impacts including emissions, noise and odours.[153]

Voluntary agreements can provide a significant boost to reducing waste when this tool is combined with others listed above, particularly when it is coupled with stakeholder engagement. Motivation can be provided by the national government being able to exercise the power of regulating schemes if a voluntary agreement cannot be reached. Discussion on aspects of voluntary agreements can be found in Guidelines for Framework Legislation for Integrated Waste Management.[154] One type of voluntary agreement that has received a lot of attention is that of Extended Producer Responsibility where national governments can work with individual industry groups to better manage waste. This tool increases the accountability of importers and retailers to create a circular approach that is workable financially and is discussed more fully in Section 3.3.3.

3.3 Financing Waste Management Initiatives

The economic benefits of instituting an integrated waste management system extend across various facets of the economy. Investing in environmentally sound waste management will enable the creation or expansion of a formal waste industry with associated employment, environmental management and advancement opportunities. Important aspects for financing waste management initiatives include full cost accounting, gaining the finance and investigating financial incentives.

3.3.1 Full Cost Accounting

To consider the full cost of waste, accounting needs to start at the beginning of the life cycle, extraction of raw materials from the Earth (air, water, and land) that are then transformed through manufacturing, transported, used, and finally reach the end-of-life stage. It also needs to include the environmental and social costs of activities. Historically, full cost accounting did not include the environmental or health externalities of waste management.[155]

Excessive waste generation stems from the reality that the total cost of waste disposal (actual cost plus externalities[156]) is rarely fully paid.[157] The problem runs through the whole value chain, starting with extraction of materials. Often it is cheaper to extract raw materials from the land, water, or air (thus depleting the natural capital of the country[158]) than to turn them into a circular material, resulting in a circularity rate of approximately 7 per cent globally.[159] Analysis has shown that in the present economic structure, the circularity potential of the global economy is about 30 to 40 per cent,[160] so a virgin materials tax can compensate for the loss of natural capital.[161]

151 UNEP (2019b).
152 Arora (2023).
153 Tilley et al. (2023).
154 UNEP (2016a).
155 D'Onza, Greco and Allegrini (2016).
156 These were stated as USD 252.3 billion and USD 243.3 billion respectively in Section 1.5.1.3.
157 IMF (2019).
158 World Forum on Natural Capital (2018).
159 UNEP (2024c).
160 Ibid.
161 IMF (2019).

The next component of the value chain is the import or manufacturing of products. Application of an advanced disposal fee as part of an extended producer responsibility scheme provides for the cost towards a circular solution for the products. Some of the common products that have advanced disposal fees applied are plastic packaging, batteries, tires, and appliances.[162] Advance disposal fees can have consequences of reducing product usage. For example, studies of changes in eight countries in plastic bag usage with advanced disposal fees showed there was an average of a 68 per cent decrease in bags consumed.[163]

Fees levied by local governments or waste collection businesses that charge by weight or volume provide another part of the life cycle costing. Where separate charges have been instituted, waste generation decreases. For example, Republic of Korea's volume-based waste fee saw waste generation decrease by 27 per cent over the 20 years it had been in force.[164]

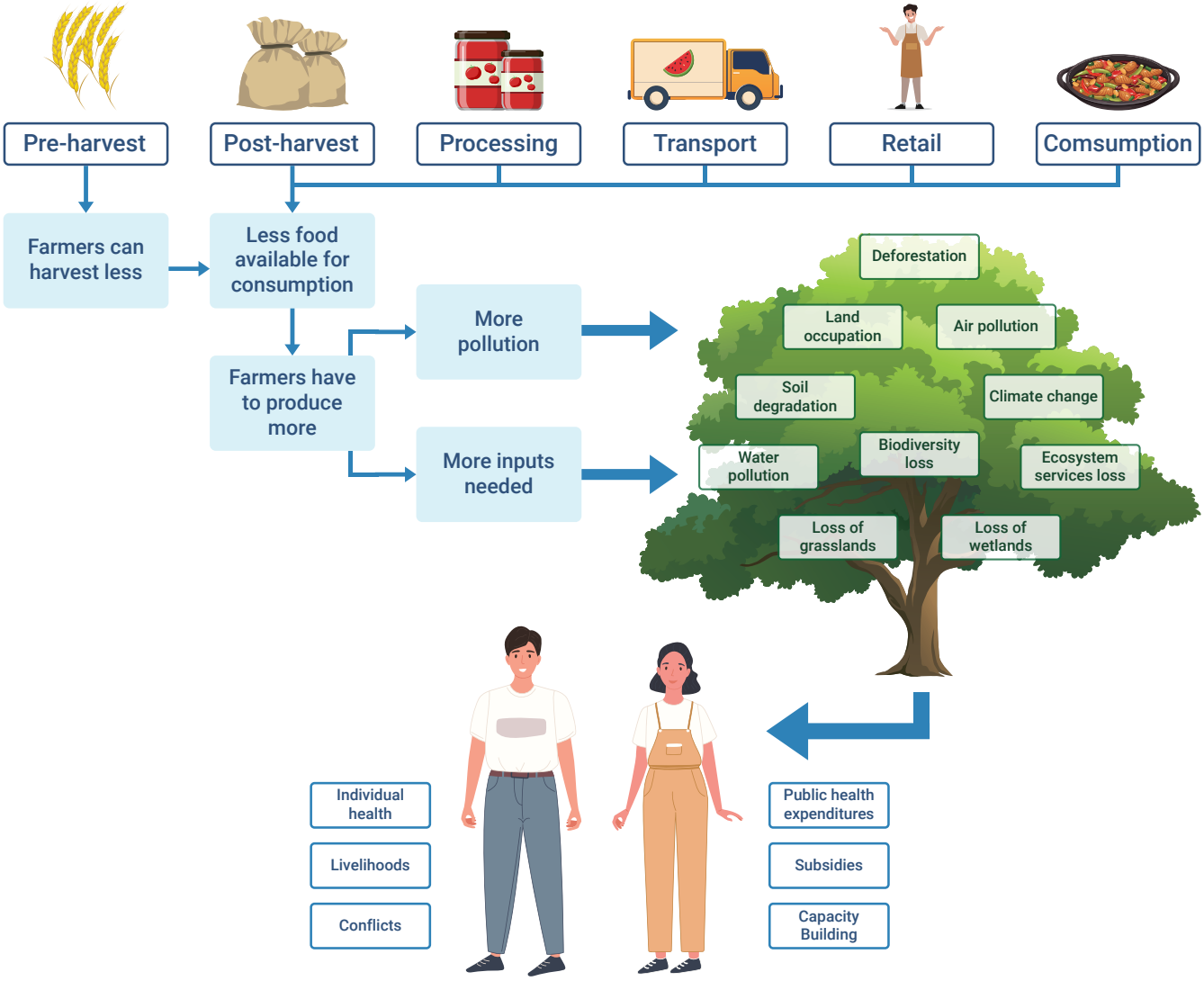
Other ways of charging for waste collection and disposal at the household or business level include flat fees, utility surcharges or property taxes. Tipping fees for disposal are typically charged at landfills. These fees are usually weight-based or volumetric. They are also variable based on the type of waste being disposed of. For example, inert waste like rock and soil are generally priced lower and those with higher reuse potential (e.g. construction debris or compostable material) also have reduced fees. The fees need to include the costs of land rent, capital and operating costs, as well as the costs of remediating any long-term environmental impacts caused by waste in landfills.[165]

When materials are sent for disposal to a landfill another set of considerations come into focus. If the disposal site is not a properly constructed landfill, then the future cost of decontaminating land and water (surface, groundwater and marine) needs to be accounted. A sanitary landfill will have costs associated with planning and gaining permission, land for the site, development, operation, management, administration and organizational overheads, and closure and aftercare. Incineration (with or without energy recovery) has similar cost types, plus a mechanism to ensure that contracted waste quantities are delivered for operation of the plant.[166] Incineration also requires a sanitary landfill for any hazardous waste generated as well as site decontamination at the end of the incinerator's life. Full cost accounting also includes health effects on disposal workers and the surrounding communities. When there is no full cost accounting, the costs noted above are paid for by local, regional, or national authorities from general revenues forming part of the government's public health and environmental protection responsibilities.[167]

An example of applying full cost accounting can be found in the FAO's food wastage footprint publication.[168] A summary of impacts of wastage along the food chain is shown in Figure 26.

162 IMF (2019).
163 Ibid.
164 Korea Environment Institute (2016).
165 IMF (2019).
166 New Zealand, Ministry for the Environment (2004).
167 UN-Habitat (2010).
168 FAO (2014).

Figure 26: Direct impacts of food wastage along the supply chain



Source: FAO (2014).

Figure 26 shows the direct internal and external costs (externalities) of food production for lost or wasted food at each stage of the value chain. The estimated full costs of food wastage at a global scale were estimated to be economically USD 1 trillion, socially USD 900 billion and environmentally USD 700 billion.[169] A breakdown of the social and environmental costs is shown in Table 19.

[169] FAO (2014).

Table 19: Annual social and environmental costs of food wastage

Impact category	USD (billions)
Greenhouse gas emissions (4.5 Gt CO_2-equivalent)	394
Water scarcity (dry regions and seasons)	164
Soil erosion (nutrient loss, lower yields, biological losses and off-site damages)	35
Wind erosion (nutrient loss, lower yields, biological losses and off-site damages)	35
Biodiversity risks (pesticide use, nitrate and phosphorus eutrophication, pollinator losses and fisheries overexploitation)	32
Conflict risk (soil erosion)	396
Loss of livelihoods (soil erosion)	333
Adverse health effects (pesticide exposure)	153
Total	1,542

Source: FAO (2014).

To put this in perspective, the economic, social and environmental costs for food wastage annually represent a cost of USD 300 per person on the planet.

3.3.2 Waste Management Funding

Waste management programmes compete with other government priorities, such as education and health, to receive funding. A variety of sources can provide means to fund waste management programmes, including international finance, private sector participation and community contributions. In addition, incomes from pricing mechanisms (i.e. local fees from waste handling and/or landfilling) can be ring-fenced for investments in waste management improvement projects. An example of the latter is establishment of a plastic eco-tax in Morocco that has generated funds enabling the construction of sorting and transfer centres across Morocco.

The scale of funding needed depends on the desired outcomes. Differentiation between capital and operational expenditures provides variable funding opportunities. Sometimes capital expenditure is higher than governments or businesses can afford, and various forms of funding are needed to bridge the gap. For an ongoing programme, operational expenditure should be covered by service charges or fees to ensure a sustainable funding model.

Private enterprise, in the form of the informal sector, can operate commercially viable businesses because there is considerable demand for their services, financial barriers to market entry are low, and user fees are negotiable.

For larger enterprises and local government, viable business cases, which require data, are needed to attract investment in waste management programmes. The Waste Wise City Tool application includes a financial analysis of MSW and recommendations for more effective and efficient use of funds to deliver waste services to all. To make waste management initiatives attractive to potential investors, it gives more confidence to them if there is a clear link with government policies, strategy, and regulations. In addition, demonstrating the ability to secure guaranteed fees and product take-off prices is important. Therefore, applying a business approach to show the rate of return, as well as environmental and societal benefits is a necessary step.

Partnerships at the local level can offer an alternative approach to international aid funding or national subsidies. With partnerships there is co-responsibility and co-ownership for the delivery of solid waste management services. Community organizations like the Zero Baht Shop in Bangkok, Thailand provide an example of a community-led programme that has improved the social status of its members.[170] They combine the advantages of the private sector (dynamism, access to financial resources and latest technologies, managerial efficiency, and entrepreneurial spirit) with social concerns and responsibility of the public sector (public health and better life, environmental awareness, local knowledge and job creation). Of note is that insecure long-term finance may lead to operational failure due to high operational costs, which may bring substantial financial risks to the municipality.

