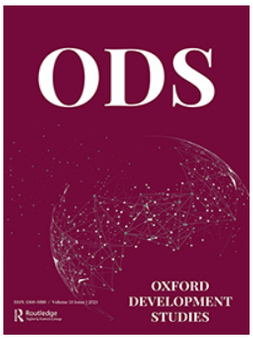

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Rethinking waste and resource management for underserved communities

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ABSTRACT

Municipal solid waste management (MSWM) is a basic service, yet over 2.7 billion people still lack access to collection, and 40% of collected MSW is open dumped or burned. This global waste emergency has severe local and global impacts — extending services to all would reduce macroplastic dispersal to the environment by ~80% and mitigate climate heating. We use our nine development bands (9DBs) framework to rethink how to extend services to underserved communities at pace and at scale. Funding needs to target community-up operator models and no regret investments. Win^5 benefits include community services, reduced disease outbreaks, more sustainable livelihoods, reduced MSW quantities and management costs, and reduced local and global environment impacts. Cities can transition earlier to more circular, integrated, waste and resource management (WaRM). Separating (wet) organic wastes from (dry) recyclable materials at source unlocks markets for both. A blend of financing is needed, from national and city sources, resource revenues, disposal pricing, extended producer responsibility (EPR) and international development (including climate and plastics) finance. New multi-lateral impact funds need to target extension of services to underserved communities.

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Municipal solid waste collection; informal recycling and recovery; informal settlements; circular economy; plastics pollution; climate change mitigation

Introduction

The first sustainable development goal (SDG1) is to end poverty. Target SDG1.4 reads: *'By 2030, ensure that all men and women, in particular the poor and vulnerable, have . . . . access to basic services . . .'* (UN, 2015). Some 10 basic services have been identified, including waste collection alongside drinking water, sanitation and hygiene (WASH), energy, mobility, health care, education and information technologies (UN-Habitat, 2020).

A global waste emergency

Securing a regular and reliable waste collection service still eludes an estimated 2.7 billion people (UNEP & ISWA, 2024; Wilson, 2023). Thus, around 29% of global arisings of municipal solid waste (MSW) remains uncollected; a similar percentage is collected but goes to uncontrolled disposal and/or open burning (Gómez-Sanabria et al., 2022).

When waste is not collected, it must be 'self-managed'; the basic options for materials that cannot be reused or recycled are 'wild dumping' (scattering, burying, accumulation in unofficial

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dumping sites) or open burning. These have severe local public health impacts, e.g. through blocked drains, stagnant water, insects breeding and infectious diseases (Vinti et al., 2021). Uncollected waste also accounts for 85% of macroplastic debris emissions to the environment and available to enter the oceans (Cottom et al., 2024). The result is an on-going global waste emergency.

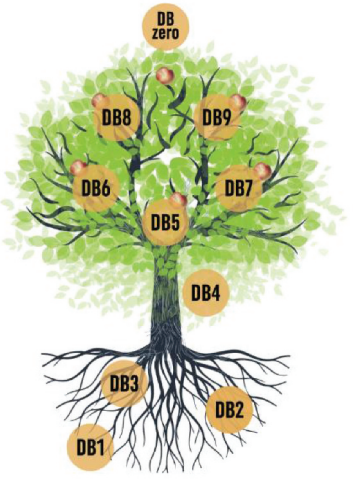
The 'Nine Development Bands' theory of waste and development

Municipal solid waste collection was first introduced from the mid-19th Century in response to repeated cholera epidemics. Disposal of the collected waste remained largely 'out of sight, out of mind', with uncontrolled disposal and open burning often the norm, until environmental legislation was introduced starting in the 1970s (Louis, 2004; Wilson, 2007). Progress in the Global North since then has been both stepwise and rapid (Wilson, 2023).

This stepwise evolution underpins the 'Nine Development Bands' (9DBs), our conceptual framework and global theory of waste and development. Each DB characterises a different development level of waste and resource management, represented schematically as the '9DBs tree' (Figure 1) (Whiteman et al., 2021). The resulting framework serves as a useful 'roadmap' and initial scoping tool, allowing a country, city or part-city to locate their current situation, understand their common challenges and identify key pressure points for change.

The DBs are defined according to several criteria. Progress from DB1 to DB5 is characterised by (a) the waste collection service coverage and (b) the proportion of MSW managed in controlled recovery and disposal facilities. These correspond to the two components of SDG indicator 11.6.1, for which a step-by-step guide is available (UN-Habitat, 2021). A city's progress in each can also be visualised using two ladders (Figure 2). In the roots and trunk of the 9DBs tree (DBs1–4), cities progressively move 'up' these ladders by increasing their collection service coverage and the control level towards 'basic' standards (Figure 2, see also Table 1). Once a basic level is reached in both, a city has achieved SDG 11.6.1 and reaches DB5, the 'new target baseline'.

DB6 and DB7 represent different pathways adopted in the Global North to achieve full control of recovery and disposal, corresponding to environmentally sound management (ESM) (Figure 2, panel b). DB8 and DB9 represent further steps they used to achieve



Annotated Key to Development Bands (DBs)

DB Zero	Circular Economy	Aspirational target of zero waste
DB9	Policy Driven by Technical Standards	Alternative pathways to full collection service level (segregated collection), and high levels of recovery
DB8	Policy Driven by Fiscal Mechanisms	
DB7	Market Oriented Systems	Alternative pathways to full control / environmentally sound management (ESM)
DB6	High Recovery Systems	
DB5	New Target Baseline	Universal basic level of collection service and controlled recovery & disposal (meeting SDG indicator 11.6.1)
DB4	Consolidating Control	Early steps to gradually extend basic levels of collection coverage and controlled recovery & disposal (Table1)
DB3	Service Extension	
DB2	Early Movement	
DB1	New Beginnings	

Figure 1. The Nine Development Bands (9DBs) conceptual framework and global theory of waste and development. Please read from bottom to top. **Source**: Whiteman et al. (2021). Figure © Andrew Whiteman. **Notes**: ESM – environmentally sound management. SDG – sustainable development goal.

