NOTES TECHNIQUES

TECHNICAL REPORTS

OCTOBER 2020

No. 54

Diverting Solid Waste

Socio-technical innovations in cities of the global South

Authors

DURAND Mathieu (Le Mans University, ESO CNRS Laboratory)

CAVÉ Jérémie (Urbanalyse)

DELARUE Jocelyne (Gevalor)

LE BOZEC André (ALBWaste)

SALENSON Irène (AFD)

AFD éditions

Countries: Colombia, India, Indonesia, Madagascar, Peru, Togo

Keywords: waste, recycling, compost, informal labour, valorisation

AFD, 5 rue Roland Barthes, 75598 Paris cedex 12, France – ☎+33 1 53 44 31 31
✉ PublicationsAFD@afd.fr – https://www.afd.fr/en/ressources-accueil

AUTHORS

DURAND Mathieu, Associate professor Le Mans University, ESO CNRS Laboratory, Director of the Waste Management and Circular Economy post-graduate programme

CAVÉ Jérémie, Ph.D., Independent consultant, Urbanalyse

DELARUE Jocelyne, Director of Gevalor association

LE BOZEC André, economist, Independent consultant, ALBWaste

SALENSON Irène, Research officer, Economic Assessment and Public Policy department, Innovation, Research and Knowledge Division, AFD

ABSTRACT

This work takes as its starting point the findings of local authorities in the global South: as and when they are required to shut down old disposal sites and invest in costly sanitary landfills, cities are taking a fresh look at the role of waste avoidance ensured by various recycling systems. In fact, these systems divert part of the streams to be managed, reduce the fill rate at landfill sites, limit wasted resources and provide jobs for the poorest. Yet, reconciling the growth of these waste valorisation processes with public waste management services raises social, economic, institutional and technical challenges that need to be precisely characterised. This study aims to analyse these challenges from a technical, institutional and financial viewpoint in six cities in the global South: Lima (Peru), Bogotá (Colombia), Lomé (Togo), Antananarivo (Madagascar), Delhi (India) and Surabaya (Indonesia).

Cover photo: Waste-weighing at the waste bank in Semampir (Surabaya – Indonesia) © J. Cavé, 2016

ORIGINAL LANGUAGE

French (English translation by Gill Gladstone)

ISSN

2492-2838

LEGAL DEPOSIT

4th quarter 2020

The Technical Reports are available for download from AFD's website: **https://www.afd.fr/en/ressources-accueil**

Table of Contents

Preface

This study has its origins in the research project ORVA2D (Organisation of waste valorisation in developing cities) conducted on behalf of the Agence Française de Développement between 2014 and 2018. We wish to thank all of the stakeholders involved in this project for supporting us throughout the process, from the initial set-up to the organisation of the project's final conference, without forgetting the field data collection.

We should first like to extend our thanks to Irène Salenson (AFD's focal point for the project) for her availability and constructive remarks, as well as to the members of the Urban Development, Town Planning and Housing unit: Guillaume Graff, Clémentine Dardy and Alexandra Monteiro, as well as Laurence Rebet-Porte and Sylvie Ory, for their meticulous organisation of the international conferences.

We also thank the colleagues who helped with the data collection and production of field reports: Mélanie Rateau and Heduen Estrella Burgos (Le Mans University) for Peru and Colombia;[1] Julien Garnier and Hélène Bromblet (Gevalor) for Togo;[2] Georges Morizot, Adeline Pierrat, Clémence Lecointre and Romain Breselec (Gevalor) for Madagascar; Rémi de Bercegol (CNRS) and Shankare Gowda (CPR) for India; Setyo Nugroho for Indonesia.[3] We also wish to thank all the colleagues in France who looked after the administrative, technical and logistics management of the project: Frédérique Leguillon, Anne Saussereau (Le Mans University).

Finally, we extend our thanks to all the partners in the countries studied for their availability and their welcome during the data collection missions:

- Peru: Jérémie Robert (IFEA, CNRS), Oswaldo Caceres (Alternativa NGO), Leoncio Sicha-Punil (Municipalidad de Comas), Municipalidad de Villa Maria del Triunfo, Municipalidad de Santiago de Surco.
- Colombia: Luisa Fernanda Tovar and Luis Jimenez (Universidad Nacional de Colombia), Igor Dimitri Guarin Muños (UAESP), Céline Valadeau (IFEA, CNRS), Sandra Pinzón (Basura Cero Colombia).
- Togo: Kodjo Enoumodji, Kossi-Dodzi Agbati (Municipalité de Lomé).
- Madagascar: Damy Rakotonjanahary (Municipalité d'Antananarivo).
- India: Nirod Baran Mazumdar (Sulabh International), SDMC, ILFS, RAMKY, JINDAL, Ministry of Environment, Forest and Climate Change, Ministry of Urban Development, RWA Defence Colony, Chintan, Green Planet Waste Management, GIZ, PVC Market Association, the residents of Hanuman Mandir.
- Indonesia: Ria Soemitro, Ms Warmadewanthi (Institut Teknologi Sepuluh Nopember), Ms Winarsi, Esa Anjani and Endhita Siregar, N. Garnier and V. Mathelin from the Institut Français in Indonesia (IFI), G. de Valon and A. Fanani from AFD's Jakarta office.

[1] Field studies headed by Mathieu Durand (Le Mans University).
[2] The two African field studies were headed by Jocelyne Delarue (Gevalor).
[3] Field study headed by Jérémie Cavé (Urbanalyse).

Acronyms and abbreviations

AULNA	Agriculture Urbaine Low space No space
BOT	Build–Operate–Transfer
CBG	Community-based group
CDM	Clean Development Mechanism
CSR	Corporate social responsibility
D2D	Door-to-door
EMUSS SA	*Empresa Municipal Santiago de Surco S.A.* (Municipal enterprise of Santiago de Surco, public limited company)
EPIC	*Etablissement Public Industriel et Commercial* (Public industrial and commercial institution)
EPR	Extended producer responsibility
FCFA	CFA francs
GHG	Greenhouse gas
GNI	Gross national income
HWRC	Household waste recycling centre
INR	Indian rupee
IPES	Instituto Para la Economía Social (Institute for Social Economy – Colombia)
HWT	Household waste tax
LCV	Lower calorific value
MSW	Municipal solid waste
MSWIR	Municipal solid waste incinerator flue gas cleaning residues
NGO	Non-governmental organisation
PET	Polyethylene terephthalate (type of plastic)
RHW	Residual household waste
PPP	Public-private partnership
PSF-RS	*Programa de Segregación en la Fuente y Recolección Selectiva* (Programme for waste separation at source and selective collection – Peru)
RDF	Refuse-derived fuel
RT	*Rukun Tetangga* / Neighbourhood association (Indonesia)
RW	*Rukun Warga* / Community association (Indonesia)
SAMVA	Service Autonome de Maintenance de la Ville d'Antananarivo (Autonomous Maintenance Service of Antananarivo)
SGC	Surabaya Green & Clean
SL	Sanitary landfill
SWM	Solid waste management
TPS	Temporary Shelter Facilities (waste transfer points – Indonesia)
WTE	Waste-to-Energy
VDP	Voluntary drop-off point
VMT	Villa Maria del Triunfo
WB	Waste bank (Indonesia)
WEEE	Waste electronic and electrical equipment

Executive summary

Against a backdrop of persistent health crises and deepening ecological crises (the depletion and increasing value of virgin natural resources), the growing mass of household and similar wastes in all cities across the global South is becoming an issue of the utmost importance. The challenge is to provide an essential public service to all populations, notably the poorest (with diverse modalities for accessing this service), while at the same time integrating the environmental issues of an economy seeking to become circular. Solid waste management (SWM) represents a substantial share of municipal expenditures everywhere, yet delivery of this public service is still far from optimal. Public authorities are looking for technical solutions and management methods that are reliable, efficient, financially sustainable and politically acceptable. However, it is now recognised that most of the industrial solid waste management and treatment systems developed in the industrialised world are only partly adapted to the characteristics of global South countries, in technical, economic and social terms. Yet, in these countries, social and organisational innovations are emerging, spurred by civil society and local public institutions and confirming the need to "contextualise waste management" (rudology).

This report presents the evolution of SWM services that now call on multiple forms, stakeholders and scales. How are local public authorities dealing with the increasing number of waste collection and recycling services offered by private, community-based, informal, etc. actors? And how do these new actors dovetail with the municipal service?

As its starting point, the report takes the observations made by local authorities in the global South: as and when they are required to shut down their old disposal sites and invest in sanitary landfill facilities (at a very high cost), local authorities are now taking a fresh look at the role of waste avoidance offered by various recovery and recycling systems (organics, materials). These systems divert part of the streams normally managed by public authorities, reduce the fill rate at landfill sites and limit the amount of resources wasted. Moreover, they also often create numerous jobs for the underprivileged. Yet, reconciling the development of these waste recovery and recycling channels with the "classical" public service (i.e. the municipal service) raises social, economic, institutional and technical challenges that need to be precisely characterised.

This report aims to analyse these challenges through a technical, institutional and financial prism in six cities in the global South: Lima (Peru), Bogotá (Colombia), Lomé (Togo), Antananarivo (Madagascar), Delhi (India) and Surabaya (Indonesia). The purpose is to understand how public SWM services are being reconfigured, pointing up the contextual specificities of each city, and also to foreground some of the levers identified during the authors' in-depth field work. The findings presented here are those of the research project ORVA2D (*Organisation de la valorisation des déchets dans les villes en développement* – Organisation of waste valorisation in developing cities) conducted by AFD, Le Mans University, the NGO Gevalor and independent consultants from Urbanalyse and ALBWaste.

General introduction

The world is quite literally collapsing under its waste: two mountains of urban waste subsided in March and April 2017, causing the death of 115 people in Ethiopia and 29 people in Sri Lanka.

As and when they are required to shut down their old disposal sites and invest in sanitary landfill facilities,[1] local authorities in the global South are beginning to take a more positive view of the function of waste avoidance assured by various recovery and recycling systems, despite the informal or even unsanitary conditions in which they operate. In fact, these systems divert part of the waste streams that are normally treated by public authorities, thus reducing the fill rate at landfill sites, avoiding wasted resources and creating economic activities for the poorest. Yet, reconciling the growth of waste recovery and recycling systems with the municipal services that manage household and similar wastes raises social, economic, institutional and technical challenges which need to be characterised. Although global South countries for many years modelled their approaches on the global North's experiences, the issues and modalities involved are not the same. In the North, population growth and rising consumption have been driving an increase in waste generation for over a century. In the South, however, this phenomenon has been happening much more intensively over a period of only several decades. The magnitude of the problems, coupled with less powerful institutions and smaller public budgets, makes their waste management all the more difficult.

For these global South cities, a purely technical approach falls short when it comes to pinpointing the underlying causes of dysfunctions, or finding realistic and context-specific solutions. On the other hand, a rudological approach – in other words, a "systemic approach to waste" (Gouhier, 2000) as a societal whole and socio-technical object (Coutard, 2009) – enables municipalities to envisage a SWM system adapted to their local potential. This report proposes an analysis of various experiences in several cities in global South countries which have tried to imagine a new SWM model. In most cases, their local authorities have acknowledged the failure of a management model based solely on municipal action but, contrariwise, they have recognised the positive impact of non-municipal actors and actions. Although it is impossible to propose a single model in view of the feedback collected and given that each case is by definition highly contextualised, this report highlights a number of key elements that could help to further the shift, case by case, towards more efficient solid waste management in environmental, social and economic terms. The pivotal question then becomes: how can waste recovery and recycling – most often inexistent or ensured by non-governmental actors – be dovetailed with the municipal SWM service?

The goal of the research programme that led to this report is to design, then put into practice a methodology for analysing and comparing the waste recovery and recycling systems specific to global South cities and integrating these into the framework of a municipal SWM service. To do so, we defined the parameters indispensable to field data collection so as to obtain:

i. a characterisation of the waste streams and of the organisation of the municipal public service,

[1] Unlike other disposal sites, a sanitary landfill (SL) denotes a waste disposal facility that has, among other things, an impermeable membrane allowing for leachate collection and treatment, as well as piping for methane capture to avoid any risk of explosion and/or to recover this greenhouse gas to generate heat or electricity.

ii. a granular knowledge of the waste collection/treatment systems and costs, and of the recovery and recycling channels,

iii. an understanding of their interactions, incompatibilities and potential synergies.

Technical and health malfunctions are often the first signs pointing to difficulties in managing waste and often stem from social, economic or institutional constraints. In this investigative approach, two key dimensions have thus been analysed: the economic and financial issues on the one hand, and the organisational and institutional issues on the other hand. This comparison focused chiefly on the cases where solutions had to some extent been able to integrate the different practices (social-technical-economic innovations), in order to establish an organisational and financial diagnosis.

Six cities were studied across the planet's three southern continents. The Latin-American cities Lima (Peru) and Bogotá (Colombia) each in their own way typify the political will to integrate the informal actors recovering recyclable waste into the municipal SWM service to supplement the public service. This stems as much from an environmental as a social concern. In Africa, Lomé (Togo) and Antananarivo (Madagascar) are trying out multiple solutions to coordinate primary collection activities and municipal services. The valorisation of compostable waste for use in agriculture is also developing very substantially, notably due to its high organic content (up to two-thirds). In Delhi (India), public authorities are trying to replicate solutions developed by the global North countries (incineration, composting units), but with limited success. Finally, the case of Surabaya (Indonesia) serves as quite a good example of social, community-based, multi-scale and multi-technology innovations that global South cities could seek to develop.

This report provides a synthesis of these different case studies, cross-comparing the analyses, observations and recommendations. The first chapter presents the conceptual and theoretical framework for the paradigm shift that has been happening in recent decades regarding solid waste management in the global South. It also presents the methodology used to characterise the innovations studied and the case studies developed. The second chapter focuses on materials recycling, the most visible activity, and highlights the role played by informal actors. It aims to analyse the socio-technical mechanisms at work in successful materials recycling. The third chapter considers the different valorisation technologies, particularly those used for organic waste, which accounts for the bulk of the waste stock and has very diverse possibilities for valorisation (for agriculture or waste-to-energy). Chapter four unravels the costs and financing of waste management and valorisation. This economic analysis made it possible to relativize the cost burden of each operation in a context where actors are particularly cash-strapped. The last chapter revisits the notion of the public waste service itself and analyses its institutional, technical and spatial reconfiguration in light of the insights gained from prior experiences. It thus foregrounds the need for a context-specific service, a fresh approach to low-tech activities and a commons-based approach.

Chapter 1. Waste valorisation: a paradigm shift for countries in the global South

Spanning international models and solutions specific to global South countries, solid waste management is underpinned by a wide variety of logics presented here. This chapter offers an overview of the current situation.

I. In the global South, a gradual exit from mimetic and maladapted schemes

Can SWM methods in global North countries be used to understand this sector in global South countries? Nothing could be less sure. In cities in the global South, disposal in dumpsites is the usual official SWM practice. More importantly, given the large socio-economic inequalities, waste turns out to be a two-sided coin: rubbish for some and a resource for others (Bertolini, 1992). Applied to urban societies, the very notion of waste can in fact become blurred: is it what city dwellers throw away? Or what no one recovers? Moreover, the recycling sector has always been active, but it operates informally in health and hygiene conditions that leave much to be desired. The challenge is thus to align these two logics.

1. A mounting problem

The most recent and comprehensive overview of the volume of generated waste was published in 2018 by the World Bank. Today, planetwide, three billion citizens generate over 2 billion tonnes of waste each year (Kaza et al., 2018). Since 2004, China has become the world's leading generator of urban waste. And since 2011, the 34 member states of the Organisation for Economic Co-operation and Development (OECD), the so-called global North countries, have generated less than half (44%) of estimated global waste (World Bank, 2012).

However, the effect of numbers hides the difference in waste generation according to the level of economic development. To complete the picture, the ratio of municipal waste generated per capita must be factored in: this is 2 kg/day in the United States and 0.4 kg/day in India (Chalmin & Gaillochet, 2009, p.11). This difference would suggest that the emerging countries are far from having achieved their full waste generation potential. Given that most demographic and urban growth is very likely to be in the global South, the volume of urban waste could rise to 2.2 billion tonnes by 2025, generated by 4.3 billion city dwellers worldwide (World Bank, 2012). This would represent an increase of more than 70% of municipal waste over fifteen years.[1]

[1] The UN-Habitat Report 2010 is more pessimistic, projecting total waste generation at between 2.4 and 5.9 billion tonnes by 2025, which is up to four and a half times the current level (UN-Habitat, 2010, p.13).

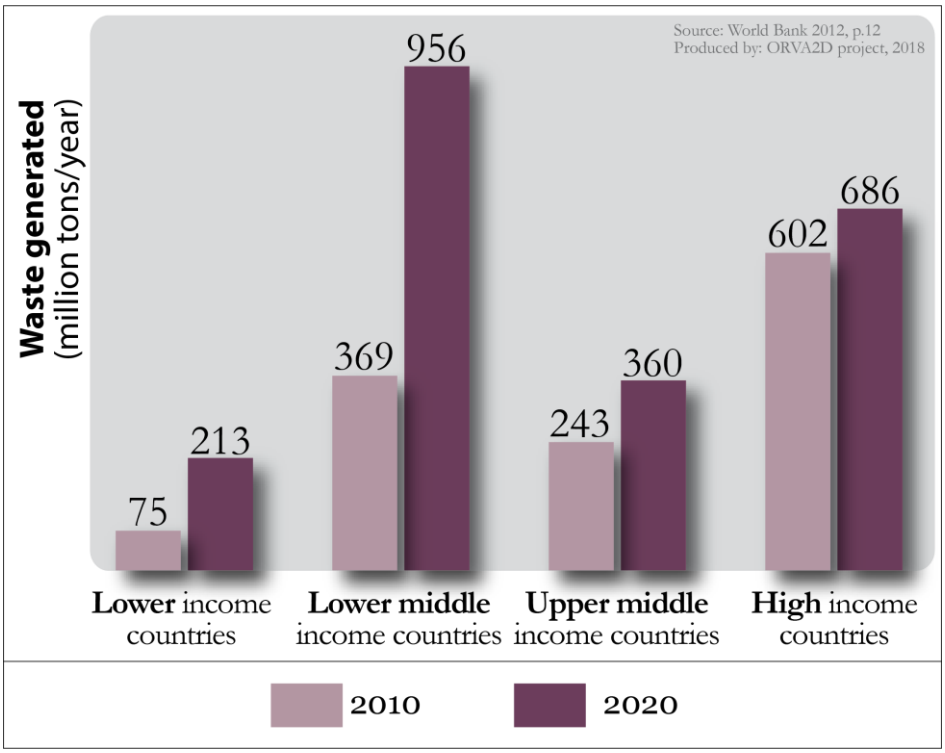


Figure 1. Urban waste generation by country income level in 2010 and 2025 (projected)

From 2010 to 2025, most of the increase in daily waste generation is set to come from the global South countries. Following the World Bank's typology, lower middle income[1] and upper middle income[2] countries will be responsible for 76% of this rise (World Bank, 2012). According to the same study, the annual cost of municipal solid waste management will increase from today's US$205 billion to US$375 billion by 2025. For this reason, urban SWM in global South cities has been identified as one of the priority action areas for public policy until 2030 (OECD, 2008). The World Bank even warns of a "disaster in the making" by 2025 and puts out an urgent call to reverse the trend (World Bank, 2012).

2. In the global South, a different composition of waste

Household waste in the global South also differs in quality from that in the global North. Firstly, in the South, waste is generated in lower quantities than in the North.

[1] Including India, Indonesia (and China).
[2] Including Brazil (and Russia, South Africa, Mexico, Turkey, etc.).

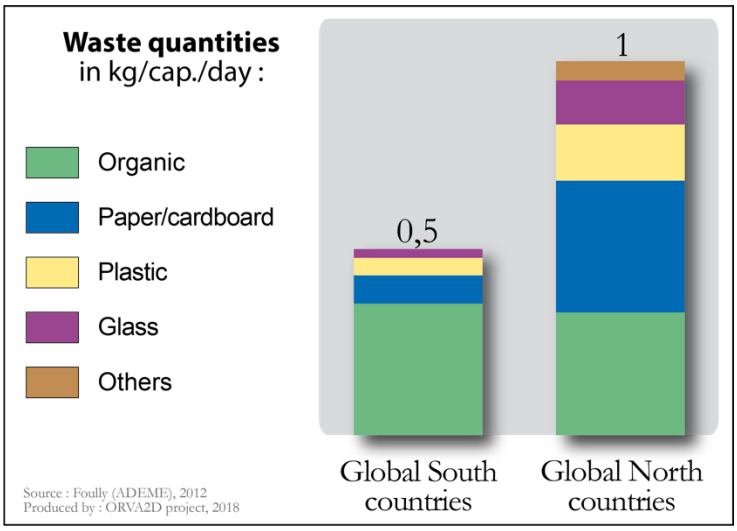


Figure 2. Average waste generation per capita per day

Furthermore, waste composition in the cities of developing countries is characterised by a much larger share of organic waste: this represents 56 to 64% in middle- and low-income countries compared to 28% in high-income countries (cf. Figure 3). Inert waste[1] also accounts for a high percentage of waste. Symmetrically, the share of recyclable materials (packaging) is much lower than in the rich countries.

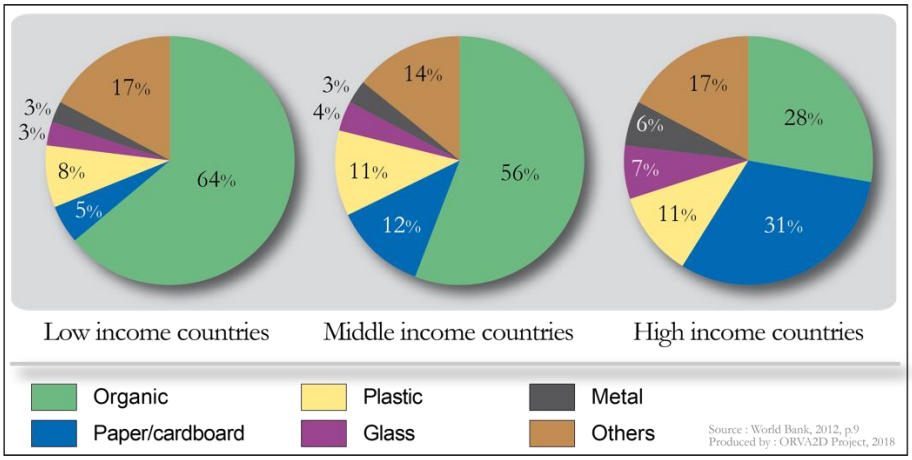


Figure 3. Household waste composition by country income level

In high-income countries, household waste is also less moist, less dense and has a higher calorific value (Foully, 2009, p.6).

[1] Inert waste does not decompose or burn and produces no physical or chemical reaction. Neither does it cause any deterioration to other materials with which it comes into contact, pollute the environment or harm human health. E.g., mineral waste produced by demolition or construction (concrete, tiles, bricks, sand, etc.) .

	Density	Moisture content	Calorific value *Kcal/kg*
Low-income countries	0.6	65%	950
Middle-income countries	0.4	50%	1,200
High-income countries	0.1	25%	2,100
Sources:	Foully 2009, p.6	Chalmin & Gaillochet, 2009, p.12	

Table 1. Characteristics of municipal waste by country level of income

Given the differences in the quantity and quality of waste, it seems logical that the management techniques (transport, treatment) also differ.

3. Inadequate management services juxtaposed with a resilient informal sector

Waste management, the poor relation of urban services

In line with regulations, the municipal authorities are responsible for ensuring the cleanliness of urban spaces through street-cleaning and waste collection. However, if we were to choose just one characteristic to describe urban cleanliness in global South cities, it would certainly be the lack of financial and material resources, or even the lack of interest or investment on the part of the local authorities.

The term “solid waste management” (SWM) appeared in the late 1980s. Before this, cities referred rather to “urban cleanliness”, which involved simply piling together the refuse from street-cleaning and household waste in order to “remove them from the city” (Miras (de) & Dorier-Apprill, 2002, p.27). The most important concern was to remove this filth away from the urban space, and no one worried what became of it. The rubbish was simply thrown onto wasteland or into gullies close to the city. This facile solution was seldom viewed as overly problematic until the late 1980s.

Contrasting with the scant attention paid to waste during the 1980s and 1990s, the sector now weighs heavily on municipal budgets but produces only mediocre results: 20 to 50% of local public expenditure (Cointreau-Levine, 1994) and for West African cities, 12 to 73% of local budgets (Folléa et al., 2001). As no treatment is planned and waste is tipped on wild dumpsites, these expenditures correspond exclusively to organising waste collection and transport. Despite this, only 50 to 70% of waste is collected by the municipal service (Cointreau-Levine, 1994). This situation gives some idea of the upcoming upheaval: the service is already costly, even though it is barely effective and includes no costs linked to the downstream end of the management chain.

A 100% technical approach, disposal and mimetism: What a waste!

In the early 1990s, while a “new philosophy of resource management is beginning to transform solid waste management” (Furedy, 1992, p.42) in global North countries, the main focus in the global South countries was still on improving engineering systems. Management approaches relied on centralised and capital-intensive systems (Furedy, 1995; Medina, 2005b) deployed in a top-down logic (Baud & Post, 2004) and justified by the idea that waste management could benefit from economies of scale (Bartone, 1995). This strategic choice went hand in hand with

the arrival of private actors supposedly more capable than public administrations of mastering the technologies involved (Bartone et al., 1991; Cointreau-Levine, 1994).

In cities in developing countries, public officials have often dreamt of adopting management technologies used by the industrialised countries. And private actors in the global North have employed seductive tactics to sell their technology products to local authorities in the South. Yet, the temptation to apply environmental engineering schemes in a context of deep poverty gave rise to difficulties. The idea spread that all waste could be eliminated by sophisticated disposal methods, whilst also earning money: "since no monies are available for disposal, proposals for sophisticated resource recovery systems that 'turn garbage into gold' are very attractive to local politicians" (Cointreau-Levine, 1982, p.60).

These mimetic approaches have created countless "white elephants" (Bertolini & Brakez, 2008; Medina, 2005a): the implementation of supposedly revolutionary collection or disposal technologies imported at great cost, inaugurated with great ceremony but which ended up as resounding fiascos. Examples of this include the incinerator built in Delhi in 1984 with assistance from Danish cooperation (UN-Habitat, 2010, p.114), which failed to function on account of the high moisture content of the city's household waste; more than 150 raw waste composting units producing unusable compost (Foully, 2012), seven composting facilities built in Morocco, dozens of sorting and composting plants built in Brazil (Eigenheer et al., 2005), and the 'Doña Juana' sanitary landfill built in 1989 in Bogotá (Colombia), which in 1997 gave rise to a massive landslide of nearly a million tonnes of waste. The list is long… To reprise the title of the World Bank's report: "What a Waste!".

The crucial factoring-in of social and spatial realities

The perception of waste varies depending on the socio-economic context and the socio-spatial functioning of the areas concerned. In addition to social inequalities, urban environments in the global South are strongly influenced by "informal" – or lower-class – living conditions and economic activity. The informal sector not only undergirds the permanency of "traditional" economies but also contributes to the contemporary liberal economic system (Chen, 2007) and forms the basis of the overall economy: most informal workers and enterprises produce or distribute legal goods and services. At the same time, local authorities encounter huge difficulties in managing rampant urbanisation. Precarious settlements account for most of the urban fabric in emerging metropolitan areas and, by 2030, the number of people living in such neighbourhoods is set to reach two billion, equivalent to two out of five city dwellers (Deboulet, 2016).

Given the different forms of urban space in the global South, the *process* of transforming "residual" objects differs from that in the global North. In many urban neighbourhoods, rubbish is deposited in a skip container located on the perimeter of a block of houses. This urban spatial feature leads to the distinction between primary and secondary collection:

- Primary collection takes place inside the neighbourhood, from door to door, along narrow winding streets.
- Secondary collection is outside the neighbourhood, via communal collection points along the main roads.

In this type of organisation, the neighbourhood serves as a kind of sluice upstream of final disposal. Both inside and on the edges of the neighbourhood, such intermediation means that the removal of waste materials is short-circuited by informal recovery channels,.

Alternative schemes to recover resources from refuse

Municipal authorities tend to allocate their limited resources to privately operated waste services serving affluent districts (Zurbrügg, 2002). There is a strong temptation to create enclaves free from the surrounding constraints, with standards close to those in rich countries. Yet, transposing intervention modes specific to industrialised countries does not work, or only works for a minority of the urban population, in an “”all-or-nothing’ logic” (Bertolini & Brakez, 1997).

As a result, refuse proliferates in the city’s other neighbourhoods (Mérino, 2002). To compensate for the shortcomings of the municipal service, primary collection services have sprung up: small operators (community-based, associative akin to economic interest groupings [EIGs] or even private) collect household waste and deposit it at intermediate transfer points. These “non-conventional options” (Furedy, 1992) solve the problem of collecting rubbish in narrow streets inaccessible to collection trucks, require simple equipment and create jobs (Zurbrügg, 2002).

Yet, coordinating these practices (technically and financially) with the municipal service downstream is often problematic (Zurbrügg, 2002). In fact, although citizens are willing to pay to have their immediate environment cleaned, once the refuse has been removed, they no longer feel concerned, and are thus little inclined to pay for the downstream management chain.

The informal recovery sector: omnipresent yet little known

In cities in Africa, Asia and Latin America, the “resource” potential of refuse has long been recognised by the population. Most urban households in the global South rigorously sort their refuse daily: “yet the majority of households and enterprises...do not discard all their unwanted materials as garbage” (Furedy, 1995, p.90). Unlike in global North countries, waste-sorting is directly motivated by the market value of recyclable materials.

Present in all cities throughout the global South, the informal sector is defined as follows:

“individuals, families, and private sector (micro-)enterprises working in waste management services and valorisation, whose activities are neither organised, sponsored, financed, contracted, recognised, managed, taxed, nor reported upon by the formal solid waste authorities” (Scheinberg, Simpson, Gupt et al., 2010).

The two basic features characterising this sector of activity: on the one hand, the recognition of waste as a resource and, on the other hand, the social stigma it carries (Nas & Jaffe, 2004). Its most emblematic figure is that of the wastepickers, also referred to as scavengers, ragpickers*, chiffonniers, biffins, catadores, pepenadores, cartoneros, buscabotes, traperos, basuriegos, chatarreros, frasqueros, segregadores*, etc.

Wastepickers everywhere find themselves on the lowest rungs of the social ladder (Baud et al., 2001) and likened to the rubbish they search through for materials of some value. Not only are they exploited by the local traders to whom they sell their booty, but they – men and *women* alike – work and often live in extremely precarious conditions that have been depicted most vividly by various anthropological accounts (Camacho, 1986; Harpet, 2001) and documentary films (Coutinho, 1993; Nelson, 1977; Prado, 2004; Walker, 2009). Although the informal recovery sector is marginal on several counts – notably socially and geographically – it is nonetheless economically and physically of considerable size. According to recent estimates, 1% of the world’s urban population works in the informal waste recovery and recycling sector

(UN-Habitat, 2010).[1] Yet, paradoxically: “the recycling economy is both omnipresent and little known” (Coing & Montaño, 1985, p.64).

A typology of informal recovery actors can be established according to the stage at which they intervene in the waste stream (Medina, 2005a; Scheinberg et al., 2011). We can list the following:

- *itinerant buyers* who buy recyclables already separated out by residents,
- *street-pickers* who rummage through residents’ dustbins and discarded waste to find materials that they can sell on,
- *dump-pickers* who operate at the final disposal site, often located on the city outskirts, and sift through the mountain of waste when the trucks arrive,
- *local traders* who buy recyclables from residents who come to their shops, and from all of the above actors. The actors who buy from these traders (recyclers or wholesalers) very often run registered businesses.

The attitude of the municipal authorities towards informal sector actors – particularly wastepickers – varies with the context but is generally unfavourable. A four-category typology can be identified here: turning a blind eye, repression, collusion and integration. The last category, which was the least commonly found in the early 2000s, involves situations where municipal authorities recognise the wastepickers’ work and give them a place in the municipal management scheme. Integration is often found in cases where wastepickers have self-organised collectively, often by setting up cooperatives as in Colombia, Brazil, the Philippines, Indonesia, Mexico and India (Bernstein, 2004). However, in most cases, the authorities turn a blind eye to informal sector actors or repress them. Finally, there are also examples of collusion between the authorities and collectors based on a clientelist relationship: dump-pickers sometimes have to pay a fee to the municipal agents in charge of a disposal site.

[1] The estimate in the World Bank’s most recent report concurs that formal and informal solid waste management represents from 1 to 5% of the worldwide urban employment (World Bank, 2012, p.1).

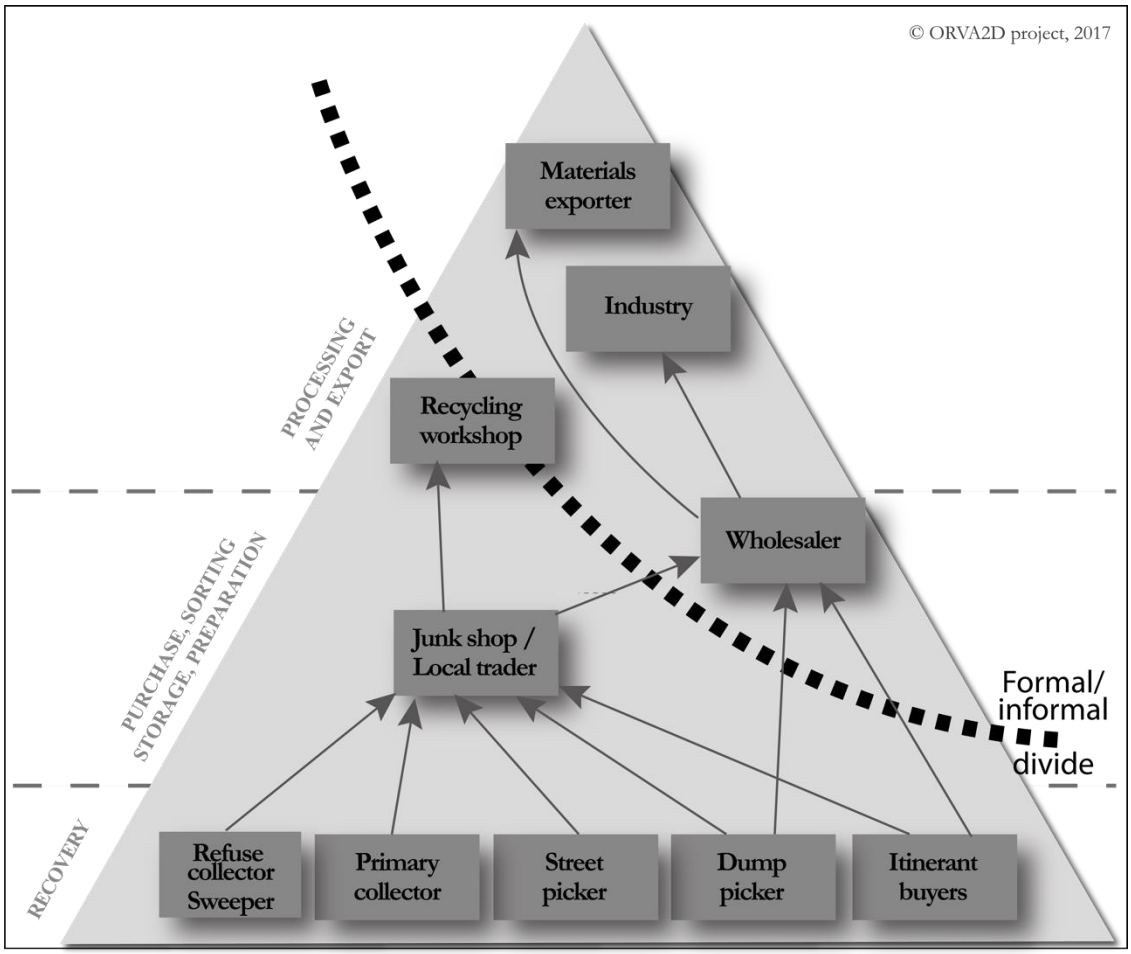


Figure 4. Actors in informal waste management

Informal systems almost always seem “archaic” to politicians in global South cities, as they aspire to a “modernisation” of urban services. However, as the urban planners H. Coing and I. Montaño pointed out in 1985: “We can never give enough thought to the incredible economic efficiency of ‘informal’ collection systems given the repeated failure of the heavy investment in sorting facilities and, on the other hand, to the current huge disparities between urban social groups regarding the level of service offered to them” (Coing & Montaño 1985, p.82).

4. The cognitive shift of the mid-1990s

Municipal SWM methods in the global South changed profoundly towards the end of the 1990s. This change in public policy direction materialised in the design of a new conceptual framework: Integrated Sustainable Waste Management (ISWM). This concept, developed in the late 1990s by the Dutch NGO WASTE[1] (Klundert (van de) & Anschütz, 2001), posited that waste management did not boil down to a purely technical issue and that it was necessary to include not only all of the stakeholders, but also contextual parameters that impact the

[1] http://www.waste.nl

sustainability of the system: the socio-cultural, environmental, institutional, economic-financial and political aspects. This systemic framework emphasises the interdependencies between the different dimensions.

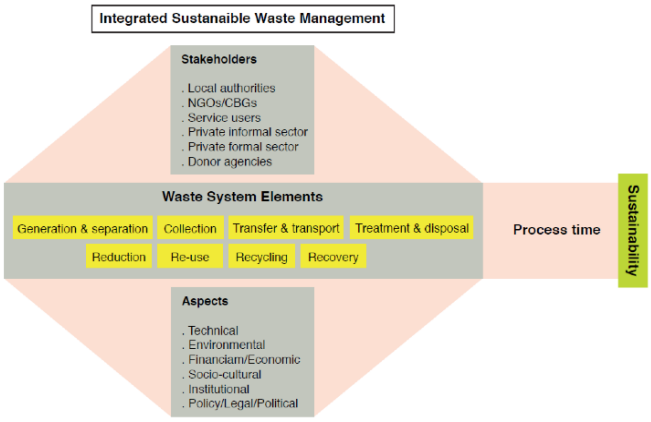


Figure 5. The Integrated Sustainable Waste Management Model

(Source: Klundert (van de) & Anschütz, 2001)

Tragedies herald the demise of wild dumpsites

In the global South, economic growth, longer production-consumption chains and changing consumption patterns have fuelled an increase in the generation of waste,[1] so much so that it can no longer disintegrate in the natural environment. When environmental issues appeared on the international agenda, notably at the 1992 Earth Summit in Rio, and the Agenda 21[2] methodology emerged, waste experts began to fundamentally reconsider this service. A cognitive change, sometimes referred to as a "global turning point" (Ta, 1998, p.11), came about.

From an ecological viewpoint, the dumping of ever-increasing volumes of waste on unclaimed land was no longer acceptable, especially as cities were growing and expanding rapidly everywhere in the global South. As a result, residential neighbourhoods have mushroomed around these dumpsites. An informal economy was proliferating on waste dumps, where men, women and children eked out their living in extremely vulnerable conditions. Tragedies occurred due to spontaneous dumpsite fires, mounds of refuse collapsing onto dwellings, neighbourhoods destroyed by earthquakes or suddenly submerged by torrential rains falling on land already saturated by rubbish.[3] These urban peripheries were becoming a source of shame and fear.

Attention then turned to the downstream end of the management chain: waste disposal, which was still "one of the absolutely necessary but consistently underinvested services" (Batley,

[1] In Brazil, from 1992 to 2000, the population grew by 16% and household waste generation by 49%, i.e., three times faster (Ribeiro & Besen, 2007).

[2] Agenda 21 is a process whereby an organisation, in partnership with its stakeholders, prepares, implements and evaluates an action plan that responds to the sustainable development challenges of the 21st century as defined by the Rio Earth Summit in 1992.

[3] Cf. The case of favelas brutally devastated by a landslide in Niteroi, Brazil, in March 2010.

1996, p.741). As uncontrolled dumpsites were the cause of these problems, it was gradually recommended that they be banned. In their place, sanitary landfill facilities (SL) made their appearance. The Clean Development Mechanism (CDM),[1] set up under the Kyoto Protocol was to act as a catalyst (Cavé, 2018): as from 2005, this opened up access to financing for the operation of sanitary landfills insofar as these facilities could prevent the release of biogas into the atmosphere (by recovering it or, more often, simply flaring it).

As a result, controlled landfill sites became the "bucket at the end of the solid waste management chain" (World Bank, 2008), the only adequate final destination (IETC, 2005; Johannessen & Boyer, 1999), the indispensable final disposal solution or "sink" for part of the waste stock.

Reconfiguring the service from downstream to upstream

Whereas wild dumpsites incur no economic cost and controlled dumpsites are relatively cheap for public authorities, sanitary landfills come at a high cost: a vast tract of land has to be acquired and investment found to build the infrastructure, then substantial funds are needed to operate it. This means that the priority now set on landfilling as a final "sink" leads to the construction of heavy infrastructure in a sector where the bulk of expenditure had previously been on operations (wages and fuel). The prohibition of dumpsites thus revealed the real cost of the service.

This financial constraint, along with the difficulty of siting a huge sanitary landfill in an urban setting (cf. Carré, 2010), has led public authorities to take a fresh look at the options of recycling and recovery. To minimise the cost that landfills now incur and extend the useful life of final disposal facilities, a new strategy has seen the light of day: diverting the largest possible fraction of the waste stream into differentiated channels for waste recovery and recycling.

"Cities and towns want to recycle because it keeps the waste out of their newly upgraded disposal facilities. This *diversion* has a value to the entire waste system. Modern recycling serves the entire waste management system by becoming a 'sink'." (UN-Habitat, 2010, p.126).

This emphasis on recovering solid waste, not so much as a treatment method but as a way of reducing the waste streams destined for landfill, is a radical change. Previously, public authorities had simply removed what had been deposited in communal containers or left lying in the street – in other words, *rubbish*, a pile of randomly mixed refuse. Now, municipal authorities are beginning to target differentiated waste streams: organics, recyclables, non-recoverable refuse, etc. This implies capturing household-generated wastes at the earliest possible stage, at source, before the wastes are mixed, contaminated and become impossible to valorise (Scheinberg, Simpson, Gupt et *al.*, 2010). In some countries, this rationale has led to household waste-sorting and selective door-to-door collection, most often separating out wet and dry wastes (Furedy, 1995).

5. The 2000s: the crowding-out and mobilisation of wastepickers

The reconfiguration of the service was unanimously hailed as a "modernisation" of solid waste management (cf. Debout, Jaglin, Salenson, ed., 2018). This is defined as the re-design of the entire service as dumpsites were being replaced by landfills as final sinks. In other words, it

[1] An international institutional mechanism that allows industrialised countries with targets specified under the Kyoto Protocol to invest in emissions reductions in developing countries and account these reductions in their own legal commitments. A CDM project is issued with certified emissions reductions, which can then be traded.

was no longer waste collection that shaped the entire management chain, but the downstream stages (controlled disposal) that were likely to impact the choices of upstream waste management.

Crowding out informal actors

On the fringes of official management schemes, informal actors continue their recovery and recycling activities. This often brings them into competition with private formal operators when these are remunerated on a pro rata basis for tonnage collected: "The process of modernisation often creates competition between formal authorities and informal enterprises for materials" (Scheinberg, Simpson, Gupt et al., 2010, p.8).

The case of Cairo is well-known for its traditional system whereby waste is collected and valorised by individuals mainly from the Copt minority: the Zabbaleen. This community provides a door-to-door collection and recycling service in return for a fee paid by residents using the service. Unlike typical wastepickers, the Zabbaleen take the view that they are providing a service. These agents of the popular economy valorise from 80 to 85% of the streams they collect (Debout & Florin, 2011; Florin, 2010b). A specific feature of their activity is that they also valorise organic waste for swine feed. They sort and recycle waste in districts close to the city centre where they live and work full time in this business. In the early 2000s, the Egyptian authorities decided to modernise urban waste management in Cairo and Alexandria. To do so, they put out an international tender and contracted several large foreign and Egyptian firms. For the Zabbaleen, the arrival of these new players jeopardised their source of income. They risked being crowded out by formal operators, whose recovery target set by the city authorities amounted to a paltry 20% of the waste stream (Florin, 2010a). This situation proved problematic as the residents often found themselves paying twice over: on the one hand, a fee to the Zabbaleen for their continuing door-to-door collection and, on the other, a collection charge paid to the municipal service (Fahmi & Sutton, 2010). The firms' strategies vis-à-vis the Zabbaleen varied. Some firms excluded them without any discussion, whereas others tried to integrate them as sub-contractors. The Zabbaleen found it difficult to defend their cause mainly because their internal political organisation was weak.

From "skimming" to conflict

These crowding-out effects, however, stemmed less from private-sector participation than from the "modernisation" of the global South's solid waste management sector.

At first, these informal recovery actors performed upstream "*skimming"* (Bertolini, Foully, & Morvan, 1999): they extracted the most lucrative items from the waste, leaving behind a stream largely depleted of the most easily recoverable materials. Gradually, however, their activities expanded. From 2010, several reports confirm the existence of conflicts: in addition to the emblematic case of Cairo's "contested" wastes (Fahmi & Sutton, 2010), conflicts also emerged as an almost "hidden" (Coffey & Coad, 2010, p.127) or "potential" phenomenon (Gerdes & Gunsilius, 2010, p.25).

This context prompted the wastepickers to organise themselves on an international scale as of the mid-2000s. Despite an obvious lack of resources, Latin American wastepickers triggered this dynamic based on the principle that: "just like the exploiters have overcome transnational

borders, we, wastepickers, too, won't have borders in our struggle."[1] The wastepickers received substantial support[2] and their mobilisation came to a head in 2008 with the first world wastepickers conference held in Bogotá. Currently, national wastepickers' alliances exist in many countries (13 Latin-American countries, Kenya, South Africa, India, etc.) and the movement's representatives attend many international conferences.

Mobilisation of experts supporting the integration of wastepickers

Little by little, the perception of wastepickers changed. During the 2000s, a consensus gradually emerged unanimously advocating the integration of wastepickers as part of the reconfiguration of the waste management sector (Baud et al., 2001; Bernstein, 2004; Forsyth, 2005; Wilson et al., 2006; Scheinberg & Anschütz, 2006; Bertolini & Brakez, 2008; Sharholy et al., 2008; Gupta, 2012). In fact, it seemed absurd to exclude informal recovery actors, especially in cases where the municipal system comprised just one landfill site and no form of treatment:

"It would seem ironic to move forward by deliberately eliminating what can be a rather efficient, existing recycling system" (Wilson et al., 2006, p. 798).

Gradually, wastepickers come to be described as economic agents (Scheinberg & Anschütz, 2006), waste management professionals (Scheinberg, Anschütz, & Klundert (van de), 2006) and even global "cooling agents" (Chintan,[3] 2009). The integration of wastepickers is presented as offering three types of advantages (Gerdes & Gunsilius, 2010), with labour conditions often serving as the starting point:

i. Formalisation helps to improve their work conditions and guarantee their social inclusion and protection.
ii. From the environmental viewpoint, wastepickers achieve high recycling rates thanks to their specific practical know-how and, clearly, because their livelihoods depend on it.
iii. From an economic perspective, the sector creates jobs and strengthens the country's industrial fabric.

2010 saw the publication of three important institutional reports that made quite a significant contribution to thinking on the reconfiguration of municipal SWM services in cities in the global South.

The UN-Habitat report on managing solid waste in the world's cities (2010)

The report published by UN-Habitat in 2010 is the most complete and consistent study to date.[4] Based on a study of twenty variously sized cities across the world, its analysis uses the dual prism of physical elements and governance, in line with the ISWM concept.

[1] http://globalrec.org
[2] Notably Avina Foundation, Association France Libertés, the Women in Informal Employment network, Globalizing and Organizing (WIEGO), Participatory Sustainable Waste Management programme and the NGO Global Alliance for Incinerator Alternatives (GAIA).
[3] http://www.chintan-india.org/
[4] UN-Habitat(2010) Solid Waste Management in the World's Cities, London: United Nations Human Settlements Programme, 228 p.

The report relies on and deepens the ISWM framework. The authors present solid waste management as two overlapping triangles:

- The first triangle comprises the physical elements:
  - public health, linked to the quality of the solid waste collection service,
  - protection of the environment, linked to disposal (pollution of soil, water, air),
  - resource management, linked to waste valorisation (reduce, re-use, recycle).
- The second triangle shows the governance features:
  - inclusivity (of all service users *and* providers),
  - financial sustainability (how can waste valorisation be made cost-effective?),
  - sound institutions that produce pro-active policies.

Figure 6. The two triangles of the UN-Habitat 2010 report

(Source: GIZ 2013, p.13)

The report takes a systemic approach to flows. Its methodology furnishes a comprehensive view of waste streams and supports a discourse on the avoided costs of disposal and the value of valorisation systems.

The major contribution of this study is that it is not limited to covering official public services, but addresses all of the waste management and recovery channels. For this, the main method used relies on process-flow diagrams (PFDs) (cf. Figure 7). [1]

Initially used to highlight the continuum between formal and informal sectors, "both intricately connected and in constant flux" (UN-Habitat, 2010, p.32), the PFDs show comprehensively and concisely all of the materials flows at the level of a city ("the system as a whole"). The picture becomes clearer: "the two sectors cannot be truly considered to be separate systems, but rather intertwined sub-parts of one large citywide waste and materials recovery system". (Scheinberg et al., 2011, p.195).

[1] Other examples of PFDs are given on pp.34-35 of the same report, and on pp.129-134 of the 2010 GIZ report.