Public-Private Partnerships represent an opportunity for private sector engagement. With these sorts of partnerships, national and/or local governments share the risk while building medium to long term relationships. There are many possible variables within this framework, but governments need to be more actively involved in governance than in traditional contracting, something they have to be prepared for.[171]

3.3.3 Financial Incentives and Disincentives

In order to move to a zero-waste society, a price component needs to be included at all stages of the life cycle. To provide for necessary solid waste management infrastructure, the system needs to be economical, affordably priced, and well equipped, particularly to carry out monitoring and enforcement functions. A system of incentives and disincentives can be utilized to help guide people's choices.

At the individual product level, the use of EPR programmes can provide manufacturers the incentive to design resource-efficient, low-impact products[172] that cost less to manage at the end-of-life stage. In EPR, manufacturers or importers take responsibility for the end-of-life stages of their products to ensure they, or the materials, remain in the circular economy. Tools available under EPR include:[173]

- Prohibiting the sale of a product unless it is part of an accredited EPR scheme. This stops 'free-riders' from being able to profit from not being part of a scheme.
- Controlling or prohibiting disposal of products to landfills. This needs to have an easily accessible alternative for end-of-life.
- Controlling or prohibiting manufacture or sale of products containing specified materials. This can control the release of materials that are hard to manage at the end-of-life.
- Requiring specified classes or people to provide takeback services and prescribing requirements for those services. Often these include retailers who sell the products in the first place.
- Requiring container deposit schemes to incentivize people to return containers to get their deposit back. The income from the non-returned containers helps to fund the programme.
- Prescribing requirements for labelling of products. This enables people to understand what the products (or packaging) are made from and guides the type of end-of-life decisions.
- Prescribing standards for reusing, recycling, or recovering the product or material. This encourages importers or manufacturers to offer products to the market that can be diverted from landfill.

170 UNESCAP (2020).
171 UNECE (2008).
172 UNEP (2024a).
173 UNEP (2016a).

Each of the option suggested above needs to be implemented in a way that is culturally appropriate for the target community. Successful schemes require opportunities for straightforward participation by consumers such as convenient drop off zones, measures to include potential free riders, adequate funding to make the scheme viable, and good record keeping.[174] It is also important the money collected under the schemes, or any waste management charges, is ringfenced for reinvestment back into the sector.

EPR can be both mandatory and voluntary. Often voluntary schemes are implemented because manufacturers perceive that a more environmental approach to their products can open market opportunities in the manufacturing country or high value markets.

At the end-of-life financial incentives come in a variety of forms. One of the more traditional incentives is to take advantage of the resource value of the waste with economic demand for reuse and repair of products and recycling of materials.[175] The use of volume-based collection fees rather than a flat fee per household has been used as an incentive to reduce waste when coupled with household waste diversion processes such as recycling.[176]

Governments (both national and local) are significant procurers of goods. As such, they can use their procurement specifications to favour less wasteful products as well as providing tax breaks for innovative product development.[177] Local government can provide financial incentives at the local level to encourage greater private sector involvement in recycling or waste infrastructure.[178] However, targets for recycling in, for example, the construction sector, can have the perverse outcome of recycling or crushing excess raw materials, rather than reusing them on further sites.[179]

A significant factor in the end-of-life stage is the environmental impact of incorrect disposal. Legislation and regulations can be crafted so that people or organizations that litter or dump waste can be fined and paid for rectifying any environmental effects.[180] Non-revenue instruments can also be used as incentives or disincentives to reduce waste generation. For example, tradeable permits could be introduced that create a market in rights to add material to landfills. Initially, these rights would be set at current levels, and over years, quantities would reduce, with those exceeding reductions able to trade excesses as a marketable commodity.[181]

3.4 Protecting the Environment

Environmental regulations focused on waste fulfil a significant need to reduce and better manage waste. However, outside influences on a country can have significant impacts, for example, illegal waste trafficking to developing counties with weak legislation or poorly enforced environmental regulations. This waste often ends up in illegal landfills, illegal storage sites or is burnt in the open. Since 2018, countries like Indonesia and Viet Nam have become regional destinations for both legal and illegal waste, despite international treaties designed to curtail this flow.[182] The size of the problem can be glimpsed from the United Nations Office on Drugs and Crime data, which estimates that the illegal e-waste trade to East Asia and the Pacific region is worth USD 3.75 billion annually.[183]

174 UNEP (2016a).
175 UNEP (2015).
176 UNEP (2024a).
177 Ibid.
178 UNEP (2015).
179 Ibid.
180 UNEP (2016a).
181 UNEP (2015).
182 UNODC (2023).
183 UNODC (2013).

To lessen environmental impacts, developing countries that receive goods and/or tourists through ports can have marine and port regulations that deal with dumping or discharge of waste.[184] New activities and infrastructure, for example landfills, can have a requirement to produce environmental impact assessments before work begins.[185] Related legislation from public health commonly addresses hazardous waste, which can also significantly affect the environment.[186]

Environmental impacts can be reduced through monitoring waste collection emissions that reveal where wastage occurs. Some jurisdictions can have multiple waste companies collecting waste as well as others collecting recyclables, thus multiplying greenhouse gas emissions for the same activity. While competition can provide pricing efficiency, consideration should be given to extra carbon emissions that occur as a result of rivalry.

Disasters can generate the equivalent of decades of waste in a very short time. For example, the Haiti earthquake in 2011 generated the equivalent of 51 years of 'normal' waste.[187] With the frequency of extreme events increasing worldwide, preparedness to manage the waste generated must also increase and should feature strongly in any disaster strategy.

3.5 Developing Sector Engagement and Public Oversight

Appropriate sector engagement is fundamental to accelerating waste policy implementation. Dialogue between national and local governments should be extensive and ongoing as national governments have the key to providing legislative support and engaging with national organizations and businesses where needed while local government has the connections to unlock local support. The role of the informal sector in developing sector engagement should not be underestimated, nor should the role of monitoring.

3.5.1 Stakeholders

The starting point for an improvement in solid waste management practices is for national governments to identify key stakeholders, including the informal sector, and ensure their engagement in initiatives through distribution of responsibilities. In this way governments can build capacity and share the load to achieve far greater and more sustainable results.[188]

Local governments are among the key stakeholders. While national initiatives bring a degree of scale and coordination, it is local government that can mobilize local resources to reflect national interests and priorities, enhancing vertical policy coherence. Many municipalities suffer from technical, funding and capacity gaps in implementing policies and strategies at sub-national levels to address growing waste volumes. However, most of the municipal waste data is collected by local government which shows there is a need for national to local data coordination to strengthen monitoring and reporting.[189]

In smaller municipalities, towns and rural communities, local government's role is often as the main specialist provider of integrated waste management services. There is a need for local training and capacity building to support the implementation of initiatives and enforcement and monitoring of the outcomes. One of the key skills for local government officials is to work with private enterprises to technically assess whether proposed solutions by businesses are locally acceptable and sustainable.

184 UNEP (2019a).
185 Ibid.
186 Ibid.
187 Ibid.
188 Carroll *et al*. 2023.
189 Carroll *et al*. 2023.

3.5.2 Informal Sector

The bridge between waste dumping and some degree of material diversion in developing countries is often the informal sector. This sector operates primarily because there is economic benefit for the workers in collecting and separating waste and selling materials. However, this is often at a small scale and workers exist at the subsistence and low skill levels, with a significant share living below the international poverty line of USD 2.15 per day. The issues of small quantities, transportation costs of materials to get them to markets, the lack of local secondary materials markets and the cost of technology implementation all add to the difficulties of establishing a viable and rewarding recycling industry.

Data derived from the informal sector is key to closing information gaps. In developing countries, this sector is an essential part of waste management. Policy development, including legislation, needs to include the informal sector.[190] Often, people within the sector have experienced trauma which has resulted in them lacking trust, that often results in unwillingness to engage with formal collection mechanisms. To overcome this reluctance, a high level of sensitivity is needed in the data collection process along with any future integration into the formal sector.[191] Work in this area is being led by UN-Habitat and the International Labour Organization. Small scale Informal service providers in Ghana operate commercially viable business because there is considerable demand for service, financial barriers to market entry are low, and user-fees are negotiable.

A focus on the informal sector needs to be a priority in developing countries to ensure the principle of Leaving No One Behind so fundamental to the 2030 Agenda and its Sustainable Development Goals can be fully achieved. The resource recovery sector in developing countries relies on the informal sector which already provides many of the services that lead to a circular economy. However, often the informal sector is very vulnerable to adverse reactions and there is very limited data on positive or negative externalities that affect the sector. Gender differences and the vulnerability of women is particularly apparent in the sector which attracts women unable to work in the formal sector. These women tend to have lower wages than men doing the same job.[192]

There is a need to provide stability for the informal sector through policies and legal frameworks to improve their working conditions which can then lead to better standards of living. For example, in India, policies on the role the informal sector within local government describe a need for:[193]

- Local government (regional) policies and strategies to recognize the principal role of the informal sector and provide broad guidance to integrate informal waste collectors into the waste management system; Local government (regional) to commence a scheme for registration of informal waste sector workers;
- Local government (municipal) creating a scheme to endorse organizations of informal waste collectors. Promote and inaugurate a system for amalgamation of these authorized collectors to aid their participation in solid waste management including door-to-door waste collection;
- Local government (municipal) to direct waste generators not to litter and deliver segregated waste to authorized informal sector workers or waste collectors;
- Local government (municipal) to setup material recovery or storage facilities to enable informal sector workers and waste collectors to separate recyclables from the waste;
- Local government (municipal) to train solid waste management practices to informal sector workers; and
- Local government (municipal) transfer segregated waste to all collectors including informal workers and pay monthly user fees or charges.

190 Arora (2023).

191 Arora (2023).

192 Kristanto, Kemala, and Nandhita (2021).

193 India Republic of (2016).

3.5.3 Crucial Role of Monitoring

Not only does monitoring provide a snapshot of the current situation, but longitudinal data provides very useful trend information, while reporting on monitoring processes needs to be timely for the data to be useful.

3.5.3.1 Longitudinal data

While most countries in the OECD have longitudinal data, most developing countries only have snapshots of data like waste quantities. This makes it very difficult to see trends over time and relate them to conditions on the ground. The lack of longitudinal data also means that building a business case for waste management programme development is more difficult.

3.5.3.2 Monitoring and reporting

Often countries do not have sufficiently sophisticated systems to enable them to generate data[194] so a system of monitoring and reporting data is needed. It has been found that less than half the Asian countries have basic data on municipal waste generated and only one -sixth have data from higher up the waste management hierarchy. Diversion rates of waste are generally unknown as is the population serviced by collections. For specific waste streams such as plastics, e-waste, and hazardous waste, United Nations and government initiatives have strengthened available data but more needs to be done to provide an integrated picture on national solid waste recycling and management. Finally, data needs to be reported in a timely manner so that policymakers can have recent information from which to make decisions.

The above chapters have discussed and suggested a number of solutions towards more effective waste life cycle management. Some key aspects of the proposed approach are summarized in the following chapters.