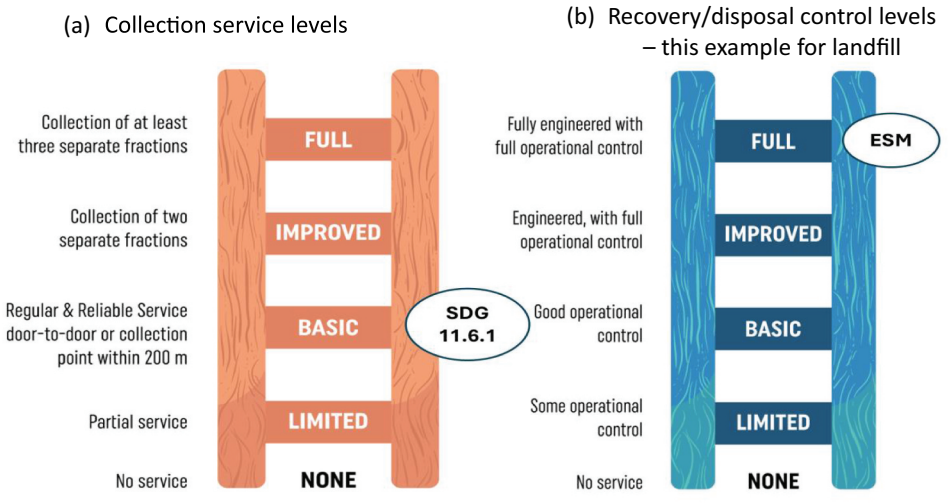


Figure 2. Evolutionary ladders for municipal solid waste management. **Notes**: The basic levels (collection and controlled recovery or disposal) must be met to 'count' towards sustainable development goal (SDG) indicator 11.6.1. The full control level corresponds to environmentally sound management (ESM). Figures © Andrew Whiteman and David C. Wilson. Adapted from Waste Wise Cities Tool (UN-Habitat, 2021).

enhanced recycling and recovery through higher service levels with collection of several source segregated fractions (Figure 2, panel a) (Whiteman et al., 2021; Wilson, 2023). DB Zero sits at the top of the 9DBs tree as an aspirational future target of 'zero waste' and a circular economy.

Integrated sustainable waste management (ISWM)

The response to 1970s environmental legislation in the Global North has been termed the 'technical fix': what mix of technologies can meet the required standards at least cost (Wilson, 2023). In the Global South this approach largely failed: the World Bank concluded that: '*The majority of MSWM investments encountered implementation problems and delays, due to poorly defined institutional structure and responsibilities, poor cost recovery, insufficient technical and managerial expertise and other problems*' (Arlosoroff & Rushbrook, 1991).

These negative experiences led directly to the development of integrated sustainable (solid) waste management (ISWM) in the 1990s (Schübeler, 1996; Van de Klundert & Anschütz, 2001). Figure 3 shows the 'two triangles' representation of ISWM, in which the technical or 'hard' physical components (the 'what to do') are balanced by the 'soft' 'governance' aspects (the 'how to do it') (Scheinberg, Wilson, et al., 2010; UNEP & ISWA, 2015). The acronym has been used with many different interpretations, often omitting the key word 'sustainable' (Wilson et al., 2013).

Focusing on early steps in lower-income communities

Using the 9DBs framework, this paper aims to initiate an important scholarly, societal and political debate on rethinking approaches to waste and development. Our focus is on how best to extend services to unserved and underserved (here collectively termed 'underserved') communities, at pace and at scale. Our perspective is as waste and resource management practitioners working in lower-income countries, writing for a broad multi-disciplinary audience.

Today, high-income countries mostly sit in the upper branches (DBs 8 and 9). Existing development approaches have helped upper-middle-income countries and the richer parts of cities in lower-middle-