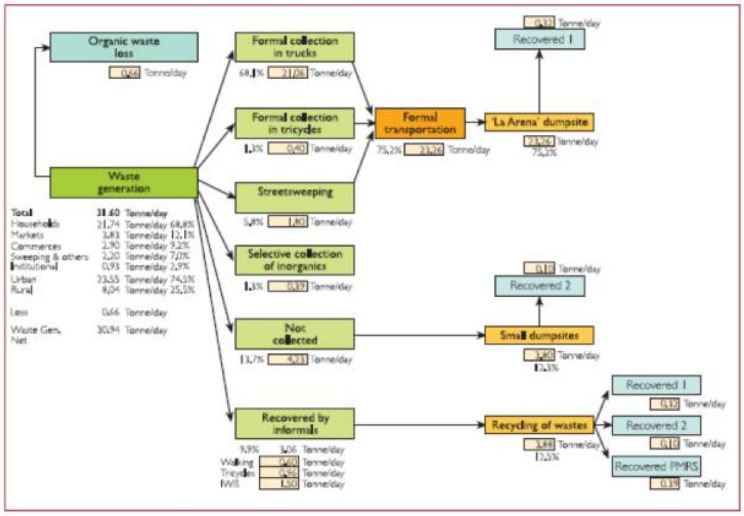


Figure 3.1
Process flow diagram for Cañete, Peru
Source: presentation for Cañete, Peru. IPES, Lima, Peru

Figure 7. Process Flow Diagram for Cañete (Peru)

(Source: UN Habitat 2010, pp.33)

According to the authors, recycling is a poorly understood phenomenon that in reality has two "faces":

- **A "commodities value" face:** the activity is driven by the intrinsic economic value of the waste materials.
- **A "service" face**, which is a relatively recent phenomenon. In fact, although municipal recycling is certainly driven by the commercial value of the waste materials, it is driven much more by a vision of the recycling chain as a "sink".[1] As cities in the global South consolidate their landfilling facility, they are gradually becoming aware of the interest of the economic savings generated by recycling.

As far as financial sustainability is concerned, the authors estimate that the bulk of the most valuable materials (15-20% of the waste stock: non-ferrous metals, high-grade paper, PET plastics) have *already* been recycled by the informal sector. A further 20-60% of the waste stock (glass, steel, rubber, plastics, low-grade paper, even organics) can be technically valorised, but the cost of their recovery would exceed their market value. Thus, if the authorities wish to recover more waste, incentives are needed: subsidies, stimulation of demand, raising tipping fees, etc. From this new perspective, valorisation practices become attractive if their *cost* is lower than the cost of landfilling. This is quite different from the idea that valorisation must be a profitable activity in itself.

The GTZ study on informal sector integration in Brazil-Egypt-India (2010)

The study commissioned by the German Technical Cooperation Agency (GTZ) presents experiences in three countries – Egypt, India and Brazil – where, in some cities, the informal

[1] "Sinks work by breaking down complex substances into simple elements" (UN-Habitat 2010, p.126).

sector has been integrated into the SWM sector.[1] It aims to identify the success factors for integrating informal sector actors into SWM systems.

The main finding of this comparative study lies in the growing awareness that integrating the informal sector "requires a minimum of official recognition and organization of wastepickers" (Gerdes, Gunsilius 2010, p.14). Four key conditions for integration are foregrounded:

1. Voice: the availability of studies and data that support the informal sector's cause vis-à-vis institutional interlocutors (role of NGOs and the media),
2. Visibility: support from state authorities to ensure adequate legal structures,
3. Validity: the formal recognition of informal sector workers (wastepickers),
4. Viability: the preservation of their economic autonomy.

The authors of the report draw attention to the fact that organising the sector could result in the arrival of autonomous wastepickers who do not operate within collective organisations and thus impact the profitability of the recycling schemes set up:

"Support activities must bear in mind that a far greater number of people will continue to intervene in a non-organised manner and might even constitute competitors to newly organized informal sector actors in searching for recyclable materials…But even when cooperatives carry out collection services, they cannot be sure that individual informal sector workers will not sort out valuable material before the collection teams pass by" (Gerdes, Gunsilius 2010, p.25).

To resolve this unwelcome rivalry, the authors suggest regulating the prices paid by the recycling cooperatives and setting stricter rules for the intermediary recycling centres considered to be "irregular" (Gerdes, Gunsilius 2010, p.23).

The authors have clearly identified the "source of potential conflict" (Gerdes, Gunsilius 2010, p.25) between formal and informal actors when services are privatised. They draw attention to the issue of how contracts are formulated:

"Where a formal enterprise is not paid according to the quantity disposed and is not interested in recycling, the interventions of the informal sector are also beneficial to formal collection enterprises because they reduce the quantity of waste to be transported and thus reduce transport costs" (Gerdes, Gunsilius 2010, p.26).

GIZ-CWG study on the economic dimensions of the informal sector (2010)

The objective of this study is to understand and quantify the overall activity of the informal sector in six major cities in the global South: Cairo (Egypt), Cluj (Romania), Lima (Peru), Lusaka (Zambia), Pune (India) et Quezon City (Philippines).[2]

The authors of the report seek to provide objective data on quantities and costs. They raise the following questions: does the informal recycling sector represent a profit or cost for the authorities? What would the impact be if it was prohibited/integrated? To answer this, they

[1] GTZ (2010) The Waste Experts: Enabling Conditions for Informal Sector Integration in Solid Waste Management. Lessons learned from Brazil, Egypt and India. Eschborn: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

[2] WASTE & SKAT (2010) Economic Aspects of the Informal Sector in Solid Waste, GTZ (German Technical Cooperation), Eschborn, Germany, 134 p.

compare the quantities of waste recycled by the formal and informal sectors, as well as their costs.

The formal sector focuses primarily on providing a service and only achieves low recycling rates. The informal sector, on the other hand, focuses mainly on recovery and recycling activities and proves successful. The organic fraction of household waste accounts for over 45% of the waste stock in the six reference cities – the type of waste that offers the best opportunity for diversion!

Moreover, the materials recovery ensured by the informal sectors brings indirect economic benefits. The authors distinguish between the economics of transport, landfill capacity and the operation of landfill facilities. On the basis of the costs and revenues specific to each sector, the authors propose two scenarios: one where the informal sector is marginalised, the other where it is recognised and integrated. They conclude that the second case would help to reduce costs for the formal sector, while also increasing the revenues of the informal sector.

The analysis conducted in the study shows that the SWM sector consumes up to 15% of municipal expenditure, which is considerably less than the estimates that had previously prevailed. In addition, whereas the official service tends to focus on waste removal and obtains low recovery rates, the informal sector mainly focuses on recovery activities and, despite substantial costs, proves to be financially viable.

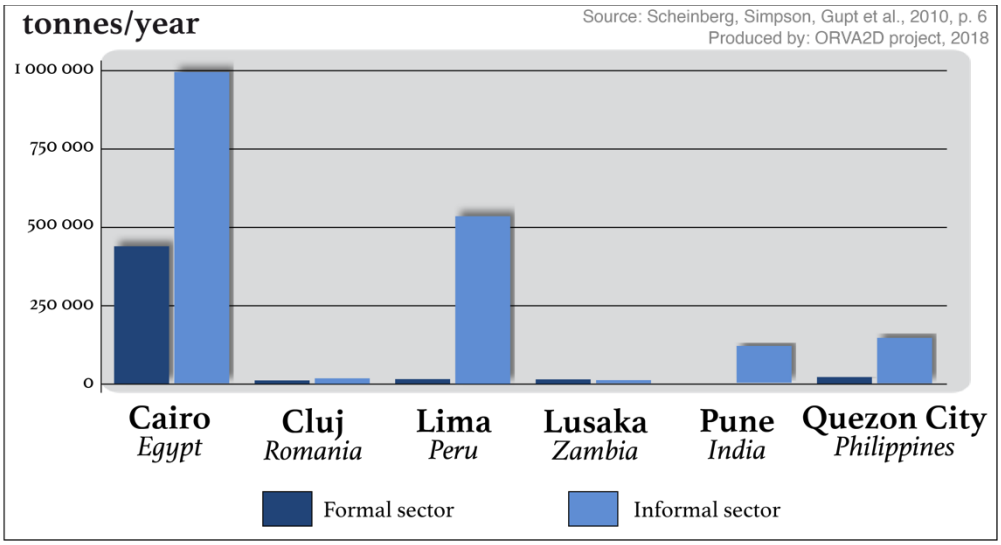


Figure 8. Comparison of material recovery by the formal and informal sectors in six of the world's cities

(Source: Scheinberg, Simpson, Gupt et *al.*, 2010*)*

As the above bar chart shows, in the six cities studied, the informal materials recovery sector handles a much larger quantity of recyclable waste than the formal sector's recovery service.

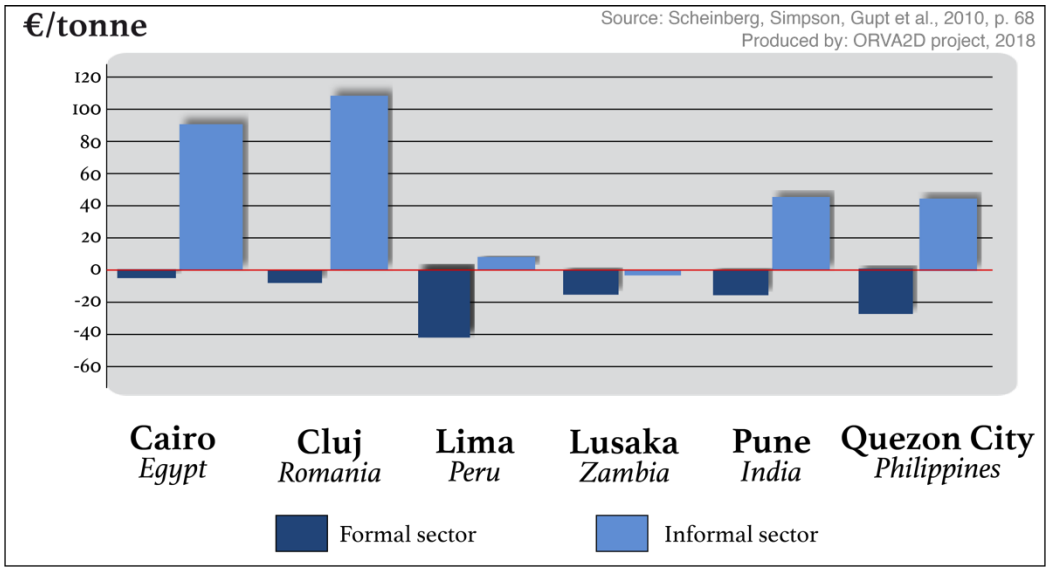


Figure 9. Comparison of net revenue (revenue - costs) of the formal and informal sectors in six cities of the world

(*Source:* Scheinberg, Simpson, Gupt et *al.,* 2010)

As the above bar chart shows, in five of the six cities studied, the informal waste recovery sector is profitable, whereas the formal-sector waste recovery service represents a cost for the local authority.

This study is complemented by the UN-Habitat report published in 2010. In the light of the report's twenty case studies, it appears that informal waste recyclers divert 15–20% (in weight) of the city's recyclables. In doing so, they save the municipal authorities some 20% of their waste management budget:

"In fact, the informal sector may already be removing and recovering as much as 20 per cent of the waste at no cost to the local authority… [whereas] formal systems have a high cost per tonne, associated with overcapitalization, the small volumes recovered, and most likely poor marketing performance associated with inexperience in valorizing recyclables" (UN-Habitat, 2010, p. 131).

The lack of a critical view on landfill sites

Surprisingly, these reports say nothing about the performance of existing disposal facilities. Landfilling, however, presents three drawbacks (ENDA, 2014):

i) It is costly in terms of avoidable collection.

ii) It is costly in terms of acquiring land and operating the site.

iii) It represents an opportunity cost since a large fraction of landfilled waste could have been valorised.

More importantly, the main reports found in the grey literature fail to mention the problems of treating leachates, which can nonetheless cause serious malfunctions in these facilities (Foully, 2009). They make scarce mention of methane recovery or the modalities for obtaining carbon credits. Neither do they mention the possible risks of ruptured membranes or the question of monitoring sites after they have reached saturation and been closed down. Finally, the authors do not point up the fact that, in low-income countries where household wastes

typically have a high organic content, landfilling this waste largely boils down to burying… water, even though this organic material could be used to replenish increasingly impoverished soils.

Hierarchy of waste treatment methods

The European directives on waste management have gradually established a hierarchy of treatment techniques,[1] which now serves as a global benchmark.[2] It is now recommended to manage waste in the following order of priority:

i) **Prevention**: reducing waste even before it has been generated

ii) Preparing for **re-use**: whereby the object is not destroyed but re-used either directly or after repair

iii) **Recycling** and **composting**: recovering materials by diverting the object from its original use and destroying it (energy consumption)

iv) **Energy recovery** (incineration, anaerobic processing): disposal of the contaminant but also recovering the energy it contains and

v) **Disposal**: the final solution aimed at concealing waste (in the best possible conditions). Theoretically, only final waste (non-recoverable) should be landfilled.

Materials and energy recovery along with disposal are viewed as treatment methods aimed at eliminating the nuisance, if possible by obtaining an environmental and economic benefit from this process. Prevention and re-use allow for intervention even upstream of the waste management stage. These different treatment techniques foreground two logics: a) prevention (*ex-ante*) or disposal (*ex-post*) of waste, i.e., the nuisances disappear; and b) the recovery of waste as a resource. As economist G. Bertolini points out, disposal (i.e., disposal) of waste differs from the logic of recovery: one is linked to the market economy (private good: the valorisation of the resource), while the other relates to a public service (public good: the reduction of a nuisance) (Bertolini, 1992). Neither do they involve the same economy of scale.

II. Investigating solid waste recovery in global South cities

In light of the available literature, it becomes clear that waste recovery activities fluctuate between commercial activities linked to the value of certain materials and citizens' growing expectations that municipalities extend their basic service. Public awareness increasingly supports extending the basic service, which relies on landfill as its main final sink option, to include recycling and recovery. Today, in most global South cities, the informal sector ensures the bulk of waste materials recovery. Yet, more often than not, this recovery is operated separately from the municipal service: when recovery is carried out by informal actors, the authorities turn a blind eye, but these informal activities can even lead to clashes or conflicts with agents working for the municipal service.

Yet, the informal recovery of waste materials also a priori alleviates the burden for the municipal authorities. In this case, would it not be possible to consider practices involving their

[1] The Waste Framework Directive 2008/98/EC of 19 November 2008; Article 4.
[2] Cf. for example: C40 2016 p.5, UNEP & ISWA 2015 p.31.

complementarity and/or integration? This line of thought underpins the approaches we have developed in the present report.

1. What public service and what waste valorisation for global South cities?

Managing waste and possibly recovering it raises several questions that are particularly salient for countries in the global South:

- The notion of "modernising" public SWM services is discussed in order to go beyond the purely technology-centric view.
- The aim here is to apprehend the question of systemic recycling (rudological approach) by cutting across the traditional formal/informal divide and adopting a metropolitan-scale approach.
- Lastly comes the need for greater insight into the dynamics created by the dual nature of waste (cf. Debout, Jaglin, Salenson, ed., 2018): between the necessary neutralisation of the nuisance and the valorisation of the economic and environmental resource it constitutes.

Mixed modernities: low-tech and the persistence of recycling activities

The modernisation process afoot in the field of waste management is changing not only the techniques employed, but also the perception of the field itself. It is also present in the evolution of urban societies in the global South, which have now been caught up in mass consumption. The overhaul of the sector does not automatically exclude informal actors, but they find themselves excluded by the "*ideology*" of modernisation (Florin, 2010a). This ideology is unanimously criticised in the literature. The UN-Habitat report has a pedagogical slant and explains that "'modernization' does not necessarily mean 'motorization'" (UN-Habitat, 2010, p.99), while other studies express indignation at the disappearance of some of the world's most efficient management methods on the pretext of modernisation (Fahmi & Sutton 2010).

The term "modernisation" is also employed to denote a social, political and cultural paradigm shift. The concepts of "mixed modernities" (Spaargaren et al., 2005), or "modernised mixtures" (Scheinberg et al., 2011) are useful to describe composite urban services that do not simply imitate a "modern" model applied in high-income countries but rather implement a more appropriate organisation in line with the concerns of global South cities. This view takes an interest in the socio-economic and territorial dimensions of waste management, and not merely its technical aspects.

The question of mixed modernities mainly refers to social and territorial innovations that complement the technological innovations traditionally associated with waste management. It recognises usages driven by either public policies or informal practices and which constitute a step forward in waste recycling or reduction. As these practices have been banned in global North countries (for many years, recycling was reserved for the poorest, as re-use and repair were viewed as stigmatising economic misery (Berdier & Deleuil, 2010)), it is important to understand the role of these practices – here considered as innovations – in the functioning of waste management in global South countries. They are at odds with a purely technologist vision of waste management. Low-technologies are becoming social alternatives to "high-tech" (Bihouix, 2014) as they are particularly well-adapted to low-income countries. Composting and the "economy of resourcefulness" (*économie de la débrouille*, Ayimpam, 2014) are seen as genuine waste management tools. This change in approach is especially interesting given that these innovations are also coming back into fashion in global North countries (Durand et al., 2019).

Undoubtedly, from a historical perspective, the situation of recovery in today's global South differs markedly from the rag-collecting found in European cities at the end of the 19th century. When rich countries began to institutionalise their waste management from the 1970s on, the informal recovery sector had ceased to exist. The sector had disappeared not only because it was prohibited by public authorities, but also due to economic and industry-related factors. The late 19th and early 20th centuries were characterised by the industrial revolution and the discovery of deposits of virgin materials planetwide: rubber, cellulose, oil, coal, etc. At the beginning of the 21st century, the situation is totally different: the virgin materials used to feed modern industry are becoming depleted. Exploiting these deposits is increasingly costly and, at the same time, global demand is growing. Due to the higher cost of virgin materials and greater environmental awareness, waste materials recovery has now become a strategic sector of intervention. And a global market for the extraction of secondary raw materials has now emerged (Cavé, 2013).

Deploying a systemic approach on the scale of territories and recovery channels

Although studies advocating the recognition of wastepickers are readily found in the grey literature, none give a precise description of the entire informal recovery and recycling channel. Clear reference is made to itinerant waste buyers, junk shops, middlemen and industry, yet nothing is said of their interactions or their operating logics. The authors of the UN-Habitat report state that "the poor are subsidizing the rest of the city" (UN-Habitat, 2010, p.138). But are all the actors in the recovery and recycling sector poor?

The informal recovery and recycling sector as a whole has been amply analysed. However, no study assesses the activity of the other links in the chain. More specifically, experts show only marginal interest in the actors who buy waste from users. The GTZ reports on India and Egypt mention "itinerant buyers" *(kabari*) or "roamers*"* (*sarriiha*), but devote barely half a page to them. Yet, this activity is worth exploring as, in many cases, these buyers help to encourage effective waste sorting in global South cities:

"In many low- and middle-income cities, itinerant waste buyers are already collecting – and paying or bartering for – source-separated materials door to door, often making a small payment based on weight; in this sense, an 'incentive system' to encourage separate collection already exists and could be built upon" (UN-Habitat, 2010, p.175).

Finally, no report explains the precise socio-economic impact of this link, which remains vague and is dubbed "industry". All we find is a passing mention:

"Many development projects…treat picking as a disembedded phenomenon, separate from the local and global economy that produces waste" (Scheinberg & Anschütz, 2006, p.257).

The impact of the national or global economy on the volume of activity in urban waste recovery has not been studied. This blind spot makes it difficult to build a dynamic view of the sector, as the reports do little more than sketch out a static picture.

Published reports consistently show insufficient knowledge on what happens in the downstream sub-sectors of recycling or, in other words, the steps that follow waste recovery and recycling. Our research has thus focused on understanding these processes in order to identify the main actors and how they operate.

We have drawn up a typology of the different sub-sectors, from the selective collection stage to the conversion of waste into secondary materials, whether this involves local traders, wholesalers, industry or artisans. The main difficulty is the fact that, most of the time, informal and informal actors are intermingled in the recovery and recycling chain.

For our analysis of each of the six cities, we sought to spatially delimit these sub-sectors and also quantify their waste streams whenever possible. This method allows the fraction of waste stocks diverted through recycling to be assessed, compared to landfill waste.

In the literature, the term "system" is used indiscriminately as a simple synonym for "arrangements". Management mechanisms, whether formal or informal, are all viewed as systems: "conventional engineering systems" (Furedy, 1992), "a modern waste management system" (Wilson et al., 2006), or "the Zabbaleen system" (Fahmi & Sutton, 2010). In fact, the aggregate of these arrangements, with the municipal service at its core, is also considered to be the "waste management system": at times "official" (Furedy, 1992; Gerdes & Gunsilius, 2010), "municipal" (Baud & Post, 2004), "modern" (UN-Habitat, 2010) or "integrated" (Baud & Post, 2004; UN-Habitat, 2010). However, the use of "process-flow diagrams" (PFDs) in the UN-Habitat 2010 report helps give us an overview of the flows of post-consumption materials in an urban environment: "all parts are related to one system" (Scheinberg, Simpson, Gupt et al., 2010, p.30).[1] We thus suggest reserving the term "system" to denote all of the waste management "mechanisms" (formal and informal, public and private) at the city scale.

Although the literature includes frequent references to "*integrated* solid waste management" (WSP, 2008; Shekdar, 2009; Coad, 2011), many studies are only interested in collection and make no mention of the downstream parts of the chain (processing, landfill) or focus on disposal without studying recovery and recycling. The concept of integrated waste management is foregrounded, yet the fundamental question of merging a "modernised" municipal service with private recovery and recycling channels is barely addressed and all too often reduced to a dichotomy between large private operators and small wastepickers.

To understand the interactions between waste disposal mechanisms (official) and recovery and recycling mechanisms (often non-governmental), we chose to adopt a "systemic" perspective and observe all the links in the chain.

[1]For a presentation of the process-flow diagram methodology, cf. UN-Habitat, 2010, p.31–35).

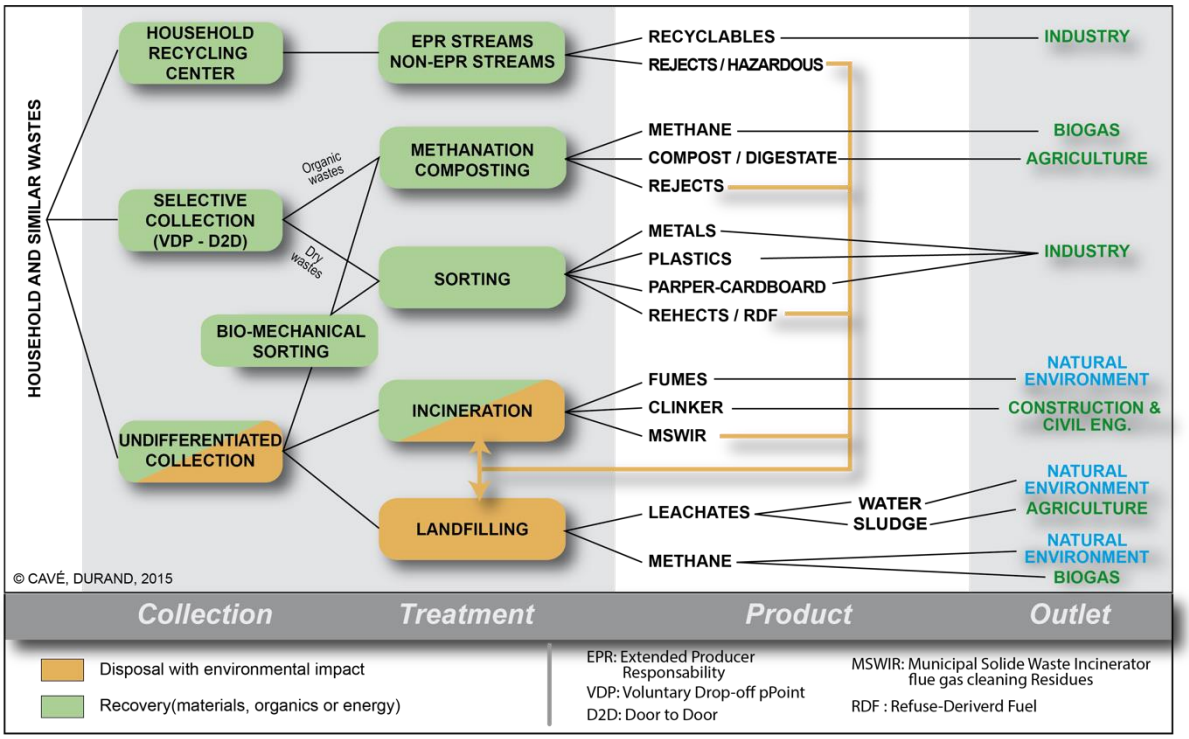


Figure 10. Synoptic overview of solid waste management in Europe

The steps of urban solid waste management in France

Figure 10 gives a simplified view by waste recovery or disposal channel:[1]

The waste deposited in household waste recycling centres is for the most part destined for specific channels. A large share of the waste is collected under Extended Producer Responsibility schemes (cf. below), i.e., financed by the producers of the product that creates the waste.

Organic wastes from selective collection channels are recycled through biogas recovery or composting. Bio-mechanical treatment allows the composting of the organic fraction of non-segregated household waste, or the sorting of organic material in view of biogas production.

Dry wastes from selective collection are valorised by recycling, i.e., after transformation, reintroduced as inputs into industrial value chains.

Mixed waste (residual household waste) is either incinerated or landfilled. In the case of incineration, the furnace residues consist of fumes (requiring treatment), clinker and MSWIR[2] (requiring landfill).

All the channels thus ultimately depend on the final disposal facility. Landfills produce leachate (residual liquid requiring treatment) and biogas (to be flared or converted into usable energy).

Waste: a valuable resource or a cost?

[1] A channel (or chain) can be defined as "an ensemble constituted by the successive steps involved in making a product that is linked by a flow of exchanges…and [which] includes all of the enterprises and other actors that contribute to the elaboration of a product or to the valorisation of a raw material, from upstream to downstream" (Plauchu, 2007 in Bahers, 2012).

[2] MSWIR: municipal solid waste incinerator flue gas cleaning residuals result from the neutralisation of polluting acidic gases using reagents such as lime or soda. MSWIR are highly toxic and require a specific treatment process.

As underlined by Gérard Bertolini, one of the first social science researchers to take an interest in waste, collection is connected to the waste disposal function and a public service, whereas recovery and recycling correspond to the objective of valorising waste and to industrial and commercial value chains (Bertolini, 1992). Public authorities very often find it difficult to combine these two aspects of waste management (UNEP, 2013). Likewise, experts often recommend integrating organised wastepickers into the municipal service but very seldom specify *how* to formalise them.

The linkage between recovery and disposal stems from the fact that what is not recovered must be suitably disposed of. Yet, as G. Bertolini points out: "recovery is selective and extensive (it skims off the best of the waste stock), whereas collection-evacuation needs to be exhaustive" (Bertolini, 1990, p.96). As these two logics exploit the waste stock in different ways, fostering their complementarity is no easy task. In the case of selective collection, it is even less easy to demarcate the frontier between the two.

In the global North, the waste sector was originally approached from the angle of a public service operating in the general interest. A change has now intervened that leads us to pay increasing attention to the other side of the coin, the commodity side (profitable service), as the sanitation expert, T.T. Ta, explains:

"Today, waste management is going through a period of transition between former practices based on the concept of public service and future developments more tightly linked to industrial constraints" (Ta 1998, p.12).

In global South cities, the linkage between waste recovery and industrial activity is often taken for granted, whereas the public service side struggles to operate effectively. Above all, the articulation between the two raises problems: "while the commodity value of materials is taken for granted, the service aspect of recycling is relatively new everywhere" (UN-Habitat, 2010, p.2). In other words, given the cost that secure landfilling now incurs, it seems economically opportune to divert part of the waste stream into recycling and recovery channels. Figure 11 below shows this methodological choice which assigns a dual-entry to waste depending on the value it may have in certain cases, or on the cost that its removal and disposal incur in other cases.

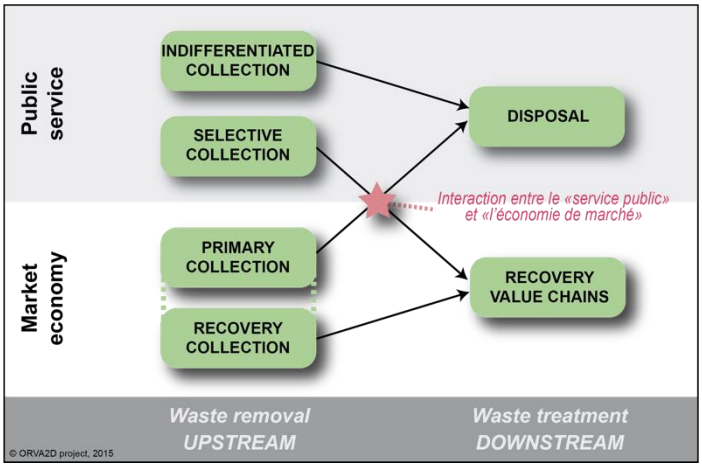


Figure 11. Waste – between a public service and a market economy

This figure can be read in both directions:

- On the vertical axis: the public waste management service is generally structured around mixed waste collection upstream and the controlled disposal of final waste downstream. Market economy mechanisms come into play, ranging from the recovery of recyclables upstream to waste valorisation chains downstream.
- On the horizontal axis: recovery mechanisms are deployed at source, that is, further upstream than mixed waste collection. Downstream, controlled landfill is the terminus of the management system. The landfill site is intended to receive the rejects from the waste valorisation chains.

In this diagram, the position of selective collection is unclear as it removes waste as a public service while at the same time giving it value through the market economy. It is thus the link between both approaches. Although implemented as a public service, it needs to be deployed upstream, like commercial recovery mechanisms. The situation is the same for primary collection, which removes household waste for a fee whilst also getting rid of the collected waste, thereby fulfilling a public cleanliness service (albeit a very limited one, as it is restricted to the neighbourhood paying for the waste removal).

The challenge of reconfiguring the sector could be, first, to encourage service providers to develop efficient recovery and recycling mechanisms; then, to incentivise informal private recovery actors to adopt a service-provision approach. This is the approach advocated by international experts to integrate the informal sector into the municipal solid waste management services (cf. below). Our analysis will pay careful attention to this issue.

Segmentation of the urban waste stock

The dual nature of waste – i.e., waste that requires setting-up a public service (rubbish) and waste that can be diverted into the market economy (recyclables) – can be shown in more detail depending on the different types of material. Some materials have a certain value and these values have been summarised in the 2010 UN-Habitat report. The authors attempt to characterise the urban waste stock according to the potential valorisation of the different categories. For this, they drew on a previous report (VNGI 2008).

Type	4	3	2	1
Intrinsic value	**Negative**	**Potential**	**Moderate**	**High**
Description	Harmful, hazardous or unusable materials	Materials subject to market development	Locally traded materials	Globally traded materials
Interaction type produced	Taxe / fee	Free access or gift		Purchase
Type of materials *(non-exhaustive)*	*Infectious healthcare waste Engine oil Batteries Mixed waste*	*Organic waste Bulky waste Electronic waste Tires*	*Glass Some metals Rubber Plastic Low-grade paper Textiles*	*Ferrous and non-ferrous metals High-grade paper Cardboard PET plastics*
Fraction of waste stock *(by weight -estimates)*	10 to 20%	40 to 60%	10 to 20%	15 to 20%

Source : UN-Habitat, 2010, cited by VNGI, 2008 then Cavé, 2013

Table 2. Proposed segmentation of the urban waste stock

This typology goes beyond the binary distinction between “refuse” and “resources”. The urban waste stock is split into four types of materials with more or less similar characteristics. Type 1 designates the most lucrative materials, which account for 15–20% of the waste stock and are already segregated by actors in the recycling chain. At the other end, Type 4 waste corresponds to materials with a negative value. In addition to toxic waste, the mixture of heterogenous materials also produces a mass of unusable waste (“mixed general waste”).

In between these poles are two intermediate types of waste that seem less well defined: the related activities have no clear connection to market transactions or to a public service. They involve a variety of recycling channels that could be developed in order to reduce the amount of landfilling. In fact, despite the high level of informal recycling activities, many types of waste that could be valorised are not recovered by anyone. This “underbelly” (50–80%) of urban waste stocks corresponds to waste that is technically recyclable, but only under certain conditions, which are clearly unfulfilled. Currently, the cost of recycling this waste exceeds its market value and, without help from support mechanisms, only a small fraction of the waste streams can acquire a positive economic value (Le Bozec et al., 2012). The percentage of compostable waste in Type 3 has a particularly high potential for valorisation. In a recent study of six cities in the global South, organics are identified as offering the best opportunity for diversion, representing on average 45% of the waste stock (Scheinberg, Simpson, Gupt et al., 2010). However, the (agricultural) outlets are far from urban centres and farmers are rarely willing to pay for an organic amendment of uncertain purity to spread on their fields.

The value of materials in the waste stock is in no way intrinsic. The value of a material, its status between rubbish and resource is dynamic, variable and contingent. It chiefly depends on the prevailing technical and economic conditions: if a treatment process is developed for any item in Category 4, the item will then move up the hierarchy. And its integration into the market or industrial value chain is not a lasting certainty: a material can attain the status of commodity, then be demoted – at least temporarily. Conversely, it is not easy to predict which material will move up the hierarchy, or when. All depends on the industrial outlets available, but these can spring up or disappear within a short period of time. Here, the value of objects appears as a contingent – not intrinsic or constant – property. The dynamic of the sector causes the value to fluctuate: “this is why what is waste today will not be waste tomorrow and why what was, common-sensically, waste yesterday is now incorporated as an economic ‘sector’” (O’Brien, 1999, p. 278).

2. Crisis-driven innovations

Innovations often stem from the initiatives of local NGOs – sometimes dating back 10 or 20 years – to provide direct support to a neighbourhood or village. What is totally new, however, is that since 2010 these initiatives have been adopted by (local or national) public authorities with a view to mainstreaming them, be it the integration of informal recyclers in Latin America, primary collection and composting in Africa or community-based management in South-East Asia.

Crises and disasters are often what kick-start changes to the waste management model chosen by municipal authorities . These exceptional events are vectors of change given their human, material and/or financial impacts. They create (or reveal) new sensitives in public opinion and in the eyes of policy makers. As a result, the often high (financial, cultural, political) costs incurred by a change of model suddenly appear more acceptable.

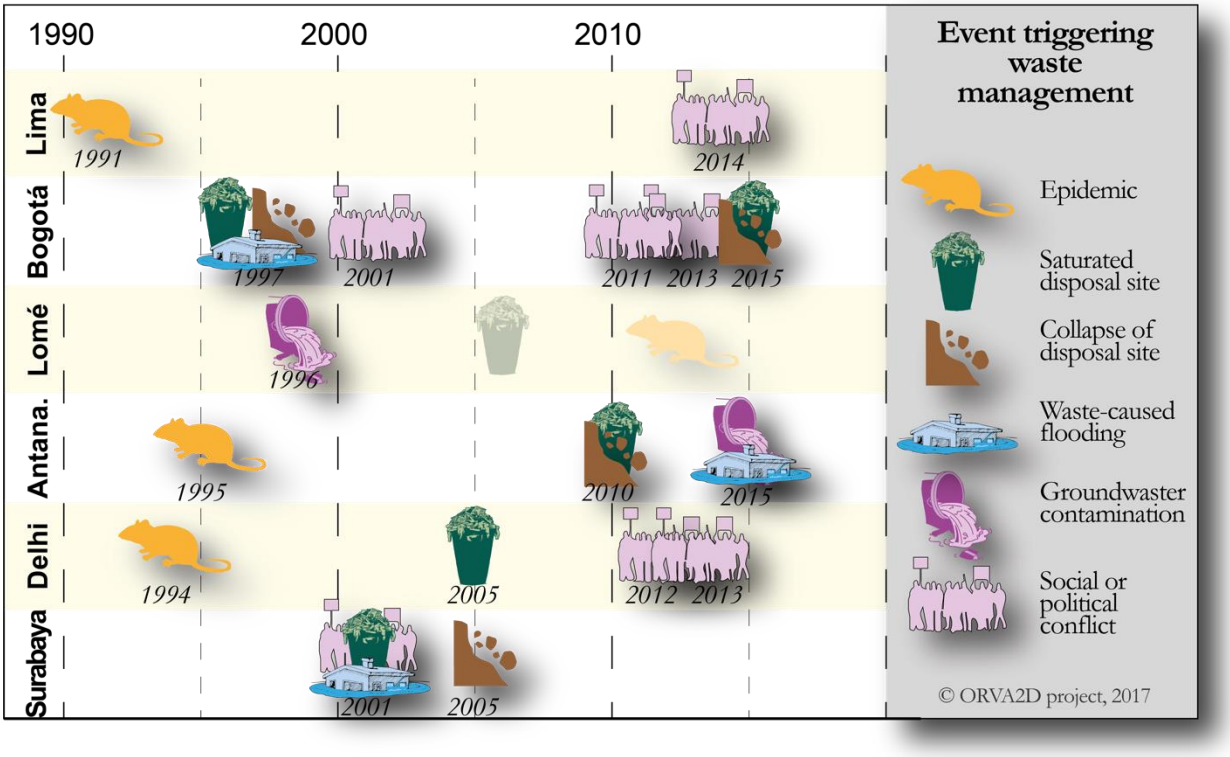


Figure 12. History of events that triggered waste management policies

Recurrent epidemics justify the priority set on health

Health crises linked to waste are frequent occurrences. Some are recurrent and small-scale, others are dramatic and short-lived. Peru experienced a major cholera epidemic in 1991 that affected 1% of the country's population (Boutin, 1991). In its wake, the country rolled out a major policy on sanitation which led to the law that launched the first waste management actions in 2000. Plague epidemics broke out in 1994 in India and in 1995 in Madagascar, but it was not until 1999 (Madagascar) and 2000 (India) that these catastrophes gave rise to laws designed to resolve the problem.

Other smaller-scale epidemics occur in the vicinity of wild dumps and disposal sites. Every unsupervised dumpsite is a source of respiratory, skin or gastric infections. A case in point is in Lomé, where the Agoé landfill, which opened in 1996 (closed down in 2018), is today in the heart of the urban zone. It directly contaminates the Agbetekpé and Sorad neighbourhoods located between the municipal disposal site and a swampy area that serves as an illegal dump. The residents regularly contract diseases such as "cholera and diarrhoea"[1] (Bodjona et *al.*, 2012). This medium-scale but chronic contamination is mainly due to the proximity of the groundwater aquifer used to supply water to nearby districts. In Madagascar, the neighbourhoods bordering the Andralanitra dumpsite, particularly the informal villages built by

[1] Information confirmed by the residents during the ORVA2D research project surveys. What is termed "cholera" are in reality very severe gastric illnesses.

Father Pedro[1] as well as the textile factories in the free zone, are severely impacted by uncollected methane emissions and by the wastepickers' practice of burning rubbish to reduce the volume of waste unsuitable for resale. Moreover, the site's leachates are drained off into the surrounding rice fields.

Saturated dumpsites causing landslides and flooding

The second type of event that strongly influences public opinion is the saturation of disposal sites and its consequences. Almost all sites in the reference cities have reached the end of their useful life and now face the problem of available space. Also, mounting social pressure, even from the poorest communities, now opposes siting or maintaining this type of infrastructure close to residential areas.

The most emblematic case of saturation is at Doña Juana in Bogotá. This controlled landfill built in 1988 to centralise all the municipal dumpsites partly collapsed in 1997. Other landslides followed, the last in 2015, each time obstructing and contaminating Tunjuelito River (which also receives some of the city's wastewater) and causing flooding. The riparian communities are largely affected by these events. The landfill site, initially designed for 47 million m^3 of waste, now exceeds 200 million m^3 spread over 594 hectares.[2] It is equipped with leachate and biogas recovery systems, but the facilities regularly malfunction. However, Bogotá municipality has little leeway regarding the construction of a new site as the neighbouring municipalities refuse to accept waste from the capital.[3] In 2012, the city hall thus rolled out a proactive waste policy dubbed "Bogotá zero-waste".[4] The policy aimed to divert certain waste streams but, as will be seen later, the "zero-waste' concept is only superficially grasped.

Other disposal sites have not collapsed but simply spilled over for want of space, blocking nearby waterways. Wild dumpsites are often found along waterways as their banks are often unbuilt and part of the waste is flushed into the river during high-flow periods. In addition to severely contaminating water resources, these obstructions also cause flooding with potentially serious impacts. This was the case, for example, in Surabaya in 2001 and Antananarivo in 2014 and 2015. In Antananarivo, the city authorities focused on the problem of urban cleanliness, sometimes neglecting the issue of the municipal dumpsite as a final sink. A retaining wall built in 2010 helped to curb the sprawl of the dumpsite but failed to solve the problem of saturation. It actually caused a build-up of waste that spilled over the wall (destroyed by a landslide) towards the nearby waterway. As in other situations, the establishment of a sanitary landfill has encountered opposition from adjacent municipalities.

In Surabaya, this problem was solved by the construction of a new landfill site in 2001. This was the year that the city experienced a major crisis. Following complaints from residents in the area, the court decided to suddenly close the Keputih disposal site, with no fallback solution. In no time, the city and its waterways were strewn with enormous "floods of waste".[5] The new Benowo landfill was hurriedly opened three weeks later and gradually brought up to standard. This event had a strong impact on public opinion and laid the ground for a highly proactive and participatory waste management policy.

---

[1] Father Pedro Opeka, a Catholic priest, founded the Akamasoa Charity in 1989 and is known for his fight against poverty in Madagascar.

[2] Visit of 18 February 2016 accompanied by Igor Dimitri Guarinan, an officer from the UAESP (*Unidad Administrativa Especial de Servicios Públicos* – Special Administrative Unit for Public Services).

[3] Field survey conducted under the ORVA2D research project (Rateau & Estrella Burgos, 2016).

[4] The term "zero-waste" disappeared in 2016 with the arrival of a new mayor, but the main lines of the scheme are still in place.

[5] Term used by the local press.

In Delhi, as existing dumpsites were saturated, a fourth (controlled) site was opened in 2012. However, instead of the 600 hectares required for the site, only 60 hectares were found to landfill the waste. This new infrastructure thus failed to solve the problem of the first three dumpsites, which should have been closed down in 2005, 2006 and 2008 respectively.

In Lomé, a new landfill was opened in 2017. Sited 23 km from the city centre on sparsely populated land purchased by Lomé municipality, it will face the challenge of tackling exploding service production costs due to the haul distance to the disposal site and the remuneration of the private operator.

Social and political conflicts: a new driver to improve waste management

Epidemics and the saturation of disposal sites are recurrent problems in all cities of the global South. But another type of event increasingly acts as a trigger for the renewal of waste management policies: social protests. These protests mobilise residents, environmental movements or waste management workers, demanding the shutdown of a disposal site or incinerator, or access to a waste stock. These movements are intensifying not only because the public is becoming more aware of the harmful impacts of waste, but also because powerful economic stakes are crystallising around waste as a commodity.

A case in point is Surabaya in 2001 when residents living near the existing disposal site obtained a court ruling that forced its closure. The shutdown caused a health crisis over several weeks but, more importantly, it spurred the crafting of a new public waste management policy.

In Delhi, complaints were filed after the construction of a new landfill site that was too small to absorb the city's waste streams. The Supreme Court then ruled in 2013 that it was crucial to identify new sites for the construction of other landfill facilities.[1] Although this court ruling has not yet been enforced, it has exerted pressure on the municipalities to find alternative solutions to divert waste streams.

A last example of citizen mobilisation that led to a significant change in waste management is the Colombian experience. Propelled by the energy of their representative Nora Padilla, Bogotá's informal waste collectors, who had long been self-organised, successfully spearheaded a change in the municipality's service provision policy.[2] After protracted legal proceedings from 2003 to 2011, the municipality was ordered to oblige the companies providing waste collection services in six defined city sectors to work together with informal actors

Political conflicts also frequently arise, notably when municipal governments change. New mayors sometimes question the contracts signed by their predecessors, which leads to conflict between the city hall and the provider. The unpaid company thus ceases all collection services, generally without prior notification, as in Bogotá in 2013[3] or in Comas and Villa-Maria-del-Triunfo (Lima) in 2014.[4] This may have long-lasting repercussions – going as far as the removal of Bogotá's mayor.

[1] http://www.dailypioneer.com/city/ddas-new-landfill-sites-rejected.html
[2] Rulings of the Constitutional Court no. 268 of 2010 and no. 275 of 2011.
[3] http://www.semana.com/nacion/articulo/cronologia-de-la-destitucion-de-gustavo-petro/380872-3 (page consulted March 2016).
[4] Resolution 141-2014/DIGESA/SA, of 12 December 2014, signed by the General Directorate of Environmental Health, Ministry of Health, Peru.

3. Comparing the socio-technical innovations of six global South cities

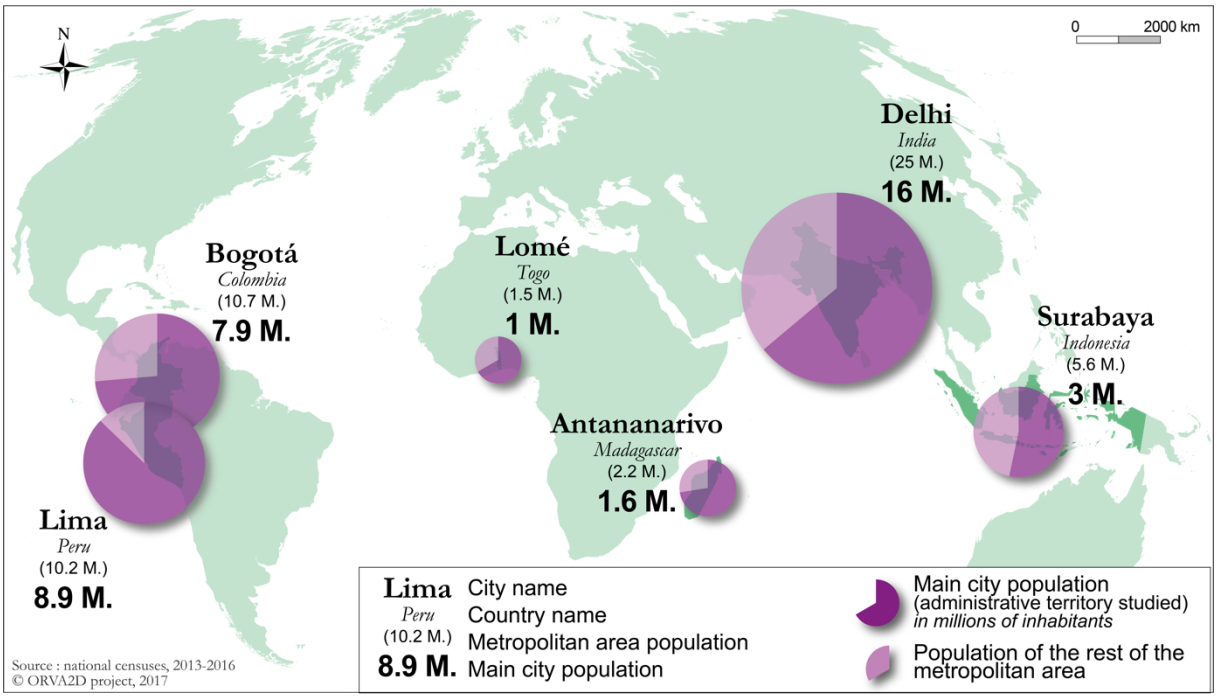
Our reflection was conducted with respect to how public waste management services have evolved, taking into account socio-environmental crises on the one hand, and the acceptance of budgetary constraints on the other hand.[1] The objective is to analyse how innovations – generally spurred by informal practices – become integrated into municipal management in six cities in the global South. Having ascertained that mimetically reproducing the management policies of North countries leads to an impasse (cf. Chapter 1), the authorities often decide to rely on local dynamics, even when these are informal and *a priori* illegal. This leads to innovative experiences and is clearly the case in the cities studied: Lima and Bogotá (Latin America), Lomé and Antananarivo (Africa), and Delhi and Surabaya (Asia).

Cities with diverse public policies

The reference cities were chosen firstly on account of the innovations they have prioritised for managing their waste, and secondly due to their different profiles (size, level of resources, etc.). Their sizes vary but all of them have over a million inhabitants in their metropolitan area, with varying levels of wealth and contrasted modes of local governance. This sample of cities is justified as some 40% of city dwellers live in cities with over one million inhabitants (Véron, 2007) and most of the world's city dwellers live in global South cities. The processes studied are thus relatively representative at a global scale.

However, the metropolises selected vary in size in order to allow for an assessment of their different realities in terms of waste management. We thus find three medium-sized cities (Lomé, Antananarivo and Surabaya), two metropolises (Lima and Bogotá) and one of the world's largest cities (Delhi), with different constraints to manage the whole of the metropolitan area.

[1] This report is the result of the research project, ORVA2D (Organisation de la Valorisation des Déchets dans les villes en Développement), funded by the Research department of AFD (Agence Française de Développement), headed Le Mans University (UMR ESO CNRS) and implemented with the support of Gevalor association and consultants from Urbanalyse and ALBWaste between 2014 and 2018. http://eso-lemans.cnrs.fr/fr/recherche/programmes-en-cours/projet-afd.html



Map 1. Population size of the reference cities

All of these cities are the political and economic capitals of the countries concerned, except for Surabaya, which is Indonesia's second largest city. In Peru, Togo and Madagascar, the capital is by far the most populated and most dynamic city, concentrating most of the country's economic activities and thus producing most waste. In Colombia and India, although the capital is dominant, other large cities populate the urban landscape, as is the case in many emerging countries.