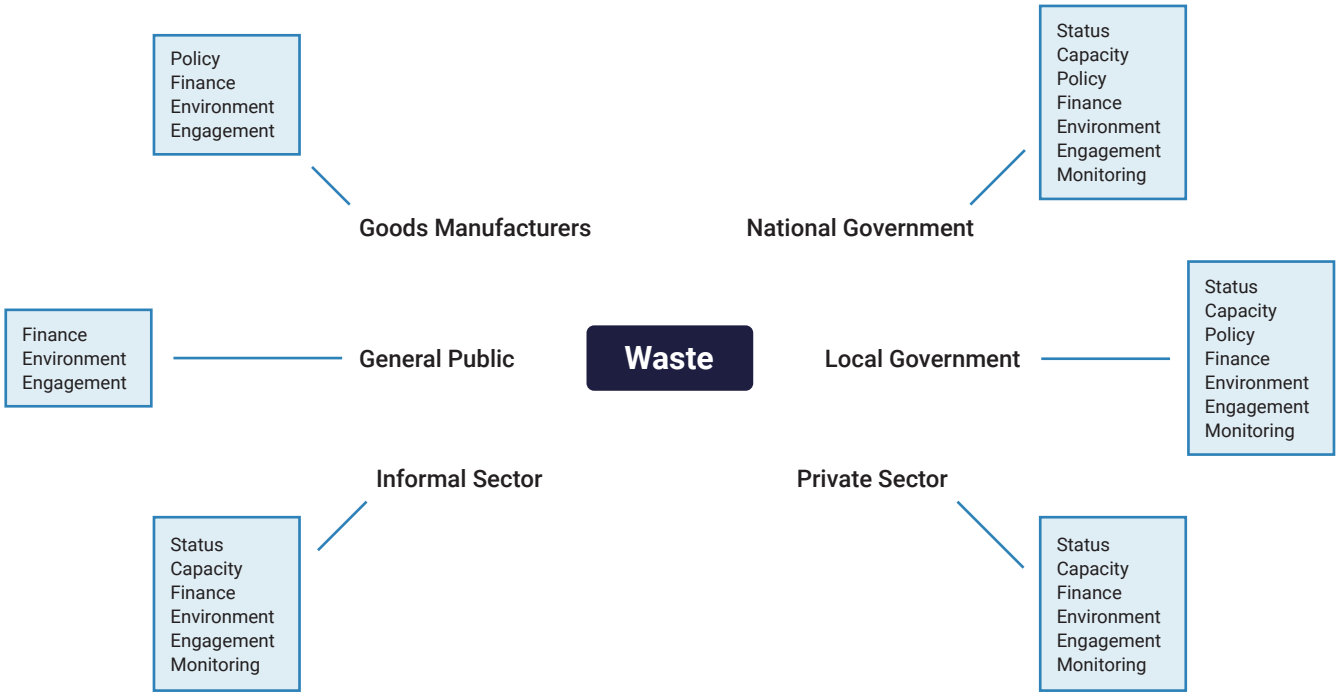
194 UNEP (2019a).

4 Pathways Forward and Recommendations

REPUBLIC OF KOREA : National to local efforts – In 2015, Seoul and Incheon, Gyeonggi Province and the Ministry of Environment embarked on a journey to transform Sudokwon Landfill, Incheon, one of the largest in the world, from a brown landfill site to a beautiful public park. © SLC

Each country is different, so individual national and local governments will need to assess their best approaches depending on their development plans and aspirations as well as financial, cultural, social and environmental circumstances. Accelerating national to local policy actions to tackle the waste crisis will involve principal stakeholders working together. However, not all stakeholders have responsibility for all actions. The mind map in Figure 27 shows the areas that each principal stakeholder has an interest in.

Figure. 27: Areas of interest for principal stakeholders



It can be seen from Figure 27 that there are six principal sets of stakeholders with much overlap in their areas of interest. The roles of stakeholders for the seven categories are:

- **Status**: As discussed in Section 3.5, four sets of stakeholders (national and local governments, private and informal sectors) are pivotal data holders. Depending on the local conditions, local government can be a conduit to national government for information from public, private and the informal sectors in their districts. Alternately, each sector may report data to the national government which is the overall holder of all information.
- **Capacity**: As discussed in Section 3.1.7, four sets of stakeholders (national and local governments, private and informal sectors) are critical to build capacity to accelerate sustainable waste management. Building governance capacity has been identified as necessary for both national and local governments, while building infrastructure capacity is required for all stakeholders involved in delivering waste management services.
- **Policy**: As discussed in Section 3.2, national and local governments need to enhance policy frameworks in developing countries to better manage waste. In addition, goods manufacturers have a stake in policy development as they can be severely impacted (both positive and negative) depending on policy settings.
- **Finance**: As discussed in Section 3.3, all stakeholders are interested in finance. For national and local governments, finding avenues of finance for waste management is a critical role. The private and informal sectors, and goods manufacturers require finance to continue operations or expand. These sectors can seek that finance from government (local and/or national) or through lending institutions. Householders are concerned about charges or taxes that are passed on to them.
- **Environment**: As discussed in Section 3.4, while all sectors bring expertise to the environmental impacts of waste management, the general public is less equipped to bring technical expertise but can provide feedback on the general direction. The public's support is important to be able to get widespread buy in for environmental initiatives. The role of government (national and local) is to enable environmental protection throughout the life cycle of an initiative. At the planning stage of waste management initiatives, assessment of potential environmental effects is needed which requires supporting legislation from national government to effect it. Goods manufacturers need to be made aware of any restrictions on trade that are imposed on them for environmental protection. The waste operators (public, private and informal) need to be made aware of demands and opportunities that environmental legislation creates at the end-of-life stage.
- **Engagement**: As discussed in Section 3.5, all sectors have a role in engagement. For central and local government, it is important to gain support for policy and to try to minimize in-built failure in any measures. Goods manufacturers, civil society organizations and the waste operators have a role to improve environmental protection and try to minimize unworkable measures. Engagement with the general public is needed to build support for environmental protection, so that when it is introduced, they will participate in those measures.
- **Monitoring**: As discussed in Section 3.5.3. under environmental protection, monitoring (and enforcement) is necessary to ensure that waste management practices are environmentally sustainable. Stakeholder engagement plays a major role in developing a workable monitoring and enforcement regime. National government has the overall responsibility to develop a framework that is viable. Local government becomes responsible for monitoring to ensure that environmental safeguards are in place during operations and that the waste operators fulfil their obligations. The public, private and informal waste operators need to comply with environmental protection measures, which hopefully they have engaged with in their development.

The chapters before this one have laid out some common themes and provided details on each of these topics. This chapter further develops those themes and provides suggestions for pathways forward by looking at governance and related topics, waste quality and quantity, the economic sectors and funding aspects of solid waste management.

4.1 Waste Governance, Management and Capacity

Having established the gaps in data, the actions needed to move from the national to local level are complex. Determination of the origin of waste is the starting point for defining solutions. Implementing successful solutions requires a multi-stakeholder approach with the public sector at both national and local levels, the private sector and the informal sector working together. Since women make up a particularly disadvantaged part of the informal sector, their voice needs to be especially sought.

The role of local government also includes taking into account the income levels of constituents, the cultural context and the nature of the area, metropolitan or rural. Interventions that are effective in one context do not necessarily work in a different profile. Hence, collaboration needs to result in common approaches to increase circularity in the technosphere.

When designing programmes there has to be a mixture of easily achievable along with long-term goals that can be more aspirational. However, it should be noted that government inefficiencies coupled with insufficient enforcement can lead to policy failure. Further difficulty arises when governments or even ministers change, which can change priorities and hence funding for programmes. On the other hand, citizens' lifestyles can be significantly improved through pursuit of circular initiatives and green solutions that can provide green jobs. This is particularly true for resource efficiency when the upstream parts of the waste management hierarchy (prevention and reduction) are targeted. For example, a good initial target for circularity is food loss and waste, as this is a significant waste stream, can cause health issues, but needs only low-level technology to divert from the waste stream and produce an economic product. Upstream, programmes can be developed at the local level whereby food retailers can donate leftover food to charities, rather than send it to disposal. In addition, information and behavioural change campaigns focused on women (who are usually responsible for food purchases and preparation in households) can make significant impacts to reduce food waste.[195]

Infrastructure development requires sufficient data to enable comparability so that mismatched solutions that can increase waste are not implemented. Data is also needed for comparison with similar, reliable arrangements or situations, so that performance and improvements can be measured.

Governments typically work in silos, but sharing knowledge between departments is critical to coordinating waste reduction. In addition, sharing knowledge between national and local governments is essential to achieving coordinated waste reduction programmes. The rollout of waste reduction programmes should be accompanied by targeted communication programmes rather than general public awareness programmes, which have been found to be ineffective.[196] In addition to top-down communications, bottom-up feedback is extremely important to ensure inclusiveness and gauge effectiveness.

The key to advancement of the circular economy is action at the local level. A movement from product to primary focus can improve resource efficiency while programmes targeted at the higher end of the waste management hierarchy provide significant waste reduction potential. To make the whole system work, sustainable financial tools (e.g. eco-taxes) are fundamental.

195 UNEP (2024a).
196 UNEP (2019a).

Recommendations

1. Establish the data gaps that need to be filled as a priority to move towards a circular economy to enable national and local government to build capacity to be able to monitor and gather the data.
2. National government to work collaboratively with local government. This will ensure that governments at various levels (e.g., metropolitan, municipal, district and rural) can share experiences and develop culturally and environmentally suitable programmes to move towards zero waste in their jurisdictions.
3. Programmes of action should include a mixture of goals that can be achieved quickly (typically focused on the lower parts of the waste management hierarchy – recycling to disposal), including the more aspirational, long-term ones (typically focused on prevention and reduction).
4. Futureproof against changes in government policies by focusing on achievable, effective targets that directly benefit local communities.
5. Build capacity at the local level so that appropriately sized technologies can be implemented, operated, and maintained. This also includes the capacity to assess performance and improvements in waste management.
6. Develop cooperation across national government agencies that work in the waste sector so that a coordinated and manageable programme is rolled out to local governments.
7. Organize sustainable funding to ensure that programmes are successfully implemented.
8. Ensure effective, direct communication with relevant stakeholders and general public and foster community engagement and participation, focusing on marginalized groups and women in the informal sector.
9. Promote inclusive decision-making processes to ensure diverse perspectives and culturally sensitive waste reduction strategies.

4.2 Waste Quality and Quantity

One approach to move towards zero waste is from an industrial development market perspective. The elements that need consideration to promote sustainable economic growth while reducing waste and environmental degradation are:

- Value chains;
- Source segregation;
- Stakeholder analysis;
- Public private partnerships;
- Waste reduction incentives; and
- Landfill mining.

Understanding value chains will reveal where value is added, and waste is created. Often waste (not only solid waste) is created at different parts of the value chain. For example, solid waste is created in the design process along with extraction from the Earth (including water, air and land) production and during the use and post-use stages. Air emissions (including greenhouse gas emissions) occur during extraction, production, transport to storage, retailer, and user, between users and at the post-use stage.

Source segregation presents a significant opportunity to increase value of recyclables with very little effort. People are prepared to undertake simple actions like separate recyclables from waste, provided it is easy to do (e.g., recycling and waste bins are situated next to each other) and is low (or no) cost. Design for recycling and improved sorting can result in a mechanical recycling rate of approximately 30 per cent.[197]

Stakeholder analysis provides a good opportunity for the right people to be around the table when decisions

are made. Bringing stakeholders together, such as product designers, manufacturers, retailers, users and waste sector providers, can provide very useful market information for the end-of-life stages for proposed products, before wasteful decisions are made.

Public-private-partnerships create an opportunity for shared responsibilities and shared rewards as well as generating new funding sources to expand, for example, current and potential infrastructure. However, for them to be successful, the public sector needs to develop capacity in operational issues in addition to its policy expertise, and it must have a more direct role and be very engaged in the details of the operation as well as in governance aspects.

Waste reduction incentives (e.g., tax breaks or subsidies) encourage waste producers to adopt more sustainable practices. These incentives can even go as far as banks and insurance companies setting lower fees for enterprises that can demonstrate more sustainable practices as there is a risk reduction for these institutions.

Landfill mining can provide a very useful source of materials for reinsertion into the circular economy. Currently, one of the more profitable types of landfills are those that have accepted waste since the 1980s when quantities of e-waste started accumulating. Due to the quantities of goods such as old computers being disposed of, there is potential to mine landfills economically.[198] At the small scale, this can be carried out by training the informal sector, but larger scales would need a more formalized approach.

Transition from a linear to a circular economy requires development of suitable technologies. Along with a strong policy and regulatory framework, and collaboration between national and local governments, funding and capacity issues have to be considered. Most importantly, the financial arrangements need to be sustainable for affected communities so that an undue burden on them is not created. In a similar way, capacity building needs to take place concurrently with technology selection, with training programmes built at a science-policy-business interface. This training will help to provide skills for assessing technologies and the ability to operate and maintain them.