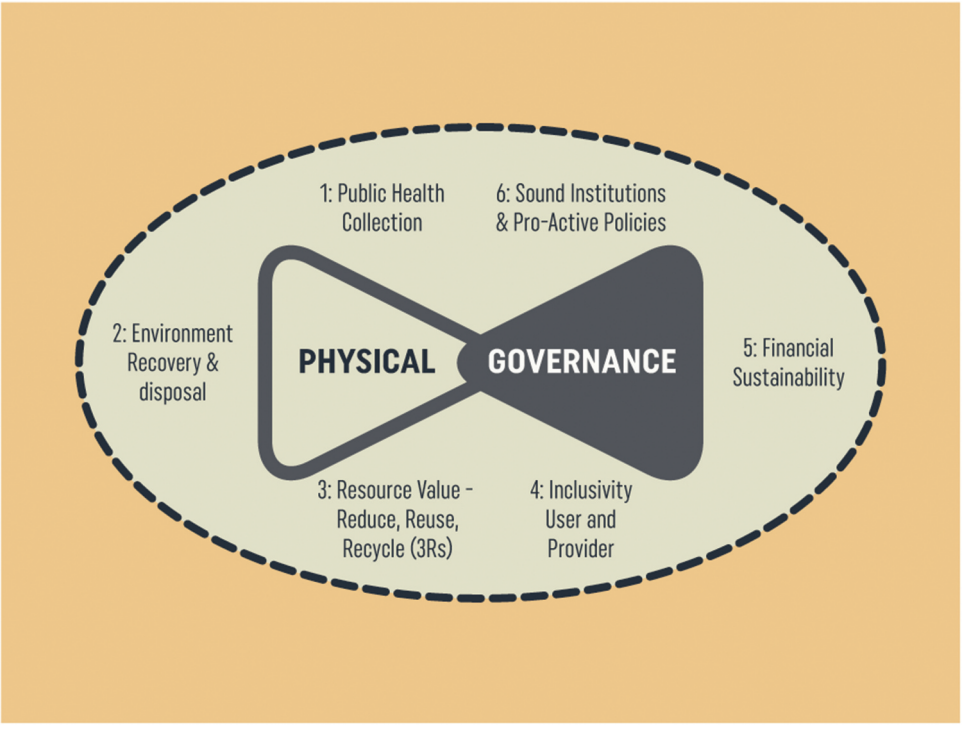


Figure 3. The simplified 'two triangles' representation of the ISWM (Integrated sustainable waste management) framework. (Adapted from Wilson et al., 2013)

income countries to make substantial progress towards DB4–5. But, many low- and lower middle-income (termed here 'lower income') cities and countries remain stuck in the roots of the DB tree (DB1–3), and struggle to extend waste collection services to the whole urban population and ensure that waste is managed in a controlled way (Table 1).

Simply trying to follow the historical trajectory of the Global North would be a mistake. In lower-income countries, the informal recycling sector is still active, operating in parallel to formal MSWM. That baseline is fundamentally different to the Global North in 1970, where recycling rates had already fallen to <5%, when the same transition occurred. So, the challenge is not how to extend linear 'collect and dispose' MSWM to provide adequate services to all (DB5); but rather, how to reach DB5 while already diverting much waste from landfill to recycling and reuse. In practice, this means building on and integrating the current parallel formal MSWM and informal recycling systems into community-up 'waste and resource management' (WaRM) services, making early progress towards higher levels of collection service (delayed in the Global North until DB8–9) and circularity (DB Zero). This is a win-win-win-win-win ('win^{5}') outcome: where underserved communities receive a service; disease outbreaks reduce; recyclers make a better livelihood; an increased proportion of the waste stream is recovered, simultaneously reducing the quantities requiring, and the costs of, collection and disposal; and the local and global environment is protected.

Expanding on the early development bands

Table 1 characterises DBs1–5 in more detail, identifying common challenges and pressure points. Allocation follows performance against SDG 11.6.1 indicators of collection coverage and management in controlled facilities.

Table 1. **The early development bands**. Please read from bottom up. Allocation of a country, city or part-city to a DB is defined by indicators for collection coverage and management in a controlled recovery or disposal facility. Pressure points cross-link to institutional functions in Figure 4. Adapted from (Whiteman et al., 2021).

Development Band		Collection coverage	Managed in a controlled facility	Common Challenges	Pressure points
DB5	New Target Baseline	95+%	95+% (→ESM)	Meet 11.6.1. Secure pathways to ESM	Control costs - **Financial regulator**
DB4	Consolidating Control	DB4a: 80–95+%	DB4b: 80–95+%	Moving towards 11.6.1 compliance	Diversify funding sources - **Revenue collector**
DB3	Service Extension	60–80%	up to 50%	Expand collection, plan controlled facilities	Develop an ISWM plan - **Planner**
DB2	Early Movement	30–60%	up to 20%	Extend collection, designate facilities	Strengthen municipal **Client/ employer** capacity
DB1	New Beginnings	0–30%	0%	Establish basic collection system	Establish **Operators**

Each of the 9DBs is linked to the primary 'pressure point' for making change happen at that level. These pressure points correspond to ISWM institutional/organisational functions which need to be in place for a WaRM system to be effective (Figure 4) (Whiteman et al., 2021).

The pressure points in Table 1 for DB1–4 relate mainly to one group of functions in Figure 4, the 'operator model'. The municipality is responsible as 'client/employer' for ensuring that a service is provided; the operator delivers the service; and the revenue collector collects the money to pay for the service. A seminal GIZ study developed a taxonomy of 42 commonly used operator models (Wilson et al., 2017), and decision support tools for their selection (Soos et al., 2017).

Extending WaRM services to underserved communities

The paper begins by exploring alternative approaches to tackling the global waste emergency. Extending services to underserved communities requires attention to both the governance and physical ISWM triangles (Figure 3). So, the following sub-sections explore how to initiate governance reforms and early 'no regret' investments.

Tackling the global waste emergency

Progress on extending collection service coverage and ensuring controlled recovery and disposal has been highly inequitable in lower-income countries, with many cities, peri-urban areas, urban slums and rural communities receiving little or no service (UNEP & ISWA, 2015; Wilson, 2023).

Without action, the situation will only worsen. With growing populations, high urbanization rates, and increasing waste generation per capita, many cities in Africa and South Asia are projected to see their waste generation double every 15–20 years (UNEP & ISWA, 2015). Such extreme growth is likely to overwhelm local capacities which are often already struggling to provide or maintain basic services to their residents.