A comparative research methodology

The ORVA2D research project, which undergirds this report, aims to collect and analyse information on the specific features of solid waste management in global South countries. While the technical and environmental aspects were considered, the main thrust focused on the organisational, economic and financial aspects so as to understand the conditions that enable the functioning of SWM in each case study. In line with this objective, the methodological work involved designing an original investigation kit to ensure the parallel alignment of data collection in the six fields so that restitution would be complete and homogenous. The investigation comprises information collection files on i) solid waste management, ii) the budget for the service provision and its financing, and iii) socio-institutional data. Collecting data directly in the field, in close collaboration with local stakeholders (municipalities, NGOs, universities), meant that the empirical data was often heterogeneous, incomplete and sometimes the result of secondary estimates that needed to be relativized (e.g., when calculating the waste collection rate – cf. Box 1). We thus only kept data judged to be sufficiently reliable for use in comparative analyses.

Methodology – Measuring collection rates

The waste collection rate is estimated on the basis of figures provided by the municipalities. It gives the ratio between the estimated generation of waste per capita and the quantities of collected waste. These figures involve a significant degree of uncertainty.

Waste collection figures are estimated by volume, but the waste is not really weighed. In several cities, there is no weighbridge at the entrance of the disposal site. The estimate is based on the number of trucks and thus the incoming volume.

Waste generation figures are highly uncertain. The age of the waste sample and the place where the characterisations are made call for caution regarding the estimated waste tonnages generated by residents. The number of inhabitants in the city is not always known with certainty. Finally, the greatest uncertainty lies in the fact that household waste is mixed with wastes "of a similar nature". Although we are able to know what waste an average consumer generates (relativized depending on the district's level of affluence), it is much more difficult to know what is discarded by enterprises (commerce, artisans, industries).[1] Enterprises may use a private operator to manage their waste, call on informal recyclers for some materials, or discard their waste on the street for kerbside collection by the municipal service, but which of these three methods they choose is not monitored.

Likewise, it is difficult to estimate the share of waste generated by the inhabitants of peripheral municipalities who spend part of their day in the urban centre.

A distinction should also be made between the collection rate for waste collected[2] by the municipal service and the coverage rate[3] of the population served by the same household waste collection service. The latter is generally higher since almost all the inhabitants of the urban areas have access to a collection service, even though waste-burning practices and wild dumpsites impair the service's performance in terms of the waste collected. In addition, it is difficult to obtain information on the effectiveness, frequency and proximity of this collection service, which can also adversely impact the rate of waste actually collected.

Economic analysis: estimating the costs of the different steps

The data analysed in this report are largely based on an economic and financial analysis of the six case studies.

The economic analysis rests on the concept of production cost (operating and capital expenditure), determined for each stage of the waste management chain: collection, transport, and processing (Le Bozec, 2008). This production cost corresponds to the cost of the technical production factors involved in performing a service (collection, transport and/or disposal). It is calculated using a method that allows for its replication in different contexts and for a cross-comparison by activity for the reference cities (cf. detailed presentation of this methodology in Appendix 6).

An estimation of production costs enables the cost drivers to be identified and thus the possible levers to control these costs. Depending on the context, two separate methods were applied. For Lima, Bogotá and Surabaya, thanks to the availability of municipal budget data, the full-cost accounting method was used. For Lomé and Antananarivo, the costs were reconstituted

[1] The same difficulty exists to a lesser extent in France.
[2] The quantity of waste collected compared to the quantity of waste generated.
[3] The number of inhabitants served by the service compared to the total number of inhabitants.

using the production-factor and unit-cost method, on the basis of in-situ observations: staff, trucks, premises, etc.[1]

The expenditures on waste management in the reference cities were collected using an economic–financial sheet and the data were exploited using the method described below.

The waste taken into account by the municipal authorities varies depending on the city. The common designation “municipal waste” encompasses not only commercial, industrial and institutional waste, but also (with almost no detail on the volume collected) waste from households and street sweeping or cleaning. Waste from green spaces and even construction debris are sometimes deposited at the same disposal site. Public health concerns are a priority for decision-makers as long as they do not directly affect the smooth running of the processing facilities. The scale of the service provided also depends on the role accorded to the informal sector: the municipal authorities either tolerate it or take a proactive approach to integrate it. This is particularly the case for waste collection from households in neighbourhoods difficult to access and where door-to-door removal is not provided. The scope of the service thus varies with the context.

The objective of the data collection in the six case studies was to find out the service provision costs and the financing method, notably the charges applied to service users. Accessing the data proved complicated (in Lima, Bogotá, Surabaya), difficult (in Antananarivo, Lomé) and impossible (in Delhi). This was for several reasons: the absence of technical and financial monitoring of the service activities managed by the municipality, service performance by companies reluctant to show their accounts, the absence of a separate waste budget and the lack of transparency on public accounts. Data collection relied on two different approaches:

- The cost accounting method for budget analysis. Depending on the information available, the expenditures recognised for service performance are recorded by category of management activity (collection, transport, treatment) in application of the Full-Cost Accounting (FCA) method in the United States or “Comptacoût” in France. This method was chosen for the cities Bogotá, Lima and Surabaya.

- The production-factor and unit-cost method. When no budget or available data exist, this method allows the costs to be reconstituted on the basis of known factors (staff, vehicles, waste recipients, etc.) and their respective unit prices. This method was used for Antananarivo and Lomé.[2]

Finally, the cost of service provision is an accounting cost determined by the authority that organises the waste management service (generally, the municipality), which records expenditure on service provision in an administrative account or profit/loss account. The cost of service provision includes production costs for the different activities of collection, transport and treatment, the financial cost of loans and the organising authority’s general administration costs. The latter costs include all the expenses for accounting, communication, meetings, billing and debt recovery.

Comparative analysis of municipal expenditure on service provision

[1] In Delhi, we were unable to strictly apply any method due to a lack of systematic information. The scant economic data concerning Delhi are thus very imprecise estimates based on the small amount of data available at city scale.

[2] The absence of structured data in Delhi precluded the reliable application of either method. Here, only fragments of the scattered information will be reported.

To compare the amounts of expenditure on service provision across the different cities, we show the per capita expenditure for service provision and the gross national income (GNI) per capita, both expressed in the countries' local currency. These expenditures on service provision are then expressed in €/cap./year (Table 3). As a point of comparison, the expenditures on municipal waste management and cleaning in France represent 0.54% of gross national income per capita (ADEME, 2016).

City	Expenditure on service provision per capita *(local curr.)*	Country's GNI per capita *(local curr.)*	Expenditure/GNI (%)	Human Development Index 2015
Bogotá	61 305	10 784 633	0.57	0.720
Lima (Surco)	64	14 843	0.43	0.734
Lima (Comas)	17	14 843	0.11	0.734
Lima (VMT)	16	14 843	0.10	0.734
Delhi	511	80 517	0.63	0.609
Surabaya	74 612	33 734 010	0.22	0.684
Antananarivo	1 935	810 628	0.23	0.510
Lomé	3 784	188 399	2.00	0.484

Table 3. Expenditure on service provision

Source: Data collected from the municipalities between 2015 and 2016, World Bank, 2015

In the city of Bogotá and the affluent district of Surco in Lima, the cost of waste management is relatively close to that in France (0.57 and 0.43 respectively). This figure is higher in Delhi due to the high cost of waste incineration and the inclusion of expenditure on wastewater disposal and treatment in the waste budget. In the other districts of Lima, in Antananarivo and Surabaya, waste management expenditures are lower (from 0.10 to 0.23). This should be viewed in the context of the population's lower level of development and a lower GNI, which only accentuates the difference in absolute value. Most of these cities thus have to ensure effective waste management even though they sorely lack funds.

The case of Lomé raises most questions as the financial burden of waste is four to eight times higher than for the other cities. We had already taken note of the high budgets in Lomé, particularly the very elevated collection costs. Yet, this cost does not signify that the collection is more efficient, given that the collection and recovery rates are no better than elsewhere.

Chapter 2. Collection and recycling, the realm of the informal sector

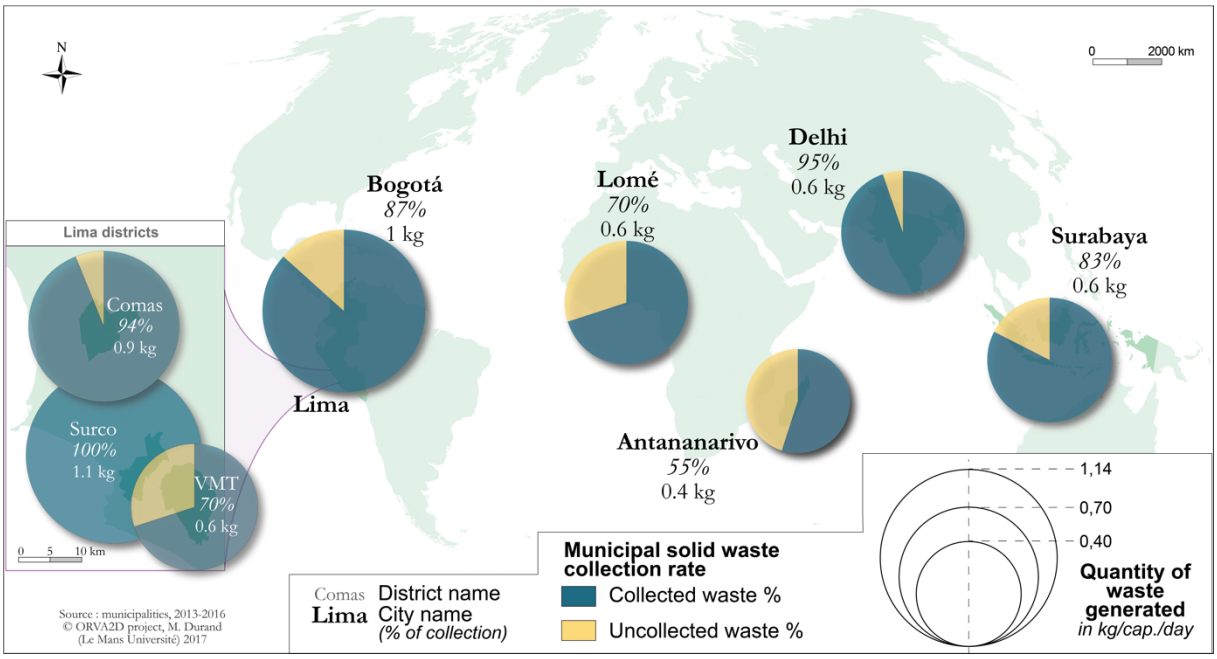
The effectiveness of a waste management system depends largely on the way that the waste is collected. The collection method influences not only waste recovery rates, but also the quality of end-of-life treatment (such as recycling). The extent of coverage of households by the collection service and the degree of upstream waste sorting in view of recovery and recycling constrain the effectiveness of the end-of-life treatment. The specificity of global South countries, however, is that the collection service does not reach all citizens in the same way. The vision of a public service such as that long provided in the global North, where collection is carried out exclusively by municipal actors (or their contractors), has shown its limits in the global South. In fact, none of the cities collects the totality of generated waste and none has mainstreamed a system for source-separation in view of recycling.

On the other hand, informal actors play a key role in these cities – be they collectors of recyclable materials or primary collectors of all waste types. The innovations observed by the ORVA2D research project show that, in many cases, public actors endeavour to coordinate their action with that of informal actors, each time in different ways. After being marginalised and harassed for many years, these informal recovery actors now find themselves at the heart of the waste management process. The second chapter of this report thus seeks to understand the limits of municipal waste collection. It then goes on to show that primary collection of waste and the informal recovery of recyclables can constitute viable solutions in some situations.

I. Inadequate municipal collection

1. Uneven collection rates within the cities

In all of the reference cities, we see that the rates of household waste collected by the municipality (or their contractors) are relatively good (over 70%) compared to the situation that prevailed as recently as ten years ago (Map 2). In the cities with greater financial resources, these rates fluctuate around 90% (Surabaya, Bogotá, Comas, Delhi) reaching even 100% for the wealthiest districts such as Surco (Lima). Only Antananarivo shows a lower collection rate of 55%. The main reason for this is the decentralised method of primary waste collection and recovery, which wipes a large part of the waste streams off the municipal radars.



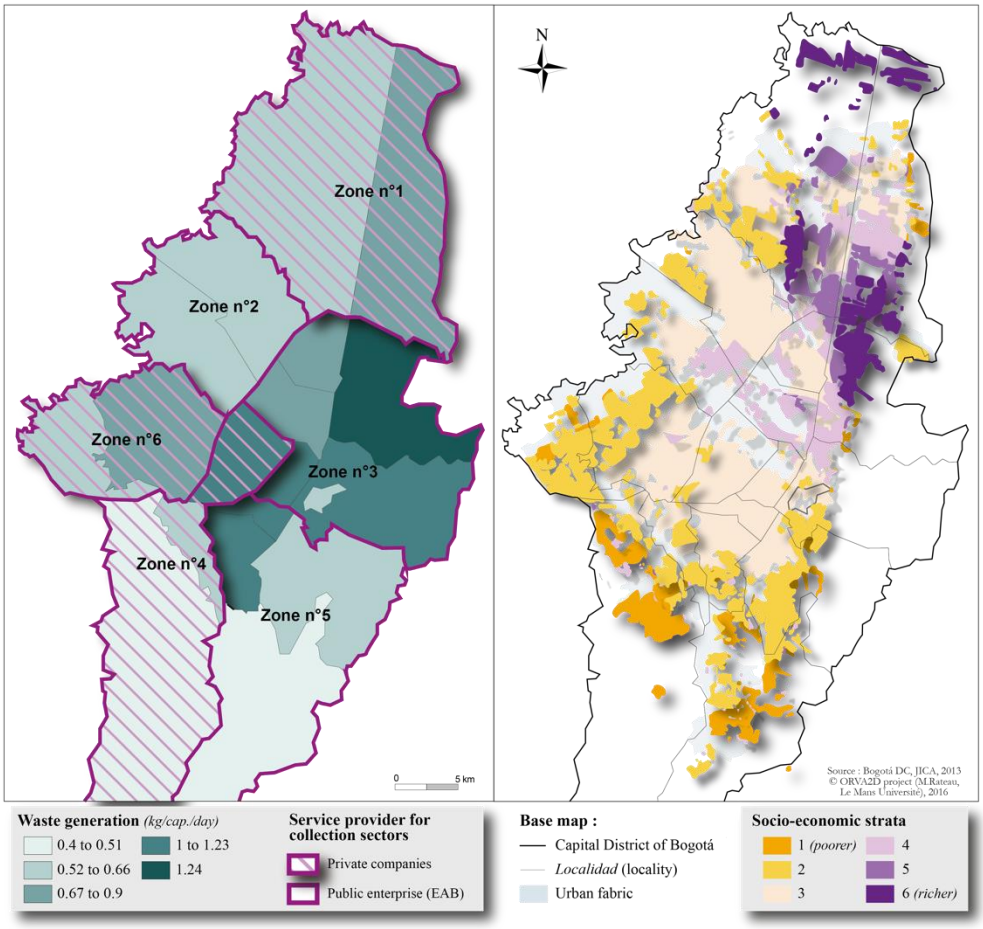
Map 2. Generation and collection of household and similar wastes

Yet in all the reference cities, there are differences in service quality (frequency, collection only along main roads, etc.) depending on the neighbourhood. There are two main explanations for this. First, some districts are difficult to access as they are located on mountainsides or their roads are in poor condition or too narrow. Second, the authorities may seek to match the service quality to the residents' ability to pay so as to minimise any budget imbalances. This is the case in Comas district or even Surco district (Lima), where the poorest neighbourhoods have their waste collected less frequently and only along the main roads.

2. A private contractor or a municipal enterprise: overcoming conflict

In all of the reference cities, the private sector may be called on to ensure waste collection. In Bogotá, three of the six collection sectors are contracted out to a private company (Map 3), while three others are managed by the municipal enterprise, EAB (*Empresa Águas de Bogotá*). This situation is the result of a deep political conflict in Bogotá.[1]

[1] Field survey conducted under the ORVA2D research project (Rateau & Estrella Burgos, 2016).



Map 3. Waste collection sectors in Bogotá

In 2012, the city's new mayor, Gustavo Petro, sought to regain control of the largely privatised public services in order to strengthen them. He signed a contract with the municipal enterprise assigning it responsibility for three of the six collection sectors. The transition from the private companies to the municipal enterprise was far from satisfactory in 2013 since the city had no waste collection service for three days and waste piled up in the streets. The political opposition denounced the new contract as contravening the constitutional principle of "free competition", which led to the mayor being ousted in December 2013. After a process of national and continental legal remedies (before the Inter-American Commission on Human Rights) and strong support from the population, the mayor reinstatement was ordered in April 2014. The choice of service provider is thus a highly delicate question.

The districts of Comas and VMT[1] (Lima) also experienced political tensions (and several days without waste collection) following a change of mayor at the end of 2014. Notwithstanding the sound legal framework underpinning service provision for the waste sector, a clientelist relationship set in between the head of the collection company and the mayor in each of the two districts.[2] To make a clean break, the new mayor chose to change service provider, which

[1] Villa María del Triunfo.
[2] Field survey conducted under the ORVA2D research project (Rateau, 2015).

resulted in temporary chaos for household waste collection. Today, 80% of the waste in Comas is collected by a private company (and the rest by a municipal enterprise), compared to 57% in Villa Maria del Triunfo.

Surabaya is the only city to have made the policy choice to entrust all waste collection to a single municipal enterprise, meaning directly by the municipal service, with a fleet of 285 trucks. The purchase of compactor-trucks is planned in order to reduce the number of collection rounds. To make this solution viable, the city went through a period of modernising all its municipal management system and consolidating its budgets.

In Antananarivo, collection is entrusted to SAMVA,[1] a public enterprise under the responsibility of the Commune Urbaine d'Antananarivo (Municipality of Antananarivo), with financial oversight by the Ministry of Finance and Budget and the technical oversight by the various ministries in charge of sanitation, decentralisation and spatial planning. This administrative complexity is a handicap. Initially equipped with an adequate number of dump trucks, SAMVA did not have the funds to either maintain or replace them.[2] Currently, it delegates collection to service providers (supplying them with workers). The contracts generally last one month (depending on the public finances available), which hampers service provision over the long term. The municipality also has its own equipment and employees and directly manages a supplementary collection service when necessary. In Lomé, although a service provider ensures collection (this time with longer-term contracts), the municipality can temporarily lend the company a hand during difficult periods (e.g., when the number of wild dumps increase sharply or during the rainy season to avoid flooding).

City		Lima			Bogotá	Lomé	Antananarivo	Delhi	Surabaya
		Surco	*Comas*	*VMT*					
Collection	***by municipal service***	■	■	■	■	■		■	■
	by a private operator		■	■	■	■	■	■	

Table 4. Waste collection management methods

It should be noted that the choice of method for managing waste collection, often critiqued by proponents of some method or other, is actually political rather than technical. The effectiveness of the service's management often depends more on what powers and resources a municipality has to implement its policy, rather than the choice between direct municipal management and a private contractor. Moreover, this is why several cities have opted for a multi-pronged system, adapted to the different neighbourhoods (cf. Table 4).

3. Source-separation in its infancy

The fraction of recoverable waste is generally around 25% of the waste stock (rates are higher in the wealthier cities and lower in the poorer cities). This involves the most readily recyclable waste given that some of the high-value materials (metals, certain plastics) are recovered spontaneously by the population and informal actors. In recent years, the six cities have begun

[1] *Service Autonome de Maintenance de la Ville d'Antananarivo* (Autonomous Maintenance Service of the City of Antananarivo).

[2] Field survey conducted under the ORVA2D research project (Lecointre, Breselec & Pierrat, 2015.)

to tackle the question of sorting and recycling more proactively. However, there is no source separation as in Europe. The rate of waste recovery and recycling by the municipality is very low in each of the cities.

Only one neighbourhood in Lima has set up a municipal service for selective collection on a door-to-door basis. In 2001, one year after the Law organising the collection-removal-treatment of waste in Peru, Surco embarked on an ambitious source-separation programme. This was set up directly by the local authorities via the municipal enterprise[1] EMUSS.SA,[2] thanks to initial financing granted by the European Union. As the second wealthiest district[3] per capita in Peru, Surco sports a strong environmental ambition (despite a few contradictory indicators such as the extensive use of private cars and mass consumption). Today, this district is held up as an example for the whole city even though its model is difficult to replicate across all districts given Surco's relative affluence.

Dry packaging (plastics, cardboard, paper, metals, glass) are collected twice a week door-to-door. Following an awareness-raising phase, the municipality is gradually extending its service coverage within the district to increase the number of households served. A manual sorting centre equipped with a conveyor belt was built by the municipal enterprise to sort the different materials that are then resold. Fourteen staff are assigned to this task daily.[4] Only plastics are not sold on. Since 2010, the municipality itself converts plastic bags and films into orange refuse bags, which are then distributed to the residents to use for discarding recyclables. As a result, the virtuous loop of recycling is completed.

In 2014, selective collection at Surco yielded 2,736 tonnes of waste, equivalent to 2% of the total waste generated by the district and 6% of its recyclable waste. This figure is rising every year. It is relatively low due to several factors: the gradual adaptation of infrastructure, notably the sorting centre (a new centre was opened in July 2016 to increase capacity), competition from informal collectors notably for high-value materials (metal, some paper-cardboard).

[1] The collection of residual household waste (RHW) is directly managed by the district before being sent to a private transfer centre.
[2] Empresa Municipal de Santiago de Surco S.A. is a multi-business company that is also in charge of managing a clinic, park and tennis club.
[3] In Surco, only 3.3% of the population lives in poverty, compared to 17.5% across the province of Lima as a whole.
[4] Interviews with Surco municipality (Rateau, 2015).

Photo 1. Selective waste collection in Surco © M. Rateau, ORVA2D, 2015

Bogotá tried to set up selective waste collection using private contractors for residual household waste (RHW) in 2008. The collection routes then covered 37% of users in sixteen of Bogotá's nineteen urban localities (UAESP, 2015). This collection service was closed down in 2011 following the move to integrate informal actors (cf. Chapter 2.3.).

II. Primary collection as an alternative to the municipal service

In global South countries, municipal services collect the bulk of waste, not through door-to-door collection but via transfer points. Transfer points are somewhat similar to voluntary drop-off points, although the operating principle is very different. In unplanned neighbourhoods, the residents take their waste to the main roads or, when they can afford it, call on primary collectors who charge them a fee for this service. Primary collection not only improves service quality, but also significantly increases the sorting rate and recovery and recycling rate as the primary collectors sell on the materials with added value.

Although primary collection is not legal, it is tolerated in most of the cities since it is the only service capable of removing a substantial fraction of the urban waste. There is also a degree of tolerance for the recovery of recyclable waste by primary collectors. Only Delhi continues to implement a totally repressive policy towards its primary collectors. On the contrary, other cities like Lomé or, to a lesser extent, Antananarivo, are trying to structure this primary collection as an effective complement to the public service.

1. Informal primary collection – often still illegal

For the most part, primary collection is still organised informally by the communities themselves. It is carried out by vulnerable inhabitants as a way of earning their livelihood, within local micro-enterprises or residents' associations. In Delhi, the municipal collection service does not currently operate door-to-door despite its legal obligation to do so. Only 10-15% of city centre districts (New Delhi Municipal Corporation) benefited from this type of service in 2017.[1] In the rest of the city, primary collection is a vital complement to the municipal service. It is ensured by informals who are sometimes organised and supported by NGOs, and paid between €1 and €2 a month, directly by households, although the practice may vary depending on the neighbourhood. *Dhalaos* – i.e., transfer points for the primary collectors – are managed by the municipalities in order to control the cleanliness of public spaces. Even so, this practice remains illegal and collectors sometimes have their equipment confiscated.

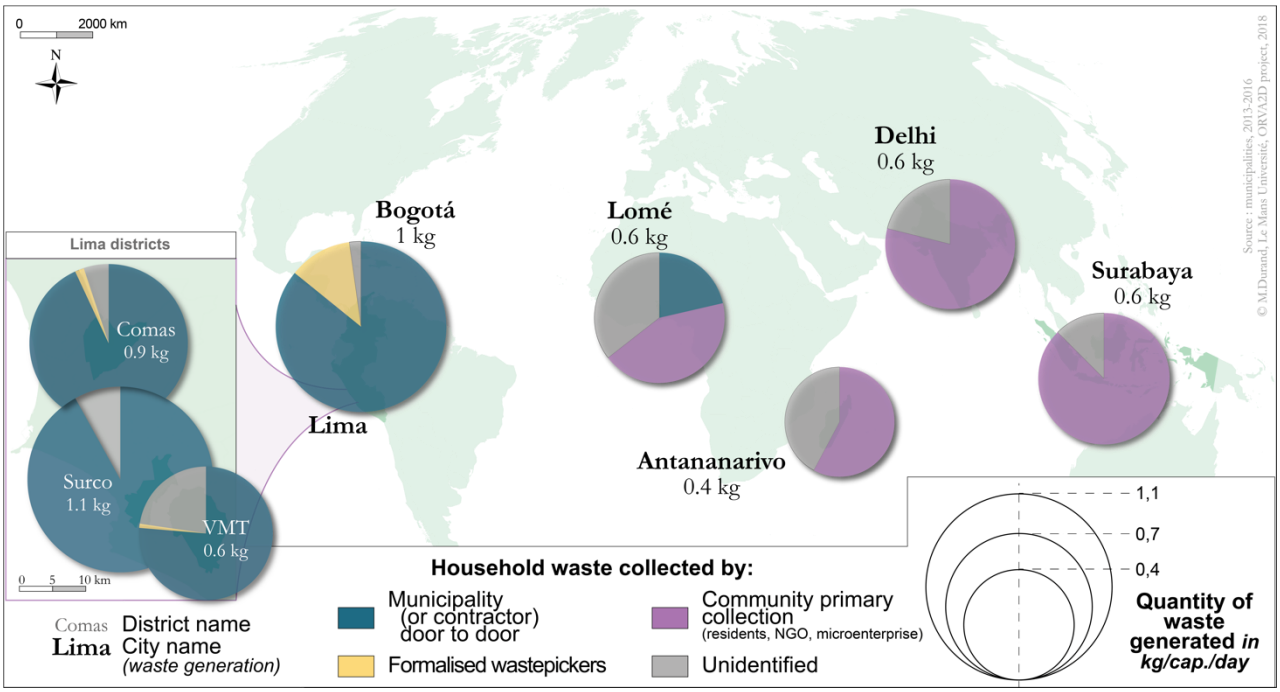
In Surabaya (Indonesia), primary collection is highly organised, albeit not officially authorised. It is deployed by community organisations (*Rukun Warga* or RW) and carried out by the neighbourhood's poorer residents or by waste collectors. They collect the waste using handcarts and take it to one of the city's transfer points (TPS – Temporary Shelter Facilities).[2] These primary collectors, or *tenanga penambil* as they are called, are paid by the RWs and their level of remuneration varies from one neighbourhood to another. The RW's administration levies a corresponding user charge on the households. As a result, Surabaya municipality has no data on the organisation of primary collection. What enables this primary collection to function and achieve internationally recognised results is actually the strong local sociability that has its historical roots in the operation of several public services. The city has in fact been awarded several international prizes for the quality of its urban environment. Surabaya municipality then takes responsibility for transporting the waste from the TPSs to the city's new sanitary landfill.

Photo 2. Primary collectors at a TPS in Surabaya © Cavé, ORVA2D, 2016

In light of these examples, the neighbourhood appears to be an effective scale for sorting and reducing the waste streams to be transported to the centralised sanitary landfill. What's more,

[1] Field survey conducted under the ORVA2D research project (De Bercegol, 2016).
[2] Field survey conducted under the ORVA2D research project (Cavé, 2016).

collecting the service charge from residents for primary collection proves relatively easy. As the service is decentralised, this also means that vulnerable citizens can be provided with work, which is why some cities have tried to organise this type of scheme.



Map 4. Share of primary waste collection in the African and Asian cities

2. Moving towards primary collection supervised by the public authorities

Many African cities such as Lomé and Antananarivo have introduced a policy to organise primary collection.

Antananarivo: community-based primary collection

In Antananarivo, primary collection is fully integrated into the municipal service as transfer points are structured on a neighbourhood (*fokontany*) scale. Formalised primary collection was launched by NGOs at *fokontany* level in the early 2000s.[1] It was officially authorised in 2006 by a municipal decree that established a collaboration with the city authorities under the RF2 system.[2] The system operates on the principle of assigning unemployed inhabitants in each neighbourhood to the primary collection service in order to improve cleanliness within a given perimeter. The households pay €0.15 to €0.60 directly to the primary collector. Primary collection operates in at least 145 of the city's 192 *fokontany*, but no data exist on its effectiveness within each neighbourhood. Each NGO has set up its own system, with variable results. In some neighbourhoods, the NGO purchases the collection equipment while in others

[1] Field survey conducted under the ORVA2D research project (Lecointre, Breselec et Pierrat, 2015).
[2] "*Rafitna Fikajana ny Rano sy ny Fakadiovana*" translated literally means "cleanliness and hygiene of my neighbourhood".

it is the residents who assume the cost. The practice is not homogeneous and payment of the collection fee is also uneven. There is no door-to-door collection. Apart from removing waste, the primary collectors also seem to be best placed to ensure the collection of recyclable waste, although this mission is not officially entrusted to them by the municipality. However, the support for the primary collection policy indirectly supports the waste-sorting activity.

The municipal enterprise (SAMVA) – which does not control primary collection – imposes a charge for all tonnage recovered on the disposal site, notably that of the informal collectors. On the Andralanitra dumpsite, SAMVA has introduced an informal fee on the dump-pickers' activity as it charges for materials that leave the site through informal channels. The fee amounts are calculated according to the type of material and the quantities involved (e.g., the fee is higher for scrap metal and bones).

Private contracts to structure primary collection in Lomé

In Lomé, two waste collection models co-exist. Some districts (central and wealthier) have the benefit of a door-to-door collection service, whereas the city's (poorer) northern periphery has to make do with primary collection. All in all, some 650,000 people are covered by primary collection, equivalent to two-thirds of the city's population. The authorities organise the intervention of primary collectors through tenders for (primary) collection services. In 2015, the municipality divided the territory into 25 lots[1] and, based on a competitive bidding process, assigned primary collection for each lot to a micro-enterprise for one year. Each lot covers an average of 25,000 people. The primary collectors collect a fee directly from users, ranging from €2 to €4 per household. In principle, a small fraction of this amount (2-12% depending on the case) is repaid to the municipality to finance collection from transfer points. In reality, however, the municipality finds it hard to collect these funds.

The companies are tasked not only with carrying out primary collection of waste and taking it to one of the city's five transfer points, but also with separating out the recyclables. These materials are then sold directly at the transfer points, which are only accessible to associations and micro-enterprises recognised by the municipality. For this purpose, the city has created premises, known as "*déchetteries*" (household waste recycling centres) to house the recyclables near to the transfer points. Logistics facilities are thus set up even though this mission and the associated actors are not officially recognised. It should be noted, however, that the design of the city's transfer points has not yet been optimised as formalised primary collectors still tip part of their waste onto wild dumpsites. As the removal of waste from these transit points, which is ensured by the municipal service, involves a large amount of sand, the useful life of the official landfill site is considerably shortened.

3. Making transfer points into choice places for recovery

Field observations highlighted a type of infrastructure that is becoming increasingly widespread (and gradually being improved): transfer points. In 2017, German cooperation came to the same conclusion.[2] Designed to assemble wastes before their evacuation, transfer points are set up at the neighbourhood or street level and offer several advantages not only for waste collection and sorting, but also for social integration between communities and the sector's actors. In situations where door-to-door collection is rare, it is vital to ensure the interface between primary collection and the transport of waste to a site for final treatment. However,

[1] Field survey conducted under the ORVA2D research project (Garnier, 2016).
[2] Participation of W. Pfaff-Simoneit at the conference "*En quête d'innovation: valorisation des déchets dans les villes du Sud*", 9 June 2017, AFD (Paris), which concluded the ORVA2D research project.

transfer points can quickly turn into unsanitary wild dumpsites if they are not carefully monitored.

In Delhi, each of the city's five municipalities has divided its territory into several lots, with the waste collection service in each being assigned to private contractors (except for several lots directly managed by the municipalities). The companies collect waste from the transfer points (*dhalaos*), but are not responsible for transporting it to these points. For example, South Delhi Municipality, which counts 5.6 million of the city's 16 million inhabitants, has 1,096 *dhalaos*. Each facility measures around 60 m^3 and is sized to store the waste generated by 10,000 to 15,000 people. Some municipalities are also thinking of creating transfer centres that would enable the collected waste to be transferred into larger trucks before being transported to the final sink option (landfill or incineration), which would thus reduce transport costs.

In Surabaya, there are 173 official transfer points (TPSs). These are no longer places where waste is simply deposited, but real sorting centres at the disposal of the neighbourhood's primary collectors. With a surface area of 100 to 300 m^2, they can house the waste of around 10,000 people. Community associations (*rakun warga*) have strong incentives to sort waste (both financially and in terms of social recognition).

In Antananarivo, the municipality estimates that only 55% of generated waste is collected. This is deposited at transfer points, comprising 325 skips and, in some cases, concrete-built facilities. The deposited waste is then collected by private contractors on an irregular basis depending on how quickly the point fills up, then transported to the municipal landfill. The contractors are paid according to the tonnage collected and the kilometres travelled. In some peri-urban settlements, however, the transfer points are too far away for the residents, who then have no choice but to resort to fly tipping or wild dumpsites[1] to discard their waste. A further problem is that transfer points become saturated given that they are not easily accessed by collection trucks and that the space in inadequate. This is particularly the case in the city centre and around marketplaces.[2]

Photo 3. A waste transfer point in Antananarivo © Pierrat, ORVA2D, 2015

The two Latin American cities are little concerned by this type of infrastructure since door-to-door collection is found almost everywhere (over 85% of waste collected). Even so, Lima and Bogotá municipalities are mulling several questions that could well be resolved by this type of

[1] Fly tipping is small-scale and temporary (alongside a transport route), whereas a wild dumpsite is long-term, larger and generally located away from transport routes.
[2] Field survey conducted under the ORVA2D research project (Lecointre, Breselec & Pierrat, 2015).

facility. Currently, their main issue is how to transport their waste to the landfill sites located on the city outskirts. The haul time and transport costs are very high given the absence of transfer station (only a few wealthy neighbourhoods in Lima have built their transfer station – signalling the persistent inequalities that strongly impact this city). These stations mean that waste can be transferred from a small collection truck manned by one driver and a crew of two or three loaders onto larger trucks that only require a driver, which helps to reduce costs. There is also a move to group together formalised wastepickers in collective facilities so that they can add value to their recyclables before selling them on to wholesalers.

Transfer points could also allow for local composting, which would avoid the transport of highly biodegradable waste. For the time being, this potential is still underexploited. Organic waste recovery is found at a few primary collection points in Antananarivo, but is widespread in Surabaya. It is being planned in Lomé. Avoiding the transport of organic waste reduces health hazards linked to runoff and fermentation. It also offers the possibility of re-using the compost locally (for green spaces), whereas large centralised stations find it hard to sell their large stocks of compost (cf. Chapter 3).

4. Competing projects for certain types of waste

In the cities where the only effective recovery channel is informal recycling, competition exists not only among the various recyclers, but also with other projects backed by public authorities, private companies or NGOs. A case in point is the competition between the primary collection service supported by Antananarivo municipality and projects backed by international NGOs (e.g., East, Enda, Care) to recover the fraction of recyclable or organic waste.

In Peru, the only case of competition between two projects is in Surco, where the legislative incentive to integrate informal wastepickers (cf. Chapter 2.3.) is at odds with the district's drive to deploy policies akin to those of rich countries by ousting the informal actors (municipal selective collection). In other cities, competition with private companies is strong and involves very different and conflicting models. In Bogotá, for example, competition exists between the informal but highly organised wastepickers and the service companies that were awarded collection contracts (notably for selective collection). This was the source of the legal battle before the Constitutional Court (judgement no. 275 of 2011) (cf. Chapter 2.3.), which ruled that the municipality was obligated to organise the sharing-out of these collection services.

In Delhi, the informal sector is encountering an increasingly intolerant attitude from the authorities, as its activity competes more and more with private firms providing door-to-door collection and incineration services (cf. Chapter 3). At least 50,000 informal street pickers roam the city (of over 16 million inhabitants) to retrieve recyclable waste from household dustbins. This waste is then sold on to local traders before being transferred to specialised neighbourhoods where the materials are sorted, cleaned and processed in makeshift workshops. Recovery is a source of income for thousands of street-pickers, who contribute to a waste recycling economy that creates work for several hundreds of thousands of other Delhi citizens. This type of recovery, however, conflicts with the private operators in charge of waste incineration, who refer to the new solid waste management rules (MSW rules 2016) recommending the implementation of door-to-door waste collection.

The authorities' positioning vis-à-vis the informal sector is often ambivalent, even contradictory (when comparing discourse and practice). Apart from Bogotá, the authorities know little about informal recovery channels and find it hard to control their economic, social and environmental impacts. Although the authorities' first tend to try and eliminate the informal sector, which is perceived as archaic and degrading, since the mid-2000s they have been increasingly inclined

(cf. Chapter 1.1.) to recognise that informal waste recovery actors make a substantial contribution to their city's environmental performance. However, when informal recovery is integrated into the municipal service, the formal agents who had previously engaged in this business sometimes feel cheated: for example, waste collection agents who had supplemented their salary by selling certain materials.

The reference cities thus envision different trajectories to improve their recycling rates, with a reliance on informal actors. The African cities focus above all on organising primary collection services to improve their collection rates, but at the same time they also promote the recovery of recyclables. The Asian cities seem to opt for the same method, yet do not recognise the role of informal actors and prefer to rely on residents' associations at the neighbourhood level. In Latin America, the role of informals is significant and even legally recognised, which amounts to a sort of formalisation of informality.

III. Recycling: the privileged realm of informal actors

Selective collection of household waste is almost non-existent in municipal policies. Yet, a sizeable share of recyclable waste is indeed collected. This is carried out by informal operators and not part of any public action. This intervention by the informal sector is not uncommon in waste management and the practice is widespread in all the economies of the reference cities. The Indian National Statistics surveys estimated that 80% of workers were operating in the informal sector in 2012, while in Peru 74% of the economy is thought to be informal (CEPLAN, 2016).

1. The nascent structuring of recycling channels

Difficulty in estimating the quantities of recovered waste

As recyclable waste is mainly collected by informal operators, this makes it difficult to measure the quantities collected. High-value materials seem to be collected in large amounts. Metal, which is barely present in the characterisations of domestic waste, is almost systematically skimmed off by waste recovery actors upstream of any collection. It is retrieved from dustbins and dumpsites, or comes directly from households or small enterprises. Moreover, some itinerant buyers specialise in metal waste. In Lomé, 75% (in weight) of recycled waste is metal (60% iron, 10% aluminium, 2% copper, 1% bronze and 1% zinc), while the rest mainly comprises plastics (12%) (Garnier, 2016). Plastics are the second type of material recovered by informal actors given that plastic has a listed value on the secondary materials market (value indexed on the barrel of oil). Recyclables may account for up to 36% of household waste (Surabaya). Unsoiled paper and cardboard are also recovered.

In Lima, 90% of recovery is informal, with over 8,554 tonnes recovered each month (Rateau, 2015). Adding the 1,030 tonnes recovered formally, this totals over 4% of all municipal waste generated, equivalent to 17% of the collected waste that is potentially recyclable. While this figure leaves room for improvement, it is nonetheless significant given the difficulty of collecting recyclables. The second difficulty resides in the economic viability of the activity as in all of the reference cities (except Bogotá) it depends solely on the resale price of the materials.

Aside from the on-the-ground reality of selective collection, recovery activities for the purposes of recycling (direct resale) and re-use (to avoid producing waste) are underestimated, albeit very common in households. Although not official, this practice involves materials that enable

households, particularly the poorest, to derive income from their resale. For example, in Antananarivo, 70% of households separate out plastic bottles, 41% separate glass bottles and 15% paper and cardboard (Gevalor and UN-Habitat, 2012). These figures are higher for the city's poorest neighbourhoods.

The high quality of domestic sorting, coupled with the wastepickers' expert know-how, results in very low rates of rejects[1] entering a recycling plant (whereas they are often high in global North countries). In Delhi, informals save the municipal authorities €3.6 million a year (collection and processing) by removing and recycling waste (Hayami et al., 2006).

Sharing territory and the international development of recycling value chains

Despite the widespread informality of waste recycling, the role of each actor in this activity is precisely defined. Collectors and buyers alike compete fiercely for territory, in line with the social regulation modes specific to each city. In Delhi, wastepickers are also primary collectors and hired by a *tekedar*, who is a sort of foreman acting on behalf of a semi-wholesaler located in the neighbourhood. Actors at the bottom of the ladder pay for an informal license entitling them to work within the "jurisdiction". Sometimes, independent collectors manage to secure a territory with direct support from the residents.

The categories of recycling actors presented in Figure 4 clearly correspond to a theoretical breakdown. In reality, a micro-enterprise can perform two or three different tasks. In Bogotá, for instance, 75% of street pickers are also local traders (sorting, preparing and reselling waste), often operating as family business at home. The different case studies have revealed similar logics regarding territorial organisation. Waste pickers are often grouped around local traders and wholesalers in poor informal settlements close to industrial or small-business areas or along waterways (rivers, canals, marshes, etc.). These are places where illegal dumps are traditionally found and choice places for wastepickers to collect materials.

In the largest cities, each recycling channel has a degree of spatial specialisation. This is the case in Delhi, where paper waste is not stored and processed in the same neighbourhoods as metal waste (see for example Map 5). In Comas (Lima), until the end of 2017, high-value materials were mostly resold on the other side of the Pacific Ocean – in China.

Since the African cities in this study do not have a highly developed industrial sector, their waste is largely exported for recycling. Lomé and Antananarivo also receive high-value materials from a broad hinterland and a good part of their national territory, as they are the only large exporting ports and/or industrial regions. Given the absence of a paper industry and the excessive export costs, paper and cardboard find local market outlets in the production of handmade paper, composting or combustion. In Lomé, the NGO STADD buys up flexible plastics (FCFA 75/kg) to sell on at FCFA 125 /kg in neighbouring Ghana (Garnier 2016). Lomé is also an outlet for metals from a whole swathe of West Africa (Burkina-Faso, Niger, Benin), which are then sold on to Indian companies. As the Autonomous Port of Lomé imposes low taxes, it attracts exports from across the whole region.

[1] The "rejects" from a processing unit designate the wastes unfit for the type of processing concerned or, in other words, result from sorting errors.

The channel for recovery and valorisation of sandals in Delhi shows all of the actors potentially involved the sector and illustrates how a product is gradually transformed into a secondary raw material (Photo 4).

Photo 4. The structure of the sandal value chain in Delhi

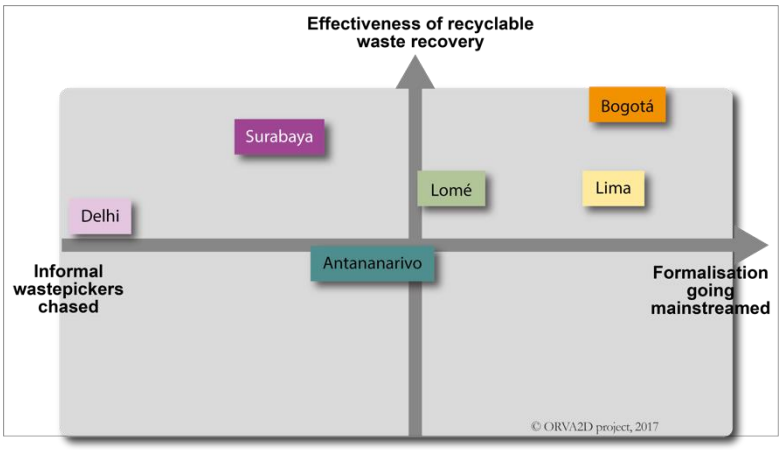


Figure 13. Characteristics of wastepickers' integration[1]

It is difficult to quantify the multitude of actors in the waste sector. Wastepickers represent by far the most numerous category, with almost all of them operating informally. Then come the buyers: local traders are informal and the wholesalers formal. Lastly, recycling and export companies are all formal and relatively few in number.

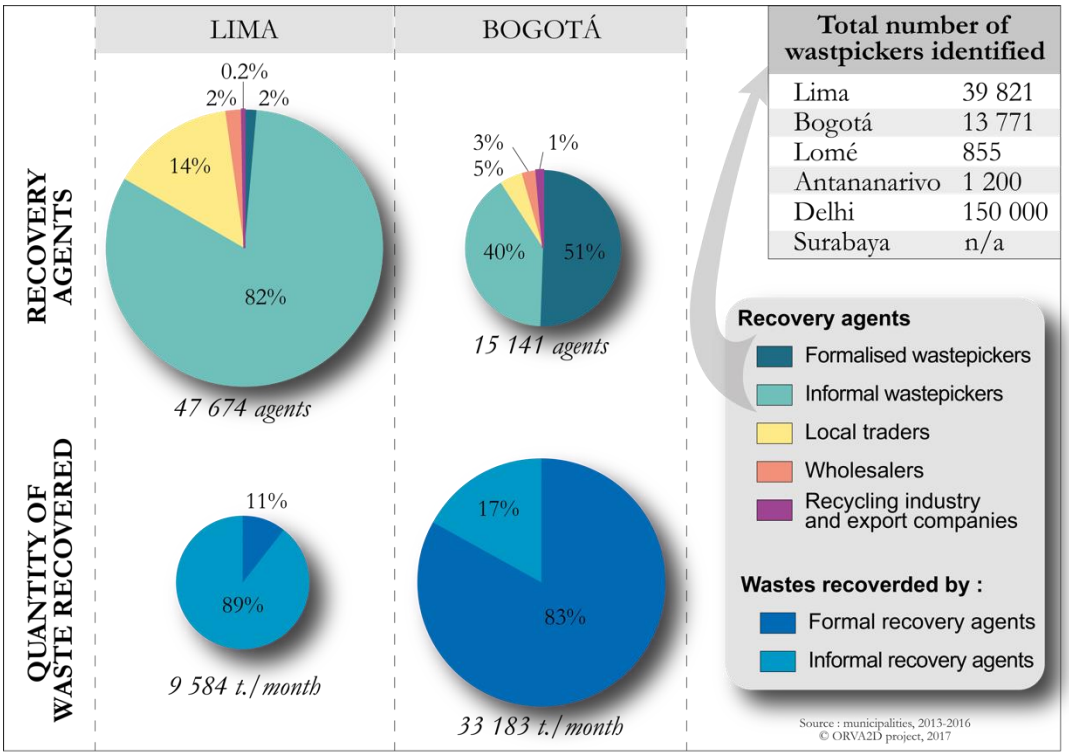


Figure 14. Actors involved in waste recovery in Lima and Bogotá[2]

[1] The efficiency of recovery is assessed on the basis of the information in Chapter 5.3.1.

[2] Only the cities of Lima and Bogotá have produced more or less precise estimates of the number of actors in each domain. In Lima, the number is probably overestimated: the 2013 estimate of the NGO, Ciudad Saludable, counted nearly 40,000 wastepickers, whereas the estimates of the metropolitan city of Lima dated 2007

2. In South America, the institutionalisation of wastepickers

South America is a pioneer when it comes to integrating wastepickers into municipal waste management, with Brazil leading the way since 1990 (Cirelli & Florin, 2016).

A conflicted legal obligation

Today, Colombia is one of the spearheads of this change, notably following the conflicts between wastepickers, the Capital District of Bogotá and contracted service providers (Rateau & Estrella Burgos, 2016). The wastepickers, organised into grassroots associations, successfully turned two elements in the 1991 Constitution to their advantage: the "right to work", and the place afforded to participatory democracy and to the legal instruments for citizen groups' direct intervention in political decisions. The wastepickers imposed their standpoint on the Capital District of Bogotá. In their view, they had been deprived of their right to work given that the criteria set out in the municipality's bidding process to select waste collection contractors automatically excluded them.[1] In 2003, the Constitutional Court ruled (and reconfirmed in 2011) that the Capital District was required to guarantee the wastepickers' participation in future tenders put out to the private sector. This ruling is now a landmark case that sets a precedent nationwide.

However, the court's ruling was not enforced until 2012, when Bogotá's mayoral election was won by Gustavo Petro, a man deeply committed to social and environmental issues. He reorganised the whole waste management policy around a "*Basura Cero*" (zero waste) programme. He also sought to reduce the quantity of generated waste (from households and the construction industry) and, in 2013, organised a census of wastepickers to establish a unique public register of organised wastepickers. He then defined a remuneration policy for the wastepickers on a pro rata basis for the quantity of waste diverted from disposal sites (on presentation of an invoice issued by an authorised weighing centre). Out of Bogotá's 13,771 wastepickers, 55% were recognised by the municipality and received financing for part of their activity. In addition, the city put an end to the wastepickers' animal-drawn carts. Apart from the authorities' wish to convey an image of "modernity",[2] horses were seen as causing traffic congestion, accidents and even pollution (excrement on public highways). Nearly 3,000 horses were surrendered to the municipality in exchange for a truck or funds for transport equipment. The wastepickers were also asked to open a bank account to receive the aid, which was no easy task for actors operating outside the law. As few of them have a driving licence, the wastepickers now mainly use small handcarts.