Technologies can encompass a wide spectrum including nature-based solutions such as anaerobic digestion for organics producing methane that can be used as an energy source through to more advanced technologies like nanotechnology and employing green chemistry practices. There are also emerging solutions for developing countries which include green hydrogen generation from biogas and chemical recycling of plastics.

The technosphere should complement the biosphere within a circular economy. Technologies should build societal resilience to climate impacts, economic crises, and waste stream diversification. Success in these endeavours requires local knowledge on what is acceptable in society and workable in practice.

198 Johansson, Krook and Eklund (2012).

Recommendations

1. When moving towards a circular economy, value chains need to be explored to ascertain where waste is occurring. This exploration should include all aspects of waste including a multimedia approach (solid, liquid, gas and energy).
2. Progress should be monitored in countries in order to strongly encourage formalization of response to international data collection efforts, including the completion of questionnaires in programmes of work within-country by using tools developed by UN-Habitat.
3. Understanding and bringing together relevant stakeholders at all stages of the project creates opportunities towards more effective waste management. Key stakeholders that should be brought into the discussions include the private sector and the informal sector including women in the informal sector. A collaborative approach for stakeholder engagement which is culturally sensitive is needed for successful integrated waste management programmes.
4. Source segregation of waste should occur as close to the point in the life cycle where it is generated (e.g. production or collection).
5. Opportunities for public-private partnerships should be explored wherever it is appropriate to have them, and particularly if the public sector has the capacity to be a full partner.
6. Waste reduction incentives should be explored by both national and local governments to increase motivation of waste generators to support waste reduction programmes.
7. Landfill mining could be considered either at the small (utilizing the informal sector) or large scale (using the formal sector).
8. Invest in technological innovation to address waste challenges and unlock opportunities for sustainable waste reduction.
9. Explore new technologies suitable for developing countries to accelerate the adoption of innovative solutions.

4.3 Social and Cultural Factors

Any successful integrated waste management programme requires significant emphasis on social and cultural factors. These factors include public awareness, education, cultural attitudes, community participation, creation of opportunities and the recognition of possible inequitable impacts on marginalized communities.

These challenges can be overcome but they require culturally sensitive education, engagement with community leaders, technological innovations (such as the low-tech solutions that require low financial input and are easy to implement as mentioned in Section 3.1.9) and a collaborative approach between all stakeholders. Particular attention to the informal sector is needed as, in many developing countries, they have a significant role in waste management (as mentioned in Section 3.5.2). This is also an opportunity to address the gender wage gap where women have lower wages for doing the same jobs as men. National and local governments have a particular role in demonstrating a collaborative relationship.

Recommendations

1. A collaborative approach for stakeholder engagement which is culturally sensitive is needed for successful integrated waste management programmes.
2. The involvement of local communities (including the informal sector) and prioritization of programmes that create opportunities for local communities and underprivileged segments of communities can generate multifaceted benefits, particularly in the waste management area.
3. Provide stability for informal sector workers through policies and legal frameworks to improve their working conditions, including equal pay for equal work, which can then lead to better standards of living.
4. Address cultural attitudes towards waste to tailor interventions that resonate with local values and norms.

4.4 FINANCING

Finances are always a crucial driver to get change in waste management. Differentiation between capital and operational expenditures provides variable funding opportunities. Sometimes capital expenditure is higher than what government or business can afford, and various forms of funding are needed to bridge the gap. For an ongoing programme, operational expenditure is best covered by service charges or fees to ensure a sustainable funding model.

Development of a case for finance should include a full cost accounting approach (as shown in Section 3.3.1) to highlight the economic, social, and environmental costs and benefits. Sources of funding tend to be government and businesses at the local, national, and international levels.

Commonly, the lowest level of funding sought is local businesses wanting to take advantage of a niche market that business owners have identified. These are businesses that start by fitting into the market or cause a small disruption. The informal sector is an example of this type of waste management. Individually the businesses make a small difference, but they provide employment opportunities and skills development as they get larger. The funding opportunities for local businesses come from families, local lenders or community cooperatives that have a vested interest in their communities.

National and/or citywide waste management businesses provide scale to the market and require higher levels of funding which requires more formal finance mechanisms such as banks. These businesses provide more employment opportunities as well as skills development.

International waste management businesses tend to work by either buying national or local businesses and expanding operations (modernization of equipment and processes) or bringing in disruptive technologies (e.g. waste-to-energy). This can have major effects on the marketplace (e.g. loss of jobs for the informal sector). Funding these operations often comes from the businesses through their own lending institutions or government (national and/or international), or a combination of the two.

Funding from local government is generally insufficient to achieve a major change in waste management. While local government can institute taxes and charges for services, there is often resistance from constituents to paying for something which they formerly had for "free." Convincing the constituents to make this change is often a slow process and can be damaging politically. One of the significant funding sources for waste management for local governments is from national governments.

Funding from the national government for waste management is generally insufficient to achieve a large-scale change in waste management, but they can institute a set of incentives and disincentives (as noted in Section 3.3.3) as part of a wider programme. National governments have many competing funding calls and waste does not generally engender much enthusiasm. However, there is opportunity to secure support by recognizing that sustainable waste management can reinforce high profile government programmes (e.g. waste management can help to reduce methane emissions that work towards human contribution to climate change). To achieve the greatest opportunities to secure funding it is important to link policy planning with budget allocation and regular data monitoring in order to provide resources and accountability. With these aligned processes there is an opportunity to build a business case to international funding agencies.

International funding agencies are often linked to the United Nations and its agencies. By working at the national level, these agencies are able to support national efforts to roll out programmes at the national or local level. The United Nations agencies work on the premise that they have to be invited by national governments to work with their country in a collaborative manner.

Recommendations

1. A full cost accounting approach should be adopted when considering projects in order to better understand the economic, social and environmental costs and benefits of plans.
2. A balanced package of projects, from small to large, at the local and national levels should be considered.
3. Opportunities for funding at the local level should include taxes and charges as well as community support for small businesses to help them get started or expand.
4. Funding programmes for sustainable waste management at national level should be aligned with government priorities, as well as international ones. National funding mechanisms should consider inclusion of incentives and disincentives to encourage behaviour change to better waste management practices.

5 Conclusions

It has been well-established that the current rate of global natural resource exploitation is unsustainable, as are the production and consumption patterns. The demand for resources also creates large quantities of waste which impacts all 17 Sustainable Development Goals. Without a change in the current trends, waste production is on track to increase by 73 per cent by 2050.

While developed countries have a long history of reducing waste disposed to landfills by moving towards a circular economy, many developing countries are still struggling to provide the basics beyond dumping waste. Many developing countries have national policies, including legislation, to address solid waste management, but its transition to the local level is not as advanced. To increase policy uptake at the local level, support taking account of different societal contexts between and within countries and municipalities-rural divides is needed. In addition, waste responsibility at national government level is often handled by different ministries that effectively split policy and operational responsibilities, so coordination across these departments has to be strengthened. The establishment of government units that coordinate the implementation of Sustainable Development Goals is a positive step in the right direction.

Decisions concerning waste and management of waste are often not as well informed as they could be due to a lack of data and information on the subject. As much as possible, advocacy for cross-institutional collaboration (e.g. among local government and national waste agencies and statistical offices) is required. This can help ensure an accurate reflection of reality on waste issues is documented and managed, and allow for policy decisions to be well informed, and address unique realities faced by a given city and country. Countries should also be encouraged to share with international organizations collecting waste statistics for the value of better cross-country comparisons and reporting on the Sustainable Development Goals waste-related indicators.

At the local level there is a need for coordination between government, stakeholders representing businesses from throughout the life cycle of products and the scientific community, to enable creation of conditions that deliver on successful programmes. One of the conditions to take into account is that waste is not only generated at the end of use stage, but also at all stages of the life cycle. Hence, to increase the circularity of materials and reduce waste a life cycle approach should be taken.

A key stakeholder in many developing countries is the informal sector, which is responsible for much of the waste services in those countries. Due to the nature of the sector, it is not easy to bring them into the more formal settings that most other sectors are comfortable with. The informal sector is often composed of women, disadvantaged people, and minorities. Their input is vital, as collectively they operate as a significant portion of the waste sector, and ways need to be found to integrate them into policy and programme development.

Accelerating national to local policy actions to manage the waste crisis in developing countries will involve a series of steps that stretch from gauging the current situation to planning for, and actioning change. A suggested series of actions is listed below, but individual countries may find a different order works better for them.

1. Determine the current state of waste management: generation, source, composition, end-of-life processes and quantities.
2. Develop a list of key stakeholders that encompass national ministries and departments, local government, private waste operators, informal sector and product manufacturers.
3. Embark on stakeholder engagement throughout the process, including allowing for public consultation at key points of the process to shift key socio-cultural norms and processes prioritizing waste as a resource
4. Ascertain current capacity and needs for governance, technology, finance and data management at all levels.
5. Facilitate knowledge-sharing and peer learning opportunities among national to local governments facing similar waste management challenges.
6. Establish short, medium, and long term national priorities for waste management in the context of a circular economy.
7. Define legislation and regulation needs to support fulfilment of national priorities.
8. Prepare a budget for planned waste reduction and waste management interventions.
9. Investigate funding mechanisms and what financial incentives can be applied.
10. Develop a monitoring and compliance process to ensure local level enforcement and measurable progress.

These steps will facilitate the transition to sustainable waste management and resource circularity, contributing to global environmental, economic, and social benefits. As data and public governance is strengthened globally, Member States, communities and households will be able to truly measure the shift towards zero-waste mitigating humanity's footprint on the Earth for generations to come.

6 References

Agenda 21: Programme of Action for Sustainable Development; Rio Declaration On Environment and Development; Statement of Forest Principles: The Final Text of Agreements Negotiated by Governments at the United Nations Conference on Environment and Development (UNCED), 3-14 June 1992, Rio De Janeiro, Brazil. New York, NY: United Nations Dept. of Public Information, 1993.

Amegah, A. Kofi, Kelvin Yeboah, Victor Owusu, Lucy Afriyie, Elvis Kyere-Gyeabour, Desmond C. Appiah, Patrick Osei-Kufuor, Samuel K. Annim, Samuel Agyei-Mensah, and Pierpaolo Mudu. (2023). Socio-demographic and neighbourhood factors influencing urban green space use and development at home: A population-based survey in Accra, Ghana. PLoS ONE. Available at https://doi.org/10.1371/journal.pone.0286332

Baldé, C.P., F. Wang, R. Kuehr and J. Huisman (2015). The global e-waste monitor – 2014. United Nations University, IAS – SCYCLE, Bonn, Germany.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, adopted Basel, Switzerland, 22 March 1989. Available at http://www.basel.int/TheConvention/Overview/TextoftheConvention/tabid/1275/Default.aspx

Cambodia, Kingdom of (2019). Cambodia's Voluntary National Review 2019 of the Implementation of 2030 Agenda. Available from https://hlpf.un.org/sites/default/files/vnrs/2023/VNR%202023%20Cambodia%20Report.pdf

Cambridge Dictionary (n.d.). Waste. Available at https://dictionary.cambridge.org/dictionary/english/waste

Canada, Ministry of Industry (2009). Design for Environment: Innovating to Compete. Available at https://ised-isde.canada.ca/site/specialized-design-services/sites/default/files/attachments/oq00010_eng.pdf

Carbios (2023). Carbios aims to be a leader in growing r-PET market with an ambition to capture 8 to 12% share by 2035 through licensing model. Available at https://www.carbios.com/en/strategic-update-2023/

Carroll, Emily, Castro de Hallgren, Sara, Shin, Chaela, Kim, Wonju, Seo, Kang-Wok and Yang Jung-Mok (2023). Background Paper. Expert Group Meeting on Policies for Resource Circularity and Solid Waste Management to Accelerate National to Local Progress on the Sustainable Development Goals. Incheon, Republic of Korea, 21 – 23 November.