International development assistance has helped some middle-income countries begin to make substantial progress towards DB4–5. Official Development Finance (ODF) includes in-kind support, technical assistance, grants and (sometimes concessionary) loans from bilateral and multilateral development institutions. The proportion of ODF directed to MSWM is, however, trivial compared to the needs: UNEP recommended an increase from 0.3% to an average of 3% over 15 years (UNEP & ISWA, 2015). Out of 147 countries receiving SWM-related ODF between 2003 and 2021, 66% went to the top 20 (mainly upper-) middle-income countries, including 17% to China and 8% to Turkey, and just 7% to low-income countries (Lerpiniere et al., 2025). ODF has thus far

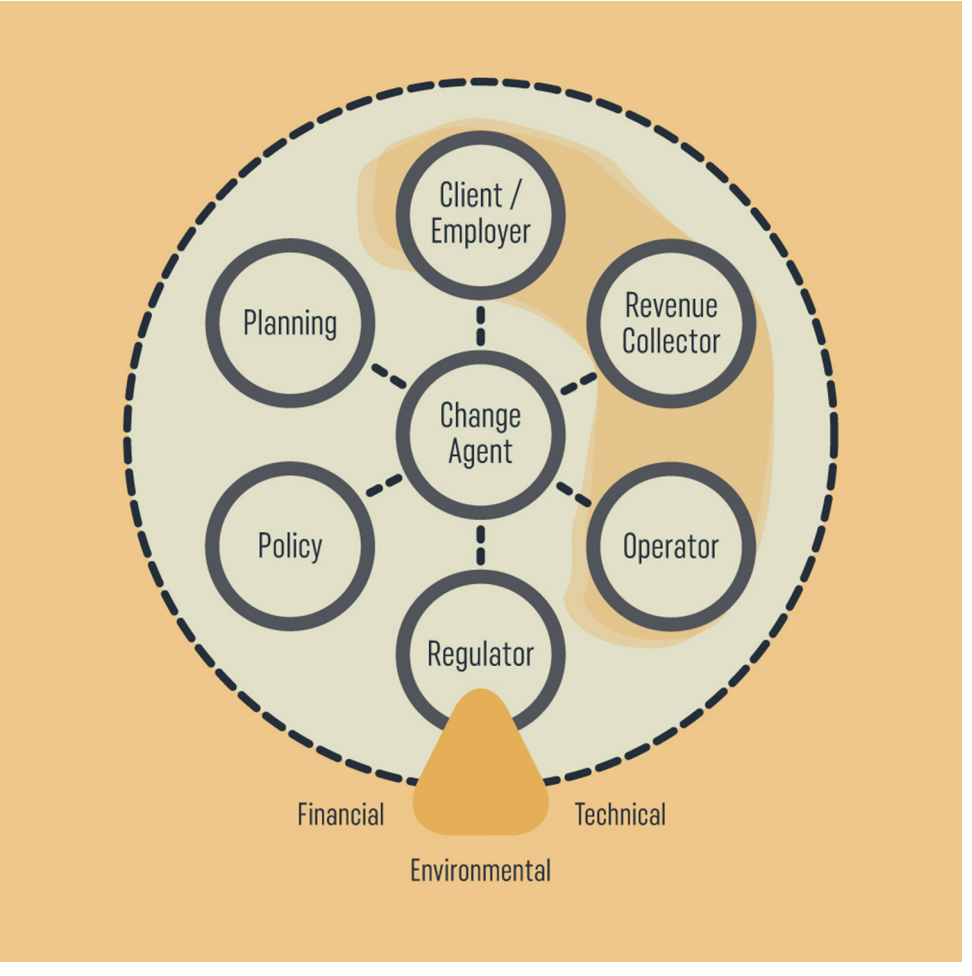


Figure 4. Institutional functions which need to be fulfilled for waste and resource management (WaRM) systems to work well. The three linked functions on the top and right comprise the 'operator model'. Source: Whiteman et al. (2021).

failed to reach countries and communities most in need. A refocus is required from major city-wide infrastructure to delivering basic services to underserved communities.

Such traditional 'top-down' assistance, directed via and possibly topped-up by national governments, is necessary, but not sufficient on its own to tackle the global waste emergency. A complementary bottom-up, community-led approach is required which works for the poorest people (Ali, 2006). The combined focus needs to be on extending waste collection and controlled recovery and disposal, providing both quality services needed to keep neighbourhoods clean and healthy, and better livelihoods for the multitude of workers who deliver collection and recycling services. *'There is an urgent need to bring people back to the heart of the narrative: the impact they suffer and the potential they hold for more effective solutions*' (Practical Action, 2021, p. xii).

Initiating governance reforms

The technical 'what to do' ISWM triangle (Figure 3) is relatively straightforward; but the governance 'how to do it', including social inclusion, financial sustainability and institutional aspects, is more complex and hinges on the willingness and capacity to implement changes effectively.

As a city progresses through the DBs, it encounters different 'pressure points' (Table 1). Where little or no waste services exist (DB1), the first step is recognising MSWM as deserving public policy attention and accompanying this with some budget. Many cities across the world still do not allocate any budget for waste management, rather relying on pure market demand for services. This approach does not deliver the services needed for a healthy, clean and prosperous city. So, the pressure point is to engage new operators, facilitating entrepreneurs to enter and stay in the sector, building on existing informal value chains, and helping micro-entrepreneurs to scale up their operations. Such initiatives can be framed within efforts to mobilise action and youth advancement.

As cities move through DB2 and DB3, the focus turns more to developing the capacity of public authorities to act as clients/employers for MSWM services and planning next stage of infrastructure and services improvements. In DB2, priority actions include dividing the city into service zones, introducing more structured administrative and contractual arrangements, and allocating more budget to sustain services. In DB3, ISWM plans provide a basis for projecting service demand, and for investments in infrastructure and services to respond. Moving into DB4, the focus becomes strengthening the legal basis for fee collection, and integrating mechanisms (such as extended producer responsibility (EPR)) to diversify revenues entering the sector.

Responsibility for MSWM is often fragmented between departments, and/or delegated to many small administrative districts, within the city/municipality. It is crucial during the DB1–5 transition to establish MSWM/WaRM as a sector and cost centre of government, and gradually build organisational capacity within the public authorities, whilst simultaneously putting in place an enabling environment for operators to thrive in delivering front-line services.