In Peru, the formalisation process is different as it emanates from the new Ministry of the Environment, but its implementation is equally contentious. The Recycler's Law (*Ley del Reciclador* – 2009)[3] is a major innovation in the sense that it establishes a framework for the wastepickers' activities under the responsibility of the district municipalities (Rateau, 2015). The municipalities are responsible for identifying and registering wastepickers, then organising their distribution (mainly spatial) in line with a source-segregation and selective collection programme (PSF-RS – *Programa de Segregación en la Fuente y Recolección Selectiva*).

mentioned barely 25,000 wastepickers. Estimates from the other cities also seem highly uncertain and are thus presented in Figure 12 simply to indicate probable orders of magnitude.

[1] This was because the bidding rules required a minimum company turnover that was prohibitive for the wastepickers' organisations.

[2] Note that a number of cities are currently reintroducing horse-drawn waste collection particularly in tourist areas (this was the case of 250 municipalities in France in 2014, including Trouville-sur-Mer and Beauvais).

[3] Law 29419 of 2009.

Although the law does not provide for legal sanctions in the event of non-compliance, its enforcement will likely be facilitated thanks to sizeable incentive subsidies[1] from the Ministry of Economy and Finance (after certification by the Ministry of Environment and based on international funding). Each district sets the eligibility requirements for the programme (e.g., in VMT, being of age and possessing a tricycle), as well as the size of actors involved (in Comas, the attempt to associate buyers and semi-wholesalers). Yet, whatever the location, the number of "integrated" wastepickers is minimal.

In parallel, district municipalities run an awareness-raising programme on sorting for residents, with the help of sorting ambassadors and the formalised wastepickers themselves. Both programmes are then aligned to assign each wastepicker to a collection area where they have exclusive access to recyclable waste. The municipality can also provide the wastepickers with equipment such as special sorting bags, protective gear (jacket, cap, gloves, etc.), and sometimes even tricycles or small trucks. This equipment also plays an important role in that it enables wastepickers to be socially accepted and recognised by residents. As a result, an illegal activity perceived as dirty (even dangerous) can be turned into a formalised activity providing communities with a (quasi-public) service while also protecting the environment.

Photo 5. Wastepicker from the Las Palmeras association in Villa Maria del Triunfo © Rateau, 2015.

Lima: a "variable-geometry" formalisation

Although the legislative framework is national, in Lima it is applied through different modalities depending on the district. Comas, a popular district in north Lima with 568,540 inhabitants, has fully engaged in the PSF-RS programme. In 2014, the municipality invested the equivalent of €45,822 to set up its PSF-RS, while receiving a ministerial subsidy of €167,983 – a level of generosity that incited all of the districts to embark on the programme. Comas district's budget enabled 17 awareness-raising staff to be hired, and equipment distributed to the wastepickers. Support from the NGO *Alternativa* was vital in bringing leadership skills to the programme. Each wastepicker was assigned an area with 300 households, potentially giving him a monthly

[1] Most municipalities receive far more in subsidies than they spend. For example, in 2014 the district municipality of Villa Maria del Triunfo spent 71,220 nuevos soles (€20,397) on its PSF-RS, whereas it received 109,330 nuevos soles (€31,312) in ministerial subsidies. The allocation of these funds depends on the percentage of households participating in the programme. This amount is recalculated each year and adapted depending on the percentage of households involved but is not systematically verified. However, it is only a commitment in principle, with no guarantee of the citizen's real involvement.

turnover of €250 (through the sale of recyclables),[1] but Alternativa pointed out that this number of households was not sufficient for a wastepicker's family to make a decent living. As a result, this threshold was raised to 750 households in Comas. In 2015, the programme involved 17 wastepickers (out of some 1,500 informal wastepickers in Comas) and two buyers' associations (representing around 40 buyers and thus considered as semi-wholesalers). The municipality struggled to find wastepickers willing to join the programme, as most of them prefer to keep their freedom of movement. The district's formalised wastepickers collected around 298 tonnes of waste a year from segregated waste, whereas its informal wastepickers captured 6,776 tonnes, which is 70 times higher (Ciudad Saludable, 2010).

In VMT, another popular district in south Lima (464,176 inhabitants), the operation officially covered 25% of the district's households in 2015 for an annual PSF-RS-related expenditure of €59,757, yielding 51 tonnes of collected waste. This represents a cost of €1,163/t. in VMT and €144/t. in Comas. It is proving difficult to involve residents and wastepickers on a steady basis given the lack of awareness or incentives for sorting. Yet, a growing trust between the different stakeholders (mainly the municipality and the informal wastepickers) is helping to push these figures up slowly but surely.[2] VMT municipality is counting on an additional innovation to encourage the residents to participate: a 10% deduction on their local taxes. As a large part of the population (over 50%) do not pay their taxes, the effect of this measure remains relative. A second financial innovation involves the participation of a private firm: operating in the VMT district, the cement company UNACEM finances the equipment given to the wastepickers involved in its corporate social responsibility programme (cf. Rateau, 2015). For the moment, out of the district's 1,230 wastepickers only 10 have been formalised. In all cases, the PSF-RS is still viewed as a "satellite programme"[3] in municipal waste management since its implementation is delegated to NGOs with national and international funding. Its sorting results are currently poor compared to those of the informal sector: 5% of all recyclables are collected by formalised wastepickers in Comas, 1.3% in VMT. These low rates should be weighed against the fact that the programmes are relatively recent (set up as from 2012). The reason for their poor performance is the households' lack of engagement due to either a failing collection service (Comas), or an unfulfilled promise to introduce an incentive scheme (the *Bono Verde*, in VMT). Yet, the programme is still lucrative for the municipalities involved and helps to launch a new dynamic for the capture of certain waste streams.

In a totally different perspective, other districts have adopted a showcase policy. Surco, a wealthy central district (355,986 inhabitants) has introduced municipal selective collection along the lines of European models (cf. Chapter 2.1.). In application of the Recycler's Law, the district has designed a minimal PSF-RS (which it only operates in reality in the district's less affluent areas).

Payment for avoided costs: an original approach in Bogotá

In Bogotá, the mission of collecting recyclables was withdrawn from private providers and reserved for wastepickers. According to the field surveys conducted under the ORVA2D research project, the 7,846 wastepickers remunerated in 2014 collected 270,352 tonnes of recyclable material that were weighed in authorised centres.[4] They were paid a total of €7,252,753, which represents a cost for the UAESP (Special Administrative Unit for Public

[1] Interview with Heduen Estrella Burgos, project leader on the programme for the NGO Alternativa, 2015.
[2] Interview with the head of the municipality's environmental department, 2015.
[3] Interview with Oswaldo Caceres, head of the programme, for the NGO Alternativa, 2015.
[4] Out of a total 2,340,095 tonnes of municipal waste collected, i.e. 11% of the total.

Services) of €27 per tonne of recyclable waste. In 2014, out of 925 tonnes of recyclable waste recovered daily, the vast bulk – 740 tonnes – was recovered by formalised actors.

The UAESP estimates that 56% of the city's territory is covered by formalised wastepickers (Rateau & Estrella Burgos, 2016). These continue to collect waste directly by searching through dustbins on pavements, even though the practice of source separation is on the rise. In fact, more and more households put recyclable waste out on the pavement in a separate bag. Through its *Basura Cero* programme and Integrated Waste Management Plan (PGIRS), the UAESP has launched communication and awareness-raising campaigns for residents to promote source separation. The goal is to encourage households to place their recyclable waste in white bags and their non-recyclable and organic wastes in black bags. The bags must be taken out the same day of the week so that wastepickers can pass by ahead of the collection truck. This is a marked difference from what happens in Lima. In Bogotá, the wastepickers are formalised but their practices are kept intact, whereas in Lima there is an attempt to change these. In Bogotá, the authorities are nonetheless trying to organise collection routes for an optimal coverage of the city.

The long-term objective is to have the formalised wastepickers organise themselves into cooperatives able to provide a classic service on a par with that of the formal businesses already on the market. The municipality aims to structure a comprehensive formal waste sector that the city can rely on for materials recovery.

The drive to control the entire chain, and the persistence of informality

One of the limits to the programmes underway in Colombia and Peru is that they do not provide for control of the whole recovery and recycling chain. Once formalised wastepickers have collected recyclable waste, they are free to sell it on to whomever they please, although in Bogotá they are required to weigh their waste in authorised centres in order to receive remuneration from the municipality. Municipalities are thus launching a second phase of trying to formalise the rest of the chain.

Comas is working with several buyers to integrate them into the formalisation process and channel the various waste streams. The municipality is also trying to upgrade the skills of formalised wastepickers and improve their working conditions by enabling them to have a small workshop where they can sort and package their wastes. They could then sell their waste at more advantageous prices. One of the difficulties is that the premises need to be large enough and comply with prevailing safety standards (particularly for fire-prevention). Formalised buyers commit to offer formal wastepickers favourable prices in order to encourage informals to enter the formalisation process. In 2017, the Comas authorities launched the construction of a waste transfer and sorting centre. Construction and management are ensured by a private company and the centre is designed to accommodate formalised wastepickers working on a 20m-long sorting belt. This type of centre is available to wastepickers' associations and designed to optimise the sorting stage.

The goal is similar in Bogotá, where the municipality plans to build several sorting centres to be made available to wastepickers. For the city authorities, the key issue is to resolve the difficulty of weighing the collected waste in view of remuneration. Currently, nothing prevents a recycler from having the same batch of waste weighed twice (and being remunerated twice over). In addition to increasing productivity, the objective is to group the sorting, weighing and buying of waste onto a single platform. In Bogotá, planning documents rely on a precise survey to estimate the number of intermediaries and even qualify the recyclable waste market as "oligopsonic" (i.e., a large number of sellers and small number of buyers). The dearth of

competition due to the very limited number of buyers allows industries to impose their prices. The municipality is well-informed about the different actors in the chain. This is an exception to the rule, as in all the other cases (notably Lima and Lomé) the authorities lack this knowledge and are not used to interacting with buyers.

Photo 6. An informal wastepicker (behind) is competing with a formal wastepicker (in front) in Comas © Rateau, ORVA2D, 2015

Although the formalisation process is underway, this has not put an end to informal waste-picking: in Lima, nearly 90% of recyclables collection is still informal. In Bogotá, the integration of informal actors comes at the price of competition with the new informal actors that replace them. Everywhere, the competition between formalised wastepickers and those who wish to remain independent is clearly visible. A large amount of recyclable materials are also diverted from formalised actors to the informal sector.

A similar phenomenon can also be seen with primary collectors in the African cities. In Lomé, primary collectors contracted by the city hall compete with informal actors who have carried out this task for decades and charge less for their services. However, as formalised primary collectors do not have the means to serve all of the population, the authorities tolerate the informal primary collectors who continue to offer their services to residents. In 2015, it was estimated that primary collection for 42% of the collection zones was carried out by informals.[1]

High-tech for the rich neighbourhoods, low-tech for the poor

The situation in Lima offers a very interesting example for an analysis of the notion of "low-tech". Each of the city's 43 districts has the power to make its own choice for waste collection. The 2009 Recycler's Law nonetheless requires them to implement selective waste collection using the services of informal wastepickers. To do so, two of the districts studied made two very different choices.

Comas, a poor district, applies the spirit of the law and relies on formalised wastepickers, notably by trying to help them self-organise around small cooperative sorting centres. In Surco,

[1] Focus group led by the NGO, Gevalor, in 2015.

the city's wealthiest district, the choice was more aligned with a model akin to that in global North countries – in other words, selective door-to-door collection by a municipal enterprise. The district then uses a municipal sorting centre equipped with conveyor belts and more advanced technology than that in Comas. Surco is currently building a larger and more modern sorting centre where sorting will be partly automated. In Comas, nothing of the sort exists. The finer sorting is done by the wastepickers themselves and thus requires more manpower.

	Comas ***(low-tech)***	**Surco** ***(hi-tech)***
Jobs created for 10,000 s*oles* spent	3.56	0.32
Jobs created for 100 tonnes collected	11.54	2.50
Quantities recovered for 10,000 s*oles* spent	30.88 t	12.73 t
Quantities recycled by worker	8.66 t	40.03 t

Table 5. Effectiveness of Comas' low-tech model and Surco's high-tech model

Table 5 summarises the effectiveness of the two systems promoted by Comas and Surco, integrating the costs of the selective collection programme in its entirety (equipment, personnel, sensitisation, etc.). The low-tech system in Comas seems more than twice as cost-effective in terms of municipal spending relative to collected tonnage. This model also creates 4.5 times more jobs per collected tonne. Environmental and social effectiveness is thus much greater in the low-tech system, at the same cost level for the local authority.

These findings of course need to be nuanced in terms of working conditions as these are not the same in Comas as in Surco. In Surco, although the workers are paid very little, the arduous nature of their work and questions of hygiene are better taken into account. However, informal wastepickers generally refuse to work in the Surco sorting centre, considering that the work is underpaid and too constraining. On the other hand, the main initiative taken by Comas municipality in formalising wastepickers involves equipping them and their workshops so as to improve safety (gloves, masks, fire extinguishers, first-aid kits, signage, etc.).

The choice of some cities to build a sorting centre (Bogotá is also envisaging this) greatly influences the organisational methods and jobs involved in selective waste collection. The job-creation argument always holds more weight in the public debate, as can be seen in France (Durand et al., 2016).

3. Surabaya's waste banks: creating ties between residents and recyclers

Waste banks – community-based waste sorting

In Surabaya (Indonesia), public policy turns a blind eye to the informal sector (unregulated activities) and encourages an official approach of community waste management (by residents). This is the rationale behind the creation of waste banks, designed to promote neighbourhood recycling. The initiative was driven by a national programme, Adipura, set up to reward cities that had environmentally virtuous waste management practices. Surabaya City won the national Adipura award every year from 2011 to 2015.

Photo 7. A primary waste collector in Surabaya © Cavé, 2016

The Adipura programme was launched by the Ministry of Environment in the mid-1990s and rewards cities that make the most efforts in urban environment management. The evaluation criteria include three main areas: *brown* issues (waste management, water and air pollution); *green* issues (green spaces and urban planning); and *white* issues (democratic participation). The contest is held every year and the participating cities are assessed by third parties (universities and NGOs). To win the award, cities now have to be equipped with a sanitary landfill and have set up waste banks (Ministry of Environment Regulation no.6/2014).

Photo 8. Waste bank with weighing scales in a Surabaya neighbourhood © Cavé, 2016

A blurred borderline with informals, despite the widespread roll-out of the system

In 2016, there were 400 waste banks across the city, defined locally as a "social engineering tool to involve citizens in waste sorting" (Cavé, 2016, p.48). The wastes deposited at the banks have been pre-sorted by households. The waste banks are managed at community level by a women's association. Each waste bank pays out its profits to residents as it sees fit, but most only make one payment a year, on the occasion of a religious festival (and during the cleanliness contest organised citywide). Some waste banks manage to remunerate their managers, thereby transforming a voluntary community activity into a real job.

Each waste bank then negotiates the purchase of its materials with the buyers: prices vary considerably depending on time and place. A waste bank sorts between 15 and 50 different types of waste materials to sell on directly to large buyers. Yet, these recyclable-waste banks, supported by the public authorities, are unable to function without recourse to the informal local traders who buy the waste. Waste banks thus represent the first step in formalising this sector.

To structure the chain, the municipality has encouraged the creation of a "parent" waste bank (Bina Mandiri waste bank) that buys waste from other waste banks. Managed by six volunteers, this "parent" waste bank actually only purchases waste materials from about 200 waste banks (50% even so). The others continue to sell to informal semi-wholesalers, who offer a better price, faster payment and a quicker response. In reality, the "parent" finds it difficult to channel all of the recyclables captured by the community waste banks to its own site. The community banks are often tempted to sell their materials to informal local traders, who offer better purchase terms: prices, frequency, payment terms, the variety of materials accepted, etc. (Cavé, 2016).

An innovative financing method for still limited tonnages

The city estimates[1] each waste bank's annual turnover from the resale of recyclable waste at between €20 and €330. This is equivalent to a yearly income of around €3 or €4 for each participating household. While some waste banks pay out their receipts directly to the residents, others use them to finance other local public services. For instance, the receipts can be deducted from water or electricity bills (also managed at community level). This can reduce bills by 20–25%. Other waste banks pay out in the form of discount coupons usable in local shops, thus helping to boost the local economy.

Although this programme is now financed by the city hall, it was for many years funded by the foundation of the multinational group, Unilever, which played a key role in developing the municipal public policy. The overall amount of its CSR (corporate social responsibility) programme is confidential but we know, for example, that the foundation contributed some IDR 400 million (about €27,000) in 2014 and IDR 300 million (about €20,000) in 2016 to support Surabaya's waste banks. In 2016, the foundation was supporting nearly 1,200 waste banks across Indonesia (Cavé, 2016).

There are no centralised data on the flows transiting through waste banks. In Surabaya, estimates suggest the figure of 3.3 t/day captured in 2014, equivalent to 0.22% of the tonnage that the municipality sent to landfill, or 0.62% of all of recyclable waste generated (Cavé, 2016). The volumes captured by these community structures thus remain limited compared to those collected by the informal wastepickers, who continue to capture the highest-value waste materials. Furthermore, although waste banks work very well in the *kampungs* – i.e., the

[1] Interview with the programme head, 2016.

traditional neighbourhoods home to a low-middle class –, they are much less successful in the wealthier, recently built residential blocks of flats and districts. All the downstream part of the chain remains outside the public authorities' jurisdiction despite their attempt to set up a "parent" waste bank. As a result, a robust network of informal wastepickers persists when it comes to recovering the bulk of recyclable waste.

An overall vision of decentralised waste management

Beyond recyclable waste recovery, a comprehensive system promoting the cleanliness of public areas has been operating since 2005. Composting, for example, was foregrounded, even though local waste banks had not yet been created. All of these initiatives are the result of the Surabaya Green and Clean programme rolled out with financial support from the Unilever Foundation.[1] The stated objective, based on the first eco-friendly *kampung* launched in the early 2000s, is to reduce waste at source through neighbourhood organisations by mobilising recycling and composting activities.

The triggers for this ambitious programme were the crisis sparked by the sudden closure of the Keputih disposal site in 2001, the long-run field experiments run by NGOs in liaison with the residents (notably Pusdakota and Unesa University) and Unilever's determination to implement a local project under its CSR policy. Partnered by the City of Surabaya, Unilever identified community "leaders" (relays within the RWs and RTs) on whom they could rely to sensitise the population and funded their training. Since 2005, a large annual contest has been organised citywide to (financially) reward the cleanest neighbourhoods. The programme was also promoted by 420 voluntary "facilitators" (with expenses paid and officially recognised) together with 28,000 community "leaders" trained in waste sorting and composting. In 2016, the programme was taken over by Surabaya municipality and 60% of neighbourhoods compete for the 118 prizes awarded each year (Cavé, 2016).

[1] This Anglo-Dutch agri-food group (Maille, Lipton, Amora, Knorr, Ben & Jerry's, Magnum, Cornetto, Hellmann's, etc.) reported net profits of over €5 billion in 2014. In Indonesia, Unilever's activities mainly involve exploiting palm oil from monoculture plantations covering thousands of hectares in Sumatra and Kalimantan, on land that had been covered until then by primary forest.

Chapter 3. What type of sink? Landfill or valorisation? Organics or energy?

The focus of the previous chapter was on waste recycling as this is one of the most developed and emblematic treatment methods for what is viewed as effective waste management. Yet, we should not forget that the most virtuous behaviour ecologically speaking is to reduce the actual quantity of waste – keeping quantities low in many global South countries. Other studies have analysed waste reduction and put forward recommendations on how to achieve it.

However, in addition to recycling, there are other ways of processing waste and, above all, of valorising it. It is best not to look for only one treatment method as a solution but possibly envisage several co-existing and complementary sinks for recovery or disposal. For stakeholders, the most important lever is their awareness and understanding of the whole gamut of available technologies. Experiences relying on a single sink have often led to failure, as in the emblematic case of the anaerobic digestion plant in Lucknow (Uttar Pradesh, India), which was forced to close prematurely on account of insufficient knowledge about informal waste-recovery channels (Cavé, 2015). Or again, the widespread challenge to having incineration as the only waste processing method in France (Luneau, 2012). In fact, the vision of a composite service using different technologies offers interesting perspectives.

Until the 2000s, the waste management strategy recommended in global South countries was removal and burial/landfill, in an effort to catch up the supposed “lag” compared to the global North. This strategy has largely shown its limits with the systematic saturation of disposal sites, the difficulty of controlling incoming quantities, and the recurrent disasters involving landslides, flooding, contaminations and health risks.

Of the six cities presented in this report, the only example where a different type of sink was chosen – incineration – resulted in significant problems (Delhi).[1] In global South countries, financial and technical constraints make the smooth running of this type of facility (requiring flue gas treatment and an adequate destination for clinker and MSWIR) almost impossible at an affordable cost. On top of this, Delhi met with strong opposition from the city’s wastepickers as most of the recyclable waste stock tended to be channelled to the incinerator (high calorific value wastes like plastics, paper and cardboard). It thus appears that to manage huge quantities of waste and ensure their optimal valorisation (even including energy recovery), the only solution is to use a range of treatment methods.

This third chapter aims to round off the analysis of the various waste treatment solutions and to characterise some of the innovations. The main point to ponder concerns the largest fraction of waste, which, at first sight, seemingly offers no potential for economically self-sustaining recovery: the “underbelly” of the urban waste stock. Granular knowledge of waste stocks leads us to challenge not only the relevance of landfilling waste but also recovering it as energy. On the other hand, given the typology of the predominantly organic waste, its recovery for agricultural use seems to offer a major development pathway, albeit one still underexplored.

[1] Which, incidentally, did not prevent other incinerator projects from being developed in Delhi and elsewhere in urban India.

I. A granular knowledge of waste stocks to adapt technological choices

The choice of which sink solution to use needs be grounded on as detailed a characterisation as possible of the waste stocks. What is important is to know the types of waste generated, their tonnage and where they are generated. On this basis, the most suitable process (for transport and processing) can be chosen and the equipment sized according to pre-defined recovery objectives. For example, to reduce dry waste at source, it would be more relevant to reason in terms of volume rather than tonnage. For recyclable waste such as plastic, tonnage quantities inadequately reflect the often very impressive volumes involved. More importantly, a volume-based estimation is undoubtedly more appropriate for evaluating the avoidable transport (particularly, for dump trucks with no compactor).

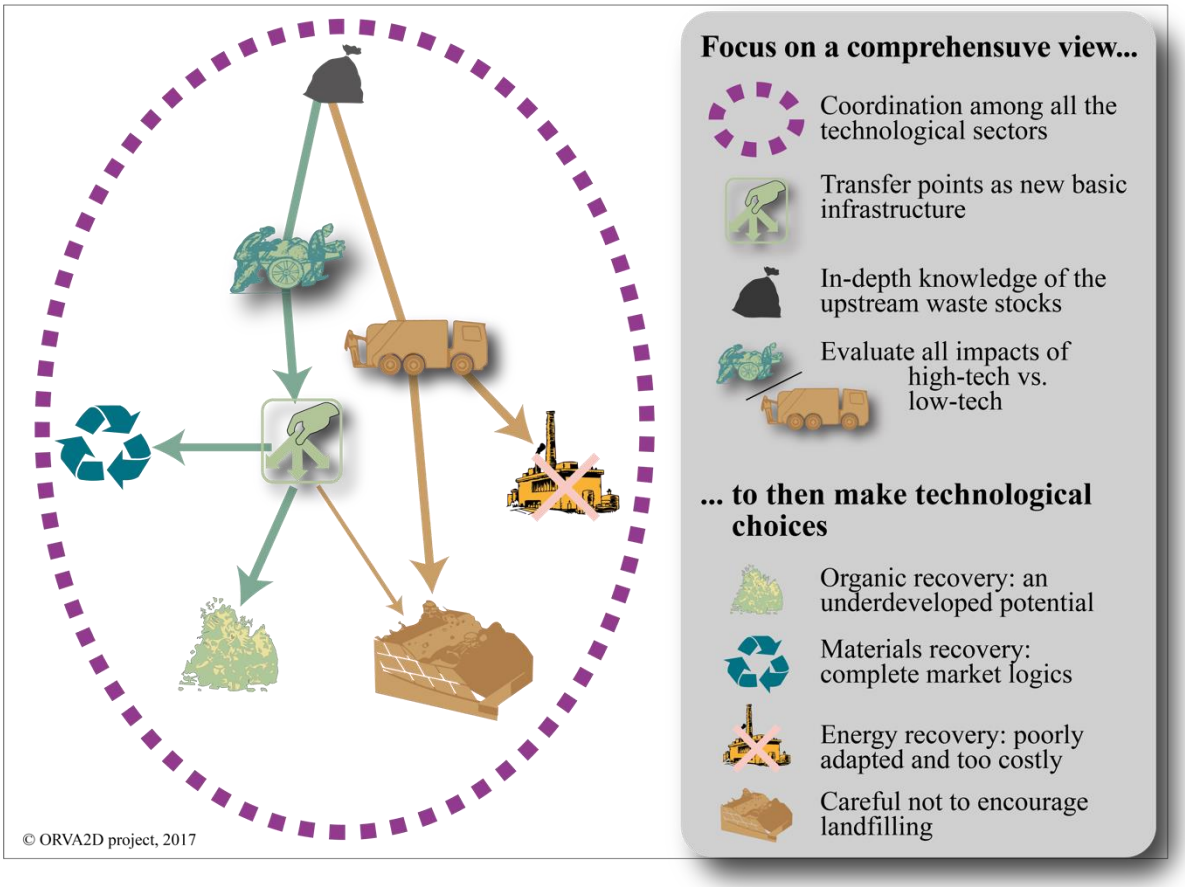


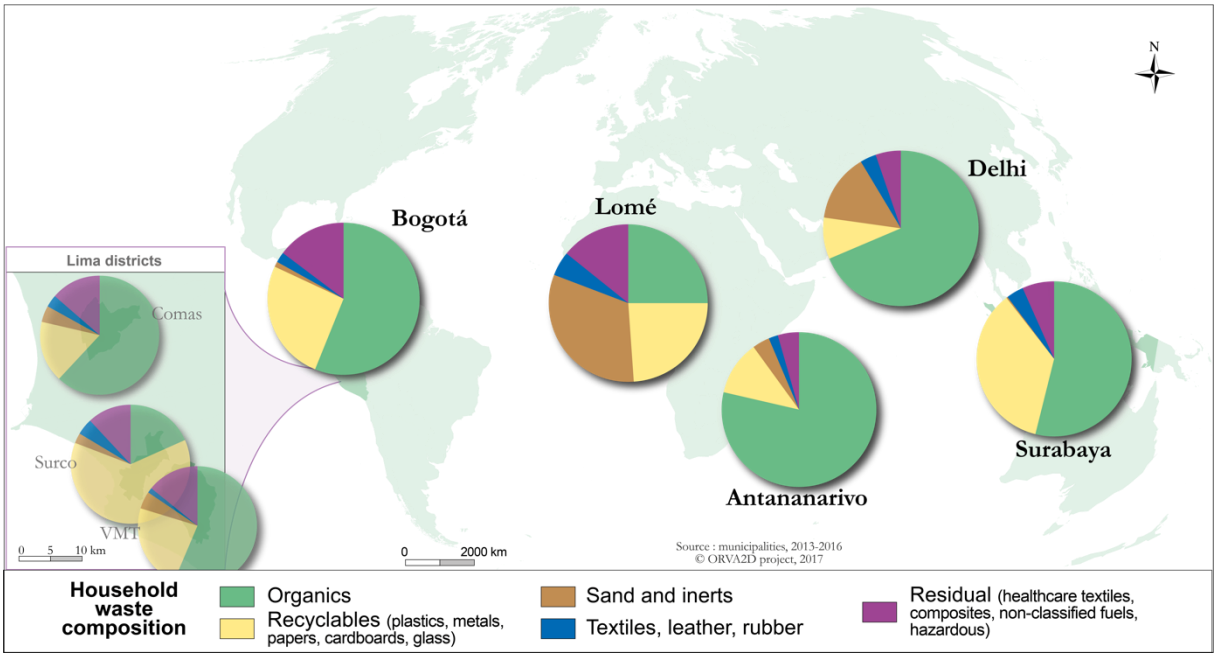
Figure 15. The technical levers for implementing waste recovery innovations

1. Typical waste composition in global South cities

In the past, lack of knowledge about waste types has been the cause of numerous failures. In fact, the bulk of waste in global South countries is composed of organic materials with very high moisture content and biodegradability, which induces a process of rapid fermentation and

a yields very low calorific value (LCV). Without these basic data, any attempt at energy or materials recovery is likely to be poorly calibrated.

Map 6 shows the types of waste found in the six reference cities. The characterisations were all carried out at the source, except in Delhi where it was done on entry to the treatment site (dumpsite), which explains the low presence of recyclables in the results (10%) as these are diverted upstream through recycling channels. This percentage is close to that for Antananarivo (11%), even though India's level of economic development is much higher (which, in principle, should yield a higher quantity of recyclables). There is also a large disparity between Antananarivo, where the fraction of organic waste reaches 79%, and all of the other reference cities, where percentages range between 52 and 62%. Only Lomé reaches an astonishingly low 25% for organics. In fact, the presence of organic materials in waste is an indicator of economic and industrial development: the quantity of organic materials being inversely proportional to the level of development. The reason for Lomé's low percentage may be either: a methodological error in the characterisation, diversion at source (households) of organics (individual composting), or the very large amounts of inert waste (sand) picked up during the collection stage.



Map 5. Composition of household waste in the six reference cities

Conversely, the higher a country's level of development, the higher the share of recyclable waste – pointing to higher consumption of manufactured products. The share of this waste ranges between 8% (Delhi) and 35% (Surabaya). Only Surco district (Lima) has a record production of recyclable waste, reaching 63%. This particularly elevated figure (higher than in France, for example) relates to two logics. First, consumption patterns in Surco, the wealthiest district per capita in Peru, are broadly similar to those in the global North. Second, it is the only district that has organised a municipal door-to-door selective collection service that captures most of the recyclable waste stock, whereas in the other districts recyclables are diverted into informal channels and thus less present in the characterisations. Finally, there is the question of inert waste, which is found in very substantial quantities in some cities. This often reflects

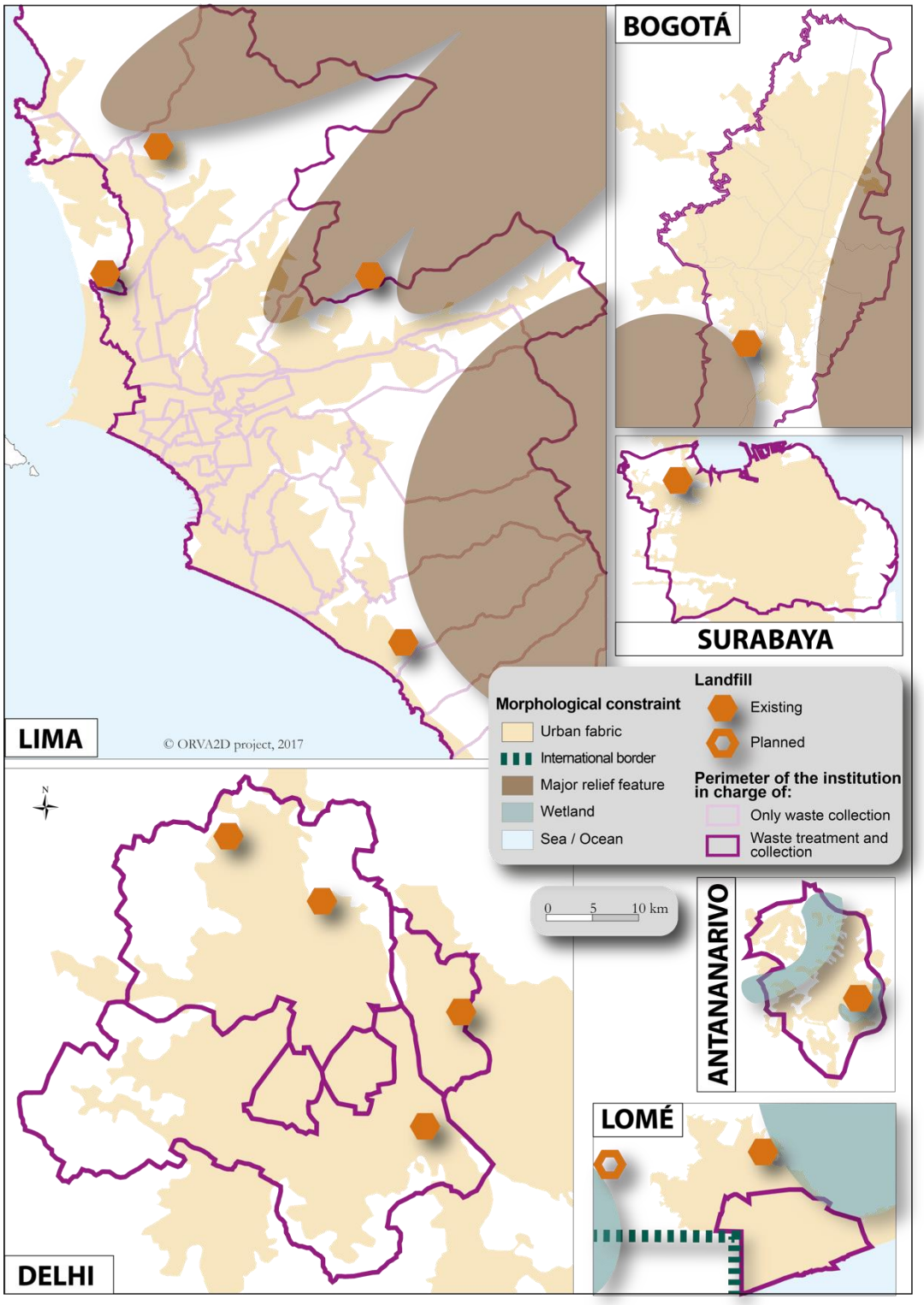
major dysfunctions in collection procedures: inflation of volumes and thus bills (Lima); malfunctioning transfer points, where waste is collected directly from sandy ground (Lomé); or poor maintenance of transfer points (Delhi). These inert materials represent a dead weight for transport and thus a cost, as well as a constraint for any recovery infrastructure.

2. Landfilling has never been a recovery method!

The identification of the urban waste stocks revealed their diversity and the very small fraction of "residual" waste, which, in theory, is the only type of waste requiring landfilling as the final solution. However, in practice, most of the stocks of collected waste end up in landfill. This increasingly involves sanitary landfills, or the simpler solution of municipal dumpsites with no real control of effluents. The only cities that still operate disposal sites that are not sanitary landfills are Antananarivo (a single controlled dumpsite) and Delhi (the oldest dumpsites). Landfilling is especially worrying as most of the sites quickly reach saturation point, which regularly causes landslides and accidents. This is notably the case in Bogotá, Antananarivo and Delhi (Lomé opened its new sanitary landfill in 2018).

Although there is a small potential for biogas recovery from landfilled waste, the recovery rate remains minimal relative to the quantities of gas produced. The main concern is to capture biogas to avoid explosions at the site, and to flare methane to convert it into carbon dioxide (methane's impact on climate being at least four times greater than CO_2). Landfilling cannot therefore be viewed as a waste-to-energy mechanism, even if designed as a "bioreactor".[1] Only the South American municipalities seem to be mainstreaming biogas recovery in their sanitary landfills. For the moment, the purpose of this recovery is not waste-to energy conversion, but to limit the impact of greenhouse gas (GHG) emissions by flaring the gas.

[1] A "bioreactor" accelerates the decomposition of organic waste by continually humidifying the waste with its own leachates (decomposition juice). The side effect of this process is that it also accelerates the production of methane, which is a greenhouse gas 25 times more potent that carbon dioxide.



Map 6. The constant race between disposal sites and urbanisation

For the countries studied (particularly India and in Africa), the challenge is to transform uncontrolled disposal sites into real sanitary landfills. The mid-term objective is to prevent pollutants from spreading into soil and groundwater. However, this crucial health-related

objective should not direct the public authorities' attention solely towards building landfill infrastructures. This approach generally leads to over-sized landfills and the destruction of existing recovery channels. While landfilling in good sanitary and environmental conditions remains a priority, it needs to be implemented in parallel to waste recovery efforts and not to their detriment.

As in Bogotá since 2014, most "zero-waste" policies worldwide have emerged amidst tensions over the extension/creation of disposal sites (Sidibe, 2015). The fact that these sites have become saturated is now a positive driver for new waste recovery and reduction practices. Global South countries have some lead in avoiding waste generation due to their consumption patterns and production methods. This allows landfills to be minimally sized and helps to abate tensions.

II. Caution required with energy recovery

Be it the capture and recovery of landfill biogas or incineration, decision-makers view energy recovery as a simple solution (being centralised and linear) that helps to resolve the problem definitively (as waste volumes are significantly reduced). The development of incineration along with energy recovery has also helped to move this technology forward as it produces electricity or heat from waste (instead of fossil fuels, which contribute to climate change). Yet, the global North countries (e.g., in northern Europe) that have mobilised this technology on a large-scale have now started to limit its use as the recovery is less complete than recycling or composting. Moreover, exploiting this technology to a maximum is at odds with the injunction to reduce the amount of waste (Rocher, 2008, Wilts & von Gries, 2015). Plans to develop incineration need to take into account the complex interactions among actors whose livelihood depends on waste recycling, as well as local environmental impacts caused by the residues of this treatment method (leachate infiltration, production of clinker, MSWIR, etc.) and global environmental impacts (GHG emissions, destruction of secondary raw materials).

1. Incineration: limited success for managing very large waste stocks

Incineration has made its way into global South countries as it compensates for the lack of landfill sites in very dense urban areas. Yet, the waste composition (high moisture content) greatly complicates implementing this technology. In all cases, the cost of incineration with adequate flue gas treatment is certainly much higher than that of other treatment methods and proves burdensome for cash-strapped municipalities. Attempts to finance incineration by selling electricity have systematically failed, as feed-in tariffs remain very low (de Bercegol, 2016).

Following the crisis sparked by the saturation of disposal sites, one of the solutions envisaged in Delhi was to build three incinerator plants (one for each municipality in the city's outer suburbs). Delhi's public authorities called on large private Indian groups to build and operate the three incinerators. The first incinerator[1] has been running since 2012. However, the opening of both the Ghazipur incinerator by ILFS (1,300 t/day,10 MW) and the Narela-Bawana incinerator by Ramky (4,000 t/day, 24 MW) was delayed several times for technical reasons until their recent opening in 2017. Only the Okhla incinerator managed by Jindal (2,500 t/day,

[1] A first incinerator was in fact built in 1984 by Danish cooperation but never operated (as the waste was too wet).

16 MW) has been effectively operational since 2009. It nonetheless runs at reduced capacity due to technical problems mainly caused by the quality of incoming waste (high percentage of inert and organic wastes and, to a lesser degree, clinker). For instance, due to the poorly adapted technology, the process for refuse-derived fuel (RDF) has been abandoned in favour of simple furnaces that dry the waste before it is burned.

The situation in Delhi has been marked by the arrival of powerful national companies operating in the energy recovery business. These players now want control over the upstream service in order to control the waste streams entering their facilities. The incinerator operators would like to see private door-to-door collection introduced in the hope of limiting the "skimming" of highly calorific materials by informal wastepickers. This would, however, mean that the informals, who also want to recover waste, would be deprived of their economic activities.

Added to this is the legal challenge from emerging coalitions of opponents who are demanding a halt to incineration technologies and criticising them as polluting and dangerous. A collective comprising residents, environmentalist movements and wastepickers associations[1] has taken legal action to have the Okhla incineration plant closed down. Some opponents proceeded on the grounds that the facility's environmental impact is not totally under control,[2] while others highlighted that operating such facilities creates a voracious need for waste that has hurt the materials recovery activities formerly carried out by thousands of informals.

Although the Delhi incinerator is not cost-effective, its cost is very low (27 €/t) compared to European plants (120 €/t), which indicates that the expensive operations to depollute flue gas and clinker are not implemented. If flue gas cleaning is deficient – which is a high risk when operating the infrastructure under difficult conditions –, the functioning of these incinerators may exacerbate an already disastrous situation for Delhi's air quality. Finally, the economic operating model has so far not proved cost-effective, as the cost of the waste-to-energy process is higher than the cost of generating electricity in thermal power plants, and thus unattractive. In 2016, the operator Jindal announced that it wished to negotiate a new contract to sell its electricity at 6 rupees/kWh (instead of current price of 2.5 rupees), which would enable it to cover the depreciation and operating costs for its plant (de Bercegol, 2016).[3]

2. Refuse-derived fuel: a by-product of waste separation

In Mahajanga (Madagascar), the city's household waste composting plant converts wood (baskets, green woody waste, etc.), paper and cardboard waste into solid fuel, but does not process plastics. These materials can be considered as refuse-derived fuels (RDFs), currently

[1] Safai Sena (which groups together primary waste collectors), All India Kabadi Mazdoor Mahasangh (which groups together itinerant waste buyers and local traders), NGOs advocating environmental justice such as Chintan, Hazards Centre, Toxics Watch Alliance and Global Alliance for Incinerator Alternatives (GAIA).

[2] According to those opposing the incinerator, as organic waste does not burn easily, little of this waste will ultimately avoid being sent to disposal sites. The emissions produced by combustion are not taken into account, even though they appear to be significant (Toxics Watch, 2016). Installing waste incinerators would thus actually worsen the already catastrophic quality of air, the concentration of fine particles being nearly 15 times higher than the standards set by the World Health Organization. In addition, the incinerators operating in 2015 send clinker, ash and MSWIR to open disposal sites, which is a significant source of air, soil and water pollution. Lastly, the NGO Toxic Watch Alliance states that, despite the inspections conducted by the Pollution Control Board, this pollution cannot be fully evaluated since the Indian laboratories entrusted with these verifications are not equipped to detect the presence of the released heavy metals, dioxins and furans (http://www.toxicswatch.org/2016/06/twas-submission-on-violation-of.html).

[3] Since then, the Indian government has mentioned increasing the feed-in tariff, but this has not materialised since the country's rise of solar energy tends to keep electricity prices below 5 rupees/kWh…

viewed in France as a new opportunity for a waste-to-energy solution. The process involves recovering rejects from sorting centres or by-products from waste processing (such as woody waste from composting in Madagascar) to produce fuel. Only dry wastes are channelled into this process, which creates an obvious risk of competition with materials recovery activities. In Madagascar, production of these alternatives to wood-fuel yielded 300 tonnes in 2016, earning the recycling company, Madacompost, revenues equivalent to those it earned from compost sales. This also gives Madacompost access to carbon credits, as this valorisation helps to reduce methane emissions.

3. Gasification: at the end of utopia

Other energy recovery methods are also being explored, such as gasification. In Surabaya, a contract was signed for a project to build a gasification power plant in 2018 (Cavé 2016), and solid waste recovery is under study, particularly in Lomé. Following similar trends, discussions are underway in several of Brazil's southern states[1] (notably Paraná) to integrate this technology into their regional waste management plans. Heated low-tech/high-tech debates are taking place around this technology, which is still mastered to a far lesser degree than incineration and used by only a few cities in rich countries (notably Japan) for MSW management.[2] These still costly and globally underdeveloped technologies designed to recover energy mostly from recyclable or compostable wastes may come up against the same limits as incineration in Delhi. In the Indonesian case, the gasification project (still far from completion) is likely to compete with the organics recovery system currently in place (Cavé, 2016). Moreover, this technology, which is highly complex to implement in global North countries (only Japan has developed it on a large scale), is nowhere to be found in global South countries. The main brakes on this method of energy recovery are the types of waste (too wet to be burnt) and the maintenance of the infrastructure, which uses highly sensitive and costly technology. As a result, the risk of dysfunction is extremely high.

In addition to the enormous long-term costs incurred, the main risk of an over-reliance on this type of technology is that it may enter into competition with the recovery of recyclables (as it requires the most easily combustible wastes). The example of Delhi shows that the two sectors inevitably experience tensions in the medium-term.

III. The underestimated potential of organics recovery

Organic waste should be at the heart of public action as it represents at least 50% of household waste stocks – and in some cities as much as 80%. It thus constitutes the bulk of waste in municipal collection and landfills. Since bio-waste carries potential health risks, it is vital to encourage rigorous local waste management so as to prevent the concentration of pathogenic vectors. Several processing techniques may be envisaged.

The first technique is the recovery (via composting or anaerobic digestion) of pre-sorted waste. This means collecting bio-waste at source, which poses many technical and financial hurdles (mainly transport-related), although various methods for composting raw waste are now

[1] Solid waste management workshops organised in 2016 in Curitiba by Le Mans University together with Paranacidade.

[2] www.bioenergyconsult.com/gasification-municipal-wastes/

possible when the portion of organic waste is large. The second technique, which is still not officially mainstreamed but holds considerable potential, is decentralised community composting within neighbourhoods. The third organics recovery method involves extracting *terreau* (i.e., screened dump waste containing biodegraded matter) directly from an existing disposal site.

The most effective initiatives implement composting on multiple scales: household, neighbourhood and city. This multi-scale approach means that different waste stocks can be captured using diverse technical and economic mechanisms involving many stakeholders.

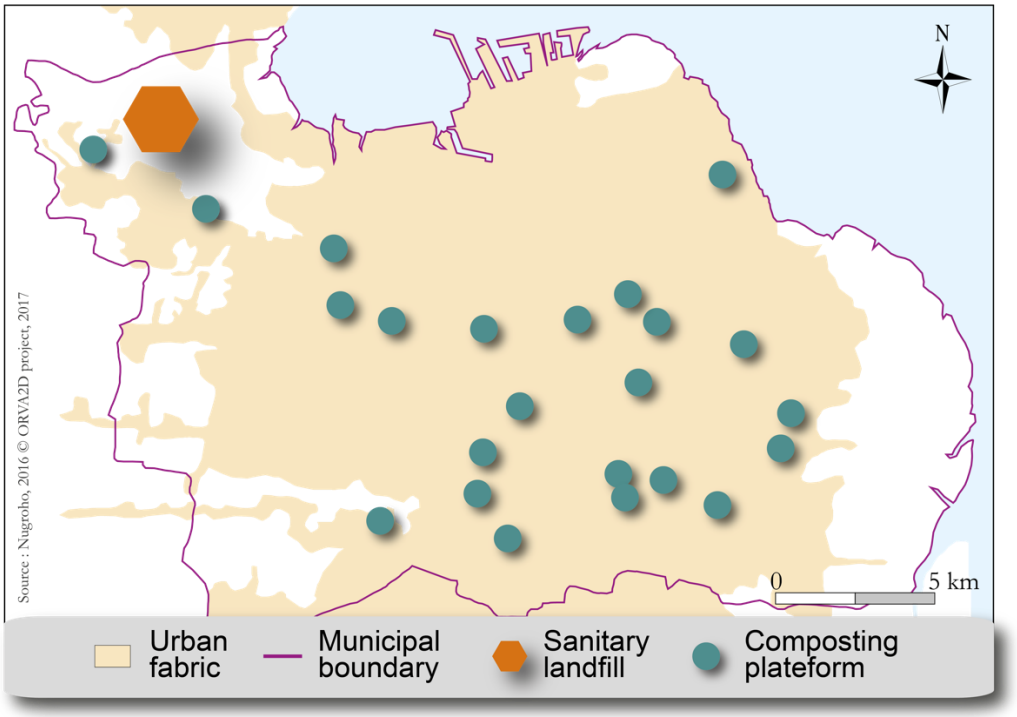
1. Composting units: channelling specific streams (green and market waste)

Composting segregated waste: a guarantee of good-quality compost

Delhi's first composting plant was set up by the municipality in 1985 in Okhla on the city's southern outskirts. Designed for a capacity of 150 t/day, it proved barely cost-effective and closed down from 1991 to 1995, before a Supreme Court directive ordered its re-opening. Following this, two other composting plants were built in Bhlaswa in 1998 (500 t/day) and in Tikri in 2001 (125 t/day), but proved unsuccessful (they were closed in 2015 and 2013 respectively). Today, the Okhla plant (with a theoretical capacity of 500 t/day) is operated by a private company: the build-operate-transfer (BOT) contract with the municipality provides waste treatment for the city free of charge. It is not operating at full capacity since the incoming waste streams are not homogeneous (sorting is on-site and not upstream), which impairs the quality of the compost (many undesirables), and market outlets are lacking (few buyers). The only way to balance the composting budget would be for public procurement to buoy up the sales price. New legislation provides for subsidies to support compost production and sales. The Ministry of Chemicals and Fertilizers could commit to co-marketing compost and fertilizer: selling 35% of compost and 65% of chemical fertilizer. For the moment, some of the output is distributed to the company, Mother Dairy, which resells the compost at a very high price (19.5 rupees/kg, equivalent to 280 €/t) in its many dairy produce retail outlets across the city.

After the "flood of waste" caused by the premature closure of the polluting municipal disposal site at Keputih in 2001, Surabaya municipality rolled out an organic waste recovery policy based on the creation of decentralised composting units and the promotion of household composting. In 2016, 23 composting units were operating across the city with an average capacity of 2 t/day for each unit, equivalent to 19,000 t/year for all units combined (around 2% of the waste generated by the city) (Cavé, 2016). The treated waste comes from the city's green spaces, the municipal plant nursery and food markets. As the waste streams are homogeneous, the compost is of good quality and used for urban green spaces or given to schools and communities.