Circle Economy (2024). Press and logo kit. Available from https://www.circle-economy.com/about/press-media

Colmar, Jonathan, Evans, Mary and Shimshack, Jay (2023). Environmental citizen complaints. Centre for Economic Performance, London School of Economics and Political Science. Available at https://cep.lse.ac.uk/pubs/download/dp1903.pdf

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention), adopted London, 13 November 1972. Available at http://www.imo.org/en/OurWork/Environment/LCLP/Pages/default.aspx

CTI Engineering International Co., Ltd (2022). Preparatory survey on the project for the improvement of solid waste management equipment for clean city in Antananarivo: Final report. Available from https://openjicareport.jica.go.jp/pdf/12364139.pdf

Cyclos GmbH (2019). "Legal Framework Study of Extended Producer Responsibility". August 2019. Available at https://d2ouvy59p0dg6k.cloudfront.net/downloads/2019___wwf___epr_legal_framework_analysis_vf.pdf

D'Onza, Guiseppe, Greco, Giulio and Allegrini, Marco (2016). Full cost accounting in the analysis of separated waste collection efficiency: A methodological proposal. Journal of Environmental Management, vol. 167, Issue 2, pp. 59 – 65. Available at http://dx.doi.org/10.1016/j.jenvman.2015.09.002

Da Costa, Zulmira and De Jesus, Bia (2020). Urban Solid Waste Management in Dili Community. International Journal of Engineering Research and Technology, vol. 7, Issue 5, pp. 48 – 52. Available at https://www.researchgate.net/publication/342113291_Urban_Solid_Waste_Management_in_Dili_Community

Denmark, Ministry of Environment and Food (2018). Environmental Protection Agency. Life Cycle Assessment of grocery carrier bags. Environment Project no. 1985. Available at https://orbit.dtu.dk/en/publications/life-cycle-assessment-of-grocery-carrier-bags

Dominica, Dominica Solid Waste Management Corporation (2013). Advance 3R initiative at the Goodwill Primary School. Available at https://dswmc.dm/press/5-advance-3r-initiative-at-the-goodwill-primary-school

Dortmans B.M.A., Diener S., Verstappen B.M., Zurbrügg C. (2017). Black Soldier Fly Biowaste Processing - A Step-by-Step Guide. Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland. Available at https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/SWM/BSF/BSF_Biowaste_Processing_LR.pdf

Ellen MacArthur Foundation (n.d.). Ellen MacArthur Foundation: Overview. Available at https://www.ellenmacarthurfoundation.org/network/overview

Ethiopia, Federal Democratic Republic of (2022). Ethiopia Voluntary National Review 2022. FDRE Ministry of Planning and Development. Available at https://hlpf.un.org/sites/default/files/vnrs/2022/VNR%202022%20Ethiopia%20Report_1.pdf

European Commission (2023). Environment: Zero pollution action plan. Available at https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en

European Commission (2018). Landfill Directive - Directive (EU) 2018/850. Available at https://circular-cities-and-regions.ec.europa.eu/support-materials/eu-regulations-legislation/landfill-directive-directive-eu-2018850

European Union (2024a). Eurostat: Statistics Explained: Municipal Solid Waste Statistics. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics#:~:text=Municipal%20waste%20accounts%20for%20only,Waste%20Statistics%20Regulation%20(env_wasmun)

European Union (2024b). Eurostat: Data. Available at https://ec.europa.eu/eurostat/data/database

Fiji, Republic of (2023). Voluntary National Review: Strengthening Resilience to Meet the Challenges of Climate Change and Other Global Issues. Available at https://hlpf.un.org/sites/default/files/vnrs/2023/VNR%202023%20Fiji%20Report.pdf

Food and Agriculture Organization (2021). Strategic Framework, 2022–31. Rome, October 2021. Available at https://www.fao.org/3/cb7099en/cb7099en.pdf

Food and Agriculture Organization (2014). Food Wastage footprint: Full-cost accounting. Available at https://www.fao.org/3/i3991e/i3991e.pdf

Ghana, Republic of (2022). Ghana Voluntary National Review 2022. Ministry of Local Government, Rural Development and Environment of Ghana, Ministry of External Affairs. Available at https://ghana.un.org/sites/default/files/2022-08/VNR_2022_Report_c5cXm4Q.pdf

Global Recycling (2022). Madagascar – Enormous Natural Potential vs. Teething Troubles. Global Recycling Magazine, Iss. 3/2022, p.26. Available at https://global-recycling.info/archives/7576

Han, Zhiyong, Zeng, Dan, Li, Qibin, Cheng, Cheng, Shi, Guozhong and Mou, Zishen (2019). Public willingness to pay and participate in domestic waste management in rural areas of China. Resources, Conservation and Recycling. Vol. 140 pp. 166-174.

Hernberg, S (2000). Lead Poisoning in a Historical Perspective. American Journal of Industrial Medicine, vol. 38 pp. 244 – 54.

Honduras, Republic of (2020). II Voluntary National Report from the 2030 Agenda: From recovery to sustainable development. National Commission of the 2030 Agenda for the Sustainable Development Goals. Available at https://hlpf.un.org/sites/default/files/vnrs/2021/26311VNR_2020_Honduras_Report_Spanish.pdf

Honduras (2018). IV Action plan for open state: Honduras 2018-2020. Available at https://www.mof.gov.jm/wp-content/uploads/Honduras_Action-Plan_2018-2020_EN_1.pdf

Ilgin, M. A. & Gupta, K. O., (2010). Environmentally Conscious Manufacturing and Product Recovery (EMCPRO): A Review of the State of the Art. Journal of Environmental Management, vol. 91, issue 3, pp. 563-591. Available from: doi:10.1016/j.jenvman.2009.09.037.

India Republic of (2016). Municipal Solid Waste Management Manual, Part II: The Manual. Swachh Bharat Mission, Ministry of Urban Development. Available at https://mohua.gov.in/upload/uploadfiles/files/Part2.pdf

Indonesia Republic of (2021). Indonesia's Voluntary National Review (VNR) (2021). Available at https://sustainabledevelopment.un.org/content/documents/280892021_VNR_Report_Indonesia.pdf

Interaction Design Foundation (n.d.). Design Thinking. Available at https://www.interaction-design.org/literature/topics/design-thinking

International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78), entered into force 2 October 1983. Available at http://www.imo.org/en/about/conventions/listofconventions/pages/international-convention-for-the-prevention-ofpollution-from-ships-(marpol).aspx

International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKER), adopted London, 23 March 2001. Available at http://www.imo.org/en/About/conventions/listofconventions/pages/international-convention-on-civil-liability-for-bunker-oil-pollution-damage-(bunker).aspx

International Council for Local Environmental Initiatives (2024). We are ICLEI Circulars: Facilitating circular economy practices for sustainable cities. Bonn, Germany. Available at https://circulars.iclei.org/

International Energy Agency (2023). Law No. 12305. Brazilian National Policy on Solid Waste (batteries). Available at https://www.iea.org/policies/15805-law-no-12305-brazilian-national-policy-on-solid-waste-batteries

International Labour Organization, White Lead (Painting) Convention 1921, C13, adopted 19 November 1921. Available at https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:51:0::NO:51:P51_CONTENT_REPOSITORY_ID:2542964:NO

International Maritime Organization (n.d.). Madagascar – National Action Plan on Prevention and Reduction of Sea-Based Marine Plastic Litter (SBMPL) 2023 – 2026. Available at https://glolitter.imo.org/resources/madagascar

International Maritime Organisation (2017). 50 years working together against oil pollution from ships. Available at https://www.imo.org/en/About/Events/Pages/50-Years-Working-Together.aspx

International Monetary Fund (2019). IMF Working Paper: Disposal is not free: Fiscal instruments to internalize the environmental costs of solid waste. Authored by Thornton Matheson. Nairobi. Available at https://www.imf.org/en/Publications/WP/Issues/2019/12/20/Disposal-is-Not-Free-Fiscal-Instruments-to-Internalize-the-Environmental-Costs-of-Solid-Waste-48854

International Standards Organisation, (2006(a)). Environmental Management – Life cycle assessment – Principles and framework (ISO 14040:2006). Available from: https://www.iso.org/standard/37456.html

International Standards Organisation, (2006(b)). Environmental management — Life cycle assessment — Requirements and guidelines (ISO 14044:2006). Available from: https://www.iso.org/standard/38498.html

Jestin-Guyon, N, Ouaalaya, E, H, Tiaray Harison, M, Ravahatra, K, Raharimanana, R, N, Rakotomizao, J, R, Rakotoson, J, L, Andriamahenina, N, Andrianarisoa, A, Ralison, A, Charpin, D, Rahoelina, B, Rakotomanga, J, D, D, M, L'Her, P, Tschopp, J, Andriambololona, R, and Raherison-Semjen, C (2022). Impact of biomass fuel smoke on respiratory health of children under 15 years old in Madagascar. European Respiratory Journal. Volume 60, pp.140. Available from https://doi.org/10.1183/13993003.congress-2022.140

Johansson, Nils, Krook, Joakim, and Eklund, Mats (2012). Transforming dumps into gold mines. Experiences from Swedish case studies. Environmental Innovations and Societal Transitions. Volume 5, pp.33-48. Available from https://doi.org/10.1016/j.eist.2012.10.004

Kala, K, Reike, N.B and Sushil. (2020). Effects of socio-economic factors on quantity and type of municipal solid waste. Management of Environmental Quality. Volume 31, pp. 877-894. Available at https://doi.org/10.1108/MEQ-11-2019-0244

Kalisz, S, Kibort, K, Mioduska, J, Lieder, M and Malachowska, A. (2022). Waste management in the mining industry of metals ores, coal, oil and natural gas - A review. Journal of Environmental Management vol. 304: 114239. Available at https://doi.org/10.1016/j.jenvman.2021.114239

Kamboj, Nitin, Bisht, Aditi, Kamboj, Vishal and Bishi, Akanksha. (2020). Leachate disposal induced groundwater pollution: A threat to drinking water scarcity and its management. In: Advances in Environmental Pollution Management: Wastewater Impacts and Treatment Technologies 304: 114239. Available at https://doi.org/10.26832/aesa-2020-aepm-05

Kirchherr, J, Reike, D and Hekkert, M. (2017). Conceptualising the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling vol.127: 221-232.

Korea Environment Institute (2016). Two Decades in Effect: Volume-Based Waste Fee System in South Korea. Korean Environmental Policy Bulletin. Ministry of Environment, Seoul. Vol. 14, Issue 3. Available from https://www.greenpolicyplatform.org/sites/default/files/downloads/policy-database//Korea%20Environmental%20Policy%20Bulletin%20-%20Two%20Decades%20in%20Effect%2C%20Volume-Based%20Waste%20Fee%20System%20in%20South%20Korea.pdf

Kristanto, GA, Kemala D, and Nandhita, PA. (2021). Challenges confronting waste pickers in Indonesia: An on-field analysis. Waste Management & Research. 40(9):1381-1389. Available at https://journals.sagepub.com/doi/10.1177/0734242X211029181

Kyoto Protocol to the United Nations Framework Convention on Climate Change, Japan, 1998. Available at https://unfccc.int/resource/docs/convkp/kpeng.pdf

Mataloni, Francesca, Badaloni, Chiara, Galoni, Martina Nicole, Bolignano, Simone, Sozzi, Roberto, Forastiere, Francesco, Davoli, Marina and Ancona, Carla (2016). Morbidity and mortality of people who live close to municipal waste landfills: a multisite cohort study. International Journal of Epidemiology. 45(3): 806 – 815. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5005946/

Meadows, D. (2008). Thinking in systems: A primer. Chelsea Green Publishing. ISBN 9781603580557.