Improved planning is needed to address the urgent need to extend services to all. ISWM plans need to build on existing waste management and informal recycling systems in underserved areas, to strengthen their foundation, catalyse their replication, integration and sustainability. A participatory planning process involving local communities in design and implementation is essential (Wilson et al., 2000). Urban planners need to identify and design spaces for MSWM infrastructure into city development plans; waste planners design the systems and interfaces. Good data are essential for effective ISWM planning.

Integrating with other urban environmental services

Attention needs to be placed on innovation in integrated urban environmental services. Bundling urban environmental services such as WaRM and WASH can be a means of diversifying revenue sources for local community-up operators, enhancing business and livelihood opportunity, and reducing risks of the operator model failing.

It makes good sense to extend sanitation and waste collection services in parallel, illustrated by experience in Kisumu, Kenya where 66% of low-income residents reported disposing nappies (diapers) in pit latrines (Practical Action, 2021). WASH, as a sector has placed a lot of focus on catalysing community-up, demand driven, systems, and the WaRM sector has much to learn in this regard.

Making early no regret investments

Developing city-wide infrastructure for MSWM requires significant investment. This needs detailed planning and feasibility studies which can take a lot of time and money to prepare. Whilst there is no 'one size fits all' WaRM system, experience in different contexts suggests that there are some things that can, and need to be, done with relatively low risks regardless of the situation – what we term 'no regret' investments. No regret investments can allow cities to make early progress whilst plans and feasibility studies are being prepared. They can bring win[5] benefits to the underserved local communities, helping to gain their support; and early lessons learned can feedback into the next round of system improvements.

Extending waste collection services

Waste collection services utilise diverse operator models. For central business and richer residential districts 'one-step' collection services are common, where larger vehicles collect from door-to-door and travel (sometimes relatively long distances) to a transfer, recovery or final disposal facilities. In high-density and/or lower-income areas with restricted vehicular access, collection services may need to be carried out in 'two-steps': with waste generators or primary collectors bringing waste out from the community to a collection point, from where the secondary collection system takes over.

Options are to establish a network of convenient 'communal collection' points to which the householder/waste generator brings their waste; or to establish a primary collection operator to collect wastes within the settlement, perhaps door-to-door. Primary collection micro-service providers (MSPs) can come from the local community, e.g. youth microenterprises. They may use a variety of small hand-, cycle-, animal- or motorised carts (Coffey & Coad, 2010; Rouse & Ali, 2002); electric vehicles are now also being used.

For communal collection to 'count' as a basic service (Figure 2, panel a), collection points must be within at least 200 m of every user. With primary collection operators in place, the interface points with secondary collection can be more widely spaced. In both cases, the interface points need to be well organised, clean and convenient, so that collected waste/recyclables reliably reach recovery and disposal facilities. Identifying and designating suitable sites in crowded urban areas is always challenging. In some cases, the places where waste is being unofficially deposited can be designated and upgraded as waste collection points; 'the waste has found the place'.

Even in the absence of a municipal collection service (DB1), informal operators may provide a partial level of service (Figure 2, panel a) by focusing on those MSW fractions for which there is positive market demand; indeed such 'itinerant waste buyers' are widespread (Lardinois & Furedy, 1999) and found throughout DB1–5. The market price for the valorisable part of MSW is rarely sufficient (or reliable enough) to sustain a basic MSW collection service. Informal collectors and community-based organisations (CBOs) often provide in-kind services, for which they rarely receive recognition from the city administrations; rather they are often motivated by wider social benefits for their community beyond a cleaner and healthier neighbourhood, particularly for younger generations. Recognising and investing in existing operators, helping them to extend their activities to include collection of non- or marginally valorisable waste, offers potential for cost-effective expansion of basic collection service coverage (e.g. by constructing designated collection points, paying primary collectors a service fee for collecting non-valorisable waste and ensuring its safe onward transport and disposal). It also strengthens community participation and generates social benefits, linking environmental management with community development.

Supporting recovery value chains

In lower-income countries, existing informal recycling systems generally operate in parallel to formal MSWM, focusing on extracting materials for which there is a stable positive market value, typically metals, PET, paper/card and some organics. Repair and reuse systems are still commonplace. In most cases, the revenue comes from selling the separated materials, not from the service they provide to the municipality by handling a proportion of MSW. Forming umbrella enterprises, associations or cooperatives of informal service providers can help bring recognition and facilitate negotiation with the municipality, improve rights, and provide supporting social services, insurances and protection (Samson, 2009). The Plastics Treaty could build value chains for plastic waste, potentially strengthening market demand for flexible plastics, or creating it for multi-layered or fibre-reinforced plastics, which are more challenging to recycle with commercial viability.

Segregation at source of wet organics from dry recyclables is key (Pfaff-Simoneit, 2023), allowing recyclers to work in more hygienic conditions, recover more materials and achieve higher selling prices. Separating and collecting the dominant organic fraction at source also provides the clean feedstock (Ricci-Jürgensen et al., 2020) necessary for organics recovery to thrive. Options (Lohri et al., 2017) include composting, community biogas, briquetting and black soldier fly. Nutritious

soil, renewable energy, cooking fuel and protein are typically in strong demand. Organics recovery can be carried out at the household, community or city levels.

The sector requires appropriate equipment, vehicles and designated facilities for materials storage and sorting. It is crucial to involve the people who are already working with 'waste' and help them to scale up their activities and operations. CBOs, informal collectors and recyclers are a spring from which community-up WaRM services can grow, helping early progress to be made towards DB Zero.