Photo 9. Municipal composting units in Surabaya © Cavé, 2016



Map 7. Spatial distribution of Surabaya's composting units

Organic recovery is relatively well-developed in Antananarivo compared to other large African cities, as attested by the composting units sited around the wholesale market in

Andravoahangy, in the Amboditsiry *fokontany*, Antanimena nursery, and in the private composting facility of Vohitra Environnement (Lecointre, Breselec & Pierrat 2015).

In Bogotá, efforts to recover organics from markets are underway. Forty-four food markets have been listed, including 19 owned by the municipality and managed by the Institute for Social Economy[1] *(Instituto Para la Economía Social* - IPES). These markets produce 24,276 tonnes of waste per year, equivalent to a daily total of 67 tonnes. This waste is composed of 89% vegetal organic waste (Hermida, 2014). In this case, the UAESP has partnered with the IPES and FUNDASES (*Fundación de asesorías para el sector rural* – Foundation to advise the rural sector) to set up a pilot project to recover market waste. So far, only four markets have joined the project: Ferias market, Doce de octubre, Siete de agosto and Quirigua. The recyclables are given to a wastepickers' association and the organic waste is collected by the company, Compostagro Willys. In return for their participation in the project, the markets receive an 80% reduction on their waste collection bills for avoided costs. Each day, four tonnes of organic waste are collected for composting and vermicomposting at a unit located outside the city (Mosquera municipality). FUNDASES then markets the compost and transfers 15% of its receipts to the UAESP, which then distributes them to residents in the vicinity of the Doña Juana landfill site. This unit lacks the capacity to compost waste from other markets in Bogotá. Thinking is thus underway to develop new composting units of this type.

In Lima, similar waste composting operations only began in 2018 at the initiative of some district municipalities (Comas, Los Olivos, etc.). Results are very different for each of the city's 43 districts.

Composting raw waste: a viable technique under certain conditions

Composting raw household waste raises the challenge of how to avoid the presence of undesirables (pieces of glass or plastic) or heavy (toxic) metals in the compost output. Given that organising selective collection of household bio-waste is not always easy, the composting chain has to be structured so that the quality of the compost produced is ensured. The following solutions have been tested successfully under Gevalor's Africompost[2] programme in Lomé, Dschang, Mahajanga and Bouaké:

- Handpicking on entry to the disposal site: this is done on a table in Lomé, Bouaké and Dschang, and on the ground in Mahajanga. This is *negative* sorting to remove plastic, glass and hazardous waste (particularly batteries or chemical waste responsible for heavy metal contamination). In Lomé, it also allows the high sand content to be separated out as this would impair the compost quality. To this end, the sorting table has sieve-like holes. The (mainly) organic fraction of household waste available after sorting is then composted.

- Continuous handpicking: during the turning of compost windrows (5 to 7 turnings over the composting cycle), the undesirables that had escaped the first sorting are removed. The

[1] An institution created by the municipality of the Capital District of Bogotá and dedicated to providing economic support to informal activities.

[2] The Africompost project is financed by AFD, FFEM, the Suez Environment Fund and the sale of carbon credits organised by the Good Planet Foundation and the associations Gevalor and ETC Terra. The project supports the development of organic waste composting stations in five large African cities. Sorting and composting helps to improve the local household waste management, while also reducing environmental impacts In parallel, compost production fosters more sustainable local agriculture and brings with it job creation for the most deprived populations.

handpicking and turning thus help to guarantee the compost quality but also incur costs as this work represents the bulk of the labour costs.

- Screening on exit: the final screening of the compost separates out most of the remaining undesirables. Depending on the consumers' requirements, the screening can be coarse or fine (in theory, the latter is more expensive). This nonetheless is likely to reduce the organic matter content of the compost (most of which is present in the coarser elements). This strategy also seems to be used in Delhi where compost products are being developed according to their different levels of quality.

- Temperature monitoring helps to assess the level of pathogens in the compost produced. The recorded temperatures serve as a guarantee of the compost's safety.

Analyses carried out in three of the cities show that the concentration of metallic trace elements in lower than the level required by the French standard (NFU 44-051). In the Africompost units, composting the organic fraction of raw household waste is combined with the composting of market, green or agri-food industry wastes to improve the quality of the compost produced.

2. Neighbourhood composting: community-led management of domestic bio-waste

In addition to the municipal composting units, Surabaya municipality has distributed a vast number of domestic compost bins for organic household waste. Between 2005 and 2010, considerable community efforts were made to promote this practice: nearly 20,000 household composting bins were distributed mainly thanks to the involvement of women's community associations and contests to reward the cleanest neighbourhoods. A study published in 2010 assessed the waste reduction gained by composting at 80 t/day, equivalent to 6% of landfilled waste at the time (Maeda 2010). However, this figure was likely overestimated as some surveys seem to show that only 5% of the composting bins were still used in 2016, meaning that a maximum of 1,500 t/year were actually treated (Cavé 2016). The municipality reported that momentum was waning and that ne activities were needed to raise awareness on composting.

The combination of the three approaches in Surabaya City (decentralised composting of green waste, composting of raw waste[1] and individual composting) shows the municipality's real commitment to reducing the amount of waste sent to landfill. Several factors appear to be positive: the composition of the waste (green spaces supply a large fraction of the organics in household waste); Surabaya's urban sprawl: by increasing the number of small units (500 m^2), the local authorities make good use of vacant urban land and helps to reduce waste transport costs. The SuperDepo was set up in the neighbourhood the furthest away from the landfill site in order to reduce transport costs. However, it is not operating at full capacity. The main limit to this approach is that the households involved in community composting are unable to sell it, which is also why composting is not undertaken by waste banks that deal with resalable recyclable waste. Composting is implemented more in line with a vision of collective neighbourhood leadership. One of the composting centres managed by Japanese cooperation is trying to sell the compost, but for the farmers located over 100 kilometres away it is seen as too expensive.

[1] Example of composting at the SuperDepo pilot-project.


Photo 10. Neighbourhood greening (left) thanks to community composting (right) in Surabaya © Cavé, 2016

In Delhi, there are also one-off experiments in decentralised community composting (Defence Colony – 1,000 households, New Moti Bag – 1,100 households) with source separation of organic waste, but these are on a very small-scale. The Indian Railways company also composts the organic waste from its dining cars, in the city centre.

Community composting has also developed around the RF2 primary collection scheme. Several community composting units have thus been created in collaboration with NGOs, such as the unit set up by ENDA[1] in 2016 for 50 households in one of city's districts. With no resources available from city hall, the unit's success basically depends on ad hoc support from external NGOs. The results thus differ greatly across districts, making it impossible to obtain a quantified view for the whole of the city. There are no statistics on the scale of these initiatives or the tonnages treated. However, "compared with the other cities studied, such as Dakar or Addis Ababa, this type of organic waste recovery is particularly well-developed in Antananarivo" (Pierrat, 2015). Yet it could be surmised that, as in the case of Surabaya, the widespread development of decentralised community composting units could have a significant impact. This is the purpose of the project AULNA (*Agriculture Urbaine Low Space No Space*) supported since 2011 by the Institut des Métiers de la Ville in Antananarivo, with assistance from the French Institute for Development (IRD),[2] French Cooperation and the Ile-de-France Region. The project develops micro-gardens and micro-market gardens in dense, popular neighbourhoods. This type of composting is easy to manage as the compost is re-used directly for community gardens (numerous in Antananarivo), whereas a centralised composting unit may well find it difficult to develop a farming clientele willing to buy its compost (mainly due to transport costs).

[1] ENDA is an international non-governmental organisation working to fight poverty, preserve the environment and promote citizenship.
[2] French public institution for research, expertise, training and knowledge-sharing.

Photo 11. Community composter at the Ambatomaity garden in Antananarivo (50 households) © Pierrat, ORVA2D, 2015

3. The extraction of screened dump waste (*terreau*)

A poorly controlled but effective product

In addition to composting, organic waste can also be recovered directly from wild dumpsites. In Lomé, degraded material is sieved to produce screened dump waste, also known as "*terreau*", a mixture of sand and organic materials. Some dozen micro-businesses are involved in this activity and move around as and when the dumpsites have been treated. Urban growth in the Greater Lomé area suggests that the city will still have a stock of available waste for several years in the future. The main consumers of *terreau* are people wanting to grow lawns, embassies, some hotels and other luxury complexes for use on their green spaces. The environmental impact of this type of recovery is poorly controlled and not analysis is carried out to ensure the absence of heavy metals and other pollutants. Although *terreau* is a lower-quality product than compost, it is easier to sell: its affordable price (FCFA 5,000/tonne compared to FCFA 24,000/tonne for compost) suits consumers cultivating ornamental greenery (Garnier, 2016). For *terreau* producers, it is a highly profitable activity. The quantity of *terreau* screened by a micro-enterprise can reach up to 3,000 t/year.

Photo 12. Screening dump waste in Lomé © Gevalor, ORVA2D, 2015

In Antananarivo, *terreau* production and composting activities have been operating for many years on the landfill site and in the city. The organic content of the waste is very high (nearly 80%) both in household rubbish and the skip containers located near the markets (Raharinjanahary, 2015). Between 1969 and 2002, the on-site operations of the official composting units were often unsuccessful due to problems of design (notably, a dangerous glass-crushing process) and maintenance, which led to insufficient production rates (800 to 3,200 t/year). The site has been organised around the production of *terreau*. This activity was initially launched with the arrival of Father Pedro and his Akamasoa association, which finds adequate commercial outlets selling to individuals (for market gardening or care of private gardens). A similar offer is proposed by informal workers who settled there in the 1990s. Some twenty informal workers are still on the site. More recently, the private company STOI Agri has developed manual activities for the production of *taroka*, a product made from a mixture of fermented organics and screened dump waste (95% of *terreau* enriched by 5% of compost), which is described by its producers as a "high-powered *terreau*".

A potential for decongesting landfill sites

Given the difficulty of setting up a composting unit in Antananarivo, excavation of the saturated Andralanitra landfill site, along with production of screened dump waste, is viewed as a viable solution by SAMVA and Gevalor (2015). The old mountain of waste is mostly composed of decomposed organic materials (organic waste in Antananarivo represents 79%). The scenario under study would require excavating 700,000 m³, which would free up space for two additional years of operation. This scenario supposes the construction of a composting unit for raw waste at the site entrance. This would be equipped to treat the bulk of new incoming waste as the quantities to be landfilled would need to be reduced so that the space made available by excavation fills up less rapidly. Three scenarios that combined the composting activity and the excavation project were chosen. The first supposes that 25% of household waste is composted during the excavation works; the second increases this to 50%, while the third aims to treat 100% of household waste by composting. The detailed results are shown in Table 6.

	Without a composting unit	If 25% of the waste is treated on a composting unit	If 50% of the waste is treated on a composting unit	If 100% of the waste is treated on a composting unit
Waste quantities to be buried per year *(raw waste or composting rejects)*	174,720 m³	148,512 m³	122,304 m³	69,888 m³
Quantities of non-treated waste	174,720 m³	131,040 m³	87,360 m³	0 m³
Volume to be extracted and screened per year to extend the required landfill capacity	313,118 m³	266,151 m³	219,183 m³	125,247 m³
Increase in the useful life of the landfill if 700,000 m³ are excavated	2.2 years	2.6 years	3.2 years	5.6 years

Table 6. Extension of the useful life of the Antananarivo landfill through excavation and composting of incoming waste

Given the estimated volume of waste currently stored on the site (2 million m³), the excavation operation could be renewed twice. If 50% of the waste entering the Andralanitra site were channelled to a composting unit, an extension of almost seven years (2 x 3.2 years) of the site's useful life could be envisaged, while waiting for the opening of a sanitary landfill. The combination of the two activities nonetheless assumes that the huge quantities of extracted *terreau* would be used for public projects (reforestation, regeneration of infertile soil, etc.) and not put up for sale. In the contrary case, the sale of the *terreau* would compromise compost sales given that the *terreau* would be sold at a much lower price due to its lesser quality for agricultural use. With a view to testing the excavation works, SAMVA conducted a topographical study of the landfill in 2017 and core sampling of the waste mountain to check the composition and safety of the screened dump waste. It will also be crucial to carry out a preliminary excavation pilot project to determine the technical and economic components.

Chapter 4. Waste and financing: what innovations?

Solid waste recovery is often presented as facing mainly technical challenges. The previous chapters have shown that these are closely interlinked with territorial, social and governance issues. To this we should add the economic dimension, which imperatively needs to be controlled in any waste management system that aims for sustainability. The detailed case studies in this report describe many economic and financial innovations that help to finance a waste recovery service.

This fourth chapter thus begins with an overview of the costs incurred by the different stages of waste management in the six case studies presented, then relates these costs to the effective service quality and the quantities treated by each of the final recovery or disposal methods identified in the previous chapters. Next, the goal is to understand how the service is financed and identify innovations in this area. We round off the chapter by highlighting the key enablers that can leverage the financial dimension of waste recovery in global South countries. These levers involve controlling and balancing budgets, seeking to make recovery profitable, and redefining the perimeter of the public service so as to compensate for the impossibility of financing the whole sector through public funding.

I. Waste management costs and the quality of service provision

1. Overview of the costs and quantities of managed waste

The costs of production and provision of waste management services

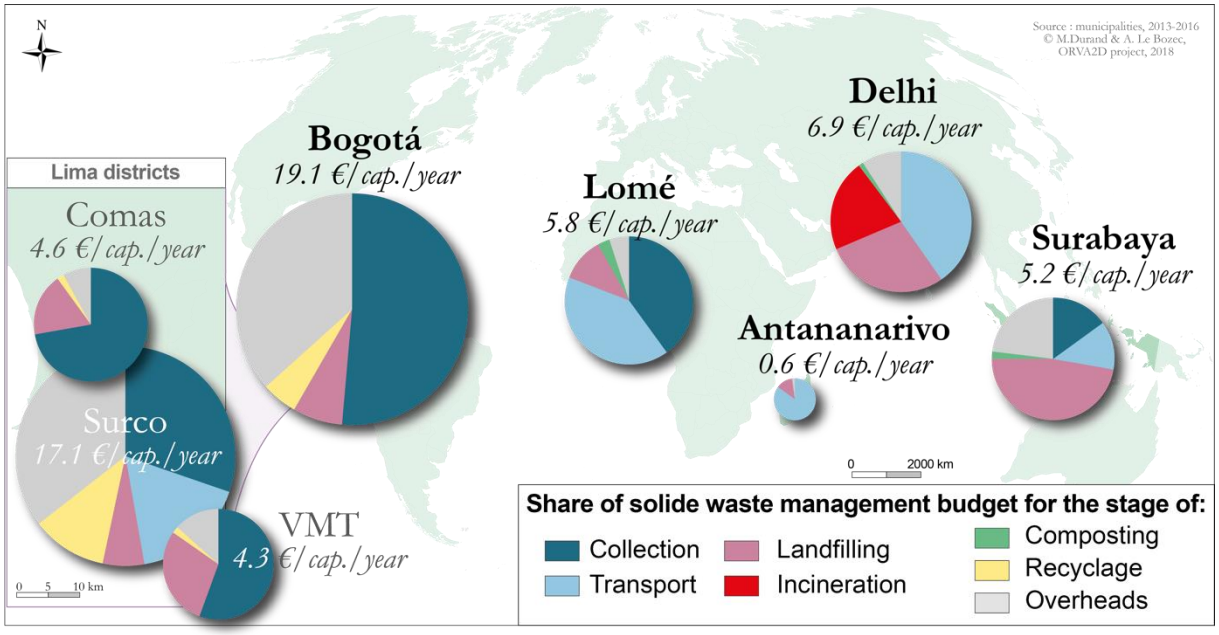
The data collected from the municipalities did not allow the production costs of public waste management services to be calculated with any precision. The figures reported below are most often the costs of contractors' service provision. This means that comparing them involves a real degree of uncertainty, but it does allow an analysis of the main trends. For Lomé, future costs relating to the commissioning of the new sanitary landfill were estimated.

City	Techniques	Collection	Transport	Treatment	Total
		€/t			
Bogotá	C_{d2d}+SL	32.9	-	4.9	37.8
Lima (Surco)	C_{d2d}+T+ SL	12.6	7.0	2.9	22.5
Lima (Comas)	C_{d2d}+ SL	11.2	-	2.9	14.1
Lima (VMT)	C_{d2d}+ SL	11.2	*in SL*	7.8	19.0
Delhi Delhi	pC+T+WTE pC+T+UDS	- -	5.5 5.5	27 N/K	32.5 N/K
Surabaya	pC+T+ SL	(2.3)	1.9	8.4	12.6
Antananarivo	pC+T+UDS	-	6.0	1.6	7.6
Lomé*	C_{d2d}+ SL	19.8	-	8.5	28.3
Lomé*	Pc+T+ SL	-	9.9	8.5	18.4

Table 7. Costs of collection, transport, incineration and landfill activities

Lomé*:	new SL (projected figures) for the part of the city served by primary collection
Surabaya:	(cleaning cost) as there is no secondary collection (only primary collection)
C_{d2d} =	Door-to-door collection
pC =	Primary collection
T =	Transport
UDS =	Uncontrolled dumpsite
SL =	Sanitary landfill
WTE =	Waste-to-energy (plant)
N/K =	Not known

The cities where only transport is indicated, with no collection, are those where door-to-door collection has been replaced by primary collection.



Map 8. Costs of collection, transport, incineration and disposal

Table 8 and Map 9 report the costs per tonne of waste. The following table focuses on the expenditure per capita. Due to the different calculation modes used in these two methodologies, as well as the relative imprecision or lack of data, it was not always possible to obtain similar ratios for these two types of information. Nonetheless, the underlying logics are the same.

City	Components of service provision expenditure (%)						Expenditure in €/cap./year
	Collection	Landfill		Composting			
		Transport	Incineration			Recycling	Service
Bogotá	52	-	7 (SL)	-	-	5	19.1
Lima (Surco)	30	17	6	-	-	11	17.1
Lima (Comas)	73	-	18	-	-	2	4.6
Lima (VMT)	55	-	29	-	-	2	4.3
Delhi	-	40	28	21	1	-	6.9
Surabaya	15	13	47 (SL)	-	2	-	5.2
Antananarivo	-	85	13	-	-	-	0.6
Lomé	40	41	11 (SL)	-	3	-	5.8

Table 8. Components of service provision expenditure

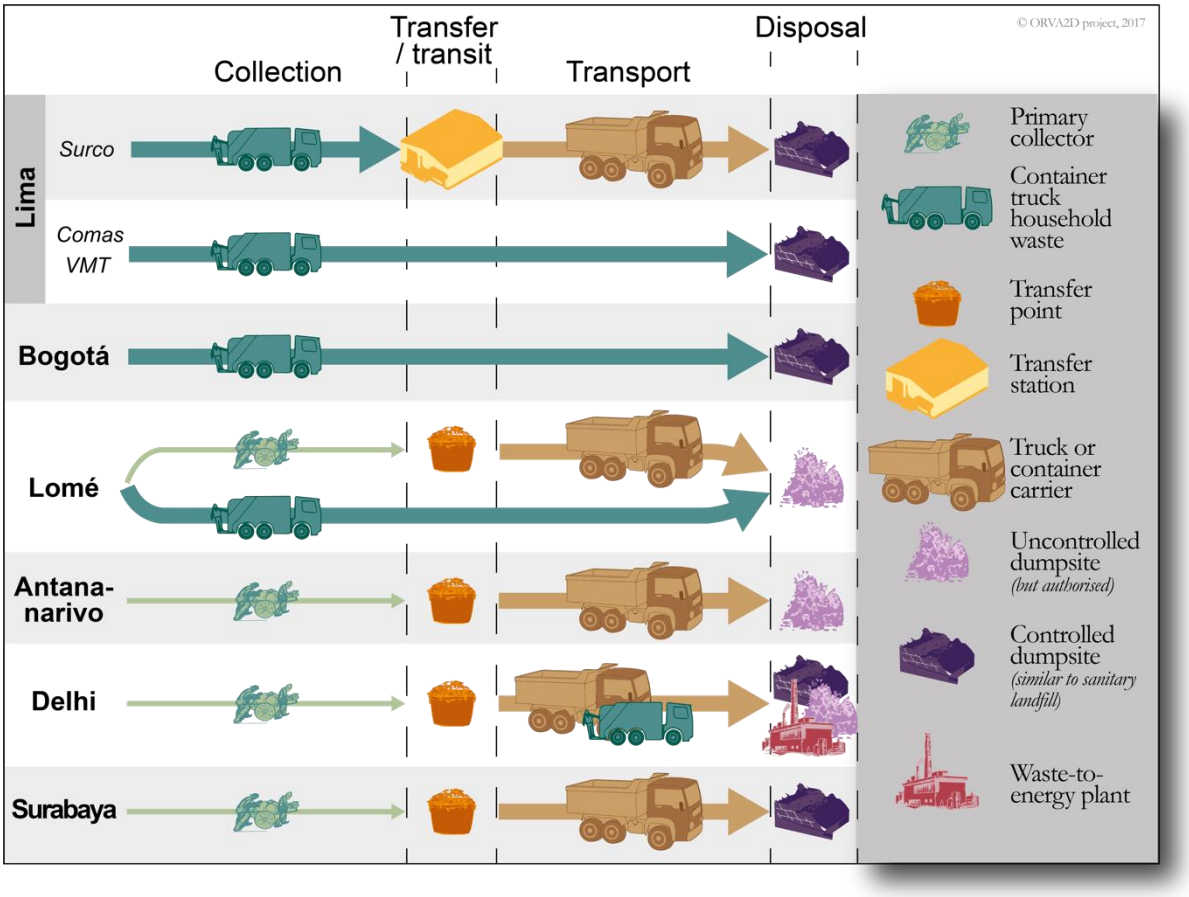


Figure 16. Synoptic diagram of waste management organisation

A non-intuitive price-quality ratio for waste

The costs presented above are relative to the quantities of waste treated for each type of sink, in each city. The financial figures give a comparative overview of the cities, but the size of each budget also depends on the composition of the services provided. The summary of

expenditures on service provision according to the main budget items makes it possible to estimate the level of financial effort for each stage (Figure 17). What stands out, for example, is the significant burden of collection (or transport) in all of the cities, as well as that of landfilling in Surabaya, which is higher in absolute value than all of the others. This is due to the high costs incurred by a sanitary landfill that complies with environmental standards – which makes the case for diverting waste stocks towards recovery and recycling channels.

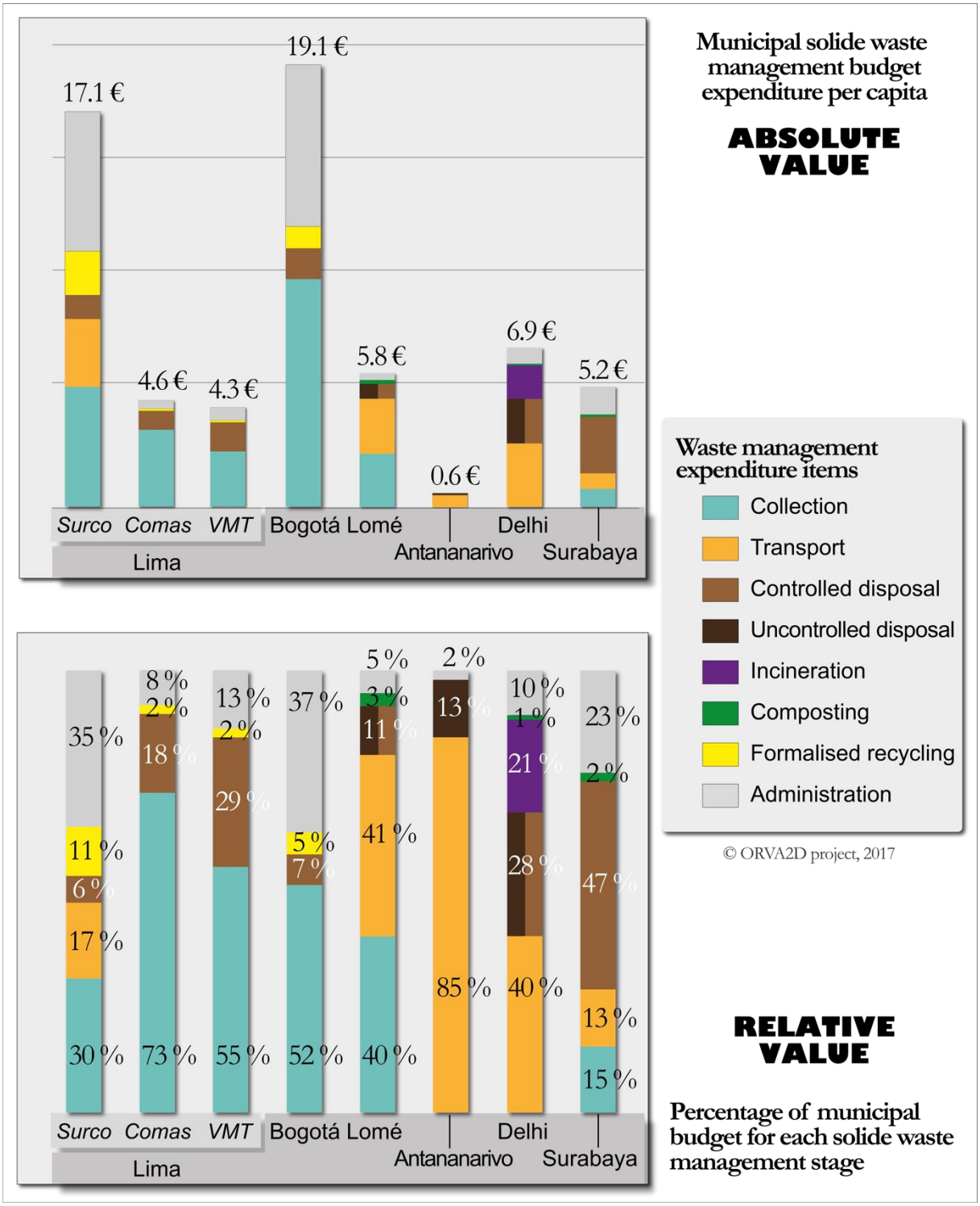


Figure 17. Summary of waste management expenditure

These elements can be compared with the figures for the different waste treatment methods (Figure 18). The information in Chapters 2 and 3 allows us to reconstitute the quantities of waste that end up in disposal sites and those that are recycled, incinerated or composted.

Noticeably, a large proportion of the waste stocks is untraceable, particularly in Lomé and Antananarivo.

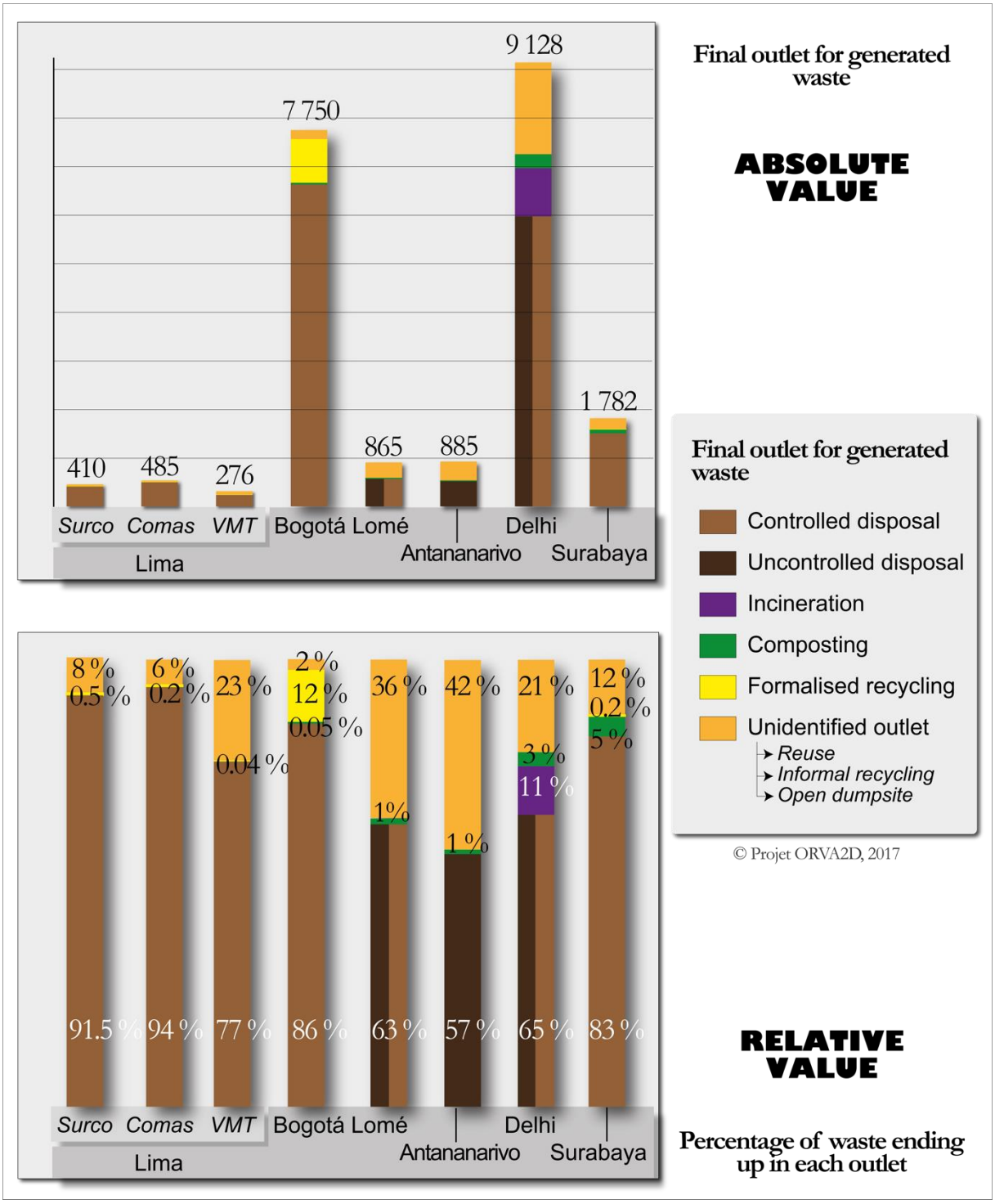


Figure 18. Quantities of treated waste by type of sink used

2. Costing each stage of waste management

Waste collection costs: still the main expenditure item

The breakdown of expenditure by stage or activity shows that collection represents over 50% of expenditure (45% in France – ADEME, 2016). Household waste collection involves two systems of organisation: door-to-door collection where a compactor truck for household waste stops at each dwelling (Lima, Bogotá, one-third of Lomé); or collection from transfer points which are usually equipped with a container where waste is deposited without compaction (two-thirds of Lomé, Antananarivo, Delhi, Surabaya).

Waste collection costs in the three districts of Lima amount to around €11/t for door-to-door collection of bagged waste. The collection cost seems much higher in Bogotá, at €30–32/t, where collection vehicles transport waste directly to the sanitary landfill. Private collectors in Bogotá provide a comprehensive offer where pricing also covers a public cleanliness service with street cleaning, maintenance of green spaces and bulky waste collection. As a result, it is difficult to make a direct comparison between these two cities. In Lomé, the high collection cost (including transport) of €19.8/t, for 2 districts, is due to the 23 km haul distance to the future sanitary landfill at Aképé, compared to €15/t for transport to the current Agoé landfill 13 km away. The cost for door-to-door collection is thus higher in Lomé than in Lima, standing at between €11–20 per tonne of waste. Without the cleaning service, bulk waste collection and the maintenance of green spaces, estimates for waste collection in Bogotá would be of the same order of magnitude.

Cost of transport: a particularly high cost in global South cities

The use of intermediate reloading, i.e. transferring waste from a collection point (or primary collection point) to a transport vehicle, is common in large metropolitan areas given the high tonnage involved and the density of road traffic. It is this reloading operation that marks the beginning of the transport stage. However, only Surco district in Lima uses intermediate reloading. The other cities either have no transport stage as such (Comas, VMT, Bogotá), or it corresponds to the pick-up at primary collection points (Lomé, Antananarivo, Delhi, Surabaya). Transport costs thus range from €5 to €8/t. In 2016, the cost of transport (pick-up of primary collection) in Lomé was €7.6/t, which corresponds to removing waste to the Agoé landfill, 13 km from the city. From 2018, the opening of the new Aképé sanitary landfill 23 km away from the city will push the transport cost up to €9.9/t.

Transport is thus an important and costly stage of waste management in these cities, much more so than in Europe, where it represents less than 6% of the service cost.[1] The reason for this is that the vehicles transport small quantities of non-compacted waste in open containers and the road networks are highly congested and in poor condition. The use of large compactor trucks brings two advantages. It reduces the number of journeys and allows night-time travel during off-peak traffic periods.

Landfilling: rising costs due to the modernisation of disposal sites

Waste dumping is the most common waste treatment process in the reference cities as it is the least costly despite having the major drawback of requiring a relatively close large area of land. Dumpsites and landfills range from the simple (uncontrolled) dumpsite that is authorised

[1] Ademe, 2015.

but saturated, as in Antananarivo, where the disposal cost is €1.6/t, to Surabaya's sanitary landfill operating with impermeable cells, leachate collection and treatment, and the capture of biogas for conversion to electricity, at a cost of €8.4/t. In Bogotá, the cost is under €5/t as disposal is at a simple controlled landfill. The waste is compacted, biogas and leachates are managed but the site is saturated, causing landslides in 2015. In Lima, the Huaycoloro sanitary landfill (for Surco) and Modelo Del Callao sanitary landfill (for Comas) are run by the same private operator, Petramas, at a similar cost of €3/t. The waste from Villa Maria del Triunfo is buried in the Portillo Grande sanitary landfill managed by the company, Relima, for 8 €/t. The reason for this difference is the cost of transport (around €5/t). In Lomé, dumping at the uncontrolled and saturated Agoé landfill costs €1.4/t (900 FCFA/t), which is close to the cost in Antananarivo. This cost will increase to €8.5/t (5,597 FCFA/t) for the new Aképé sanitary landfill operating with impermeable cells, leachate collection and treatment, as well as methane capture and flaring.

All in all, the cost of uncontrolled disposal is close to €1.5/t, whereas controlled sanitary landfilling (with leachate and biogas management) costs €8 or €8.5/t. The qualitative leap towards disposal in a sanitary landfill clearly has a significant impact on the service cost, with a mark-up of €7/t. Considering the high tonnages of waste to be managed in large metropolitan areas, the creation of a sanitary landfill implies a considerable increase in financing needs. This could be a key argument for opting to finance the waste recovery and recycling sub-sectors in order to limit costs.

Recycling: cost experiments in an adjustment phase

In Bogotá, recycling based on the formalisation of informal wastepickers has a production cost of €27/t, whereas the production cost for collection and disposal of residual household waste (RHW) is in the vicinity of €37.8/t. Moreover, recycling is relatively economical as it consumes 5% of the municipal waste management budget and enables recovery of 12% of the waste stocks.[1]

In Peru, the integration process is more recent. Its profitability is less well-established for the moment, since the recycling programme costs €263/t in Surco and €144/t in Comas, compared to production costs for RHW collection and disposal amounting to €22 and €14 respectively. These very high cost levels are attributable to the extensive awareness-raising programme and the many waste-sorting ambassadors deployed in the field. What is noticeable, however, is the marked difference between the much less costly Comas programme and that of Surco. This is down to very different choices: in Surco, high-tech solutions have been used (buried selective-sorting containers, mechanised sorting platform), while Comas opted for low-tech (waste recovery by formalised wastepickers, sorting in small artisanal workshops).

Energy recovery: no cost control

Thermal recovery involves recovering the energy content of waste, either from raw waste by incineration, or from pre-treated waste by gasification, or by conversion into refuse-derived fuel (RDF).

- Incineration – waste-to-energy

[1] The figure of 12% would be even higher if the real relationship between the municipal budget and the quantities of waste managed by this municipal service were known. To obtain this, the fraction of waste for which the sink is "unidentified" would have to be deducted.

Decision-makers in large metropolitan areas are particularly interested in incineration, especially in India. The reason for this stems from the difficulties they encounter with landfilling, which is land-intensive, pollutes water and may cause pockets of methane to explode. On these points, incineration offers undeniable advantages. It significantly reduces (90%) the volume of waste and can be operated on a limited area of land. Yet, the technique has inherent drawbacks (cf. Ngoc & Schnitzer, 2009; Corvellec et al., 2013; Gutberlet, 2013). First of all, it requires advanced technology. Homogenisation of the waste relies on different patented technologies that ensure the necessary conditions for complete combustion. Likewise, the heat-exchangers for the furnace-boilers are exposed to extremely abrasive and corrosive hot gases that require expert design/manufacturing. Second, incineration must be used for waste whose lower calorific value (LCV) is sufficiently high to allow self-sustaining combustion and justify energy recovery in the form of hot water and/or electricity. Otherwise, fuel would need to be introduced to run the incinerator. In addition, the flue gas (dust, dioxins-furans, NO_x) must be treated to avoid atmospheric pollution; the clinker (ash) produced must be treated to prevent water and soil contamination; and finally, the flue gas cleaning residuals (MSWIR) carrying contaminants must be confined. The incinerators in Delhi do not control all of these risks, as is pointed out by the NGO Toxics Link.[1]

For example, the Sukhdev Vihar incineration plant, which came into operation in 2012, received repeated warnings about excessive pollution from the National Green Tribunal, which adjudicates environmental disputes (De Bercegol, 2016). The Okhla incinerator, which started up in 2009, is equipped with four lines of furnace-boilers incinerating around 26 t/h of waste, equivalent to a capacity of 2,500 t/day, or 780,000 t/year. In 2012, it processed 212,549 tonnes, which was well below its installed capacity. The utilisation rate of around 27% in 2012 rose to 47% in 2016 according to data provided by the operator. The quality of incoming waste has been called into question as 80% is composed of food and green waste. High-LCV materials (plastic, paper, cardboard, wood, rubber) represented only 16% of the tonnage in 2012. The waste is thus of poor quality with a low LVC and high moisture content. What's more, according to ORVA2D field studies conducted between 2016 and 2018, the MSWIR are deposited in already saturated open dumpsites, with no specific precautionary measures. Moreover, competition over waste materials has led to the impoverishment of wastepickers in the area around the incinerator, who earned their living from reselling salvaged materials.

From an economic viewpoint, the investment cost for building the incinerator amounted to INR 2 billion, equivalent to €27 million (€1 million per t/h installed), which gives a technical depreciation rate of around €1.1 million per year over 25 years, that is, from €1.4/t (at nominal capacity) to €5.2/t (2012).[2] The operating cost was not disclosed, but according to the operator, Jindal, current revenues stand at around INR 2.5/kWh (i.e., €0.01/kWh), from electricity sales under 25-year contracts. Jindal considers that electricity sales of INR 6/kWh would cover the incinerator's production cost (depreciation + operation) on the basis of 122 GWh of power sold. This price is much higher than the cost of producing electricity in India's recent (coal-fired) thermal power plants. Thus, reaching a financial balance solely based on electricity sales is highly unlikely, and remuneration by the municipality or through state subsidies for waste treatment services may well be unavoidable, as in Europe.[3] In France, the resale of recyclables and energy (industrial products) represents no more than 6% of waste management budgets,

[1] http://www.toxicswatch.org/2016/06/twas-submission-on-violation-of.html
[2] In 2016, this figure was €3.1/t.
[3] In 2019, the government of Delhi made a gesture towards incinerator operators by allowing them to sell part of their generated electricity to industry without having to invoice the costs of transmission over the public distribution grid (https://timesofindia.indiatimes.com/city/delhi/delhi-no-extra-cost-for-buying-power-from-wte-plants/articleshow/67695313.cms?from=mdr).

the remainder coming from taxes and fees paid by users, from state aid and funding by eco-organisations (ADEME, 2015b). The estimated production cost of the Jindal incinerator would be around €10 million per year, equivalent to €13/t operating at nominal capacity or €27/t when below-capacity (2012). The financial impact is thus significant and about two or three times higher compared to a sanitary landfill. The incineration budget takes up 24% of municipal expenditure on waste management, whereas incineration burns only 11% of collected waste.

Despite the high cost, two new plants opened in Delhi in 2017: an incinerator burning 4,000 t/day in North Delhi and an refuse-derived fuel (RDF) plant with a boiler treating 2,000t/day in East Delhi. The sole purpose of the RDF facility is to improve fuel quality by preparing/drying the fuel prior to its combustion in the boiler.

In short, while incineration is certainly an option to be considered given the pressure on land and the (very) large quantities of waste to be treated, it would be unadvisable to mainstream this technology until the waste is of a more suitable quality (i.e., mostly dry). Moreover, the recovery of both recyclables and organic waste is a path that should be privileged upstream of the thermal processes, mainly so as not to divert that the potential waste streams feeding these two modes of valorisation.

- Production of refuse-derived fuel

In 2016, Lomé mounted a project to produce refuse-derived fuel at its sanitary landfill in order to prolong the landfill's useful life (120,000 t/year of treated waste yielding between 30,000 and 50,000 tonnes of RDF). The project plans to resell the RDF to the cement manufacturer, Heidelberg, which started production activities early 2015 and which would thus no longer need to import coal from South Africa (Garnier, 2016, p.78). The project requires a substantial investment of €7–9 M., most of which (€5–7 M) would be financed by Heidelberg. It involves building a sorting (pre-treatment) unit at the sanitary landfill site as a first phase in selecting waste to be recovered as RDF. The pre-treatment unit covers three steps: waste-sorting on the ground, pick-up using an excavator with a grab attachment, trommel screening for part of the organic and inert fraction of waste, then primary crushing. Non-selected waste will either be recovered (metals, rubble) or buried in the sanitary landfill.

Once the first phase has proved effective, the construction of a new sorting line is planned to recover all of the incoming waste. A second unit for waste conversion will reduce the water content through bio-drying with fermentation of the organic fraction and further sorting of plastic and metal, as well as the segregation of the remaining inert waste with an air separator and secondary crushing. This second unit will also be funded by Heidelberg.

Based on the above performance assumptions – which nonetheless seem highly optimistic given the composition of waste in Lomé (20-40% of paper, cardboard, plastic and green waste according to the waste characterisations) –, the cost of producing RDF would be €49/t. A feasibility study (Willerval, 2014[1]) demonstrated that the RDF channel was more cost-effective than that of coal. The study estimated the economic saving for the municipality at €280,000/year in terms of the gain in remaining landfill capacity.[2] The environmental gains are evaluated at 21,000t/year of avoided GHG emissions. Moreover, the RDF unit would create 29 jobs. However, this approach is only on paper for the moment.

- Gasification

[1] EGIS (2014) Feasibility study for the option of RDF recovery at Aképé sanitary landfill.
[2] Remaining landfill capacity is the landfill space still available for storing new waste.

In Surabaya, a gasification project for landfill waste was under consideration in 2018, providing a capacity of 100 t/day to generate 8 MW/day of electricity. The choice of this process seems risky as it requires homogenised waste, which in turn demands heavy and costly preparation. This unit, which would be a first in Indonesia, is still under construction, which means that its performance cannot yet be assessed. It should be noted, however, that MSW gasification projects are currently very rare worldwide and only suited to very specific contexts.[1]

The cost of organic recovery: highly variable depending on the project

Currently, organic waste recovery, chiefly in the form of composting initiatives (still often at the project stage), is not widespread. While Antananarivo and Lomé have ambitious projects for this, Delhi and Surabaya have carried out experiments with mixed results. The economic data reported below come mainly from declarative interviews and do not include depreciation of investments.

In Delhi, a centralised industrial-scale facility treating mixed household waste is in operation. The compost quality is poor with undesirables still present, but sales are facilitated through the offer of a varied product range. The cost per treated tonne is low, at €4.69/t. This privately owned facility seems to balance its finances by selling to large buyers or via public procurement at high prices (Mother Dairy).

In Surabaya, there are 23 small composting units for green community waste. One of these also treats organic waste sorted by SuperDepo. Green waste composting costs €16.35/t. However, if the cost of SuperDepo's sorting is factored in, the cost of treating the organic fraction of mixed household waste would rise to €36 per tonne of raw waste. All of these costs are borne by the municipality, which directly manages these facilities.

In Lomé, there is a decentralised unit for treating mixed organic waste. The compost quality complies with the French standard. The treatment cost is €17.6/t. per tonne of waste (compared to €27–32/t. in France, ADEME, 2015a). On the other hand, the compost output is low due to the waste composition in Lomé. The production cost per tonne is very high (€110/t) compared to possible sales prices, which greatly limits commercialisation.

	Delhi (Okhla)	Surabaya (SuperDepo)	Surabaya (Composting facility)	Lomé
Tonnage treated (waste)	91,000	2,920	18,980	5,000
Tonnage produced (compost)	10,950	1,577 (ROW)	N/A	750
Number of workers	74	15	115	60
Total cost/year	NA	€15,960	€310,512	€82,500
Cost/t treated	€4.69/t	€5.4/t	€16.35/t	€17.6/t
Cost/t produced	€50/t	€10/t	€33/t (Jp CPF)	€110/t
Sales price/t produced	€20/t standard €114/t large buyers	-	-	€37/t

[1] Only Japan has implemented this type of project.

Carbon credits/tonne produced	€3.65/t (USD 5/tCO_2a)	-	-	€9/t (€15/tCO_2a)
Coverage of cost by revenues	47.3% to 560%	0%	0%	41.8%
Remaining amount to be financed/t SHW treated	€0/t	€21.75/t		€10.2/t

Table 9. Characteristics of municipal composting units

ROW = Raw organic waste sorted (before composting)
Jp CPF = Japanese composting unit
tCO_2a = Tonne of CO_2 avoided
SHW Solid household waste

Composting represents 3% of municipal expenditure in Lomé, 1% in Delhi and 3% in Surabaya, while the volumes of composted waste are 1%, 3% and 5% respectively.[1] While for Lomé and Delhi, the efficiency of composting seems in line with the investments made, this operation appears to be particularly well run in Surabaya, where it costs little compared to the quantities composted. This is mainly due to the large number of solutions that Surabaya proposes for composting waste at several scales.

The case of Antananarivo is different as the city obtains a result for composting (1%), without allocating any funds to this operation. This is due to the involvement and funding provided by NGOs and donors, but also to particularly dynamic neighbourhood composting.

Lastly, it should be noted that, in all cases, recovery via composting is labour-intensive. Although this affects the production cost of the finished product, the activity creates jobs and has a strong social impact. In fact, the opportunity afforded to a fringe of population that has difficulty in accessing the formal labour market should also be seen as a social gain, and a driver of growth and consumption.

II. Difficulties in financing the public service

The financial analysis unravels all the expenses incurred by the waste management service: activities, infrastructure financing, general administration of the service. Moreover, in this analysis, the notion of "service provision cost" makes it possible to address the crucial question of the municipal financing of waste management. Waste from households, economic activities (restaurants, shops, artisans) and from the maintenance of public parks and gardens is collected then transported to the disposal site. Street-cleaning activities are also often recorded as a waste management cost.

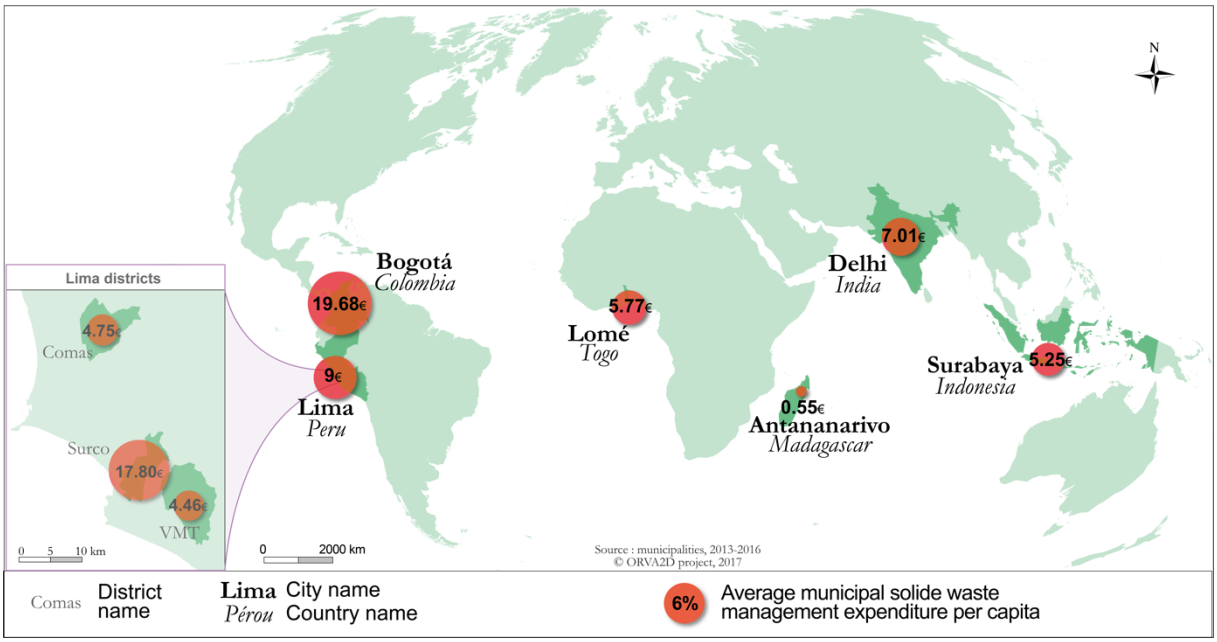
The question of financing MSW management services is pivotal as it impacts the continuity of this public service from day to day, as well as its sustainability over time. A low level of cash flow or a cash shortfall can create difficulties in remunerating collection crews, as has been the case intermittently in Lomé, Antananarivo, Bogotá and Lima in recent years. This leads to the service level being reduced by contractors awaiting payment or affected by strikes, and can

[1] These figures even rise to 1.6%, 3.8% and 5.1% if "missing" waste is omitted from the calculation.

even result in interruptions of the waste collection service. This impacts the level of satisfaction of households, who then become reluctant to pay waste disposal taxes or fees.