Meadows, D. (1999). Leverage Points: Places to Intervene in a System. The Sustainability Institute, Vermont, United States of America. Available at: https://donellameadows.org/wp-content/userfiles/Leverage_Points.pdf

Minamata Convention on Mercury, adopted Kumamoto, Japan, 10 October 2013. Available at http://www.mercuryconvention.org/Convention/Text/tabid/3426/language/en-US/Default.aspx

Montreal Protocol on Substances that Deplete the Ozone Layer, adopted Montreal, Canada, 16 September 1987. Available at https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-2-a&chapter=27&clang=_en

Morocco, Ministry of Energy Transition and Sustainable Development (2023). Waste Management in Morocco. Workshop on Waste Management: Policies and practices on the basis of UNECE Environmental Performance Reviews. Skopje, North Macedonia, 19 – 20 September. Available at https://unece.org/sites/default/files/2023-10/Waste%20Management%20Workshop%20Skopje%20-Morocco%20Session%201%20.pdf

Morocco, Kingdom of (2020). Voluntary National Review of the implementation of the Sustainable Development Goals 2020. Available at https:// www.hcp.ma/file/229718/

National Aeronautics and Space Administration (2022). NASA Sensors to Help Detect Methane Emitted from Landfills. December 15, 2022. Available at: https://www.nasa.gov/missions/emit/nasa-sensors-to-help-detect-methane-emitted-by-landfills/

National Aeronautics and Space Administration Jet Propulsion Laboratory (2024). Methane Source Finder. Available at https://methane.jpl.nasa.gov/National Science and Technology Development Agency (n.d.). BCG Model: Fostering Sustainable Development in Thai Economy. Bangkok, Thailand. Available from https://www.nstda.or.th/en/images/pdf/BCG_Booklet1.pdf

New York City Council (2023). Council Votes on Legislative Package to Create Citywide Residential Curbside Organics Collection Program, Advance NYC's Zero Waste Efforts. 8 June 2023. Available at https://council.nyc.gov/press/2023/06/08/2421/

New Zealand, Ministry for the Environment (2004). Landfill Full Cost Accounting Guide for New Zealand. Wellington, New Zealand. Available at https://environment.govt.nz/assets/Publications/Files/Landfill-Full-Cost-Accounting-Guide.pdf

Omang, Donald, John, Godwin, Inah, Simon and Bisond, Jude (2021). Public health implication of solid waste generated by households in Bekwarra Local Government area. African Health Sciences, Volume 2, Issue 1, Pages 1467-1473. Available at https://doi.org/ 10.4314/ahs.v21i3.58

Organisation for Economic Co-operation and Development (n.d. (a)). OECD.Stat. Available at https://stats.oecd.org/

Organisation for Economic Co-operation and Development (n.d. (b)). Behavioural Insights. Available at https://www.oecd.org/gov/regulatory-policy/behavioural-insights.htm

Organisation for Economic Co-operation and Development (2024). Eurostat Data Browser: Waste Generation per Capita. OECD Publishing, Paris. Available at https://ec.europa.eu/eurostat/databrowser/view/cei_pc034/default/table?lang=en

Organisation for Economic Co-operation and Development (2022). Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options. OECD Publishing, Paris. Available at https://www.oecd-ilibrary.org/environment/global-plastics-outlook_de747aef-en

Paris Agreement under the United Nations Framework Convention on Climate Change, adopted Paris, 12 December 2015. Available at http://unfccc.int/paris_agreement/items/9485.php

Philippines, Republic of the (2022). 2022 Voluntary National Review of The Philippines: Rekindling Commitment and Using Innovation to Accelerate Recovery and Ensure Progress to Achieve The SDGs In 2030 and Our Ambisyon Natin 2040. National Economic & Development Authority of Philippines. Available at https://hlpf.un.org/sites/default/files/vnrs/2022/06222022%20VNR%20of%20the%20Philippines.pdf

Reuse and Recycling EU Social Enterprises Network. (2015). Briefing on job creation potential in the re-use sector. Available at: http://www.rreuse.org/wpcontent/uploads/Final-briefing-on-reuse-jobs-website-2.pdf .

Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, adopted Rotterdam, the Netherlands, 10 September 1998. Available at http://www.pic.int/

Seadon, Jeffrey, (2006). Integrated waste management – Looking beyond the solid waste horizon. Waste Management, Volume 26, Issue 12, 2006, Pages 1327-1336, ISSN 0956-053X. Available at https://doi.org/10.1016/j.wasman.2006.04.009

Secretariat of the Pacific Regional Environment Programme (2023). Solid Waste Management Country Profile: Fiji. Available at https://www.sprep.org/sites/default/files/documents/publications/JPRISM%20II%20Solid%20Waste%20Management%20Country%20Profile_Fiji.pdf

Shammi, Afra, Hassan, Nazia, Golder, Rony, Molita, Hriday and Islam, Shikder (2023). Health status assessment of people adjacent to temporary waste disposal sites in Khulna city, Bangladesh. Heliyon, Volume 9, Issue 9. Available at https://doi.org/10.1016/j.heliyon.2023.e19810

Steffen, W., W. Broadgate, L. Deutsch, O. Gaffney, C. Ludwig. 2015. The trajectory of the Anthropocene: The great acceleration. The Anthropocene Review 2: 81–98.

Stockholm Convention on Persistent Organic Pollutants, adopted Stockholm, Sweden, 22 May 2001. Available at http://chm.pops.int/

Strategic Approach to International Chemicals Management, adopted Dubai, 6 February 2006. Available at https://sustainabledevelopment.un.org/content/documents/SAICM_publication_ENG.pdf

Tilley, Elizabeth, Chilunga, Hope, Kwangulero, Jonathan, Schobitz, Lars, Vijay, Saloni, Heilgendorff, Heiko and Kalina, Marc (2023). "It is unbearable to breathe here": air quality, open incineration, and misinformation in Blantyre, Malawi. Frontiers in Public Health, Volume 11: 1242726.
Available at https://doi.org/10.3389/fpubh.2023.1242726

United Nations (2015). Sustainable Development Goals. Available at
http://www.un.org/sustainabledevelopment/sustainable-development-goals/

United Nations (2012). The Future We Want. Available at
http://www.un.org/disabilities/documents/rio20_outcome_document_complete.pdf

UN (2022). International Day of Zero Waste 30 March. Accessed April 2024 at:
https://www.un.org/en/observances/zero-waste-day#:~:text=Background,countries%20joined%20in%20sponsoring%20it

United Nations (2023a). International Day of Zero Waste: 30 March. Available at
https://www.un.org/en/observances/zero-waste-day

United Nations (2023b). Intergovernmental Conference on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (General Assembly resolution 72/249). New York. Available at https://www.un.org/bbnj/

United Nations (2023c). The Sustainable Development Goals Report. Special Edition.
https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf

United Nations Centre for Regional Development (2023a). IPLA - International Partnership for Expanding Waste Management Services of Local Authorities. Available at https://uncrd.un.org/content/environment-ipla

United Nations Centre for Regional Development (2023b). IPLA Statement/Declaration. Available at
https://uncrd.un.org/content/ipla-statementdeclaration

United Nations Department of Economic and Social Affairs (2024). Goal 12: Ensure sustainable consumption and production patterns. Nairobi. Available at https://sdgs.un.org/goals/goal12#targets_and_indicators

United Nations Department of Economic and Social Affairs (2016). A/RES/70/1Transforming our world: The 2030 Agenda for Sustainable Development. Nairobi. Available at
https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

United Nations Development Programme (2023). Harnessing the role of private sector in waste management through South-South and Triangular Cooperation for inclusive urbanization. Istanbul. Available at https://www.undp.org/sites/g/files/zskgke326/files/2023-09/undp-harnessing-the-role-of-private-sector-in-waste-management-through-south-south-and-triangular-cooperation-for-inclusive-urbanization.pdf

United Nations Development Programme (2022). Reimagining Indonesia's New Capital City: Foresight Approaches for an Inclusive Smart Forest City. Available at https://www.undp.org/indonesia/blog/reimagining-indonesias-new-capital-city-foresight-approaches-inclusive-smart-forest-city

United Nations Economic and Social Commission for Asia and the Pacific (n.d. a). Part 3 City 2 Battambang 01. Available at https://www.unescap.org/sites/default/files/2.%20Battambang.pdf

United Nations Economic and Social Commission for Asia and the Pacific (n.d. b). Part 3 City 7 Kon Tun 01. Available at https://www.unescap.org/sites/default/files/7.%20Kon%20Tum.pdf

United Nations Economic and Social Commission for Asia and the Pacific (n.d. c). Part 3 City 8 Quy Nhon 01. Available at https://www.unescap.org/sites/default/files/8.%20Quy%20Nhon.pdf

United Nations Economic and Social Commission for Asia and the Pacific (2020). Green Growth: Zero Baht Shop. Authored by Chris Oestereich. Bangkok. Available at https://sdghelpdesk.unescap.org/sites/default/files/2018-08/GG%20-%20Zero%20Baht%20Shop.pdf

United Nations Economic Commission for Europe (2023). Transport: Dangerous Goods: About the GHS. Available at https://unece.org/about-ghs#:~:text=The%20new%20system%2C%20which%20was,labels%20and%20safety%20data%20sheets.

United Nations Economic Commission for Europe (2008). Guidebook on Promoting Good Governance in Public-Private Partnerships. Available at http://www.unece.org/fileadmin/DAM/ceci/publications/ppp.pdf

United Nations Environment Programme (n.d. (a)). About Montreal Protocol. Available at https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol#:~:text=The%20Montreal%20Protocol%20on%20Substances,ozone%20depleting%20substances%20(ODS).

United Nations Environment Programme (n.d. (b)). Beat Pollution: Civil Society. Available at https://www.unep.org/beatpollution/civil-society

United Nations Environment Programme (n.d. (c)). Environmentally Sound Technologies. Available at https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/environmentally-sound

United Nations Environment Programme (2024a). Global Waste Management Outlook 2024: Beyond an age of waste – Turning rubbish into a resource. Nairobi. Available at https://www.unep.org/resources/global-waste-management-outlook-2024

United Nations Environment Programme (2024b). Food Waste Index Report 2024. Nairobi. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/45230/food_waste_index_report_2024.pdf?sequence=5&isAllowed=y

United Nations Environment Programme (2024c): Global Resources Outlook 2024: Bend the Trend – Pathways to a liveable planet as resource use spikes. International Resource Panel. Nairobi. Available from https://wedocs.unep.org/20.500.11822/44901

United Nations Environment Programme (2023a). Plastic Pollution. Available at https://www.unep.org/plastic-pollution

United Nations Environment Programme (2023b). Global Framework on Chemicals: ICCM5. Bonn. Available at https://staging.saicm.org/events/iccm5

United Nations Environment Programme (2023c). Cities embrace "zero waste" philosophy amidst torrents of trash. Available at https://www.unep.org/news-and-stories/story/cities-embrace-zero-waste-philosophy-amidst-torrents-trash

United Nations Environment Programme (2023d). Madagascar strengthening public's protection from hazardous chemicals. Available at https://www.unep.org/technical-highlight/madagascar-strengthening-publics-protection-hazardous-chemicals

United Nations Environment Programme (2022a). Historic day in the campaign to beat plastic pollution: Nations commit to develop a legally binding agreement. Available at https://www.unep.org/news-and-stories/press-release/historic-day-campaign-beat-plastic-pollution-nations-commit-develop

United Nations Environment Programme (2022b). Convention on Biological Diversity. Montreal. Available at https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf

United Nations Environment Programme (2022c). 2022 Global Status Report for buildings and construction: Towards a zero-emissions, efficient and resilient buildings and construction sector. Available at https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction

United Nations Environment Programme (2021b). From Pollution to Solution: A global assessment of marine litter and plastic pollution. Nairobi. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/34804/LACDUMEN.pdf?sequence=4&isAllowed=y

United Nations Environment Programme (2021c). Coalition for the progressive closure of dumpsites in Latin America and the Caribbean - Baseline report. Available at https://www.unep.org/resources/pollution-solution-global-assessment-marine-litter-and-plastic-pollution