Upgrading existing designated disposal facilities

Extending WaRM services to underserved communities must include controlled disposal of residual wastes that are not recovered. Historically, waste disposal has often been 'out of sight, out of mind', leading to uncontrolled sites with significant health and environmental risks. Despite progress, many lower-income cities still face both 'wild' dumpsites and designated but underfunded and poorly managed disposal sites.

Developing new, controlled landfills will take time. Siting will be controversial and past mismanagement will fuel NIMBY ('not in my backyard') objections. So, a strong option is to upgrade existing sites with available capacity, thus reducing the impact on local communities. Controlled disposal meets high standards of operational control (Figure 2, panel b). Implementing the '3Cs' - confine, compact and cover the waste – eliminates risk of fires and unstable slopes, and significantly reduces nuisance of flies, vermin, odour, and windblown litter (Wilson, 2023).

Upgrading existing sites will require actions on governance, efficient service delivery and scalable landfill practices. Early engagement with local residents, including informal recyclers working on-site, is essential. The principles of controlled disposal are set out by UN-Habitat (2021); more detailed guidance was developed in the 1990s (Ali et al., 1999; South Africa DWAF, 1998). One approach focuses on low-technology, cost-effective, semi-aerobic landfill (Fukuoka Prefecture, 2020). All three of these guidelines go beyond basic to improved control of landfill gas and leachate, thus reducing climate impacts (Figure 2, panel b).

Avoiding early regret investments

Everywhere we have worked, Ministers and Mayors are inundated with offers for technologies that will 'solve their waste problem'. The genuine challenges inherent in ISWM opens the door to unscrupulous salespeople selling technical fixes, often branded as waste-to-energy (WtE).

Proven WtE technologies such as mass burn incineration with energy recovery can make sense as part of an institutionally mature, well-functioning WaRM system, where the city can afford to move on to the next steps beyond DB4 and DB5. However, when a city is still struggling to develop a basic WaRM system, as is the case from DB1–3, investing heavily in thermal treatment technologies can be a dangerous distraction (Wilson, 2023). Several decision-making guides are available for Mayors and their advisers, e.g. from GIZ (2017) and UNEP (Liu & Nishiyama, 2020). Other advanced thermal treatment technologies, such as pyrolysis and gasification, have not been fully proven for treatment of mixed municipal solid waste, even in the Global North.

What money matters?

How can the extension of services to underserved communities be paid for? This section looks at how to raise and balance funding for the WaRM sector from a variety of sources.

National and city financing of community services

Introducing new, or upgrading existing, services requires sustainable revenues to pay for ongoing operating (and maintenance) costs (Opex), as well as capital funding to cover the initial and

recurring investments (Capex). Ensuring that the direct financial cost of MSWM services is met is a municipal responsibility.

Given the negative impacts of waste mismanagement, it is in cities' self-interest to provide basic MSWM services for all their citizens. The conundrum is that low-income communities cannot readily afford to pay for these services, and as systems move up the 9DBs, the costs generally escalate (Whiteman et al., 2021). Variations and neglect within larger cities are common and a major challenge, with central business districts and richer neighbourhoods receiving high levels of service, while neglecting low-income areas. MSWM focused on waste collection and disposal is a net cost service, and extending services to underserved communities increases these net costs.

Levying a direct charge on all householders to cover the full costs (including amortisation of equipment and construction of facilities) is unusual internationally, precisely because non-payment harms society more than the individual. More usual is some combination of a direct flat charge to selected users; indirect charges collected with property or other local taxes or utility charges (e.g. electricity or water bills); and transfer from general budgetary funds, either municipal and/or national (Scheinberg, Wilson, et al., 2010).

Many people in underserved communities are already investing their time and energy to keep their neighbourhood clean as best they can. In-kind contributions are common, often falling disproportionately on women and youth; waste is a gender issue (Seager et al., 2020). So, working with the community is essential when new services are introduced: to bring local community leaders on board; to build livelihoods of women and youth groups in particular; to change people's behaviours away from dumping and burning; and to persuade people to pay a (small) fee.

City budget will be needed to kick-start and sustain the functioning of services. Relying only on cash payments from the door and the value of the collected materials will, at the very best, result in 60% collection service coverage, often much lower. Revenue from sales of valorisable materials will pay only a small fraction of total costs for a basic waste collection system.

Even the poorest communities are ready to pay a small fee for a regular and reliable waste collection service when they can see the benefits, in keeping their neighbourhood clean, their children healthy (Scheinberg, Wilson, et al., 2010) and the local youth out of crime. So, charging households will often be feasible to cover costs of primary waste collection; but not for street cleaning, secondary collection, transfer and disposal, which provide wider collective benefits (UNEP & ISWA, 2015).

Willingness and ability of people to pay for services is a common constraint when extending services to unserved communities. Dedicated funding, and funding mechanisms, are needed to ensure service delivery in communities that are either difficult to access or will struggle to pay. How to deal with those who cannot afford to pay is crucial. Two comparative case studies are interesting: in both Dakar, Senegal and Dhenkanal, Odisha State, India, a collection service is available to 95% of the population and 60% pay for the service. The collection coverage in Dakar is thus 60%, while in Dhenkanal it is 95% as the city chooses to provide the service irrespective of ability to pay (Practical Action, 2021).

National governments raise revenue from taxation on citizens, so government transfers to cities to fund investment and/or services with collective benefits to citizens is rational, equitable and commonplace. One innovative approach is performance-based grants; top-ups for those cities/municipalities that demonstrate their performance in extending WaRM services. One example is Kosovo, where a transition from DB3 to (close to) DB5 has been significantly assisted by a competitive national grant award scheme for high performing municipalities, backed up by international development financing (Tuncer et al., 2023).