1. Unequal municipal budgets

An analysis of municipal budgets reveals large disparities among the reference cities. One city in particular stands out in terms of municipal expenditure per capita: Bogotá, where expenditure reaches nearly €20 per capita per year (cf. Map 10). This is linked not only to the city's level of affluence and industrialisation, but also to strong social pressure regarding the issue of waste. Surco (Lima) is similar to Bogotá at almost €18 per capita per year. Surco is one of the city's wealthy districts but is not required to shoulder the costs of service provision to more disadvantaged populations (unlike Bogotá, where management functions at the metropolitan level).



Map 9. Municipal expenditure on waste management

To rank the cities according to their spending on waste management, local currency expenditures have been converted into euros. This reveals a wide variation in expenditure expressed as €/cap./year, ranging from €1/cap./year in Antananarivo to over €19/cap./year in Bogotá. A distinction appears between Bogotá and Surco (Lima), which are relatively well-equipped for door-to-door collection and disposal at a sanitary landfill and whose expenditure is €15–20/cap./year, and the other cities where expenditure totals around €5/cap./year, except for Delhi whose expenditure includes some costs for wastewater treatment and incinerator operations. The situation in Antananarivo stands out as a case apart since the level of spending on waste management is extremely low at €1/cap./year.

A comparison with European countries is not very meaningful as in Europe the price of goods and services is far higher. In France, in 2012, municipal waste management (household waste and similar wastes, cleaning waste, green waste) represented a recurrent expenditure (non-capital) of €127/cap./year (ADEME, 2016).

2. Users' financial participation: pricing and fee/tax recovery

User participation takes the form of a tax or fee. The fiscal tax depends on the rateable value of dwellings or on the households' ability to pay. The fee, on the other hand, is based on the service provided according to criteria such as collection frequency, household composition, etc. Incentive-based fees link the amount payable to the quantity of waste generated by each household. For primary collection, a fee is negotiated between the household and the primary collector. It is sometimes proportional to the family composition or the location of the dwelling[1] (cf. Table 10).

City	Actor	Criteria	Fees in €/month/household	
			Min.	Max.
Antananarivo	Associations		0.12	0.50
Lomé	Micro-enterprises Associations	Population Subscribers	2.30	3.80
Surabaya	Micro-enterprises	Household income	0.62	1.87
Delhi	Informal	Neighbourhood	0.64	1.92

Table 10. Criteria and amount of primary collection fees

The financing of expenditure by service users is difficult to identify as it most often depends on the municipality's finance department. It was impossible to obtain the price structure for the amounts that households had to pay for the waste service. Table 11 shows the criteria used by the cities for taxes or fees and the nature of the expense covered.

Cities	Tools	Criteria	Amount	Expenditure
Bogotá	Tax	Socio-economic level,	-	C + SL
Lima	Tax	dwelling	-	C + SL
Delhi	None	Nb. people, dwelling	-	-
Surabaya	Tax	-	IDR 500-19,000/	T + SL
Antananarivo	Tax	Dwelling, electricity	month /household	-
Lomé *primary collection*	Tax	consum., streets	-	T + SL
Lomé *D2D*	Fee	-	FCFA 313/coll. round	C_{D2D} + SL
		Rateable value of dwelling	-	
		Collection frequency		

Table 11. Criteria for calculating household taxes or fees

C: Collection
SL: Sanitary landfill
T: Transport
D2D: Door-to-door

[1] A lot, or waste collection sector, is defined by a number of inhabitants and a number of subscribers.

The criteria used by the municipalities to set their prices are disconnected from the service provided. They depend either on the characteristics of a dwelling (Antananarivo), or district (Bogotá). A fee system based on the collection service offer is only applied in Lomé for users benefiting from door-to-door waste collection. Antananarivo and Delhi have not introduced a waste removal tax.

In theory, inhabitants served by transfer points pay not only the municipality for transport and disposal, but also the informals in charge of primary collection of their waste (Antananarivo, Surabaya, Lomé). This system is relatively unclear for the residents, who feel that they are paying for the service twice over, and impacts their willingness to pay.

The level of household financial contribution seems low, ranging from less than one euro to several euros per capita a year. Surco alone reaches €10/cap./year, whereas in France the tax or fee is close to €90/cap./year. In Antananarivo, the household contribution rate seems high (35%) – yet, it is the lowest in absolute value (€0.20) as the budget allocated to waste is very small. Moreover, the one-off but recurring financial support from the Malagasy government does not appear in this official budget, which otherwise would increase the share contributed by the state.

Moreover, on account of the poor service quality, users refuse to pay their taxes: only 25% of taxes were collected in Comas in 2014 and only 20% in VMT.

3. What is the main source of financing?

Municipalities need revenue to cover what they spend on providing waste collection, transport and disposal services. In the reference cities, these resources come from residents, the state and the municipalities themselves (cf. Table 12).

It proved possible to obtain the total amount of taxes or fees paid by the residents, as well as the state subsidies. By deduction, the remaining amount has to be financed by the municipalities. With the exception of Bogotá and Surco (Lima), the revenue received covers less than 50% of waste management expenditure. The state sometimes intervenes to support materials recovery (Lima) by training waste collection personnel, raising the population's awareness or providing financial assistance for the purchase of collection equipment (trolleys, carts, carrier tricycles). No municipal authority thus ensures the financial equilibrium of its waste management services. As a result, they have to bridge the funding gap either by drawing on their general budget or requesting a balancing subsidy from their government, as in the case of Antananarivo.

City	Contributors' share (%)			User participation	
	State	Municipality	Users	In lc*/cap./year	In €/ cap./year
Bogotá	0	36	64	39,431	2.75
Lima (Surco)	1	40	59	37.5	10.00
Lima (Comas)	7	56	37	6.4	1.70
Lima (VMT)	1	72	27	4.3	1.15
Delhi	0	100	0	0	0
Surabaya	0	86	14	-	-
Antananarivo	15	50	35	677	0.20
Lomé	0	87	13	472	0.70

Table 12. Financing of the service

*lc: local currency

When assessing the financial soundness of the service with respect to the share of expenditure covered by the taxes or fees paid by households, four groups of cities emerge depending on whether household contribution is:

- greater than 55% of expenditure: Bogotá, Surco (Lima)
- between 25% and 40%: Comas and VMT (Lima), Antananarivo
- less than 15%: Lomé, Surabaya
- zero: Delhi.

Municipal budgets are thus often the main source of financing to cover service provision expenditure. Yet, as the municipalities are often unable to financially cover their own resource requirements, they turn to the state to obtain subsidies.

The situation in Delhi is unusual to the extent that no tax or fee is levied for waste management. The City's three municipalities are required to cover their waste services expenses, but only South Delhi manages to raise its own fiscal resources via the property tax that replenishes 76% of its budget.

Lomé's financial situation is particularly critical. With the upcoming opening of the sanitary landfill in 2017, the operating budget for waste management (excluding cleaning expenses) will represent 43% of the operating section of the city's 2015 general budget. On top of this, 87% of expenditure on waste management and cleaning are financed by the municipality. The cash-flow difficulties that hamper payments to service providers are thus far from surprising. Yet, Lomé has regulatory tools – taxes and fees – to ensure revenues. Extending the property tax, currently only levied on companies, to include residential properties could help to increase the city's fiscal resources. Yet, given the weight of waste management expenditure as a ratio of GNI per capita, the households' ability to pay is most likely already strained and their solvency status low. The urban cleanliness budget could also be consolidated to target expenditures more effectively and become proportionally consistent with the other reference cities.

Surabaya's financial situation is hardly any better since 86% of waste management expenditure is borne by the municipality, but 6% of municipal resources come from central government and 34% from the provincial government. Waste management expenditure, however, represents only 7% of the municipal budget.

The financial situation of SAMVA in Antananarivo is also fragile. SAMVA, a state-owned industrial and commercial enterprise of the Antananarivo Urban Community, manages or contracts out the transport and disposal of waste and is obliged to comply with the requirement to balance its budget. It derives its revenues from the fees for household refuse collection (FHRC) paid by households for primary collection, of which it receives only 50% from the municipality. The city keeps back the remaining 50% to finance the sweeping of public spaces. Since 2016, the municipality has committed to transfer 100% of the fee to SAMVA, which would place it closer to the other cities in terms of the per capita budget allocated to waste management. As SAMVA has no equipment of its own, it has to hire waste transport vehicles and this is contingent on the amount of funds it has available each month. As a result, waste removal from the transfer points is highly chaotic and unpredictable.

By contrast, Bogotá has an enviable financial position. The city covers 64% of its expenditure on the waste management service through a tax. The municipality depends on the state for only 16% of its financial resource.

III. Financing waste management innovations

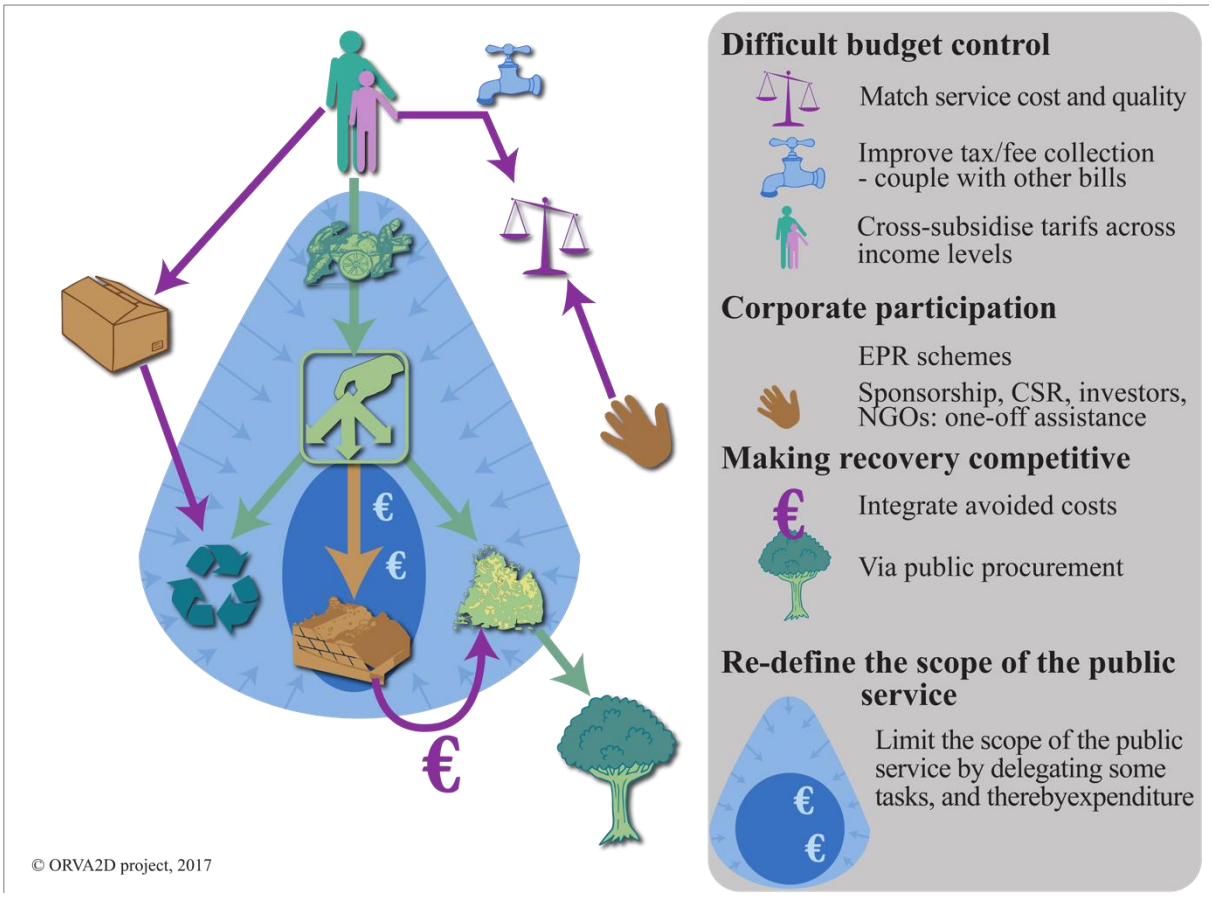


Figure 19. Financial levers to implement waste recovery innovations

1. Bolstering municipal budgets

Matching cost with service quality

The first difficulty involves ascertaining the production costs of the municipal service in order to: develop performance and effectiveness indicators for the means of production, assess the relevance of renewing obsolete equipment and control costs.

The six reference cities show that these expenditures are seldom fully known to the municipal departments themselves. The South American cities perform best on this count because, as of 2015, the ministries have made some financing conditional on well-managed accounts (Rateau, 2015). The Asian cities now keep precise accounts that make it possible to identify the main budget lines allocated to waste. The African cities find it more difficult to have precise knowledge of what their annual budget forecasts will be. In Antananarivo, government agents

rarely have more than a month's visibility on their budget (Lecointre, Breselec & Pierrat, 2015, p.66). Moreover, waste management activities are not always distinguished from cleaning activities. Yet, disposing of information on annual budget estimates gives visibility on the financing that will be needed over the long term.

Most of the operating budget earmarked to solid waste management is spent on salaries for collection, cleaning and transport personnel. Waste treatment and service improvements receive a very limited share. Moreover, the accounting method used should show depreciation or amortisation for the useful life of equipment. The municipalities could thus monitor the running and maintenance costs of their vehicles (it often costs less to purchase a new vehicle than repair a very old one).

In addition, none of the municipal authorities in the six reference cities achieve full financial equilibrium for their waste management service. Some of the key principles to be respected include clearly separating out budget appropriations to waste management, and keeping budget revenue and expenditure balanced (without excluding possible transfers from the municipal general budget or even from the state). On the revenue side, the authorities still largely depend on government subsidies but have little visibility on the annual or even monthly amount allocated to them. It is thus important to bolster the municipalities' own resources so that they can fulfil their legal obligations. Municipal budgets should not be viewed as a means of replenishing waste management budgets. This means that a system for taxing the removal of household waste needs be implemented. Other financing tools similar to fees can also be implemented, but we did not find that this mechanism had been introduced in any of the cities.

Moreover, the household waste collection service covers "similar" wastes, i.e., waste generated by enterprises. Although this service is understandably provided to small enterprises (shops, artisans, often administrations), they seldom bear its cost. Taxes thus need to be collected from this type of waste generator (special fee), who is often more solvent than households. Specific solutions can even be proposed for certain types of waste, with direct management by the enterprises themselves. This is notably the case for heavy construction waste, which adds a huge cost to transport when collected together with household waste. Construction waste also greatly shortens the useful life of disposal sites, whereas in fact its overall inert characteristics could prompt less constraining sinks (Lomé or Lima).

Finally, it should be acknowledged that any improvement to service quality gives rise to increased costs (far from the illusion that "green is gold"). This can be seen in Bogotá and Surco (Lima), which are relatively well-equipped for door-to-door collection and sanitary landfilling: their level of expenditure ranges between €15 and €20/cap./year. Conversely, for the other reference cities, it is around €5/cap./year. It is unrealistic to think that the operator of a waste recovery facility, be it composting or incineration, could cover its expenses if its sole source of revenue is from compost or energy sales.

Improving the collection of user charges: coupling billing with other public services

The financial lever presented above is the same as those deployed in countries of the global North. However, it has shown its limits in global South countries as it is very difficult not only to have in-depth knowledge of the budgets allocated to waste management, but also to balance these budgets. Drawing on the present case studies, this report thus highlights other levers that could be used to finance the waste management service through different channels or to supplement financing to ensure the service's long-term stability.

To tackle the earlier mentioned difficulty of billing local charges, some cities have envisaged coupling the bill for the waste management service with the bill for other services such as piped water (Bogotá). Failure to pay the urban cleanliness bill immediately results in the cut-off of the water service, which has a considerable impact. On the other hand, Colombia has introduced an original welfare-based pricing scheme to avoid mass protests. In Surabaya, good waste management practices rather than joint billing helps to finance other services. The sale of waste collected by a community waste bank provides a small reserve that users can draw on to pay their other bills, such as water or electricity. Territorial solidarity has thus emerged within the neighbourhood. However, to integrate community waste recovery more closely into Surabaya's MSW management service, it would be more logical to allow citizens to pay part of the waste removal fee (*retribusi*) in the same way. This measure would help citizens to become fully aware of the synergies between waste recovery on the one hand, and the reduction of the cost (and price) of the MSW collection and disposal service on the other. In other words, it would introduce a type of incentive-based fee (incentive to generate less waste). In the case of Surabaya, this seems quite possible as even the poorest households manage to earn a monthly income of IDR 8,000 from the sale of sorted dry waste, whereas the *retribusi* amount fluctuates between IDR 500 and 19,000 per month.

Social cross-subsidisation: have the wealthy pay for the poor

In 1994, Colombia passed a law introducing welfare-based pricing for all its urban services. It organises Bogotá into six strata corresponding to different levels of housing quality, and the fees for urban utilities and services are calculated at differentiated rates. The wealthiest thus subsidise the poorest, which enables the municipality to reach an overall financial equilibrium. This system nonetheless has several limits.

This stratification uses criteria based on the external characteristics of buildings and the quality of the neighbourhood's infrastructure, which does not always reflect households' real income or their consumption patterns (and thus their waste generation). It also fixes this segregation in time and space according to the stratum assigned to a building. What's more, finding a sufficient number of solvent residents to subsidise services for the poorest inhabitants is a complicated task. The system works well in Bogotá and the country's large cities, where affluent residents are relatively numerous (cf. Map 3), but it is more problematic in small or peri-urban towns. Moreover, it has no impact on the possible prevention of waste generation or on the effectiveness of sorting. Yet the system does create a certain solidarity among the inhabitants, which is crucial in a city that displays very large disparities in levels of wealth.

2. Encourage the financial contribution of companies: mechanisms to be institutionalised

Extended producer responsibility

The key innovation for financing waste recovery could be the introduction of Extended Producer Responsibility (EPR) (cf. Hestin et al., 2014). Now largely deployed in Europe (with different modalities depending on the countries), the principle involves financing the collection and recovery of specific types of waste (electro-electronic waste, food packaging, end-of-life vehicles, etc.) through an eco-fee paid by consumers when they purchase a product. The producer of the good thus appears as the entity responsible for treating the waste generated upstream by its commercialisation, as the producer finances the treatment system (although it

transfers the additional cost onto the consumer in the form of an eco-fee). The cost of managing waste is thus shifted from the waste generator to the consumer of the good.

Although this mechanism has proved effective in Europe for over 20 years, it has only rarely been deployed in global South countries. Brazil has set up a system of "*logística reversa*" (reverse logistics) for some products (mainly packaging for agricultural products) in the richest states of southern Brazil. The country has primarily targeted products consumed by businesses or farmers, which are easier to trace than consumer goods. Tunisia is also working on EPR chains for oils, packaging, batteries, tyres, while South Africa is introducing voluntary industry participation in the area of packaging. WEEE (Waste electronic and electrical equipment) is also central to many EPR experiments (Tunisia, China, Cameroon, Costa Rica, etc.) (UNEP & ISWA, 2015: 160–165).

The main obstacle to applying EPR is that it taxes consumption. In countries where a large number of purchases are made informally, it is difficult to introduce a tax levied along with the local equivalent of VAT (value-added tax) on the basis of the environmental characteristics (recyclability, eco-design, etc.) of consumer goods. The only goods that could follow this logic are some imported products.

Peru enshrined the EPR principle in its Circular Economy Law late 2016, but its implementation modalities are currently unknown. This could eventually be a key lever to be further developed.

It could be thought that encouraging large distribution and agri-food companies to financially support waste banks is a way of implementing EPR. In fact, these are the very companies that cause waste generation: 60% of the dry waste collected by waste banks is packaging from manufactured products. This means that requesting the companies' support for EPR schemes can be viewed both as the application of the EPR principle and a remedy for cash-strapped municipal budgets.

The problem with this reading is that the application of EPR is a unilateral corporate decision. If there is no law requiring companies to participate, it seems risky to base municipal public policy on companies' voluntary commitment with no guarantee of any continuity. Also, this highly commendable and impactful corporate commitment should nonetheless be viewed in light of the activities of the company itself.

Soliciting external financial participation: an initial effect, but inconclusive for the long term

- Is sponsorship and publicity under the EPR umbrella long-lasting?

In several instances, companies were solicited within the framework of their Corporate Social Responsibility (CSR) policy. In Surabaya, the Green & Clean project began with a collaboration between the Unilever Foundation and local NGOs. As a major palm oil producer,[1] the company needed to enhance its image and thus decided to invest in the project. Its provides annual grant-based support for the urban cleanliness contest and training for sorting and cleanliness ambassadors. Private sponsors are at the source of this funding.

[1] This Anglo-Dutch group (which owns the brands Maille, Lipton, Amora, Knorr, Ben &Jerry's, Magnum, Cornetto, Hellmann's, etc.) marked up a 2014, net profit of over €5 billion. In Indonesia, Unilever operations mainly involve voraciously exploiting oil from palm trees in monoculture plantations covering thousands of hectares in Sumatra and Kalimantan, on land that had until then been covered by primary forest. The multinational has in particular been fined due to actions by NGOs for its cooperation with Wilmar, one of its suppliers notorious for its illegal deforestation and repeated violation of human rights (Cavé, 2016).

The district of Comas (Lima) is looking for shopping mall partners to advertise the jackets distributed to waste collectors, the aim being to improve the collectors' individual protective gear. In the coming years, the malls could offer reductions to households that source-separate their waste in liaison with formalised wastepickers. A similar scheme has been set up in another Lima district, Villa Maria del Triunfo, thanks to support from a cement manufacturer that operates locally. Discussions are underway in Lomé to develop EPR with support from another cement maker. In Antananarivo, large companies in the city intermittently contribute to the city's cleaning ahead of major cultural events (e.g., the international day of the French Language in 2016).

In all cases, close relationships are being established between the local authorities and companies willing to contribute funds for cleanliness and recycling at local level. The key question regarding these financing methods is that of their longevity. Although it is unfeasible to base a municipal waste management policy on such short-lived partnerships, their participation could nonetheless serve as a springboard to launch innovative operations. Any scaling-up would require a longer-lasting financial mechanism and more direct involvement from public stakeholders. This is why, in Surabaya, the municipality subsequently took over from the Unilever Foundation.

The next step will thus be to make the actual waste generator pay, particularly when the waste is produced by companies… yet very often managed by the public service.

- Can private investment finance a public service?

Different arrangements for infrastructure financing by private actors exist (concession, PPPs,[1] BOTs,[2] etc.). In fact, these mechanisms were used in Europe in the 19th century to finance the first urban services networks. However, financing is mainly sourced from city residents (through taxes, fees or income tax), even though in some cases the operator takes on part of the financial investment risk. This solution is not in itself an innovation for waste management financing, but rather one among different possible modalities.

Private financing is, however, generally limited to investment in infrastructure construction. The subsequent operating expenditure requires regular and up-front budget support. Here, the key issue requiring vigilance is the degree of knowledge regarding the technical, economic, legal aspects, which need to be well-balanced between the private partners and the public contracting authority. Otherwise, the risk of recurrent abuses arises, as is experienced by a good many cities.

- NGOs and donors: innovation vectors that need further support to ensure service longevity

The issue of international donors is somewhat similar to that of EPR. Their involvement in waste management is often confined to investment financing, which is channelled through the local authority's or state's general budget. Depreciation costs are seldom factored into the budgets for waste management services. This financing thus kick-starts an operation – building an infrastructure or launching a recycling programme – but a more direct, more local financing mechanism is required for the long-term sustainability of the process. The question here is the basic concept of development aid aimed at empowering budgets (Paris Declaration on Aid Effectiveness, 2005).

- Carbon finance

[1] Public-private partnership.
[2] Build–Operate–Transfer.

In the wake of the Kyoto Protocol, the year 2004 saw the emergence of carbon finance and, in particular, the Clean Development Mechanism (CDM), designed to enable the purchase or sale of carbon credits, depending on whether one is an emitter or absorber of GHG. This first helped to finance projects for landfill, then incineration and composting (2006). An analysis of the database of the UNFCCC (United Nations Framework Convention on Climate Change) conducted early 2015 shows a total of 365 projects recorded in the area of solid household waste. Most of the registered projects (285) involved methane capture at landfill sites (including 41 small-scale projects[1]), 42 involving incinerators and 29 composting projects (including 11 small-scale).[2] To these CDM-registered projects, we should add those validated by voluntary commitments (notably VCS[3] and Gold Standard[4]), which doubtless include many composting projects, but the data are not readily accessible. However, many CDM-registered projects seem to be empty shells that have not yet produced any GHG savings, or much less than what was initially announced (Cavé 2018).

This may be due in part to the volatility then fall in carbon prices. Due to the 2008–2009 economic crisis, the price was only €8 per tonne in 2015, compared to €20 in the mid-2000s. Added to this is the fact that the calculation methods are unfavourable for the waste sector: one tonne of methane (the main GHG emitted by the sector) is considered equivalent to 25 tCO_2 over 100 years, whereas it is 72 tCO_2 over 20 years, which means that in the short run it is a strong driver of global warming. Project developers also seem likely to have overestimated the growth of waste processing activities. Finally, projects based on landfill methane capture, by far the most numerous, are not the most virtuous given that: in the best case, it produces little electricity; most often, the methane is simply flared; and, in any event, the organic materials are not returned to the soil. Promoting this system thus comes into contradiction with the waste treatment hierarchy (Ludington et *al.*, 2013).

The composting units in Delhi and Lomé are registered under regulated (CDM) and voluntary (Gold Standard) carbon finance markets respectively. The principle holds that composting helps to avoid GHG emissions generated by the anaerobic decomposition of organics. In Delhi, the tonne of avoided carbon earns the composting unit US$5 (€4.2), and in Lomé €15. The difference in earnings stems from the social impacts of the Lomé project, brought to the notice of carbon credit buyers by the Good Planet Foundation[5] (a French charitable foundation in charge of monetising carbon credits). Carbon finance can thus bring in a sizeable income for composting units.

A new avenue in this field seems promising thanks to the recent adoption of a new methodology[6] that recognises emissions reduction due to the final covering of a disposal site in the form of a drainage layer topped by a porous compost layer (2 m). The advantage of this covering method, which allows for the complete oxidisation of methane gases, is that it does not require a biogas capture system and offers a market outlet for compost, including low quality compost.

[1] Generating less than 60,000 tCO_2e of GHG savings per year.
[2] Cf. https://cdm.unfccc.int/ and https://unfccc.int/climate-action/momentum-for-change/activity-database
[3] The Voluntary Carbon Standard (VCS) label is another standard with broad international reach. Also based on the Kyoto Protocol mechanisms, its sets out criteria for validating, measuring and monitoring a carbon-offset project (cf. https://verra.org/project/vcs-program).
[4] The Gold Standard label is a standard developed by a private foundation working in the area of climate change and renewable energies, which set up its own certification for carbon-offset projects (cf. https://www.goldstandard.org).
[5] https://www.goodplanet.org/en/
[6] The AMS III AX methodology developed by CDM.

It should be noted that fuel production from organic materials also gives access to carbon finance on two counts: the avoidance of methane emissions and the substitution of fossil fuels by renewables.

To round off, it should be remembered that compost is a useful way of promoting carbon storage in soil, even though this has not yet given rise to any financing. One possible way of moving forward is thus to promote returning carbon to the soil through composting.

3. Make recovery and recycling competitive

Provide incentives via public-sector procurement

From a financial viewpoint, EPR chains help to make recycling competitive. Similar mechanisms are applied to organic and energy recovery systems. In fact, setting a feed-in tariff for electricity suggests that energy recovery in Delhi could become less of a loss-making activity. In this case, the public sector is purchasing electricity to subsidise a waste recovery activity.

The main setback for composting is selling the output. Its relatively poor quality as an agricultural input and the costs incurred by its production or transport mean that it often has to be offered as a free "root-service" (i.e., given away to farmers who pick it up from the composting unit) to encourage farmers to take it. A financial compensation mechanism can resolve this issue. It may involve direct subsidies for composting unit operations (Surabaya), taxation of other inputs, or more likely the re-use of compost by the municipal green spaces services (Delhi). Antananarivo is considering the public procurement of compost for the upkeep of its green spaces and indirectly financing the waste recovery activity.

The Indian model shows how a large quantity of raw household waste can be treated through composting (100,000 t/year; 11,000 t of compost produced), using a private contractor. In this case, support via public-sector purchasing of compost can help to offset the constraint of its low added value for farmers. The financial expenditure on waste treatment is thus transferred from the municipality to the state bodies that commit to buying the compost. The fall in carbon credit prices is unfortunately putting a brake on the development of this model. Both of the African cities are facing the same difficulties.

As in Surabaya or Delhi, Lomé's composting unit will only be able to continue treating waste if the public authorities (municipality or state) bear a share of the costs (as part of waste disposal). If this constraint were lifted, the increase in tonnages treated would also help to reduce the production cost by distributing fixed costs more effectively.

Recognise avoided costs

In the reference cities, there is no financial incentive scheme to reduce the amount of waste generated. However, it can be assumed that some financing aims to encourage residents to sort their waste and thus reduce the amount of waste discarded as RHW. A case in point is the "*Bono Verde*" scheme in the Villa Maria del Triunfo municipality (Lima), whereby a 20% reduction on local taxes is given to residents who source-separate their waste in conjunction with formalised wastepickers. Similar mechanisms are found in Vila Velha (Brazil) with the "*Moeda verde*" (green coin) or in Mombasa (Kenya) with the "*EcoPesa*" scheme (Cavé, 2015). Although these schemes do not directly advocate the principle of avoided costs, the rationale is the same: the municipality agrees to forego tax revenue in view of the fact that the residents'

practice enables it to avoid certain expenditures. In the above-cited examples, however, no direct link is made between the reduced tax amount and the costs actually avoided, which are often of a lesser sum. In fact, French cases have shown that the growth of selective collection did not allow a significant decrease in taxes and fees.

Reasoning in terms of avoided costs thus involves recognising the economic value of diverting waste. Not collecting waste and not treating it in landfills means that the expenses incurred by these activities are avoided. Selective collection (even if informal) and recycling certainly have a cost, but if the cost of reselling secondary materials and avoided cost are summed, this in itself raises the economic potential of recovery and recycling activities. Some local authorities have had the idea of recognising the avoided cost and thus contribute to financing waste recovery activities.

According to Sicular (1981, cited by Bertolini, 1990), the authorities in charge of cleanliness consider that recycling, when undertaken, needs to be profitable, whereas they view paying for waste disposal as perfectly acceptable. If recovery and recycling channels are to be integrated not simply as "spontaneously" commercial sectors, but as sinks permitting a decrease in the amount of landfilled waste, a paradigm shift is needed. Seen from this new angle, recovery practices become more attractive, which is quite different from the notion that recovery must be a lucrative activity in itself (UN-Habitat, 2010).

Among the reference cities, the only one to have mainstreamed this principle is Bogotá. Following the conflict with the wastepickers, the municipality agreed to remunerate them on a per-tonne basis in return for the avoided cost for its waste service. The wastepickers thus receive a sum of money equivalent to the cost that the service would have had to pay had the recyclable waste remained in the RHW stream. This money supplements what they earn from selling materials. Almost 8,000 wastepickers remunerated in 2014 collected over 270,000 tonnes of waste and were paid over €7 million, i.e., a cost for the municipal enterprise of about €27 per tonne of recyclable waste (UAESP, 2015). The justification for this approach, as ruled by the Colombia's Constitutional Court, is based on the quantified performance of both the municipal service and the alternative mechanisms that divert waste streams, and on a precise calculation of the costs of each activity.

Modelling the potential avoided costs for Antananarivo and Lomé

On the municipalities' behalf, the NGO Gevalor modelled the prospective economic impact of developing composting on a large scale in 2015 (Antananarivo) and 2016 (Lomé). This was based on a cost-benefit analysis to reveal the possible avoided costs. The objective was to clarify the financial advantage of integrating recovery actors into municipal waste management. In Lomé, the operator earns revenue from its sale of compost, but this does not cover all expenses. In fact, the cost per tonne of compost produced from urban waste is higher than the price that the farmers are willing to pay. A financing strategy has thus been elaborated, but not yet implemented, to cover all of the activity's operating expenses. It is based on financial contributions from the public authorities that remains below the avoided transport and disposal costs. The financial arrangement is backed by an institutional arrangement: as a result, the composting initiative has been "half-integrated' into the municipal waste management system.

The cost-benefit analysis studied the sector-wide economic impacts and externalities generated by an activity. In the case of recovery by composting, three externalities were taken into account: the savings generated on waste that will not be collected; the savings generated on waste that will not be landfilled (both operating and depreciation of the facility); and the reduction of GHG emissions. Added to this was

the social impact of job creation for a fringe of the generally poor population. As a matter of fact, the composting centre provides more jobs than landfilling.

In Lomé, the city's management plan provides for the development of waste treatment by composting 22,000 t/year (7% of all municipal waste). The prospective calculations were based on a scenario that included the start-up of the new Aképé sanitary landfill, which will significantly increase the city's waste management costs, the mechanisation of the composting site to reduce production costs, and the gradual increase of the quantities treated (so as to ultimately reach 22,000 t/year).

In Antananarivo, the development of composting is envisaged on the now saturated Andralanitra dumpsite. The first scenario includes opening a new landfill further from the city, as in Lomé, and reducing the quantities to be transported by developing a composting activity on the old dumpsite, which will then become a transfer and composting centre. The second scenario includes extending the current dumpsite's useful life through excavation and production of screened dump waste, coupled with composting on entry. This second scenario is presented in the following paragraph.

The cost-benefit analysis for Lomé shows that, even with an initial annual rate of 5,000 tonnes treated, recovery by composting is attractive, since the savings it generates are higher that the composting unit's deficit. Mechanisation is considered for some stages of production, which would increase labour productivity and reduce the production cost. Yet, it should be noted that this cost-effectiveness was calculated on the assumption that the new sanitary landfill, which is to be built shortly and much more costly than the current uncontrolled dumpsite, will be operating. In other words, the calculation assumes that all waste will be sent to the new infrastructure and that this facility will effectively comply with the established technical and environmental standards – two ambitious objectives. The "local authority's necessary contribution", based on the avoided waste management cost, is then equivalent to the production cost of the unit required for composting.

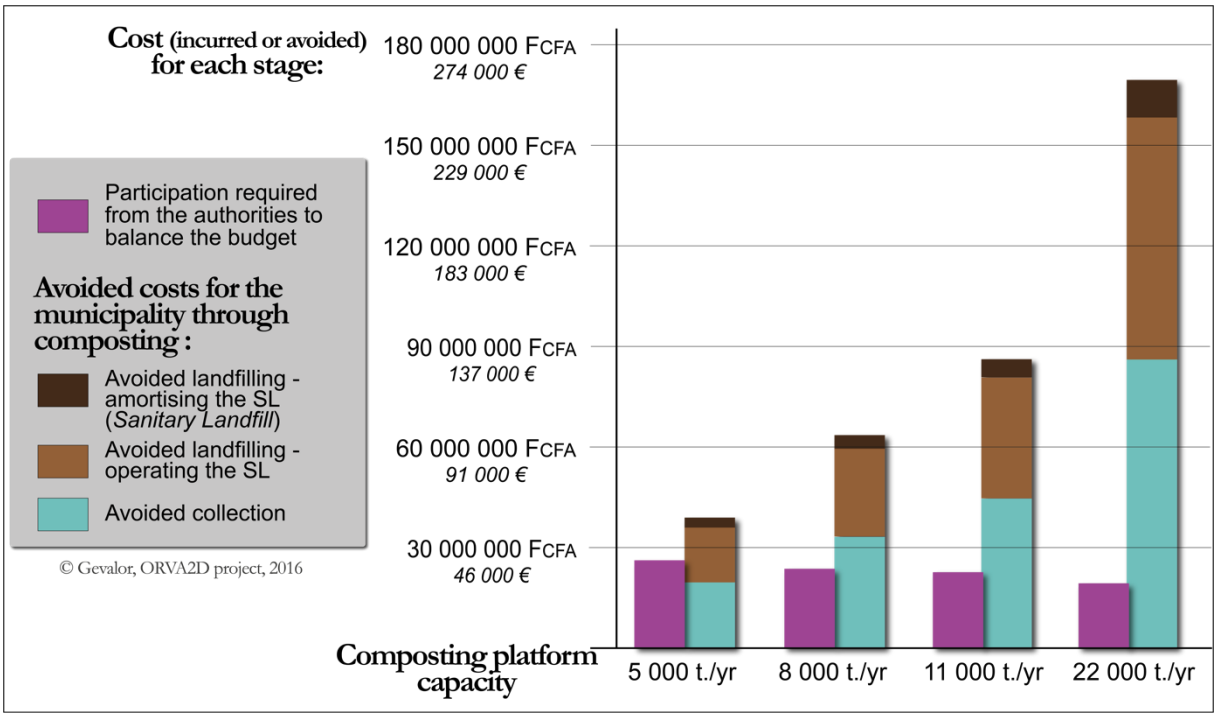


Figure 20. Avoided costs (prospective) thanks to waste composting in Lomé

For Antananarivo, a long-term assumption was modelled, in which Andralanitra (the current dumpsite) is converted into a sorting, composting and transfer station in the event that a sanitary landfill is opened elsewhere. The collection trucks would still go to Andralanitra, where organic material would be treated at the mechanised composting unit. The rejects from the sorting and composting would be compacted, baled and transported to the new sanitary landfill.

The analysis of the operating cost structure in this assumption showed that the savings on collection and disposal could finance the operating cost and depreciation of the sorting/composting/transfer station, particularly the differential between the production cost and the income from compost sales. If the compost were subsidised, it could be sold at an affordable price. The station would help to extend the useful life of the Andralanitra dumpsite and reduce its negative environmental impacts. Discussions can continue once a site has been found for the construction of a sanitary landfill, and will help to minimise the required size of the future landfill.

Although the cost-benefit analysis for Antananarivo needs to be fleshed out, it has already shown that the developments modelled represent a very high cost, which the municipal enterprise, SAMVA, is not currently able to assume. Other solutions (decentralised or screened dump waste) must then be considered for the city.

This line of reasoning for composting units would be important at all levels (neighbourhood or city). These units struggle to become profitable as their potential customers are mostly on the city outskirts and, for famers, the transport costs wipe out any economic incentive. The challenge is considerable as organic waste accounts for over half of the city's waste stock and the organic matter in farmland soil is being depleted due to overexploitation and the overuse of chemical fertilisers (rich in minerals, but poor in organic matter). Here again, it would be possible to envisage municipal aid based on avoided costs.

4. Redefine the scope of the public service to limit costs

The last financial lever does not imply increasing budgets, but rather reducing the scope of the public service. This sparks a broad ethical debate which, in France or Europe, could take other dimensions. In global South countries, the stakes are different. The challenge here is to provide populations with a basic health service (eliminating nuisances due to waste) and to avoid increasing environmental pressures (continue recycling what can be recycled, prevent increased levels of waste generation), without side-lining the social challenge (providing economic activities for marginal populations).

Our empirical observations led us to conclude that a public-sector service seldom fully ensures all the stages of waste management – collection, transport, treatment and disposal. There are two possible approaches to this. The first implies persevering and endeavouring to gradually consolidate the full-service model. In Europe, it took many decades (from the late 19th century) to successfully implement it. The second approach acknowledges the recurrent dysfunctions and adapts the objectives to make them achievable and realistic. In this vein, several cities have chosen to redefine the limits of the public service and consider it simply as the core of the overall service (neutralising sources of nuisances), while delegating the ancillary missions to other actors.

The service is then reduced upstream. The municipality is no longer responsible (in practice, as legally speaking it still is) for door-to-door collection of household waste. The system of primary collection is widespread in African and Asian cities (and only for poorer neighbourhoods in South America). In Surabaya, it is even an organised neighbourhood community that finances or directly implements this service, with each neighbourhood waste bank setting its own user tariffs.

The cost for the municipality is considerably reduced given that collection often represents nearly half of its waste management budget. Yet, the need for this expenditure item is not totally eliminated. It is either externalised to the residents (which then makes it difficult to demand a tax to pay for the rest of the service) or carried out by the residents themselves (often by a community-based organisation). Citizens are thus in a position to organise a service in line with their capacity to contribute. Does this mean one service for the poor requiring their involvement, and another, delegated, service for the more affluent? In any event, it is a widespread practice that helps to keep sanitary conditions within a neighbourhood at a generally acceptable level.

For this reason, several cities (Lomé, Antananarivo, Surabaya) have organised the institutional processes for both the primary collection service and financing in an attempt to link this service's cost recovery with the costs of the other stages. Another way of reducing costs is through recycling and recovery. The municipality is no longer responsible for selective collection, sorting and resale of materials: these missions are instead ensured by informal or community actors. They can then be organised with a view to integrating informals as assistants to municipal agents (Lima, Bogotá), preparing specific places (e.g., transfer points) to facilitate the activity (Lomé, and, to a lesser extent, Antananarivo and Delhi), or encouraging a community-based service in the neighbourhoods (Surabaya).

Yet, the question of the financial sustainability of this outsourcing remains. We have shown that recycling and recovery is only cost-effective for some high-value waste streams (metals, certain plastics). For the rest (other plastics, paper and cardboard, organics, etc.), a complementary mechanism is necessary if financial equilibrium is to be reached. This may involve the logic of avoided costs, EPR chains, CSR, etc. Moreover, global environmental crises may cause the cost of raw materials to rise, which could benefit local recycling activities.

Chapter 5. Rethinking the public waste service

The experiences presented in the previous chapters show that there are numerous possibilities to promote waste recycling and recovery in global South countries: make use of and integrate the activity of informal actors, promote composting, and encourage actions jointly set up by grassroots initiatives and public authorities. Although financing these activities is a recurrent difficulty in a context of cash-strapped budgets and weak public institutions, Chapter 4 pointed up the pathways taken by different cities to stabilise waste management budgets, reduce certain costs or contract out part of the service to third party providers (informal workers, companies, organised communities).

All these innovations suggest that the public waste management sector needs to be viewed through a different lens so that it can be adapted to local contexts which always have their own specific features. The case studies do not lead us to propose one-size-fits-all solutions. On the contrary, they show that headway can only result from a localised reflection and context-specific solutions. It is in this spirit that the final chapter of the report highlights a number of levers (territorial, organisational, logistic, technical) which, depending on the case, may offer possible avenues for diverting waste. This chapter is also an opportunity to reflect on the main models underpinning waste management and to look at waste management through the prism of the commons, going beyond the dichotomy that opposes resource and nuisance.

I. What governance and what territorial scale for waste recovery?

Before developing any technical or financial models for waste management, it seems important to structure the institutional framework for this activity. This framework is based on the actors traditionally in charge of waste management, as well as others who have been incorporated more recently.

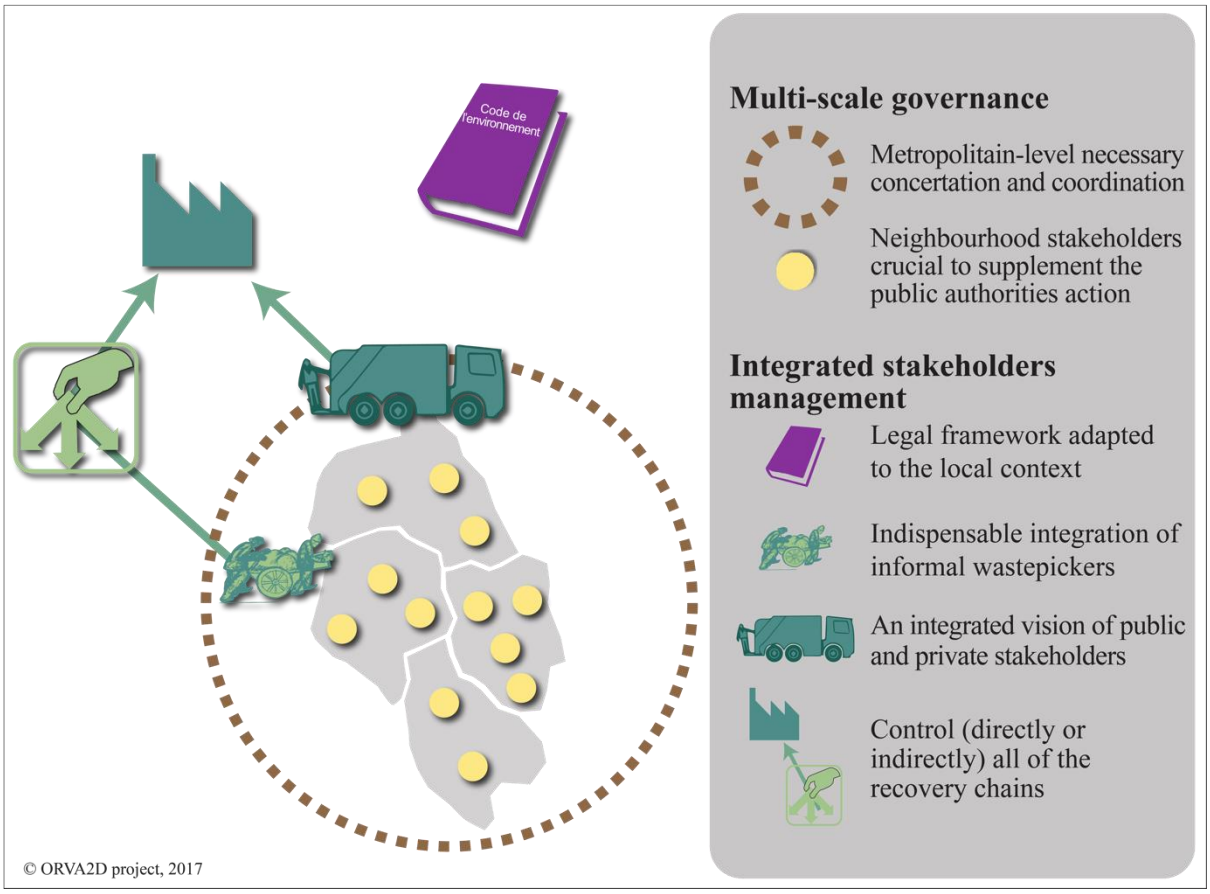


Figure 21. The institutional levers to implement waste valorisation innovations

1. From the metropolis to the neighbourhood: indispensable multi-scale management

A metropolitan governance that influences waste management

Waste management – or more exactly urban cleanliness and hygiene – is the local public service par excellence. In all countries, this mission is ensured by local authorities, whether its managers are elected or appointed by central government. Differences depend on the degree to which this competence is decentralised, as well as on the multitude of actors responsible for its implementation.

One of the challenges is how to manage a public service on the scale of multimillion cities. Almost none of the reference cities has a legal entity with the power to act over the whole of the urban area. Only Bogotá (Capital District) is in charge of the destiny of more than 87% of the population in its metropolitan area (city of 7.9 million inhabitants in a metropolitan area of

10.7 million, DANE,[1] 2015). Conversely, this rate oscillates around 50% in Antananarivo, Lomé and Delhi, which limits the municipal authorities' ability to act.

In some cases, the central state intervenes quite extensively in the management of public services to compensate for this vacuum (Antananarivo, Lomé, Delhi). In Lomé, all levels of local government are directly appointed by the central state. The city of Lima is covered by two provinces: the Peruvian government intervenes mainly in the event of conflict between the municipalities, or for logistical needs (e.g., to eliminate wild dumpsites along rivers ahead of the rainy season to prevent flooding). Only the Bogotá and Surabaya municipalities seem to have acquired a larger political role and the financial resources to implement their policies. These are also the cities that have achieved the most significant results in terms of waste recovery.

At the opposite end, at the infra-urban scale, it is interesting to examine the growing number of stakeholders responsible for waste management and the resulting dispersal of the means of action. This is the case of Delhi and Lima, for instance, where waste collection is ensured by several municipalities. In Lima, this responsibility for collection and transport is shared among the 50 district municipalities, as well as two provincial municipalities for treatment (disposal).[2] In Delhi, the urban area corresponding to the National Capital Region (NCR) spans four legal entities: three federated states and a "territory" (National Capital Territory – NCT). Each of these administrations has the powers to authorise and manage waste recovery and disposal facilities. Collection and transport for the city centre are ensured by the NCT's five municipalities. Added to this are the municipalities of the other States concerned.[3]

Figures 22 and 23 in fact show the importance of one link in the waste management chain that is missing from global North countries: primary collection. This is the case for Antananarivo, Lomé, Delhi and Surabaya. Bogotá and Lomé appear to be the cities where waste management is most centralised around municipal institutions, while the other territories call on a multitude of actors at all levels. These particularities impact the waste management models proposed by each city.

It is also important to note that these synthetic diagrams do not render all the diversity of the situations studied. For example, several municipalities do not intervene directly in managing their waste, but operate through autonomous municipal enterprises: as is the case in Bogotá with the UAESP (*Unidad Administrativa de Servicios Públicos*[4]) and in Antananarivo with the SAMVA. Moreover, the Malagasy ministries are strongly involved in SAMVA's management, alongside the municipality.

[1] *Departamento Administrativo Nacional de Estadísticas* – National Administrative Department of Statistics, General Population Census.

[2] Not to mention the current extension of the urban zone to three new peripheral provinces.

[3] These institutions, representing the central hub of the urban area, are those for which all the data below have been collected, and which involve the population of the country's major city: Lima Metropolitan Municipality, Capital District of Bogotá, Special Delegation of Lomé, Urban Community of Antananarivo, Surabaya Municipality and National Capital Territory of Delhi.