United Nations Environment Programme (2021d). Policies, regulations and strategies in Latin America and the Caribbean to prevent marine litter and plastic waste. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/34931/Marine_EN.pdf?sequence=1&isAllowed=y

United Nations Environment Programme (2019a). Small Island Developing States Waste Management Outlook. Authored by Jeff Seadon and Claudia Giacovelli. Nairobi. Available at https://www.unep.org/ietc/node/44

United Nations Environment Programme (2019b). Waste to Energy: Considerations for Informed Decision-Making. Authored by Man Mei Chim. Osaka. Available at https://www.unep.org/ietc/resources/publication/waste-energy-considerations-informed-decision-making

United Nations Environment Programme (2018a). Waste Management Outlook for Latin America and the Caribbean. Authored by Atilio Savino, Gustavo Solórzano, Carina Quispe and Magda Carolina. Nairobi. Available at https://www.unep.org/ietc/resources/publication/waste-management-outlook-latin-america-and-caribbean

United Nations Environment Programme (2018b). Single-use plastics: A roadmap for sustainability. Available at https://www.reloopplatform.org/wp-content/uploads/2018/06/UNEP-report-on-single-use-plastic.pdf

United Nations Environment Programme (2018c). Trade in Environmentally Sound Technologies: Implications for Developing Countries. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/27596/TEC_PolBr.pdf?sequence=1&isAllowed=y

United Nations Environment Programme (2017). Asia Waste Management Outlook. Authored by Prasad Modak, Agamuthu Pariatamby and Jeff Seadon. Available at https://www.unep.org/ietc/resources/publication/asia-waste-management-outlook

United Nations Environment Programme (2016a). Guidelines for Framework Legislation for Integrated Waste Management. Authored by J. Seadon. Env.Law/MTV4/Pollution/2016/1. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/31379/IWM_Guidelines.pdf?sequence=1&isAllowed=y

United Nations Environment Programme (2016b). List of Sustainable Development Goal indicators. The 18th Global Meeting of the Regional Seas Conventions and Action Plans Incheon, the Republic of Korea. Available at https://www.unep.org/resources/report/list-sustainable-development-goal-indicators

United Nations Environment Programme (2015). Global Waste Management Outlook. Available at http://web.unep.org/ourplanet/september-2015/unep-publications/global-waste-management-outlook

United Nations Environment Programme and United Nations Institute for Training and Research (2013). Guidelines for National Waste Management Strategies: Moving from Challenges to Opportunities. Available at http://wedocs.unep.org/handle/20.500.11822/8669

United Nations Environment Programme (2011). Basel Convention. Available at https://www.basel.int/TheConvention/Overview/History/Overview/tabid/3405/Default.aspx#:~:text=Law%20in%201981.-,The%20Basel%20Convention%20on%20the%20Control%20of%20Transboundary%20Movements%20of,world%20of%20deposits%20of%20toxic

United Nations Environment Programme International Environmental Technology Centre (n.d). Needs Assessment Study on Capacity Building on Waste Management. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/27367/Needs_WM.pdf

United Nations Environment Programme International Environmental Technology Centre (2020). Waste Management during the COVID-19 Pandemic: From Response to Recovery. Available at https://wedocs.unep.org/bitstream/handle/20.500.11822/33416/WMC-19.pdf?sequence=1&isAllowed=y

United Nations General Assembly (2022). A/RES/77/161 Promoting zero-waste initiatives to advance the 2030 Agenda for Sustainable Development. Nairobi. Available at https://digitallibrary.un.org/record/3998545?ln=en
United Nations General Assembly and United Nations Economic and Social Council (2018). Circular Economy for the SDGs: From Concept to Practice. New York. Available at https://www.un.org/en/ga/second/73/jm_conceptnote.pdf

UN-Habitat (2023). Rescuing SDG 11 for a Resilent Urban Planet. Nairobi, Kenya. https://unhabitat.org/sites/default/files/2023/07/sdg_11_synthesis_report_2023_final_0.pdf

UN-Habitat (2023a). Waste Wise Cities Tool. Available at https://unhabitat.org/sites/default/files/2021/02/Waste%20wise%20cities%20tool%20-%20EN%203.pdf

UN-Habitat (2010). Solid waste management in the world's cities: Water and sanitation in the world's cities 2010. Available at https://unhabitat.org/sites/default/files/2021/02/solid_waste_management_in_the_worlds_cities_water_and_sanitation_in_the_worlds_cities_2010.pdf

UN-Habitat (2021). Combating marine litter by improving solid waste management. Available at https://unhabitat.org/waste-wise-cities

United Nations Industrial Development Organization (2023). International Yearbook of Industrial Statistics. Available at https://ewastemonitor.info/

United Nations Institute for Training and Research (2024). Sustainable Cycles (SCYCLE) Programme. Available at https://ewastemonitor.info/

United Nations Office on Drugs and Crime (2013). Transnational Organized Crime in East Asia and the Pacific: A Threat Assessment. Available at https://www.unodc.org/documents/data-and-analysis/Studies/TOCTA_EAP_web.pdf

United Nations Office on Drugs and Crime (2023). Unwaste: Tackling waste trafficking to support a circular economy. Available at https://www.unodc.org/unodc/en/environment-climate/asia-pacific/unwaste.html

United Nations Statistics Division (2021). Tier Classification for Global SDG Indicators as of 29 March 2021. Nairobi. Available at https://unstats.un.org/sdgs/files/Tier%20Classification%20of%20SDG%20Indicators_29%20Mar%202021_web.pdf

United Nations Statistics Division (2021a). Available at OurWorldInData.org/waste-management

United Nations Statistics Division (2024). SDG Indicators: Metadata repository. Nairobi. Available at https://unstats.un.org/sdgs/metadata/

United Nations Statistics Division (2023a). SDG Indicators: Data Collection Information & Focal Points. Nairobi. Available at https://unstats.un.org/sdgs/dataContacts/?selectIndicator=12.3.1+%28a%29+Food+loss+index+and+%28b%29+food+waste+index&selectAgency=

United Nations Statistics Division (2023b). Environmental Statistics. Available at https://unstats.un.org/unsd/envstats/country_files

United Nations Statistics Division (2023c). Statistics: SDG Indicators Database. Available at https://unstats.un.org/sdgs/dataportal/database

United Nations Statistics Division (2023a). Environmental Statistics: Country files from the UNSD/UNEP data collection on environment statistics. New York. Available at https://unstats.un.org/unsd/envstats/country_files

United Nations Statistics Division (2023b). UNSD showcase of practical use of country-owned waste data for SDGs. Environmental Statistics Section, Presentation to the tenth meeting of the Expert Group on Environment Statistics. 3, 4, 6 and 10 October. Available at https://unstats.un.org/unsd/envstats/fdes/EGES10/2.2.4_UNSD_UUQ_Waste.pdf

United States Agency for International Development (2022). Save Our Seas Initiative - Annual Report 2022-2023. Available at https://www.usaid.gov/sites/default/files/2023-06/2023-USAID-Save-Our-Seas-Initiative-Report_1.pdf

United States Environmental Protection Agency (2001). U.S. recycling economic information study. Final Report. Authored by R.W. Beck. Available at: https://archive.epa.gov/wastes/conserve/tools/rmd/web/pdf/n_report.pdf

United States of America, Department of Commerce, International Trade Administration (2023). Market Intelligence: Brazil Waste Management. Available at https://www.trade.gov/market-intelligence/brazil-waste-management

Vienna Convention for the Protection of the Ozone Layer, adopted Vienna, 22 March 1985. Available at http://ozone.unep.org/en/treaties-anddecisions/vienna-convention-protection-ozone-layer

Viet Nam, Socialist Republic of (2023). Viet Nam's Voluntary National Review on the Implementation of the Sustainable Development Goals. Ministry of Planning and Investment, Available at https://hlpf.un.org/sites/default/files/vnrs/2023/VNR%202023%20Viet%20Nam%20Summary.pdf

Washington Declaration on Protection of the Marine Environment from Land-based Activities, adopted Washington, DC, 3 November 1995. Available at http://wedocs.unep.org/bitstream/handle/20.500.11822/13421/

White P.R., M. Franke and P. Hindie (1995). 1st Edition, Integrated Solid Waste Management: A Life cycle Inventory, 47p.

World Bank (2023). Data for Ghana, Lower middle income. Available at https://data.worldbank.org/?locations=GH-XN

World Bank (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Authored by Kaza, Silpa, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden. 2018. Urban Development Series. Washington, DC: World Bank. doi:10.1596/978-1-4648 -1329-0. License: Creative Commons Attribution CC BY 3.0 IGO. Available at https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

World Bank (2019). Brief February 11, 2022. Solid Waste Management. Accessed April 15 2024 at: https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management

World Forum on Natural Capital (2018). What is natural capital? Available from https://naturalcapitalforum.com/about/

World Health Organization (2020). Food safety: Persistent organic pollutants (POPs). Available at https://www.who.int/news-room/questions-and-answers/item/food-safety-persistent-organic-pollutants-(pops)#:~:text=Human%20exposure%20%2D%20for%20some%20compounds,genotoxicity%20and%20increased%20birth%20defects
.

World Salaries (2023). Average Salary in Ghana for 2023. Available at https://worldsalaries.com/average-salary-in-ghana/

World Trade Organization (2023). Dialogue on Plastic Pollution and Environmentally Sustainable Plastics Trade (DPP). First Draft - Possible Mc13 Statement. 11 August 2023. INF/TE/IDP/W/10. Available at https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/INF/TEIDP/W10.pdf&Open=True

Zero Waste Europe (2021). Rethinking the Landfill Target. Available at: https://zerowasteeurope.eu/wp-content/uploads/2021/10/Rethinking-the-Landfill-Target_OCT2021.pdf

7 ANNEXES

ANNEX 1 SELECTED MULTILATERAL ENVIRONMENTAL AGREEMENTS

Year of Ratification	Multilateral Environmental Agreement	Coverage
1921	Use of White Lead in Painting[199]	Prohibits the use of white lead in paint because of its toxicity.
1972	London Convention[200]	Prevents marine pollution caused by dumping wastes and other matter.
1973	International Convention for the Prevention of Pollution from Ships (MARPOL)[201]	Preserves the marine environment by eliminating pollution by oil and other harmful substances and minimizing spillage of those substances.
1975	International Convention on Civil Liability for Oil Pollution Damage (CLC)[202]	Provides for adequate compensation to people suffering oil pollution damage from bulk oil ships.
1985	Vienna Convention[203]	Promotes cooperation on the effects of human activities on the ozone layer and promotes the adoption of legislative or administrative measures against activities likely to have adverse effects on the ozone layer.
1989	Basel Convention[204]	Regulates movements of hazardous waste between nations, minimizes and prevents the generation of hazardous waste and promotes their environmentally sound management.
1989	Montreal Protocol on Substances that Deplete the Ozone Layer[205]	Protects the ozone layer by stopping production of substances responsible for ozone depletion.
1992	Agenda 21[206]	Changes consumption patterns to optimize resources and minimize waste; develops an integrated environmental structure for water, sanitation, drainage, solid-waste management, and sustainable energy and transport systems; makes effective use of economic instruments and market mechanisms; promotes the environmentally sound management of hazardous, solid, sewage and radioactive wastes, transfer and capacity building in developing states.
1995	Washington Declaration[207]	Protects the marine environment from land-based activities especially sewage, persistent organic pollutants (POPs), radioactive substances, heavy metals, oils, nutrients, sediment mobilization, litter, and physical alteration and destruction of habitat.
1997	Kyoto Protocol[208]	Controls emissions of greenhouse gases (e.g. methane) including from waste through recovery and use by working nationally and internationally to mitigate climate change.