Resource recovery as a revenue source

Over the last few decades, the high costs of operating full environmental control landfills, incineration and other recovery (DB6/7) has led the Global North to move from basic to

full service collection of several source segregated fractions (Figure 2, panel a) to facilitate high levels of reuse and recycling (DB8/9). The revenues from recyclate sales did not cover the costs of separate collection and material recovery facilities (MRFs); rather, the net costs (often accounting for landfill and incineration taxes) made recycling competitive as an alternative 'sink' (Wilson, 2023). Similarly, revenues for energy sales never cover the costs of incineration and other WtE technologies, rather they make the net costs marginally closer to those of ESM landfill. The high net costs of ESM incineration with energy recovery compared to basic controlled landfill reinforces the earlier conclusion that investing in incineration facilities should only be considered when transitioning through DB4/5 and upwards.

The current situation in lower-income countries is that the informal recovery sector often collect and recycle perhaps 10–30% of the total waste generated (Scheinberg, Simpson, et al., 2010; UNEP & ISWA, 2015; Wilson et al., 2009), leaving the municipality to collect the remaining 90–70%. Every tonne of waste that leaves the MSWM system reduces overall costs, justifying support from the city to enhance and integrate existing recovery activities (Aparcana, 2017; Velis et al., 2012), and triggering win[5] benefits to communities.

One case where a properly integrated 'municipal WaRM' system has been built from the community-up is San Fernando, Philippines. Recovery increased from 12% to 80+%, cutting the city's waste management costs by half whilst creating new jobs, increasing livelihoods by remunerating the recyclers for their previously 'in-kind' contributions, and increasing landfill lifespan (Dayrit, 2019). Recognising and working with the informal sector, via non-governmental organisations (NGOs), CBOs and/or umbrella enterprises, associations or co-operatives, can open pathways for enhanced recovery as a primary driver of service extension.

Extending financial responsibility to producers

A significant and growing fraction of municipal solid waste is packaging – often 15% to 25% by weight (UNEP & ISWA, 2015) and 50+% by volume. In much of the Global North since the 1990s, the responsibility for managing packaging wastes has been shifted from the municipality to the producers (supply chain) who place packaged products on the market (Cahill et al., 2011). In the 2020s, such extended producer responsibility (EPR) is beginning to be given more teeth: to incentivise reduction and reuse; to ensure recycling takes place; and to cover all the associated costs of collection, sorting, reusing, recycling and managing any residual wastes (Wilson, 2023).

Fast-moving consumer goods (FMCG) companies now sell their products in every country, many with inadequate MSWM. There is a strong case that such companies, alongside regional and national producers, are directly responsible for the pollution from their mismanaged plastic packaging, including open burning and leakage into the ocean (Tearfund, 2020). So, they need to pay for proper MSWM of their packaging through EPR.

More work is required to develop EPR paradigms tailored to the needs of the Global South. Rather than national EPR schemes, a mechanism is required for negotiation of regional or even global EPR, to allow smaller and lower-income countries to benefit on a more level playing field. Producers need to be responsible for making recycling and reuse work, not just for easy to recycle commodities but also problematic materials (e.g. flexible plastics and multi-layer sachets) and products (e.g. disposable diapers). Full financial responsibility requires development of new and effective mechanisms to channel funds both to cities and/or their ISWM operators, and to the MSPs working the frontline of service delivery; who may in turn need capacity building. Operators need to be paid for their services rather than just the market value of the materials they collect, and incentivised to meet targets.

Extending MSWM services to 95+% of the population (reaching DB5, SDG 11.6.1) would reduce macroplastics dispersal to the environment by 77% and open burning by 90% – an overall pollution

reduction of 85% (Tanner et al., 2024). So, there is a strong case that both EPR on packaging and international 'plastics finance' should target the extension of MSWM and WaRM services to underserved communities, rather than focusing solely on plastics waste management.

Pricing of disposal

Achieving basic standards of disposal is often the rate determining step in the transition to DB5. Ensuring regular and reliable budget to sustain basic operational and environmental control of disposal sites is essential. There are different ways of doing this; the public authority can set aside a proportion of the municipal waste management budget, and/or some sort of gate fee or trip ticket system can be implemented.

Introducing a price on disposal has had a knock-on effect on stimulating the recycling and reuse sector (Scheinberg, 2011). Materials will tend to flow towards cheaper facilities; where disposal is not priced there is no stimulus to enhance recycling/reuse. Where disposal is priced, then so long as open dumping of collected waste is prevented, waste collectors (including the municipality itself) will try harder to find (cheaper) recycling/reuse options. Countries in the higher DBs have long used disposal price as the primary means of stimulating the waste industry to invest in recycling/reuse, through a combination of full cost tariffs/gate fees and landfill taxes on top.

International development financing

The costs of even current inadequate services are already pushing the limits of affordability in many cities (UNEP & ISWA, 2015). The direct financial costs of extending MSWM services may be local, but the benefits are global – slashing plastics reaching the ocean (Cottom et al., 2024) and significantly mitigating climate heating (Wilson et al., 2024).

It is therefore of global importance to ensure universal service coverage for all. So, it is both a moral obligation on the international community, and in their long-term financial self-interest, to bridge the financing gap between the improved MSWM services and infrastructure which are needed for the global good and what can be afforded locally.