[4] Special Administrative Unit for Public Services.

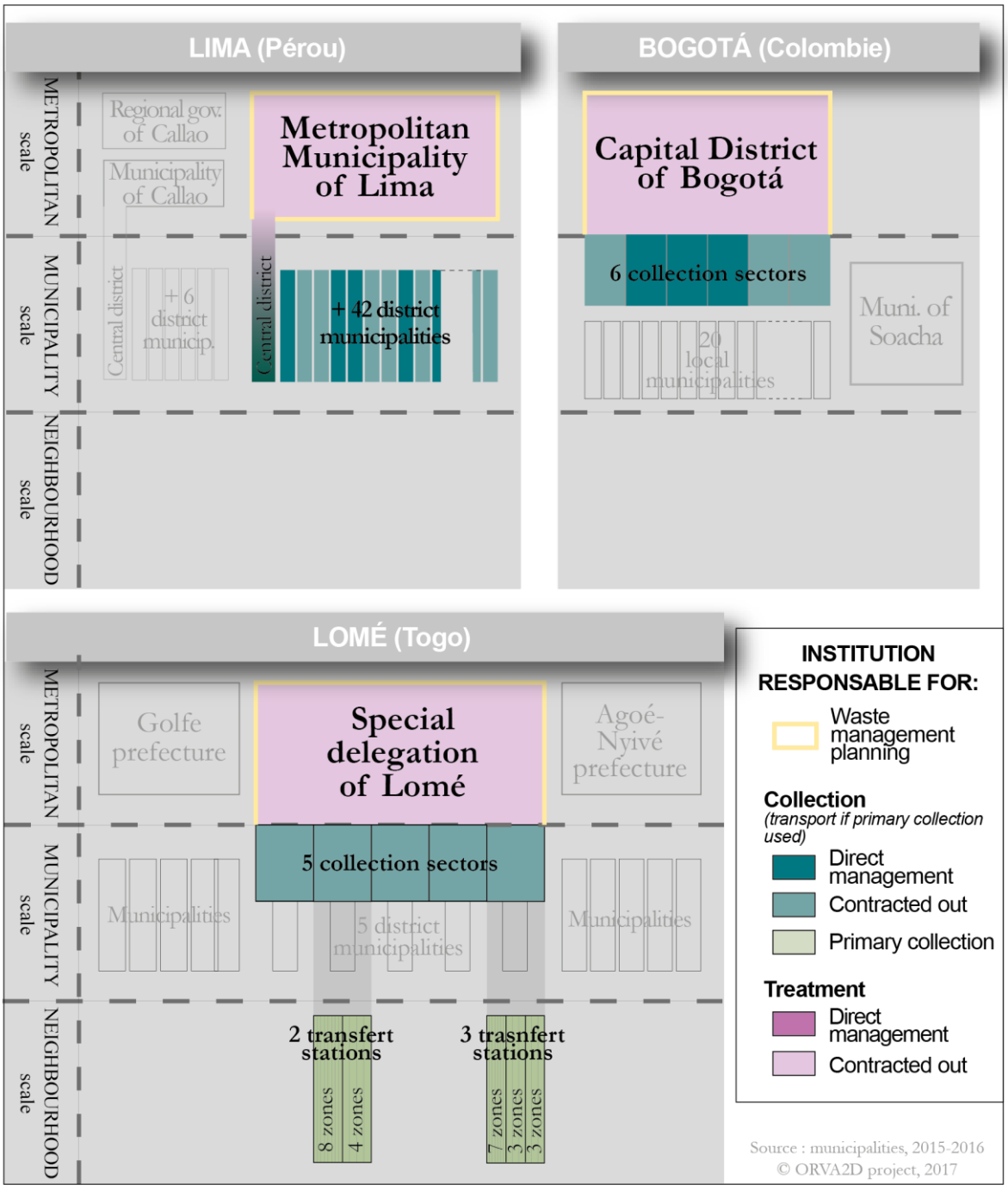


Figure 22. Responsibility for waste management in the reference cities (1/2)

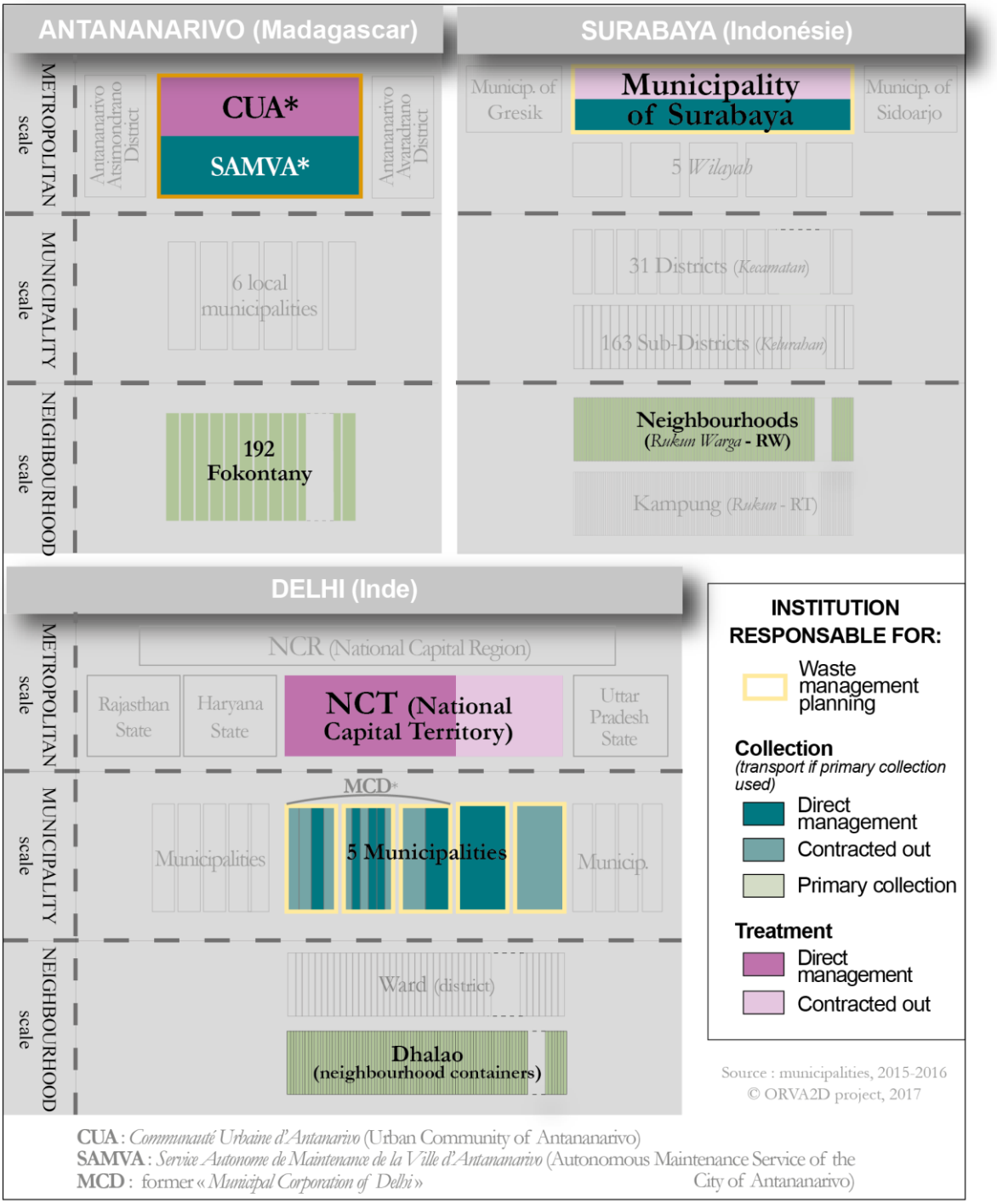


Figure 23. Responsibility for waste management in the reference cities (2/2)

Taking the neighbourhood as the fundamental scale for innovative policy

Waste collection practices differ across all of the case studies. The South American cities opt for a unitary collection system, whereas the Asian and African cities have not been able to

mainstream this type of collection and rely rather on primary collection. In Surabaya, the most interesting innovation involves community waste banks for recyclables, which are widespread at the *kampung* scale (cf. Chapter 2). The neighbourhood is not simply the technically defined perimeter for primary waste collection, but also the level for managing and decision-making on some aspects of the service. In the case of Surabaya, neighbourhood organisations decide on the local policy to be implemented. The *kampungs*, however, take responsibility for their area's cleanliness, for collecting and sorting the waste, maintaining green spaces, managing the community composting unit, etc. While this policy produces very different results across the *kampungs*, it promotes strong involvement from the residents (especially women's associations) in a context where the municipal public service lacks the capacity to directly offer these facilities on a massive scale.

In Antananarivo and Delhi, governance remains informal. It does, however, rely on *dhalaos* (Delhi) and transfer points managed by the *fokontany* (the Antananarivo neighbourhoods). This leads to a complete divergence between the municipal policy, which continues to advocate a unitary system, and the actual practices of local organisations. In Lomé, the municipality has taken over the neighbourhood-level organisation and is trying to structure it. Lima also has a very strong neighbourhood governance at the level of the city's 43 districts. These are on the front line of waste management and show highly contrasted levels of service quality. Bogotá is the sole exception in this area, as it gives no substantive role to neighbourhood organisations. On the other hand, direct democracy is institutionally highly developed in Colombia and leaves a place for various citizen pressure groups, although these are not necessarily linked to a specific territory.

Finally, the neighbourhood appears to be the preferred scale for raising the population's awareness of urban cleanliness and waste sorting. Lima and Bogotá have developed the role of their "sorting ambassadors" at the neighbourhood level, whereas this mission is assigned to formalised primary collectors in Lomé and Antananarivo. The next step is perhaps to raise awareness regarding waste prevention – in countries that already produce much less waste than those in Europe.

2. Informals, government, enterprises… the shift towards integrated waste management

Beyond the multi-scale approach, the success of the innovations explored is always contingent on integrating a broad diversity of stakeholders into the waste management system. The role of local public actors is on the whole clearly defined, but interactions with actors on the rim of the management system can prove crucial. Primary collectors and informal wastepickers, wholesalers and companies are all actors to be integrated into empirical practices or national legal frameworks.

Sectoral legislation: a different vision from the multi-stakeholder approach

A legal framework is indispensable for good waste management. Yet, modelling standards on the legislation of global North countries for reasons of health and environmental requirements (Figure 24) is generally counter-productive, since global South countries lack the capacities to achieve the same objectives. The challenge is thus to have laws that are adapted to local realities.

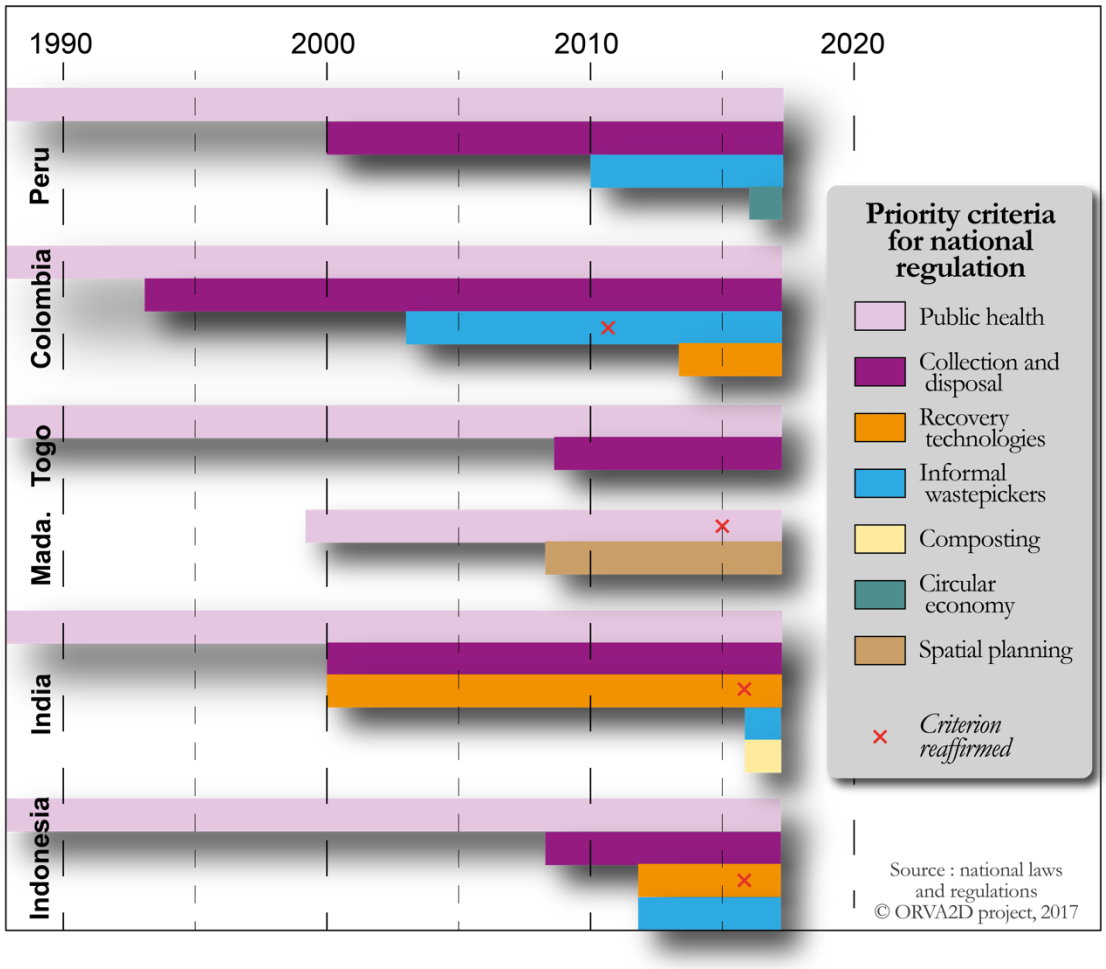


Figure 24. Promulgation dates for national waste-related laws or regulations

- Urgent public health considerations always present in the laws

In the 1970s and 1980s, most of the countries studied enacted a law to stabilise the legal status of waste and require its removal from the urban space. In fact, since the 19th century and the proven connection between disease and urban environmental pollution in Europe, the main goal of waste management worldwide has been to reduce health hazards (Berdier & Deleuil, 2010), and thus to limit all contact between populations and waste – although this radical perception of the issue has been subsequently challenged (Durand, 2012). Before the 1970s, most countries did not have a waste management policy as such, having only public health policies that also covered the treatment of sewage and other urban contaminants.

Madagascar alone passed a law – much later in 1999 – that imposed sanctions on people who contaminate their environment and required the disposal of waste in listed and authorised disposal sites. This goal was reaffirmed by a 2015 law that introduced a “public health code”. This was not designed to develop waste management but simply limit the impact of urban pollution.

- Collection, transport, disposal: implementing the "polluter-pays" principle

Little by little, the responsibility of the waste "generator", be it an individual, company or community, has been legally recognised on the basis of the polluter-pays principle. Waste management has thus become one of the main public services assumed by municipalities in their capacity as custodians of each citizen's responsibility. To fulfil this mission, legislation passed in the 2000s developed precise details on the different technical stages: the collection of waste, then its transport and treatment/disposal (2000 for Peru and India, 2008 for Togo and Indonesia). To ensure the final stage, national regulations most often prescribe the construction of sanitary landfills to put an end to the heavy environmental pollution from wild dumpsites. In Indonesia, this requirement was introduced following a waste-slide at the municipal dumpsite in 2005 which claimed 143 lives. Moreover, the law now obliges the municipalities to treat polluting discharges at these landfills: piping and treatment of leachates, biogas capture and flaring. In reality, only the largest cities have the material and financial resources to enforce this regulation. In most national legislations, the use of private-sector services is strongly encouraged based on the assumption that the private sector outperforms the public sector (Barraqué, 1995, Lorrain, 1995).

Following these new laws, waste management has become one of the main expenditure items on municipal budgets, although policy makers often remain more focussed on collection/removal (a more politically sensitive question) than on the effectiveness of treatment.

- Waste as a part of spatial planning

Almost all of the countries studied legally require metropolitan areas to produce waste management plans, referred to as "integral" (i.e., taking into account all waste stocks) and "integrated" (i.e., coordinated with the other urban policies). These planning documents commit the municipalities to a coordinated policy at the level of their jurisdiction, and sometimes attempt to extend planning to the scale of their metropolitan area.

In practice, the plans are mostly sector-based, limited to framing how waste is to be managed and to defining which sink to use (primarily landfills). Antananarivo proposes going a step further and has integrated waste management into its urban spatial planning. A 2008 law enshrines the principle which, like the recent French regional spatial planning schemes,[1] fully integrates waste management and other urban and environmental issues. However, in Antananarivo, the law has had no effect as it has not yet been implemented.

- A legal framework gradually adapted to local constraints

Most of the countries studied thus have a legal framework defining health and technical standards for waste management. However, observations indicate that the frameworks are only partly applied. This is why some countries are redesigning a legal framework with less stringent principles and better tailored to the realities of local implementation. Peru is a case in point, having adopted the 2009 "Recycler's Law" to soften the criteria authorising recovery and recycling activities by integrating all informal actors and gradually encouraging them to upgrade their practices (in terms of health and environment). These adaptations help to provide an effective service that is gradually being improved and requires fewer financial, technical and human resources.

[1] SRADDET (*Schéma Régional d'Aménagement, de Développement Durable et d'Égalité des Territoires* – Regional Scheme of Spatial Planning, Sustainable Development and Territorial Equality) set up by the 2015 NOTRe Law.

Integrating informals: a revolution in integrated waste management

The integration of informal actors, whether collectors of recyclables or primary collectors, is embedded in the now widely deployed strategies. This involves partly legalising informals generally on an associative or collective basis. It also means organising their activity by defining their collection routes or districts and establishing a contractual relationship.

Besides the financial obstacles to integrating informals, these operations have certain constraints. In particular, if they are to succeed, the practices of informal actors should not be overly modified. In Bogotá, which has the most successful experience in this area, the wastepickers were initially very free to organise themselves as they wished. The only requirements were that they should register and weigh their waste in certified centres. In Lima, on the other hand, the municipalities were required to organise small cooperatives and allocate a sector and work schedules to each one. As a result, many informals refused to participate. In other cases, formalised wastepickers found themselves competing on the same territory with new informal recyclers who had kept the former practices and schedules that the residents preferred.

The other constraint lies in the role of the municipalities: as public actors, they may sometimes formalise wastepickers and primary collectors who do not always meet all health standards and ministerial work authorisations. This then poses the question of the municipalities' responsibility. The city of Lomé recognises *de facto* the existence of these actors by contracting them to organise primary collection. The legal framework thus becomes an evolving one.

Beyond recycling, informal recovery actors are also key actors in re-use activities and thus help to reduce the quantities of waste requiring treatment. It should be remembered that re-use is more virtuous than recycling as it involves no artisanal or industrial transformation, which consumes energy or water and discharges polluted effluents and gases. Re-use is thus at the top of the hierarchy of waste management routes. Repackaging and re-use are very widespread in Antananarivo and Delhi, as well as all the other cities, given the number of people working in collection activities. This implies that sorting, cleaning, repackaging and sometimes repairing have an important function. This sector of activity is particularly dynamic and deserves deeper study (Ngambi, 2015). Bottles and packaging in glass or PET are also very often re-used.

Rethinking company participation

Private-sector participation in urban services such as waste management was the subject of highly divisive debates in the 1990s and 2000s (Barraqué, 1995; Lorrain, 1995). Today, the model is more stable and legislation in all of the countries studied allows companies to intervene under public-private partnerships, public service concessions, etc. At present, landfill sites in all the reference cities (except in Antananarivo) are operated by private enterprises. These different partnership arrangements can offer one-off advantages depending on the project concerned. However, they mainly come into play for major infrastructure such as sanitary landfills and, above all, incinerators. Research conducted since the 1990s (Breuil, 2004; Marin 2009; Binder & Trémolet, 2010) clearly shows that, whatever the configuration chosen, the challenge is for the contracting authority to have full ownership of the project. It is crucial that the municipality be in a position (notably in terms of its powers) to discuss with the private stakeholder in order to move towards a balanced partnership in the long term. It is also

important to have an overview of all the stakeholders (e.g., informal actors) to avoid being subsequently locked into a contract that offers little flexibility.

Collaboration between private providers and informal actors is growing. Although dismissed or tolerated by default for many years, this collaboration is today being formalised, as is the integration of informals. In Bogotá, after strong judicial pressure from wastepickers' federations, service providers are now compelled to integrate formalised actors into their own collection service. The wastepickers are thus entrusted with collecting recyclable waste following routes and schedules similar to those of the private company's residual household waste collection. Similar examples are found in other countries outside our area of study (Egypt, Brazil, etc.). Informals are also often unofficially allowed to search for recyclable materials on landfill sites. Beyond the fact that this helps to reduce the volumes to be landfilled, the issue here is primarily the social acceptability of landfilling. Today, the wastepickers' presence on landfills tends to be organised and official.

Private companies can also intervene in waste management through their Corporate Social Responsibility (CSR) programmes. This type of partnership was behind the Surabaya Green and Clean programme in Indonesia. Jointly organised by a corporate foundation, local NGOs, local residents and the media, the operation was subsequently taken over by the municipality so that it could be mainstreamed as public policy. Companies, like NGOs, thus play an important role in launching new initiatives. CSR allows financial resources to be released outside the conventional modes of financing urban services. A similar rationale is found in Lima, where some districts are trying to arrange for wastepickers to be subsidised by industries through CSR schemes or by shopping malls as a form of advertising (which shows that the profession today enjoys a much more positive image).

Coordinate all the stakeholders in the valorisation chain

The examples studied have shown that one of the limits to multi-stakeholder integration lies in managing the whole of the valorisation chain. This does not mean public management of the whole of the chain, but rather knowledge-sharing and coordination among the stakeholders. Surabaya has tried to set up a "parent" waste bank to centralise all recycled waste streams, but this has met with relative failure as the networks of buyers and waste dealers continue to operate. Lima and Bogotá adopt same approach to formalising buyers and gradually controlling the whole of the chain. The objective is not only to improve workers' health conditions throughout the entire chain, but also to ensure economic sustainability for formalised or community-based recovery actors.

In the 2000s in Quezon city in the Philippines, the "Linis Ganda" formalisation model was implemented in two ways. First, the waste collectors are formal workers authorised to collect and recover materials. In exchange, they agree to be paid low wages, which reduces waste management expenditures for the local authorities and the *barangay* (village/neighbourhood). Likewise, informal junk shops can be authorised to operate as materials recovery facilities (MRFs). This semi-formal status channels recovery activities towards the private recycling sector, bringing benefits for both the authorities and local traders. The informal wastepickers and local traders are gradually organising themselves into sales cooperatives. The objective is to integrate them into the supply chain at a higher and more favourable level (Chiu, 2010).

The authorities often encourage formalised actors to group together so that they can upgrade their skills and become waste buyers. The question remains as to how informal traders could react to this new competition.

II. What waste management model to support policy?

The purpose of identifying the levers that enable a shift towards waste valorisation is to give waste management actors an overview of opportunities. Clearly, each situation is different, each territory has its own specificities, and it would be pointless to seek to systematically apply the same levers across the board. Three main models emerge, all in fact implemented in parallel in each of the cities, but with different objectives and applied to different populations and waste types.

1. A centralised, unified and linear model

The first model foregrounded by the cities studied is at the same time centralised, unified and linear. It adopts the same goals as those generally set by global North countries with a focus on public health objectives. It aims to remove waste from the urban space to prevent health risks for residents and, as far as possible, also control the disposal of this waste to reduce its environmental impacts.

A model that mimics global North practices

The actors implementing this model aim for waste management that is:

- **Centralised** in the hands of a single actor at the metropolitan scale in order to compensate for inadequate management of the urban area in most of the cases studied. This helps to gradually strengthen the municipalities. If no metropolitan authority exists (the case in four of the six cities), the state and its ministries take direct responsibility for management. This thrust for centralisation sometimes seem to reflect a wish to prevent the empowerment of potential political competitors at the local level.
- **Unified**, meaning that the same municipal public service is provided to all citizens. This corresponds to a vision of theoretical equality, offering the same door-to-door service to all.
- **Linear**, as the main objective remains to limit health risks and thus move waste away from the city. All waste streams converge towards a single sink – a (more or less controlled) disposal site – to avoid dispersing waste to sites not directly controlled by the central actor.

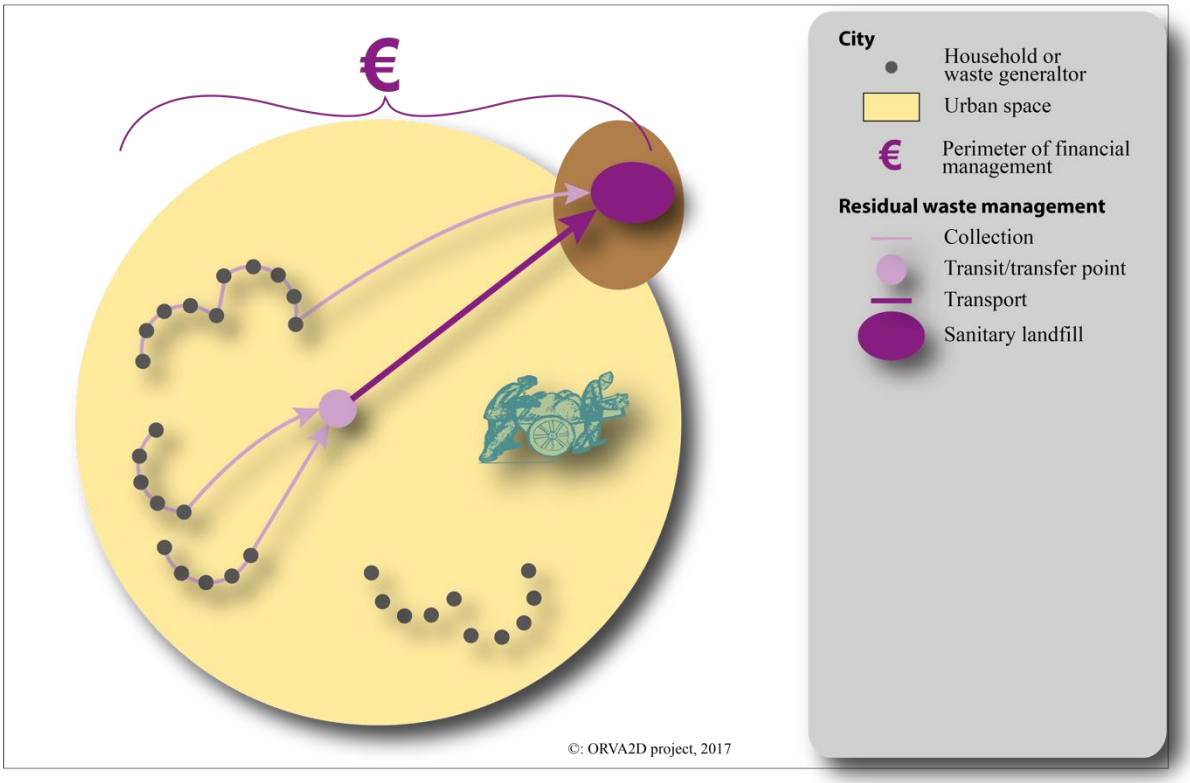


Figure 25. Centralised, unified and linear waste management model

A model not fully operational in the global South cities

Although this model long served as the international benchmark to be universally replicated, today various limitations to its application have been observed.

- **The impossibility of implementing citywide door-to-door collection** creates a socio-spatial segregation of service access. While city-centre and affluent districts are able to benefit from this service, this is not the case for the poorest peri-urban settlements (no accessibility, inability to pay, illegal housing, etc.).
- **The absence of generalised waste recovery and recycling** is one of the features of this model. Since the foremost objective is health, it precludes any possibility of recycling or composting in order to prevent waste stocks from being dispersed to inadequately controlled sinks. It is better to landfill all waste rather than allow individuals to handle it given that it is a source of risk.
- **The persistent presence of informal actors**. Despite a relentless struggle against informals, it seems impossible to dislodge them, not only because they compensate for the shortcomings of the municipal service, but also because of the influx of vulnerable populations seeking a source of income.
- The fourth limit is **the impossibility of collecting the taxes** intended to finance the service. Unable to pay or dissatisfied with the poor service quality, users massively opt out of paying, which exacerbates the dysfunctioning of an already under-financed service. The local authorities' general budget or the state budget then has to make up the shortfall.

- Lastly, this model is greatly limited by the very serious **problems of controlling landfill sites** and thus curbing pollution in the vicinity. Only the richest cities are on the way to achieving this (Lima, Bogotá, Surabaya), and only partially.

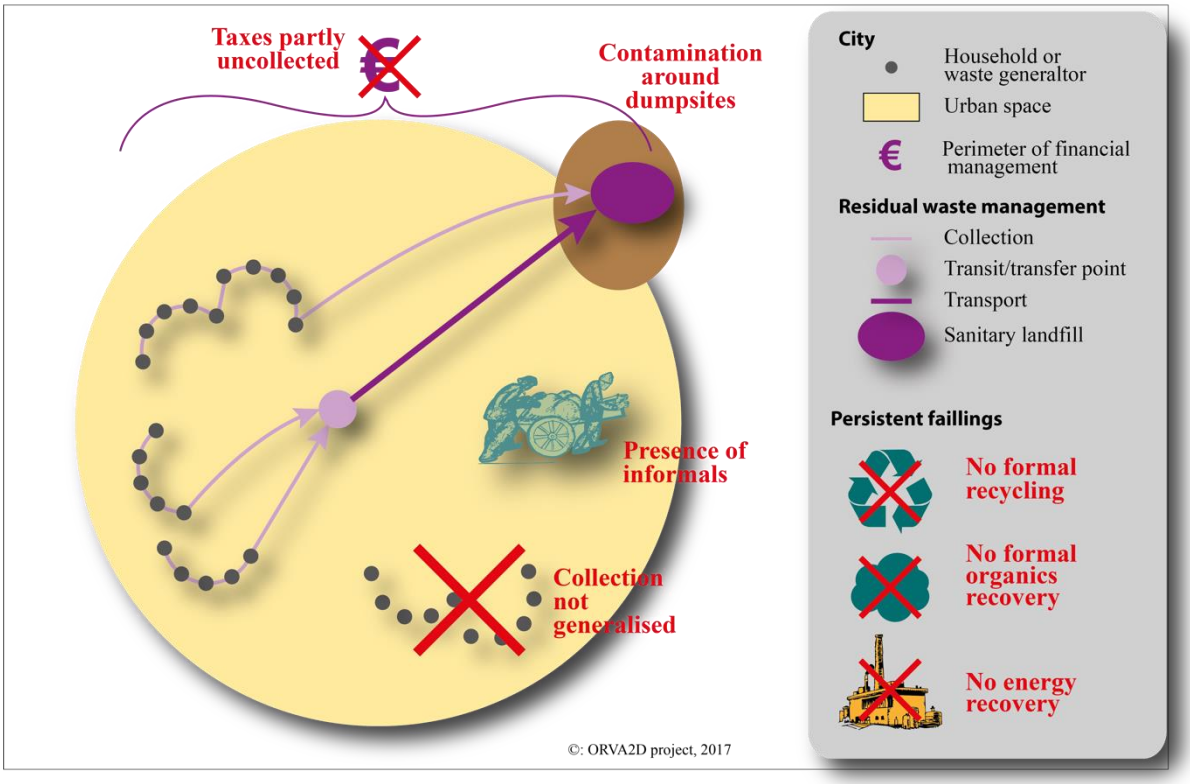


Figure 26. Dysfunctions of the centralised, unified and linear model

2. An informal, diversified and insalubrious model

The second existing model has advantages and disadvantages that are diametrically opposed to the previous model.

A model linked to the deficiencies of municipal management

As it stands, the centralised model seems difficult to apply to global South cities since their social and economic structure does not fit the requirements. In the absence of a centralised model, another model emerges by default, spontaneously, in order to ensure a minimal waste removal service for residents.

This involves primary collection by the residents themselves (when they deposit their rubbish at the end of the street) or by informal primary collectors paid directly by the residents. The primary collectors then dump the rubbish on the roadside, at spontaneous transfer points or in the natural environment (ravines, rivers, fields, ditches, etc.). Although unorganised, these practices can be qualified as “self-management” since they are a form of spontaneous management that differs from a situation in which there is no waste management at all.

This model is diversified since each neighbourhood sets up its own method of primary collection in line with its specific financial, technical, territorial, social and cultural characteristics. The diversity of management methods stems from the fact that informal actors work extensively on recovering recyclable waste. Residents also sometimes source-separate in order to save themselves the cost of primary collection and make a little money by selling their waste to informal recovery actors. These diverse options give rise to an intense activity involving the re-use of objects, out of necessity, which also prevents the generation of large amounts of waste. However, the local impacts on health are often negative.

Finally, the model is often insalubrious as it produces a diffuse contamination of the territory in each locality where waste remains uncollected: in homes and all the illegal dumpsites along the roadside and waterways.

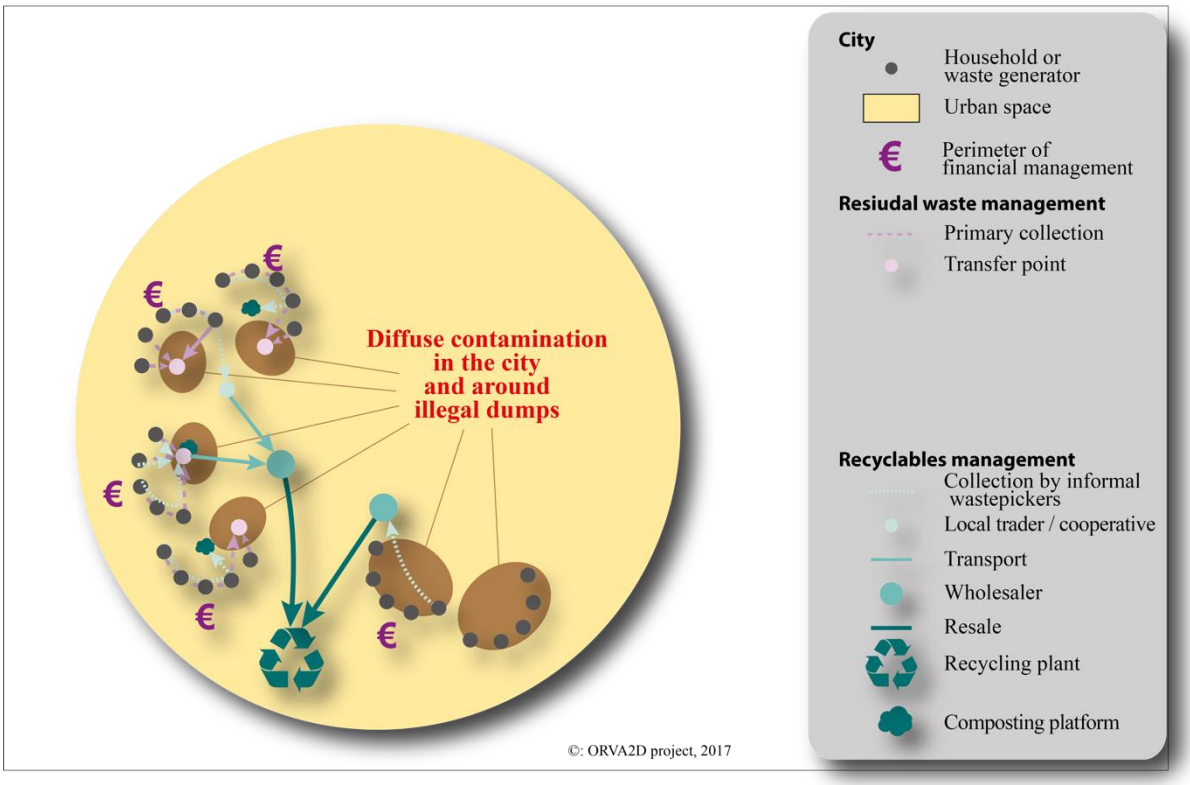


Figure 27. The informal, diversified and insalubrious waste management model

In practice: an informal semi-integrated model

This model is actually more complex given that it rarely exists alone. It is generally found alongside the centralised, unified and linear model. The points where the waste from primary collection is dumped are habitually located on main roads. The municipality then attempts to provide a more or less regular service to collect this loose roadside waste and transport it to disposal sites that are more or less controlled.

The informal model is only implemented as the sole solution in the poorest neighbourhoods of the reference cities. In these localities, contamination of the natural environment is very high and the first to be adversely affected by this model are the residents themselves.

Some advantages not to be disregarded

In all the cities, this informal model is described as a situation to be avoided and as the reason why it is urgent to intervene in waste management. Although it is crucial to change the model, it is also important not to reject all of its characteristics.

In global North cities, which operated on a similar model until World War II, mistakes were made that later had to be rectified at great cost. This model does indeed offer some advantages:

- First of all, it allows for **a high level of waste recycling**, whereas the centralised model includes no waste recovery activities. Informal actors constitute a workforce that has considerable know-how on recognising the different types of material (even if their usual freedom of action is difficult to reconcile with fixed employment in a sorting centre). It will take Europe years to re-train waste workers in modern sorting centres now that this practice has disappeared.
- **Residents also continue their habit of source-sorting** at home. They do this out of necessity, but do not yet feel disgust at materials that can be sold on, composted in their backyard or fed to animals.
- **The practice of re-use is also widespread**. When the centralised model arrives in a neighbourhood, residents enjoy the luxury of being able to discard objects more easily (linked to mass consumption). Yet, today European policies are trying to encourage re-use in order to reduce waste.
- Lastly, the daily need to remove waste out of a neighbourhood (primary collection or direct action by residents) **forces the inhabitants to collaborate** and organise a minimal degree of community action. The cleanliness of a neighbourhood thus necessarily implies a high level of sociability. This is shown by the examples of Antananarivo and Surabaya.

3. A participatory, composite and circular model

The third, emerging, model deploys some of the innovations highlighted throughout this report. It attempts to maintain the objectives of public health and service improvements found in the centralised model, while also recognising the aspects that are difficult or impossible to implement locally. It thus seeks to rely on the advantages of the informal model to build a hybrid solution (or “mixed modernities”, cf. Chapter 1) that is more adapted to global South countries. In fact, each territory has to invent its own model – one which is not systematically or globally replicable.

A model under construction based on empirical innovations

This model thus encompasses all of the innovations identified as levers for developing waste valorisation and management. And as such, it has hybrid characteristics:

- It is **participatory** in that the population takes an active part in managing waste, with a collective objective and not out of necessity. Residents sort some of their waste at home and/or in community sorting centres, remove the waste themselves to outside the neighbourhood, or collectively manage a primary collection service by delegating these tasks to primary collectors or wastepickers. This is the case of the Indonesian waste banks, the Malagasy RF2 system and Peru’s formalised wastepickers. They can also participate in exchanges with the public actors. Coordinated at metropolitan level, these exchanges may take place with the

neighbourhood's municipality or district authorities. This means that there is also a **(partly) decentralised** aspect.

- It is **composite** insofar as waste management no longer involves one single model common to all city residents or all types of waste, but is instead tailored to micro-local contexts, as well as to the types of material discarded. This diversity means that a primary or secondary collection service can be proposed to suit a neighbourhood's means and practices. It implies trusting a multitude of stakeholders to collect waste, sort it and recover it (e.g., a private firm for RHW collection, a formalised wastepicker organisation for recyclables and a community for compostables).

- It is **circular** because, contrary to the first model, the stated objective is clearly to move towards a high rate of waste recovery. The local authorities that implement the innovations described above always do so in order to recover the maximum quantity of waste, taking account not only environmental, but also social and economic issues. This circularity could be broadened to a model that aims to avoid increasing waste generation by maintaining and encouraging relevant practices (re-use, returnable packaging, repair, etc., which are widely developed in the informal model).

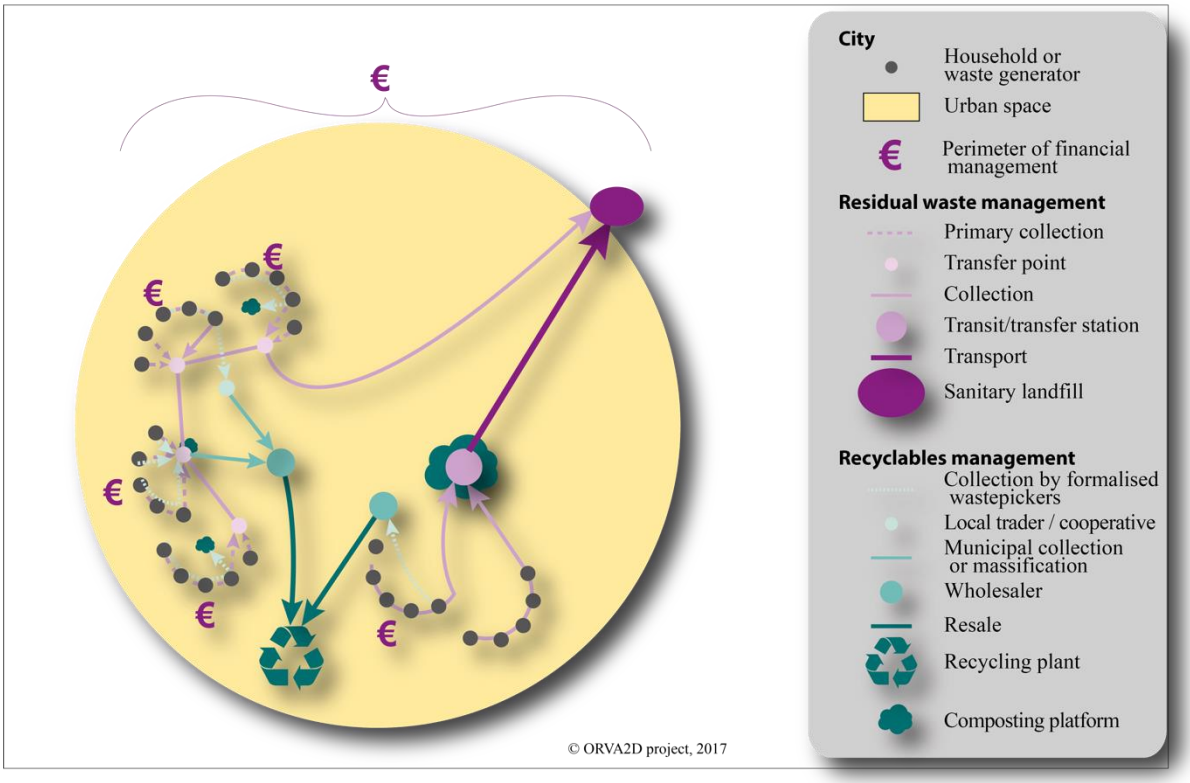


Figure 28. The participatory, composite and circular waste management model

Multi-scale complementarity and evolution over time

Like the previous models, what is observed in reality is a blending of the participatory model and the other models. Sorting and recovery systems complement a municipal service that, in

all cases, lacks the capacities to meet the requirements for generalised collection and recovery.

This complementarity emerges at multiple levels. While there is considerable coordination at metropolitan-scale, the neighbourhood scale always seems to be pivotal. It is the long-standing sociability in Surabaya that enables the roll-out of sorting and composting innovations. It is neighbourhood solidarity in Antananarivo and Delhi that helps primary collection to function *a minima*. It is the relationship of trust between the residents and primary collectors (Lomé) or wastepickers (Lima and Bogotá) that facilitates local intervention. Moreover, this local sociability is expressed in different ways within the neighbourhoods in the same city, whether they are central or peri-urban, rich or poor, horizontal or vertical. The role of metropolitan coordination is to ensure that this multi-faceted dimension does not ultimately lock poor neighbourhoods into below-standard solutions and thus increase socio-spatial segregation.

An important question here is the timeline for moving from one model to another. Are centralised and informal models set to shift to the participatory model or coexist within the same city? Is the participatory model destined to evolve towards a more integrated system with greater control by public actors as is the case in global North countries? Or on the contrary, are global North countries – where an increasingly composite aspect is visible (multiplication of sub-sectors and actors) – going to slide towards a more participatory and technically decentralised model, notably due to budget constraints?

This model also radically challenges the logics implemented in the global North countries by proposing “post-network” and “post-policy” solutions (Coutard, Rutherford & Florentin, 2014). This no longer signifies offering a unified and homogenous service to all of a city’s inhabitants, but shifting the limit of the public service in order to provide waste management adapted to local constraints.

4. Applying the models to the reference cities

The three models (choremes) presented above are clearly theoretical. In practice, they are present to varying degrees in all six reference cities:

- While no city as a whole matches the “centralised, unified and linear” model, the district of Surco (Lima) – which takes what happens in global North cities as its example –has the closest fit. We could also add some districts in Delhi.

- The second “informal, diversified and insalubrious” model mainly concerns the cities’ poorest neighbourhoods. It is in Antananarivo that it seems most widespread because the municipality has by far the lowest level of financial resources to manage its waste.

- Finally, the “participatory, composite and circular” model is emerging in several cities, particularly Bogotá, Lima and Lomé. It is in Surabaya that the broadest diversity of technical and organisational innovations are proposed.

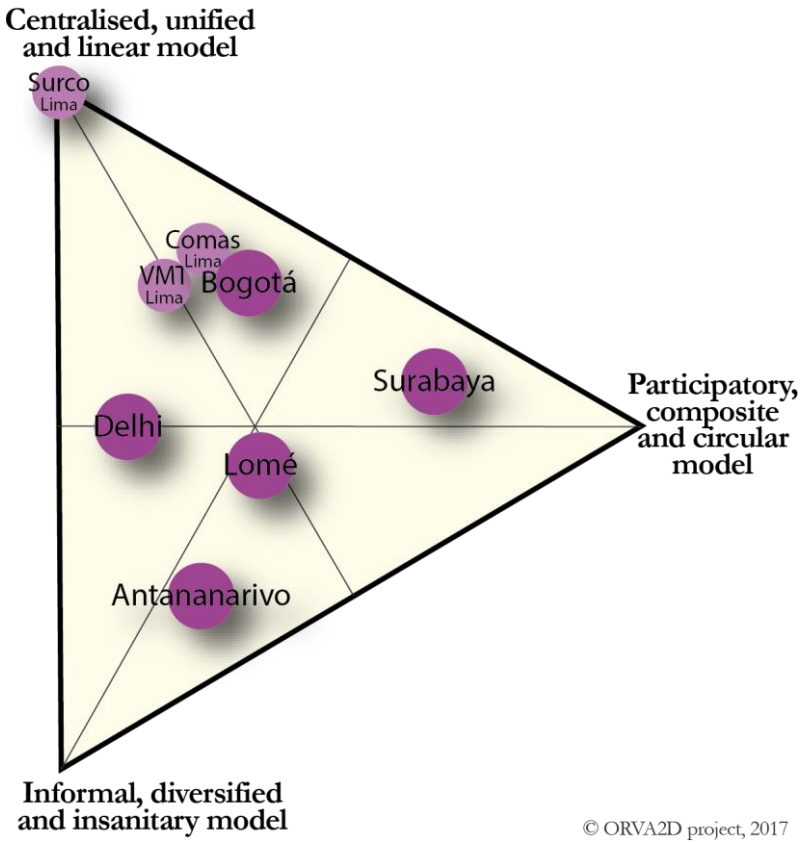


Figure 29. Positioning of each city compared to the models studied

III. Managing waste as common resource

1. Waste: a "common good" that confirms the empirical analysis

Our empirical analysis of the spatial and economic dynamics at play shows that urban solid waste has the characteristics of a common good:

- Economically, given that the potential revenues from recycling are substantial, dry waste appears as a rival good since its appropriation by one actor deprives others of its possible resale.
- Spatially, the absence of underground waste disposal networks, as well as the multiple intermediate reloading operations (transfer points, transfer stations), makes any exclusion impractical: it is virtually impossible to prevent waste from being intercepted (both in space and time) upstream of the municipal service. In fact, the most lucrative elements of a city's discarded waste are often skimmed off upstream by informal collectors.

In light of this empirical analysis, urban waste – rival and non-excludable – appears as a resource with the characteristics of a common good (Cavé, 2015), as defined by the originator of this concept (Ostrom, 1990).

Considering stocks and flows of waste together

However, so as to avoid the conflation whereby all urban waste is assimilated to its most recoverable and lucrative part (dry waste), it is useful to reason in terms of stocks and flows:

- In fact, one part of the waste generated by citizens in the global South is quite quickly recovered or purchased and never ends up in a disposal site. These fractions of waste have a sufficiently high obvious value that they are never abandoned for long. They can be equated to *flows*.
- The other part of the waste is permanently discarded and abandoned. This fraction of waste, which has zero or even negative value, corresponds to a *stock*: no actor is spontaneously prompted to recover or recirculate it.

Mixed together, flow and stock constitute the overall urban solid waste deposit generated. However, this contiguity leads to cross-contamination. As the individual properties of materials that come into contact with each other become degraded, it is this mixing of different types of rubbish that is partly responsible for generating waste. For instance, a sheet of paper brought into contact with a mouldy tomato will soon become wet and unusable for its original purpose. It turns into waste. In other words, mixing some materials that could have been flows end up as a stock with no value.