199 International Labour Organization (1921).
200 Convention on the Prevention of Marine Pollution by Dumpling of Wastes and Other Matter 1972 (London Convention) (1972).
201 International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78) (1983).
202 International Convention on Civil Liability for Oil Pollution Damage (CLC Convention) (1969).
203 Vienna Convention for the Protection of the Ozone Layer (1985).
204 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989).
205 Montreal Protocol (1987).
206 Agenda 21: Programme of Action (1993).
207 Washington Declaration on Protection of the Marine Environment from Land-based Activities (1995).
208 Kyoto Protocol (1997).

2000	Millennium Development Goals[209]	Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources.
2004	Rotterdam Convention[210]	Promotes shared responsibilities for the importation of hazardous chemicals and open exchanges of information; requests exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans.
2004	Stockholm Convention[211]	Eliminates or restricts the production and use of POPs; requires the environmentally sound management of waste containing POPs.
2006	Dubai Declaration[212]	Promotes environmentally sound management through the reduction, recycling and recovery of hazardous waste and prevents illegal international traffic in hazardous banned chemicals (including products containing them).
2008	International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKER)[213]	Requires ships to have adequate insurance to cover liability against bunker oil leakage.
2012	The Future We Want[214]	Prevents waste through innovative public-private partnerships, increased resource efficiency, sustainable management of waste through the 3Rs, environmentally sound chemicals and waste management, promotion of life cycle assessment, increased waste to energy.
2015	2030 Agenda and The Sustainable Development Goals	While waste management is covered in Goals 11, 12 and 14, there are also many direct links throughout the Goals to accelerate global action on waste prevention, management and circularity as well as its adverse impacts.
2015 (entered into Force in November 2016)	Paris Agreement[215]	Strengthens the global response to the threat of climate change.
2017	Minamata Agreement[216]	Phases out mercury in products and processes; introduces control measures on emissions to air, land and water.
2022	Resolution 5/14	175 Member States at the UN Environment Assembly agree to develop a legally binding agreement to phase out plastic pollution.
2022	Resolution 77/161[217]	Member States agree to promote zero-waste initiatives to advance the 2030 Agenda for Sustainable Development.
2023	UN High Seas Treaty	Framework for the conservation and sustainable use of marine areas that fall outside of country jurisdiction.
2023	Global Framework on Chemicals - for a planet free of harm from chemicals and waste	Member States agree on a framework including a roadmap for countries and stakeholders to collaboratively address the life cycle of chemicals, including products and waste.

209 United Nations (2015).
210 Rotterdam Convention (1998).
211 Stockholm Convention on Persistent Organic Pollutants (2001).
212 Strategic Approach to International Chemicals Management (2006).
213 International Convention on Civil Liability for Bunker Oil Pollution Damage (2001).
214 United Nations (2012).
215 Paris Agreement (2015).
216 Minamata Convention on Mercury (2013).
217 United Nations General Assembly (2022).

ANNEX 2 INNOVATIONS FOR MORE EFFECTIVE POLICYMAKING

When looking at the life cycle of a product, it is convenient to consider it as a linear process that starts off with extraction from the Earth (land, water or air) and ends with the end-of-life processes ending with disposal to the Earth. However, when looking at the waste system it can be seen from Figure 5 that it is a complex web and there is no single way of arriving at 'the' waste solution. The same applies with approaches to arrive at actions to reduce waste disposal so it is worthwhile to consider integrated thinking and use several approaches. Three approaches considered here, systems, design and behavioural thinking were used at the Expert Group Meeting to reveal aspects of solid waste policy design. These approaches can all be applied to strengthen policymaking and planning for effective waste minimization and resource efficiency.

Systems thinking

Systems thinking frequently involves observing events or data, and from that to identify patterns of behavior that begin to reveal the underlying structures that drive those events and patterns.[218] Use of systems thinking can show that actions (or their absence) can have far reaching effects. Consideration of drivers for solid waste policy design showed that involvement of householders (as significant waste producers), data provision and willingness of consumers to pay for services were key influencers. Second to that were service performance, enforcement and relationships between users, local and national governments.

Design thinking

Design thinking is an iterative process applied to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test.[219] A design thinking approach showed that solid waste policy design can have significant positive impacts on the informal sector, especially women and particularly mothers. Government support was needed to upskill young people to reach their aspirations. In addition, training and technology support is needed for the informal sector to build capacity which provides social protection for them.

Behavioural insights

Behavioural insights[220] is an inductive approach that examines human behaviors motivating economic and societal outcomes. It combines psychology, cognitive science and social science with observed results to discover how humans make choices. Behavioral insights methods showed that stakeholders focused on waste as the issue, rather than as an opportunity to turn it into new resources. The approach identified capacity, political willingness and challenges to develop solutions at scale as the prime issues to be addressed. In addition, government and the private sector needed to cooperate to provide incentives to convert waste to resources and link to the local marketing of goods and services.

It can be seen from the three approaches that they provide three different lenses on the issue which provides a more holistic picture.

218 Meadows (2008).

219 Interaction Design Foundation (n.d.).

220 Organisation for Economic Co-operation and Development (n.d. (b)).

Life Cycle Thinking

Life Cycle Assessment (LCA) is an analytical tool for the systematic evaluation of the environmental impacts of a product or service system through all stages of its life. It extends from extraction and processing of raw materials through to manufacture, delivery, use, and finally onto end-of-life (cradle to grave).[221] Several other environmental assessments are restricted to the partial product life cycle (cradle to gate), the production process (gate to gate), and closed loop production (cradle to cradle).

ISO 14040 defines LCA as:[222]

"… a technique for assessing the environmental aspects and potential impacts associated with a product, by:

- compiling an inventory of relevant inputs and outputs of a product system;
- evaluating the potential environmental impacts associated with those inputs and outputs;
- interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.

LCA studies the environmental aspects and potential impacts throughout a product's life (i.e. cradle-to-grave) from raw material acquisition through production, use and disposal. The general categories of environmental impacts needing consideration include resource use, human health, and ecological consequences."

The internationally accepted framework for LCA methodology is defined in ISO 14040[223] and 14044.[224] These standards define the generic steps to be taken when conducting an LCA. The steps are goal and scope definition, inventory analysis, impact assessment and interpretation.

While each of these steps must be undertaken in a LCA, the impact assessment stage is of particular importance in the context of this report. The impact assessment translates the results of the inventory analysis into environmental impacts (e.g., climate change, human toxicity). The aim of this phase is to evaluate the significance of potential environmental impacts. ISO 14044[225] states that *"the selection of impact categories shall reflect a comprehensive set of environmental issues related to the product system being studied…"*.

While the most common impact category currently chosen is global warming potential (to measure carbon emissions), this only provides a small lens to view environmental impacts of products and processes. Some of the other more common impacts categories are:

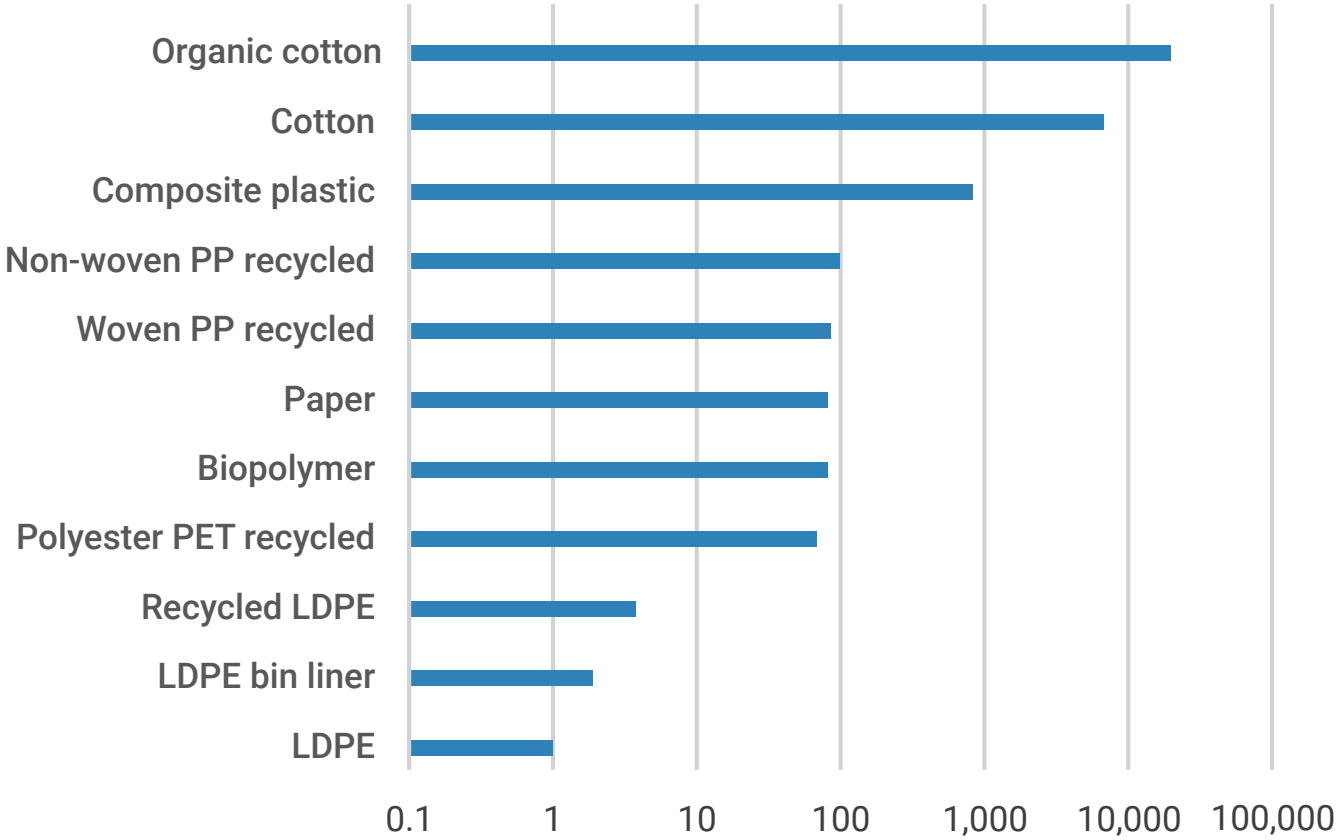
- Fine Particulate Matter Formation;
- Fossil Resource Scarcity;
- Freshwater Ecotoxicity;
- Freshwater Eutrophication;
- Human Carcinogenic Toxicity;
- Human Non-Carcinogenic Toxicity;
- Ionizing Radiation;
- Land Use;
- Marine Ecotoxicity;
- Marine Eutrophication;

221 Ilgin and Gupta (2010).
222 ISO, 2006(a).
223 ISO, 2006(a).
224 ISO, 2006(b).
225 ISO, 2006(b).

- Mineral Resource Scarcity;
- Ozone Formation, Human Health;
- Ozone Formation, Terrestrial Ecosystems;
- Stratospheric Ozone Depletion;
- Terrestrial Acidification;
- Terrestrial Ecotoxicity; and
- Water Consumption.

Where policy recommendations are based on scientific information, it is advised that a LCA is considered. For example, if a ban on single-use plastic carrier bags was to be considered, it would be useful to do a LCA that locally compared the results along with alternatives. The Danish government[226] carried out such an assessment using multiple categories from the above list and the results for the number of uses to have the same environmental impact as a typical low density polyethylene bag is shown in Figure 28.

Figure 28: Number of uses needed to have the same environmental impact as a single use LDPE carrier bag[227]



Key: LDPE = Low Density Polyethylene; PET = Polyethylene Terephthalate; PP = Polypropylene

If scientific information was the major driver for policy making, the results from Figure 28 show that single use plastic carrier bag bans would not measure up environmentally, but this is only if they were also recycled properly. In reality, single use plastics as a whole, including bags, contribute greatly to plastic pollution across the planet when not recycled or managed properly. Due to poor waste management practices throughout the world, plastic pollution has become an international issue politically driving the move against single use plastics as a whole.

226 Denmark (2018).
227 Denmark (2018).