How can this be achieved? Official Development Finance (ODF) needs to reach the lowest income countries, cities and communities who need it most (Lerpiniere et al., 2025), and the proportion devoted to MSWM needs to increase (UNEP & ISWA, 2015). Multiple components need to be mobilised, including climate and plastic finance; EPR; and plastic credits if they can meet criteria for their effectiveness (Eunomia, 2024; TCI, 2021). The grant component of funding needs to recognize the benefits to the wider global community of extending collection to all and eliminating uncontrolled disposal and open burning.

Continuing to target international (and indeed national) finance at investments in city-wide infrastructure and capacity development is necessary but not sufficient. Financing needs to include short- and medium-term operational financing, within the framework of a sector policy and/or ISWM plan. Such funds need to flow into community-up operator models, which are key to service extension. Field experience suggests that relatively small amounts of 'gap funding', combined with access to technical assistance, could tip the balance.

New multi-lateral funds are urged that blend financing from different sources to help WaRM systems transition through DB1-DB4. These could take the form of impact funds that extend services, deliver circularity, reinforce livelihoods, mitigate climate heating and stem plastics pollution. Such funds could potentially blend resources from international financing institutions, private finance, EPR and philanthropic donors.

Maximising impact requires international development and financing organisations to use their comparative advantages, expertise, global reach, and ability to leverage private finance (OECD, 2022). Financial institutions, including banks, insurers and fund managers, are already

collaborating with international development organisations on initiatives that deliver impact on environmental and social considerations (UNEP, 2022). Funds able to support the specific needs of lower-income countries transitioning through DB1-DB4, will reap significant local, as well as global, economic, environmental and social benefits.

Conclusions and call to action

The conclusions and call to action are organised initially under the two main headings used earlier in the paper.

Extending services to all

Everyone has a right to basic services (SDG1.4), one of which is regular and reliable solid waste collection. Yet despite much progress, some 2.7 billion people worldwide still lack access to collection services; and of municipal solid waste that is collected, 40% is open dumped or burned. This constitutes an on-going global waste emergency that has severe impacts, locally on public health and environmental pollution, and globally on climate heating and plastics pollution. Meeting target SDG11.6, ensuring universal collection service and controlled recovery and disposal, would reduce macroplastics dispersal to the environment by 77%.

An integrated sustainable waste management (ISWM) approach focuses on both technical aspects and on governance factors. ISWM means inter-connected waste management and recycling services provided at a financial, social and environmental cost that can be afforded across generations. To extend services to underserved communities, the technical 'what to do' is relatively straightforward; but the governance 'how to do it', including social inclusion, financial sustainability ('how to pay for it') and institutional aspects is more challenging.

The conventional top-down development approach has so far led to highly inequitable progress with little success in extending services to underserved communities, particularly in lower-income countries. Extending services at pace and at scale will require both a refocusing of development efforts, AND a parallel bottom-up community-led approach involving people from the community in their design and delivery.

The nine development bands (9DBs) framework helps identify key governance pressure points to catalyse change at different stages in developing WaRM systems. In the early stages, priorities are to establish operators of services; strengthen municipal capacity to oversee and manage these services; and strengthen and diversify revenues for services.

Recognising and working with the informal sector can open pathways for enhanced recycling/reuse as a primary driver of service extension, helping early progress towards the ultimate aspiration of circularity (DB Zero). Separating (wet) organic wastes from (dry) recyclable materials at source unlocks markets for both. The outcome is win-win-win-win-win ('win^{5}'); underserved communities receive a service, disease outbreaks reduce, recyclers make a better livelihood, the municipality avoids costs of collection and disposal of much waste, and the local and global environment is protected.

What money matters?

The costs of MSWM are local but the benefits are local and global. Cities are responsible for providing services and need to raise revenues to cover the costs. But basic services are often unaffordable to the poorest in society, so extending services to all is challenging; more so as rising waste quantities and technical standards increase costs exponentially.

Operators may gain a foothold by focusing on collecting those MSW fractions for which there is positive market demand. However, the market price for valorisable components of MSW is rarely enough (or reliable enough) to sustain a basic MSW collection service. Collection service expansion

can be anchored on existing operators (including informal collectors and recyclers). Public budget is needed to help cover the costs of collecting non- or marginally valorisable waste from underserved communities.

Many underserved communities are already investing time and energy to keep their neighbourhood as clean as possible. In-kind contributions are common, and disproportionately fall on women and youth. Transitioning to a payment-for-service arrangement is challenging. The WaRM sector has much to learn from WASH on how to create and sustain demand for services.

A significant and increasing percentage of MSW is packaging. Financial responsibility needs to be extended from the municipality to the producers who place packaged products on the market. Funds raised by EPR need to be targeted at underserved communities to address gaps in service delivery and resulting plastic pollution.

The international community has an obligation to bridge the financing gap between the improved MSWM services and infrastructure which are needed for the global good and what can be afforded locally at the present time. The proportion of traditional ODF directed to MSWM needs to be increased significantly. To be effective, climate and plastics financing mechanisms need to target extending WaRM services to all.

Continuing to target international finance at city-wide infrastructure and capacity development is necessary but not sufficient. Funds also need to flow into community-up initiatives focused on service extension and early no-regret investments. Cities and politicians need to step up to recognise WaRM as a priority. National governments can introduce performance-based grants, top-ups for those cities/municipalities that demonstrate performance in extending WaRM services. International development institutions can devise new multi-lateral impact funds that blend financing from different sources to help WaRM systems transition through DB1-DB4.

Call to action

Tackling the ongoing global waste emergency by extending waste collection and WaRM services to all is essential. A new approach is required, supplementing traditional infrastructure-led international development with parallel people-centred community-up initiatives. Governments can step up and different development partners can focus on what they are good at; the whole can be greater than the sum of the parts, and the poorest communities who most urgently need services can look forward to no longer ‘falling through the cracks’.

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