Flows and stocks in Ostrom's Common Pool Resources

Here, the concept of common pool resources (CPR) (Ostrom, 1990) proves useful both from an analytical and operational perspective. In the 1980s, E. and V. Ostrom conducted important empirical research on environmental resources managed outside of governmental or market spheres (Ostrom, 1990) and developed the concept of "common pool resources". Elinor Ostrom defines CPR as a "resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use" (Ostrom, 1990). This kind of resource generally involves fishing grounds, groundwater or pastureland. A common pool resource has the characteristics of a common good: it is rivalrous and, in most cases, its provision typically makes it difficult to exclude other beneficiaries. As with a public good, this means that players may spontaneously be tempted to take advantage of it. However, unlike a public good, a CPR is rivalrous: its use by one actor can lead to the eviction of other actors. Moreover, issues of resource overuse can arise.

The main contribution of the CPR concept is precisely the distinction it makes between the resource as stock and the resource as flow. Any resource system is formed by these two interdependent elements. The resource flow corresponds to the unit withdrawal from the resource stock and the stock is equivalent to the unextracted units of the resource. However, this conception of waste as a common pool resource implies inverting the internal system dynamics:

- In the common pool resources described by E. Ostrom, the stock (e.g., young fish) is required to replenish the flow (e.g., mature fish).
- In the case of waste, it is the contrary: "the flow (waste-resource) goes hand in hand with a stock (waste-refuse) that is potentially harmful and which, consequently, must not grow. However, no one wants to appropriate this stock" (Cavé, 2015).

In other words, the danger does not lie in the depletion of the stock, but rather in its growth and its uncontrolled disposal. The risk generated by waste recovery actors when they extract the most lucrative part of the waste is that they create a financial imbalance for the municipal service and thus endanger the controlled landfill of final waste.

A service semi-decentralised through the assignment of usage rights

Derived from a combination of private and public law, usage rights – which give privileged access to a flow of resource units – seem appropriate for managing common pool resources. Unlike property rights, usage rights define "who might have what use of which quantity of the resource, in the form of which goods and services derived from it" (Varone et al., 2008, p.7). Usage right can emanate from public policies that assign these rights to beneficiaries who may not be the legal owners. Usage rights thus refer to resource unit withdrawal rules that do not grant absolute freedom in the use of the resource.

Since part of the waste is inevitably intercepted by informal recovery actors given the service's intermediate reloadings and the value of some of the materials involved, the assignment of usage rights could be a novel way to regulate the participatory, composite and circular waste management model. In fact, the difference between assigning property rights and usage rights is that the latter would make the appropriators accountable to a regulator for the traceability of the flow circulating at the metropolitan scale. As exclusion is impossible, it is pointless to ban the diversion of flows, but it is important to recognise and regulate them in order to ensure adequate management of the stock. In fact, rejects (solid, liquid or gaseous) from the recovery chains are currently dispersed in the environment without any control. "Treating the solid waste deposit as CPR points to a unifying principle: the proper disposal of refuse (the stock) in controlled landfills. The implementation of usage rights may allow this principle to be put into practice. Non-governmental solid waste interceptions could be accepted – and even stimulated – on condition that the refuse from every collection is strictly channelled towards adequate landfill facilities" (Cavé, 2015).

The inclusion both of stock (for minimisation) and flows (for maximisation) within the analytical framework of CPR suggests the idea of a multi-stakeholder, semi-decentralised solid waste management system. In such a system, non-governmental recycling initiatives would not be crowded out to the benefit of a centralised monopolistic service focused on final landfill solutions. Informal recovery actors could be integrated as local agents able to efficiently capture the largest amount of recoverable waste possible at source. However, they would only be integrated on condition that they channel their own residual waste to centralised treatment facilities so that health and environmental externalities could be suitably managed. In this way, stock management would be centralised and flow management decentralised.

2. Implementing waste management as a common good

Following on from this analytical approach, we now look at how this logic could be operationalised.

Spatial and institutional dimension: shifting to a semi-decentralised model

Rolling out some kind of primary collection organised on a sub-municipal scale (neighbourhood) allows for early-stage reloading. This is an opportune moment for sorting and diverting waste to recovery options either *in situ* (composting) or close by (recycling channel). This reduces quite considerably the volume/tonnage of waste to be sent for landfilling at a centralised facility.

Technical dimension: another look at the segmentation of urban waste stocks

High-value waste is easily managed by the market (informal) without intervention from public actors. Hazardous waste, on the other hand, requires strictly controlled supervision to oblige

its generators to control its decontamination. The remaining waste constitutes an “underbelly”, meaning the largest quantity of waste that neither receives any specific attention nor creates fierce conflicts over its appropriation.

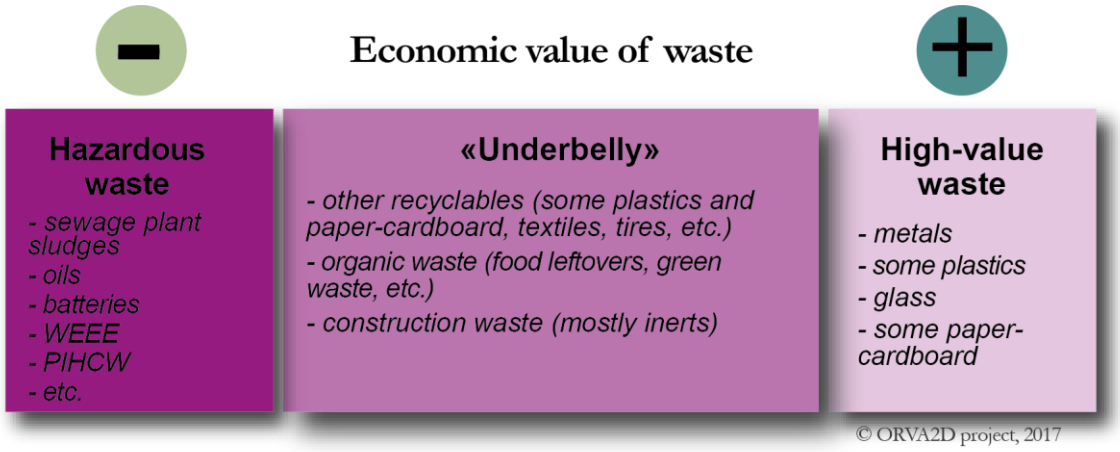


Figure 30. Economic value of different types of waste

This “underbelly” of waste corresponds to refuse that is technically recoverable, but only under certain conditions that are unfulfilled (its recovery cost exceeds its market value) as long as no specific mechanism (organisational, technical or financial) intervenes to facilitate its recovery. The waste in this “underbelly”, equivalent to residual household waste, mostly comprises:

- **organic waste**, representing from 52% to 79% of a city’s waste[1] and offering the best opportunities for diversion,
- **inert waste** (from urban worksites or street cleaning), which cannot be incinerated and which, if landfilled, would greatly limit the useful life of landfill sites even though their (inert) character obviates the need for landfill.

As things stand today, this waste forms a stock that no actor wants. The challenge is thus to convert it into flows: either by increasing the prices charged for landfilling this type of waste, or by encouraging recovery channels, centralised or not (composting, anaerobic digestion, use for road construction or embankments, etc.).

Economic dimension: usage rights and contractual models

How can the logic of usage rights be incorporated into contract-based models of a public service?

- Firstly, it would require **ceasing to remunerate collection service providers on the basis of each tonne transported to a landfill facility** so as not to discourage diversion to recovery chains.

[1] Only Lomé has a lower share of organics, which should be viewed in light of the very high (and abnormal) presence of inert waste.

- Next, for the public authorities, it means **maintaining contractual control over the landfill facility so as to send a price signal to the whole sector** by freely defining tipping fees.
  - In fact, if tipping fees are kept high, this will serve as an incentive to divert waste flows to recovery channels that, otherwise, do not seem financially lucrative. As Anne Scheinberg points out: "Municipal recycling is rare, or underperforms, because there is simply not enough of a price signal to stimulate the diversion of materials from disposal" (Scheinberg, 2015, p.984). Having the power to set tipping fees is a crucial lever for public authorities.
  - This kind of contractual arrangement also makes the rationale of avoided costs actionable. And, through a ripple effect, forms of incentive-based charging can be envisaged: waste sorted by residents earning them money-off vouchers on their waste collection taxes for the good reason that this practice reduces the tonnages to be landfilled.
- Acceptance of these logics means **challenging the limits of the public service**, accepting the outsourcing of certain tasks (primary collection, sorting/recycling) to other groups of population (communities or informals), as well as diversifying (with the risk of inequality) the methods of financing each stage.

3. Between low-tech and high-tech, creating a model adapted to global South cities

One of the challenges that emerged from our field observations lies in the divergence of the models implicitly promoted by waste management actors. Most global South elites consider that the only proper way to manage waste is to opt for sophisticated technologies to massively reduce nuisances and, ideally, obtain economic and environmental benefits from its valorisation. Yet the whole of this report shows that, on the contrary, even though such technologies can theoretically enable an appropriate treatment of waste, they are not suited to all contexts as they require specific technical expertise and a sound ability to pay.

While some actors rely on high-tech to manage waste, others rely more on low-tech solutions (Bihouix, 2014). The latter concept is essentially based on the notions of social integration, proximity, sobriety and conviviality (Illich, 1973). Low technologies foreground alternative systems based on new principles: circular flows of water, energy and materials (recycling, circular economy), ecological performance (conservation of resources and environments) (Le Bris & Coutard, 2008), proximity and decentralisation. Some global South local authorities in charge of urban services, are testing new models that integrate these principles, spurring the emergence of a diversity of social (Bernal, 2014), organisational and technological innovations. To some extent, these techniques have the virtue of relocating a territorial metabolism[1] that has been partly externalised by urban networks (Emelianoff, 2015; Barles, 2017), and thus mobilise a greater momentum for waste reduction. They do not replace large networks (centralised waste collection) but enable the emergence of composite systems (Le Bris & Coutard, 2008) and urban eco-cycles[2] (Coutard & Rutherford, 2009). These autonomous systems constitute among other things a

[1] In S. Barles' work, territorial metabolism denotes all the flows of energy and materials brought into play by the functioning of a given territory. This metabolism is conceived as being produced by the interweaving of natural (or physical) processes, particularly including the natural cycles of water, carbon, nitrogen, etc., and techniques used by human societies.

[2] Contrary to the model of a centralised network, the technical and ecological urban cycles depend on the principles of autonomy, porosity, circular metabolism, short cycles, demand management, resource preservation, and the principles of sobriety (Coutard & Rutherford, 2013)

technical response to the challenges of pluri-urbanity, establishing a “right to the city”[1] that differs depending on the individual and social group. Low-tech systems thus seem particularly fitting for global South countries, in a context of raw materials depletion and the high availability of labour, even though there may be a cultural obstacle to promoting them.

This debate is at the heart of the promotion of energy recovery. Must waste-to-energy technologies be developed in global South countries? Should waste be aggregated in large quantities for incineration, now a widely used technology in global North countries? Should anaerobic digestion of organic waste be developed when it can be easily composted? Should new types of sinks, such as refuse-derived fuel (RDF) or gasification, be promoted, without prioritising recycling, given that worldwide deployment of these technologies is in its infancy (with fragile technical and financial control)? Or, on the contrary, should global South countries rely on technologies deemed more rudimentary, yet deeply embedded in industrial globalisation, and develop them at a local level? These technologies range from waste composting, to remelting scrap metal locally, plastics-shredding or even the re-use (after washing) of packaging to avoid waste generation.

It is important think through the solutions starting from the lowest rung of the hierarchy of treatment modes in order to divert as many flows as possible. The choice of which sink to use should not be made at the outset, as this will bias the structuring of the sector, which will then be organised simply to provide a stock of waste for the preferred sink. When choosing a treatment method, it is important to consider what market outlets exist for products from recovered materials (agriculture for compost / domestic market for both re-use and recycling). The choice may even be boosted by public policy measures: public procurement, subsidies for fertilisers/compost, feed-in tariffs for electricity from incinerators, etc.

[1] The right to the city does not boil down to access to urban services: it was defined by the philosopher Henri Lefebvre as a basic right, constitutive of democracy, which defines cities as common goods, accessible to all the inhabitants (Lefebvre, 1968).

General Conclusion

In a context where many global South cities are finding it very difficult to manage municipal solid waste (saturated disposal sites, impossibility of collecting all the waste generated, low recovery rates, etc.), the aim of the research programme whose findings are presented in this report was to analyse the cases of several cities that have implemented innovative solutions. These sometimes involve technical and technological innovations such as transfer points, primary collection, waste-to-energy plants, composting units, but that is not all.

We also observed that the most important levers for waste recycling and recovery lay in organisational and financial innovations. On one hand, this means stimulating multi-scale and multi-stakeholder management so that the whole gamut of possible local treatment modes can be used. It also means imagining alternative financing when the residents' have little ability to pay as , for instance, billing the waste service jointly with other public utilities, calling on corporate social responsibility, or implementing the logic of avoided costs. This last method seems to hold considerable potential. Other avenues remain to be explored as, for example, financing waste management through consumer goods purchases (Extended Producer Responsibility chains) or mobilising public procurement to stimulate the purchase of the by-products of recovered resources.

The comparison of different fields gave deeper insights into the advantages of shifting the scope of the public service's responsibilities and of totally rethinking the service offered to the inhabitants (and the planet), so as to circumvent the traditional stumbling blocks that make it difficult for local public actors to finance their services and ensure their robustness. Primary collection, community-based management, and the use of informal actors all seem to be expanding in many cities, despite the still strong reticence of traditional waste management stakeholders.

In every case, it appears that the invention of new endogenous models is the main pathway developed by local authorities seeking to solve their waste problem and transform it into social and environmental opportunities. The emerging models are "participatory, composite and circular", each time with different characteristics depending on the territory and the society in which they operate.

The global South cities have long been seen as lagging behind those in the global North when it comes to waste management. Yet, when viewed through the prism of certain criteria, it would appear that this binary relationship could is well worth reassessing. Low consumption leads to a low level of waste generation and, although relatively unclean streets are synonymous with locally negative impacts, this low production of waste also means a weaker environmental impact worldwide (in terms of raw materials extraction, GHG production, etc.). The potential of organic materials is also particularly strong in the global South countries, as these materials are easier to move around in a local circular economy seeking to promote a local territorial metabolism. All that remains to be done is to take some of these practices from the global South and transform them into solutions for the admittedly different problems in the global North.

Bibliography

ORVA2D project monographs

The present report is mainly based on 6 monographs, available online (in French) at: http://eso-lemans.cnrs.fr/fr/recherche/programmes-en-cours/projet-afd.html

- CAVE J. (2016), *Surabaya: La valorisation communautaire des déchets dans le cadre d'un service semi-décentralisé*, AFD, ORVA2D research programme, Field report No.5, May, 80p.
- DE BERCEGOL R. (2016), *Delhi: Des complémentarités à inventer, une gestion en pleine transformation*, AFD, ORVA2D research programme, Field report No.4, June, 102p.
- GARNIER J. (2016), *Valorisation des déchets à Lomé: La valorisation des déchets perçue comme un moyen de réduction des coûts du service public*, AFD, ORVA2D research programme, Field report No.6, September, 113p.
- LECOINTRE C., R. BRESELEC, and A. PIERRAT (2015), *Valorisation des déchets fermentescibles à Antananarivo: Solution et innovation pour une gestion déficiente des déchets ? Réflexion sur une capitale pauvre d'Afrique*, AFD, ORVA2D research programme, Field report No.2, October, 94p.
- RATEAU M. (2015), *Intégration des récupérateurs à Lima: Étude de trois modèles liméniens de structuration des filières de valorisation des déchets*, AFD, ORVA2D research programme, Field report No.1, August, 96p.
- RATEAU M. and H. ESTRELLA BURGOS (2016), *Valorisation des déchets à Bogotá: L'intégration des récupérateurs pour faire face à la saturation du centre d'enfouissement*, AFD, ORVA2D research programme, Field report No.3, April, 69p.

Other bibliographical references

- ADEME (2016), *Déchets, chiffres-clés édition 2016*, Angers: ADEME, 96p.
- ADEME (2015a), Le compostage, fiche technique, Angers: ADEME, 20p.
- ADEME (2015b), Référentiel national des coûts du service public de gestion des déchets 2015, Synthèse, Angers: ADEME, 8p.
- ANNEZ P. C. (2006) ,*Urban Infrastructure Finance from Private Operators: What Have We Learned from Recent Past Experiences?,* World Bank, Washington, D.C., 30p.
- BARLES S. (2017), « Écologie territoriale et métabolisme urbain: quelques enjeux de la transition socioécologique », *Revue d'Économie Régionale & Urbaine*, December, pp. 819-836. DOI: 10.3917/reru.175.0819.
- BARRAQUÉ B. (1995), « Les politiques de l'eau en Europe », *Revue française de science politique*, No. 45-3, pp.420-453.
- BARTONE C. R. (1995), The Role of the Private Sector in Municipal Solid Waste Service Delivery in Developing Countries: Keys to Success, in *ISWA Conference on Waste Management - Role of the private sector*. Singapore, p.6.
- BARTONE C., R. LEITE, T. TRICHE, and R. SCHERTENLEIB (1991), "Private Sector Participation in Municipal Solid Waste Service: Experiences in Latin America", *Waste Management & Research*, 9(1), pp.495-509.
- BATLEY R. (1996), "Public-Private Relationships and Performance in Service Provision", *Urban Studies*, 33(4), pp. 723-752

- BAUD I. and J. POST (2004), “Government, market and community in urban solid waste management; problems and potentials in the transition to sustainable development”, in BAUD I., J. POST and C. FUREDY (eds) *Solid Waste Management and Recycling: Actors, Partnerships and Policies in Hyderabad, India and Nairobi, Kenya*. Dordrecht: Kluwer Academic Publishers, pp. 259-281.
- BAUD I., S. GRAFAKOS, M. HORDJIK and J. POST (2001) ,“Quality of life and alliances in Solid Waste Management: Contributions to urban sustainable development”. *Cities*, 18(1), pp.3-12.
- BERDIER C. and J.-M. DELEUIL (2010), « Le système "ville-déchet", une mise en perspective historique », in DORIER-APPRILL E., *Ville et environnement*, Paris: Sedes, pp 453-466.
- BERNAL M.E. (2014), *Experiencias en innovación social*, CEPAL, Fundación Kellogg, Su aporte en el avance de los Objetivos de desarrollo del milenio, Mimeo.
- BERNSTEIN J. (2004), *Toolkit: Social Assessment and Public Participation in Municipal Solid Waste Management*, No. 33781, The World Bank, Urban Environment Thematic Group, 210 p.
- BERTOLINI G. (1992), « Les déchets : rebuts ou ressources ? » *Economie et statistique*, 258(1), pp.129-134.
- BERTOLINI G. (1990), *Le Marché des Ordures, économie et gestion des déchets ménagers*, L’Harmattan, Paris.
- BERTOLINI G. and M. BRAKEZ (2008), « Gestion des déchets, innovations et territoires. Retours d’expériences et recherche contextuelle ». In *Développement durable des territoires. Economie sociale, environnement et innovations. Marché et Organisations.* Paris: L’Harmattan, pp.151-182.
- BERTOLINI, G. and M. BRAKEZ (1997), « Le déchet, indicateur social : le cas des ordures ménagères à Agadir (Maroc) », *Géographie et cultures*, (24), pp. 91-112.
- BERTOLINI G., B. FOULLY and B. MORVAN (1999), « Le tri des ordures ménagères dans les pays en développement : Etude de cas au Brazil », in *Sciences et Techniques*, (14), pp.30-38.
- BIHOUIX P. (2014), *L’âge des low-tech: vers une civilisation techniquement soutenable*, Édition du Seuil, 330p.
- BINDIAR D. and S. TREMOLET (2010), *La régulation des services d’eau et d’assainissement dans les PED*, A Savoir, Paris: AFD.
- BODJONA M. B., K. A. KILI, S. TCHEGUENI, B. KENNOU, G. TCHANGBEDJI and M. EL MERAY (2012*)*, *Evaluation de la quantité des métaux lourds dans la décharge d’Agoè (Lomé-Togo)*.
- BOUTIN, J-P. (1991), « L'épidémie de choléra au Peru en 1991 », *Bulletin Epidémiologique Hebdomadaire*, No. 49, 9 December, pp.214-215.
- BREUIL L. (2004), « *Renouveler le partenariat public-privé pour les services d’eau dans les pays en développement: Comment conjuguer les dimensions contractuelles, institutionnelles et participatives de la gouvernance ? »,* Ph.D. thesis in management, Nanterre: Paris X.
- C40 (2016), *Waste to Resources, Good Practice Guide*, C40 Cities Climate Leadership Group, February, London, 23p.
- CAMACHO M. (1986), *Les poubelles de la survie : la décharge municipale de Tananarive*, Paris: L’Harmattan.

- CAVE J. (2018), “La gestion des déchets au prisme de son impact climatique » in Curvello Saavedra Avzaradel, P. and Parola G., *Climate change, environmental treaties and human rights,* Rio de Janeiro: Ágora21.
- CAVE J. (2015), “Who owns municipal solid waste? Appropriation conflicts in emerging countries”, *Global Waste Management Outlook*, UNEP & ISWA, p. 217.
- CAVE J. (2015), *La ruée vers l’ordure*, Presses Universitaires de Rennes, 250p.
- CAVE J. (2013), *La gestion disputée d’un mal public impur: économie politique des ordures*, Ph.D. thesis, Aménagement de l’Espace et Urbanisme, supervised by O. Coutard, Université Paris-Est.
- CEPLAN (Centro Nacional de Planeamiento Estratégico) (2016), *Economía informal en Péru: situación actual y perspectivas*, Lima: CEPLAN, 53p.
- CHALMIN P., and C. GAILLOCHET (2009), *Du Rare à l’Infini, Panorama mondial des déchets*, Economica, Paris.
- CHEN M. A. (2007), *Rethinking the Informal Economy: Linkages with the Formal Economy and the Formal Regulatory Environment*, DESA Working Paper No. 46, UN Dpt of Economic & Social Affairs, New York, 12 p.
- CHINTAN (2009), *Cooling Agents: An Analysis of Greenhouse Gas Mitigation by the Informal Recycling Sector in India*, The Advocacy Project, New Delhi, 51 p.
- CHINTAN and WITNESS (2010), *Counterbalance*, Chintan Environmental Research and Action Group. Available at: www.archive.org/details/witness_5640_E007059.
- CHIU A. S. F. (2010), *The 3Rs and Poverty Reduction in Developing Countries: Lessons from Implementation of Ecological Solid Waste Management in the Philippines*, Institute for Global Environmental Strategies, Asia Resource Circulation Policy Research, Working Paper Series, October.
- CIRELLI C. and B. FLORIN (2016), « Les récupérateurs de déchets: entre marginalisation et reconnaissance » in *Mouvements des idées et des luttes* (ISSN: 1291-6412), 2016, Où va l’homo detritus ?
- CIRELLI C. and B. FLORIN (2015), *Sociétés urbaines et déchets: éclairages internationaux*, Tours, PUFR, 452p.
- COAD A. (2011), *Collection of Municipal Solid Waste: Key issues for Decision-makers in Developing Countries*, United Nations Human Settlements Programme (UN-Habitat), Nairobi, 30 p.
- COFFEY M., and A. COAD (2010), *Collection of Municipal Solid Waste in Developing Countries*, United Nations Human Settlements Programme (UN-Habitat), Malta, 198 p.
- COING, H. and I. MONTAÑO (1985), *Villes et Déchets dans le Tiers-Monde : Technique et Société - Tunis et Caracas, la gestion du service*, Noisy-le-Grand: ENPC.
- COINTREAU-LEVINE S. (1994), *Private sector participation in Municipal Solid Waste Services in Developing Countries*, Washington, D.C.: Urban Management Programme (The World Bank).
- COINTREAU-LEVINE S. (1982), *Environmental Management of Urban Solid Wastes in Developing Countries: A Project Guide*, No. 5, World Bank, Washington, D.C., 214 p.
- CORVELLEC H., M.-J. ZAPATA CAMPOS and P. ZAPATA (2013), “Infrastructures, lock-in and sustainable urban development: the case of waste incineration in the Göteborg Metropolitan Area”, *Journal of Cleaner Production*, vol. 50, no.1, pp.32-39.

- COUTARD O. and J. RUTHERFORD (2009), « Les réseaux transformés par leurs marges: développement et ambivalence des techniques "décentralisées" », *Flux,* 2009/2, n°76-77, p. 6-13.
- COUTARD O. and J. RUTHERFORD (2013), « Vers l'essor de villes post-réseau: infrastructures, innovation sociotechnique et transition urbaine en Europe » in FOREST J. and A. HAMDOUCH (eds) *Quand l'innovation fait la ville durable*, Presses Polytechniques Universitaires Romandes, pp.97-118.
- COUTINHO E. (1993), *Boca de Lixo*. Documentaire, Centro de Criação de Imagem Popular (CECIP).
- DARDOT P. and C. LAVAL (2014), *Commun, Essai sur la révolution au XXI*^{ème} *siècle*, Paris: La Découverte, 600p.
- DE BERCEGOL R. (2012), *The emergence of municipalities. An analysis of the redistribution of power caused by the decentralization of small town governance in Uttar Pradesh*, Ph.D. thesis, Paris: Université Paris-Est Marne-La-Vallée
- DEBOULET A. et al. (2016) *Repenser les quartiers précaires*, Etudes, AFD, Paris, 273p.
- DEBOUT L., and B. FLORIN (2011), « Chiffonniers contre entreprises privées internationales? Résistances, adaptations et négociations des acteurs formels et informels face à la réforme de la gestion des déchets au Cairo », *Egypte Monde Arabe*, 7, pp. 31-59.
- DURAND M. (2015), *Residuos y desagües: una geografía limeña*, Lima, IFEA, IRD, 349.
- DURAND M. (2012), *La gestion des déchets dans les pays en développement: comment tirer profit des difficultés actuelles ?*, Revue Flux n°87 « Mutation des services urbains: processus et enjeux », pp.18-28.
- DURAND M. (2010), *Gestion des déchets et inégalités environnementales et écologiques à Lima : entre durabilité et vulnérabilité.* Ph.D. thesis, Géographie et Aménagement de l'espace. Rennes: Université de Rennes 2.
- DURAND M. (2007), L*es zones humides urbaines à Bogota, conflits d'usage et patrimonialisation*, Géographie et culture nº62, Paris: l'Harmattan, pp.43-60.
- DURAND M., S. BECAT and M. RATEAU (2015), "La integración de los recicladores como modelo de gestión compartida de los residuos en Lima*"*, in BANDEIRA AMARO A., VERDUM R., *Política nacional de residuos sólidos e suas interfaces com o espaço geográfico: entre conquistas e desafíos*, Porto Alegre: UFRGS.
- DURAND M., J. CAVÉ and A. PIERRAT (2019), « Quand le low-tech fait ses preuves: la gestion des déchets dans les pays du Sud », In *La ville (s)low tech*, Revue Urbanités nº12, forthcoming.
- DURAND M., Y. DJELLOULI and C. NAOARINE (2015,) *Innovations sociales et territoriales de gestion des déchets*, Rennes, PUR, 302p*.*
- EMELIANOFF C. (2015), « La ville durable, une notion fossile ? », in THEYS, J., *Un demi-siècle d'environnement entre science politique et prospective*, pp.137-144
- EMELIANOFF C. (2006), « Connaître ou reconnaître les inégalités environnementales ? » *ESO, Travaux et Documents,* n° 25, December., pp. 35-43.
- ENDA (2014), *Etat des lieux du secteur informel des déchets en Afrique et dans les Caraïbes: Pour une gestion inclusive et sociale*, Plateforme Re-Sources, Gevalor, June.
- FAHMI W. and K. SUTTON (2010), "Cairo's contested garbage: sustainable solid waste management and the Zabbaleens right to the city". *Sustainability*, (2), pp.1765-1783.
- FLORIN B. (2012), « Dimensions spatiales d'une crise: les stratégies des zabbalîn (chiffonniers) du Cairoface à la réforme du système de gestion des déchets », eds BONNY

Y., S. OLLITRAULT, R. KEERLE and Y. LE CARO, *Espaces de vie, espaces enjeux. Entre investissements ordinaires et mobilisations politiques,* Presses Universitaires de Rennes.

- FLORIN B. (2010a), « Réforme de la gestion des déchets et reconfigurations des territoires professionnels des chiffonniers du Cairo», *Géocarrefour*, 2(85), pp.109-118.
- FLORIN B. (2010b), « La gestion des déchets au Cairo», *Séminaire Served 'Services urbains et Services publics'*, May 17.
- FOLLEA V., F. BRUNET, N. BENRABIA, M.-P. BOURZAI and P. FAUCOMPRE (2001), *Revue comparative des modes de gestion des déchets urbains adoptés dans différents pays de la ZSP*, Paris: Agence Française de Développement (AFD).
- FORSYTH T. (2005), ""Building deliberative public–private partnerships for waste management in Asia", *Geoforum*, 36(4), pp.429-439.
- FOULLY B. (2012), *Reconstruire le projet Compostage à Agadir, après l'abandon de la décharge*, ADEME, Paris, 8 p.
- FOULLY B. (2009), *Les enjeux et opportunités partenariales de la valorisation des déchets dans les pays en développement*, Presentation at the ONUDI / POLLUTEC workshop, 1 December, Parc des expositions de Villepinte.
- FUREDY C. (1995), "One world of waste: should countries like India solve solid waste problems through source separation?", in *Enriched by South Asia: celebrating 25 years of scholarship*. Montreal: Canadian Asian Studies Association, pp. 87-107.
- FUREDY C. (1992), "Garbage: exploring non-conventional options in Asian cities", *Environment and Urbanization*, 4(2), pp.42-61.
- FURTADO J. (1989), *L'île aux fleurs* (A ilha das flores), documentary.
- GERDES P. and E. GUNSILIUS (2010), *The waste experts: enabling conditions for informal sector integration in solid waste management: lessons learned from Brazil, Egypt and India*, GTZ (German Technical Cooperation), Eschborn, Germany.
- GEVALOR (2012), *Identification des opportunités de recyclage et évaluation rapide du secteur de la gestion des déchets solides à Antananarivo (Madagascar)*, partnered with UN-Habitat, May, 147p.
- GEVALOR (2013), *Faisabilité du potentiel de valorisation et de réduction des déchets dans la ville de Toamasina (Madagascar)*, with contributions from Enda OI et de Pascal Bouer, March, 90p.
- GIRAUD, P.-N., J. RUET, B. LEFEVRE and A. MARIA (2006), « Le financement des services essentiels dans les villes pauvres », *Revue d'économie financière*, (85), pp.285-308.
- GIZ (2013), *Operator Models. Respecting Diversity - Concepts for Sustainable Waste Management*, 192p.
- GIZ (2011), *Recovering resources, creating opportunities: Integrating the informal sector into solid waste management*
- GOUHIER J. (2000), *Au-delà du déchet, le territoire de qualité*, Manuel de rudologie, Rouen: PURH, 240p
- GUPTA, S. K. (2012), « Intégrer le secteur informel pour une meilleure gestion des déchets », in *Secteur Privé & Développement*, n°15, Proparco, AFD, pp.12-15.
- GUTBERLET J. (2013), "Social facets of solid waste: insights from the global south", Waste and Resource Management, vol. 166, issue WR3, pp.110-113.
- HARPET, C. (2001), *Vivre sur la décharge d'Antananarivo. Regards anthropologiques*, Paris: L'Harmattan.

- HAYAMI, Y., A. K.DIKSHIT and S. N. MISHRA (2006), "Waste pickers and collectors in Delhi: poverty and environment in an urban informal sector", *The Journal of Development Studies*, 42(1), 41-69.
- HERMIDA H. (2014), *Plazas de mercado en Bogotá, generadoras de residuos y desarrollo*, Bogotá: CONAMA, Universidad Central de Colombia, 15p.
- HESTIN M., V. MONIER, J. CAVÉ, I. LAUREYSENS, E. WATKINS, H. REISINGER and L. PORSCH (2014), *Development of Guidance on Extended Producer Responsibility* (EPR), European Commission - DG Environment, 226p.
- ILLICH I. (1973), *La convivialité*, Paris, Seuil.
- JAGLIN S., L. DEBOUT and I. SALENSON (2018), *Du rebut à la ressource: valorisation des déchets dans les villes du Sud*, AFD, Paris, 296p.
- KAZA S., YAO L., BHADA-TATA, P. and VAN WOERDEN F. (2018), *What a Waste 2: A Global Snapshot of Solid Waste Management to 2050* Urban Development Series. Washington, DC: World Bank.
- KLUNDERT (van de) A., and J. ANSCHÜTZ (2001), *Integrated Sustainable Waste Management – the Concept - Tools for Decision-makers, Experiences from the Urban Waste Expertise Programme (1995-2001)* Gouda, The Netherlands: WASTE. 44p.
- LEFEBVRE H. (1968), *Le Droit à la ville*, 3rd edition (15 April 2009), Paris: Economica.
- LE BOZEC A. (2008), *Mise en place de la redevance incitative du service public d'élimination des déchets*, Versailles: éditions QUAE, 151p.
- LE BOZEC A., S. BARLES, N. BUCLET and G. KECK (2012), *Que faire des déchets ménagers ?*, Versailles: éditions QUAE, 231p.
- LE BRIS C. and O. COUTARD (2008), « Les réseaux rattrapés par l'environnement ? Développement durable et transformations de l'organisation des services urbains », *Flux* 2008/4, n°74, p.6-8.
- LORRAIN, D. (1995), *Gestions Urbaines de l'Eau*. Economica.
- LUDINGTON G., G. MORIZOT, B. FLIPO and J. DELARUE (2013), Emission reductions of greenhouse gas emissions and domestic waste composting in less advanced countries. Why new assessment tools are requested ?, Lyon: Gévalor, 5p.
- LUNUEA A. (2012), Le rejet de l'inciération des ordures ménagères: entre controverses sanitaires et conflits politiques, Environnement, risques et santé nº11(5), pp.397-404.
- MAEDA T. (2010), *Enhancing public awareness and stakeholders' empowerment and involvement in waste management – Through a case in Surabaya, Indonesia*, Kitakyushu Initiative for a Clean Environment, Institute for Global Environmental Strategies (IGES), March.
- MARIN Ph. (2009), *Partenariats public-privé pour les services d'eau urbains Bilan des expériences dans les pays en développement*, Tendances et Orientations n°8, World Bank/ Public-Private Infrastructure Advisory Facility, Washington DC.
- MEDINA M. (2005a), "Serving the unserved: informal refuse collection in Mexico". *Waste Management and Research*, 23(5), pp.390-397.
- MEDINA M. (2005b), "Waste Picker Cooperatives in Developing Countries", *WIEGO/Cornell/SEWA Conference on Membership-Based Organizations of the Poor.* Ahmedabad, India, p.22.
- MIRAS (de) C. and E. DORIER-APPRILL (2002), *Gestion des déchets urbains et aide à la décision municipale : Municipalité de Mopti (Mali) et Circonscription Urbaine de Porto Novo (Bénin)*, PDM; Ps-Eau.

- NAS P.J.M. and R. JAFFE (2004), “Informal Waste Management: Shifting the focus from problem to potential”, *Environment, Development and Sustainability*, (6), pp.337-353.
- NELSON J. (1977), *Cabuçu - O lixo nosso de cada dia*. Documentary.
- NGAMBI J.R. (2015), « Déchets solides ménagers de la ville de Yaoundé (Cameroun) : de la gestion linéaire vers une économie circulaire », Ph.D. thesis, Nantes.
- NGOC U.N. and H. SCHNITZER (2009), “Sustainable solutions for solid waste management in Southeast Asian countries”, *Waste Management*, 29(6): 1982-1985.
- O’BRIEN M. (1999), “Rubbish values: Reflections on the political economy of waste”, *Science as Culture*, 8(3), pp.269-295 .
- OECD (2008), *OECD Environmental Outlook to 2030*, Paris: OECD, 520p.
- OSTROM E. (1990), *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press, Cambridge, 280p.
- PIERRAT A. (2014), *Les lieux de l’ordure de Dakar et d’Addis Abeba. Territoires urbains et valorisation non institutionnelle des déchets dans deux capitales africaines*, Ph.D. thesis in Geography, Université Paris 1 Panthéon-Sorbonne, 559 p.
- PIERRAT A. (2006), *La gestion des déchets à Tananarive. Etude de la valorisation des déchets en produits fertilisants*. Geographical approach, Master’s 1 de l’Université Paris 1 Panthéon Sorbonne, 193p.
- PRADO, M. (2004), *Estamira*, Documentaire, Zazen Produções.
- RAHARINJANAHARY R. (2015), *Processus d’intégration de la filière des déchets à Antananarivo: des activités informelles à un système formel ?*, in DURAND M., Y. DJELLOULI and C. NAOARINE, « Gestion des déchets: innovations sociales et territoriales », Rennes: PUR, pp.53-72.
- RATEAU M. (2014), *La formalisation des recycleurs au Peru: expériences dans les districts liméniens d’Indiapendencia et San Martín de Porres*, Master’s thesis, Le Mans: Université du Maine, 285p.
- RIBEIRO H., and G. R. BESEN (2007), « Panorama da Coleta Seletiva no Brasil: Desafios eperspectivas a partir de três estudos de caso », *Revista de Gestão Integrada em Saude do Trabalhoe Meio-Ambiente*, pp.2-18.
- ROCHER L. (2008), « Les contradictions de la gestion intégrée des déchets urbains: l’incinération entre valorisation énergétique et refus social » in FLUX, n°74, vol. 4, pp.22-29.
- SCHEINBERG, A. and J. ANSCHÜTZ (2006), “Slim pickin’s: Supporting wastepickers in the ecological modernization of urban waste management systems”, *International Journal of Technology Management and Sustainable Development*, 5(3), pp.257–270.
- SCHEINBERG, A., J. ANSCHÜTZ and A. KLUNDERT (van de) (2006), « Waste Pickers: Poor victims or waste management professionals? » In *Solid waste, health and the Millennium Development Goals* (p. 16). Presented at CWG – WASH Workshop, Kolkata, India.
- SCHEINBERG, A., M. H. SIMPSON, Y. GUPT, et al. (2010), *Economic Aspects of the Informal Sector in Solid Waste,* GTZ (German Technical Cooperation), Eschborn, Germany.
- SCHEINBERG A., S. SPIES, M.H. SIMPSON, and A.P.J. MOL (2011), “Assessing urban recycling in low- and middle-income countries: Building on modernized mixtures”, *Habitat International*, 35(2), pp.188-198.

- SHARHOLY M., K. AHMAD, K., MAHMOOD, G., and TRIVEDI, R. C. (2008), "Municipal solid waste management in Indian cities – A review", *Waste Management*, 28(2), pp.459-467.
- SHEKDAR, A. V. (2009), "Sustainable solid waste management: An integrated approach for Asian countries" *Waste Management*, 29(4), pp.1438-1448.
- SIDIBE C. (2015), *Le Zero waste made in New Zealand, du concept à la pratique*, in DURAND M., Y. DJELLOULI and C. NAOARINE, « Gestion des déchets: innovations sociales et territoriales », Rennes: PUR, pp.271-290.
- SPAARGAREN G., P. OOSTERVEER, J. BUUREN (van) and A.P. MOL (2005), *Mixed Modernities: towards viable environmental infrastructure development in East Africa*, The Netherlands: Environmental Policy Department, Wageningen University and Research Centre.
- TA T.T. (1998), *Pour une gestion efficiente des déchets dans les villes africaines : les mutations à conduire*, Cotonou: Partenariat pour le Développement Municipal.
- UAESP (2015), *Plan de gestion integral de residuos solidos 2016 – 2027 « Bogotá se orienta hacia el aprovechamiento total de sus residuos »*, Bogotá: UAESP, 1228 p.
- UNEP (2013), *Municipal solid waste: Is it garbage or gold?*, UNEP Global Environmental Alert Service.
- UNEP and ISWA (2015), *Global Waste Management Outlook*, United Nations Environment Programme & International Solid Waste Association, Osaka, 332p.
- UN-Habitat (2010) *Solid Waste Management in the World's Cities*, London: United Nations Human Settlements Programme.
- VARONE F., S. NAHRATH and J.-D. GERBER (2008), « Régimes institutionnels de ressources et théorie de la régulation » in *Revue de la Régulation*, n°2, 26p.
- VÉRON J. (2007), « La moitié de la population mondiale vit en ville », *Population et Société*, nº435, Paris: INED, 4p.
- VNGI (2008), *Closing the Circle: Bringing Integrated Sustainable Waste Management Home*, July, The Hague, The Netherlands.
- WALKER L. (2009), *Waste Land*. Documentary, Eurozoom.
- WIEGO (2010), *Reclaiming reusable and recyclable materials in Africa. A critical review of English Language Literature*, Working Paper (Urban Policies) No.16, March.
- WILLERVAL S. (2014), *Note sur les mécanismes financiers de la gestion des déchets*, Etude de faisabilité de l'option valorisation RDF sur le SL d'Aképé, Lomé: Egis Structure et Environnement, 5p.
- WILSON D.C., C. VELIS and C. CHEESEMAN (2006), "Role of informal sector recycling in waste management in developing countries", *Habitat International*, 30(4), pp.797-808.
- WILTS H. and N. VON GRIES (2015), "Europe's waste incineration capacities in a circular economy", in *Waste and Resource Management*, vol. 168, issue WR4, pp.166-176.
- WSP (2008), *Secured Landfills: The Bucket at the End of the Solid Waste Management Chain*, The World Bank, Water and Sanitation Program South Asia, New Delhi, 6p.
- WORLD BANK (2012), *What a Waste! A Global Review of Solid Waste Management,* Knowledge Papers No. 15, Washington, D.C.: The World Bank.
- WORLD BANK (2008), *Secured Landfills: The Bucket at the End of the Solid Waste Management Chain*, New Delhi: Water and Sanitation Program-South Asia.
- ZURBRÜGG, C. (2002), "Urban Solid Waste Management in Low-Income Countries of Asia; How to Cope with the Garbage Crisis", *Urban Solid Waste Management Review Session. Scientific Committee on Problems of the Environment* (SCOPE). Durban, South Africa, p. 13.

Appendices

Appendix 1: Summary of the ORVA2D observations for each city

Innovation sheet 1. Lima: integrating informal wastepickers

Innovation / objective

- Recycle waste
- Legally integrate informal wastepickers

Modalities

- Recycler's Law and ministerial subsidies
- Register of informal wastepickers
- Decentralised roll-out by district
- Territorialised organisation into collection zones

Potential

- 26% of recoverable waste in Lima (currently less than 1% of waste is officially recovered) – excluding here volumes recovered by informals

Advantages

- Improves recycling rate
- Improves work conditions for wastepickers
- Stabilises jobs
- Waste pickers raise residents' awareness of sorting
- Reduces taxes for residents who sort (*Bono Verde*)
- Low municipal expenditure on low-tech
- Avoided collection and landfill costs via recyclable waste recovery

Difficulties

- Convincing informals to join
- Structuring the whole purchasing chain
- Organising economic profitability for all materials

Innovation sheet 2. Bogotá: financing informal workers to avoid costs

Innovation / objective

- Recycle waste
- Legally integrate informal wastepickers
- Avoid congesting the landfill space

Modalities

- Court ruling in favour of organised wastepickers
- Registration of 14,000 wastepickers
- Freedom for wastepickers to collect in all neighbourhoods
- Municipal tonnage-based remuneration of wastepickers
- "Zero waste" policy

Potential

- 25% of recoverable waste in Bogotá (currently 12%)
- A cost for the municipality 2/3 lower than that for RHW collection

Advantages

- Improves the recycling rate
- Improves wastepickers' work conditions
- Improves wages
- Waste pickers sensitise residents to sorting
- Large-scale participation of wastepickers
- Taxes based on social strata
- Payments coupled with water service

Difficulties

- Structuring the whole purchasing chain
- Controlling financing for wastepickers more effectively
- Organising wastepickers into service companies

Innovation sheet 3. Lomé: two-stage collection tailored to the territory

Innovation / objective

- Collect waste
- Organise primary collection

Modalities

- Municipality's organisation of primary collection via contracting micro-enterprises
- Door-to-door collection in some districts, "two-stage" collection in others (primary collection + transport)
- Creation of transfer points

Potential

- 64% of waste collected thanks to primary collection
- Cost 54% lower than door-to-door collection

Advantages

- Improves pre-existing practice of primary collection (work conditions, hygiene)
- Organisation of sustainable financing for the activity
- Avoids wild dumpsites
- Organisation personalised and adapted to different neighbourhoods
- Possibility of recycling during (informal) primary collection

Difficulties

- Adapting transfer points (dysfunctions): high level of sand collected
- Double billing for users: collection + primary collection or THRC (tax)+ FHRC (fee)
- Persistence of the informal channel

Innovation sheet 4: Lomé: advantages and drawbacks of the sanitary landfill

Innovation / objective

- Increase the useful life of the future sanitary landfill
- Divert waste flows to organic and materials recovery

Modalities

- Discussions on how to increase the capacity of the composting unit - *project*
- Discussions on how to transform transfer points into sorting centres - *project*
- Highlight the avoided costs for municipal financing

Potential

- 24% of potentially recyclable waste and 25% of compostable waste in Lomé (currently 1%) + sand
- An estimated economic gain of 4% of the waste budget through avoided costs

Advantages

- Improves the recycling rate
- Increases the useful life of the sanitary landfill
- Improves environmental and health conditions of recovery activities
- Valorises organic waste
- An adapted territorial coverage with transfer points

Difficulties

- Organising the economic sustainability of the organics channel
- Municipality's financial contribution
- For the associations involved, pursuing primary collection and recycling

Innovation sheet 5. Antananarivo: composting on several scales

Innovation / objective

- Increase the useful life of the future sanitary landfill
- Divert waste flows towards organic recovery

Modalities

- Decentralised composting thanks to neighbourhood organisations (RF2s)
- Potential to free up landfill space (screened dump waste)
- Potential to directly compost raw waste on site

Potential

- 79% of potentially compostable waste in Antananarivo
- Cost-sharing among several non-municipal actors (notably, the *fokontany*)

Advantages

- Increases the useful life of the disposal site by 5 years
- Improves the composting rate
- Creates jobs
- Takes advantage of primary collection by RF2s by associating them with decentralised composting
- The long-standing practice of using dumpsite *terreau*

Difficulties

- Compost is not competitive on the input market
- Lack of space at the disposal site
- Very few municipal resources to incentivise the RF2s
- Insufficient recognition of indirect costs by the municipality

Innovation sheet 6. Delhi: incineration and composting

Innovation / objective

- Manage the enormous waste flows
- Stop the construction of landfills, and valorise waste
- Valorise waste

Modalities

- Construction of 3 incinerators (2 of which opened in 2017)
- Construction of a composting unit

Potential

- 69% of potentially compostable waste (currently 3%)
- 30% of waste with high LCV (paper, cardboard, plastics, etc.), thus easy to incinerate (currently 11%) – 100% provided waste is dried upstream

Advantages

- Avoids landfill in a city that has run out of space for this purpose
- Produces energy from waste
- Produces compost from waste

Difficulties

- Incinerating waste that has excessive moisture content
- No energy recovery
- Economic sustainability of a very costly technology
- Selling compost at an affordable price
- Competition with informals for the most combustible waste stocks

Innovation sheet 7. Surabaya: community management to avoid centralising waste stocks

Innovation / objective

- Have a cleaner and greener city
- Improve waste valorisation
- Optimise the useful life of the storage centre

Modalities

- Cleanliness contest between neighbourhoods
- Very active management of urban services by the *kampung's* administration body
- Creation of hundreds of community waste banks for sorting, with a view to recycling
- Distribution of 20,000 domestic composters to residents
- Creation by the municipality of 23 composting units citywide

Advantages

- Improves urban cleanliness and city greening (using the compost)
- Promotes an income-generating activity in the neighbourhoods and social inclusion in the *kampung*
- Improves the waste recovery rates
- Voluntary community-based management
- Contributions from private sponsors (large companies, CSR)
- Use of profits from sorting decided on collectively
- (Small) decrease in the quantity of waste sent to landfill

Difficulties

- Dependence on private companies to finance the annual contest

Potential - 36% of potentially recyclable waste (currently 0.2% recycled) et 54% compostable (currently 5% composted) - An economic gain from avoided costs (currently 3% of the budget for 5% of composted waste)	- Relative loss of momentum in social mobilisation (mainly for composting) - Downstream part of the recycling channel remains unchanged / Difficulty for the "parent" waste bank to replace informal local traders - Not easy to encourage participation outside the *kampung* (notably in vertical housing and affluent neighbourhoods)

Appendix 2: Glossary

Other frequently used terms are indicated in italics. The terms in bold have been used in this report to harmonise the vocabulary and facilitate understanding.

Anaerobic digester (*biodigester*, *biogas reactor)* – Facility for the anaerobic treatment (digestion) of organic waste and the production of biogas and digestate.

Anaerobic digestion (*bio-methanation*) – Anaerobic digestion is a reaction that occurs spontaneously in nature in places having a large concentration of organic matter with no air supply. At the industrial level, the process is developed mainly in biogas plants for waste (agricultural waste, kitchen waste, garden waste), producing two main products: methane and solid residues from decomposition (digestates).

Biogas – Gas produced by the anaerobic digestion of organic matter. Biogas is mainly composed of methane (50–60%).

Brick (*pellet*) – Alternative fuel produced from non-carbonised waste. The types of waste used are usually paper, cardboard or green waste.

Bulky waste – Voluminous waste from households, such as furniture large household appliances (white, brown and grey goods), scrap metal (two-wheelers, fencing, etc.).

Carbon credit – Tradable permit aimed at reducing greenhouse gas emissions.

Carbon finance – Financial activity introduced by the Kyoto Protocol, which involves monetising greenhouse gas reductions expressed as CO_2 equivalent units. In the waste sector, these emissions may be due to the storage of waste in an anaerobic environment, e.g. in dumpsites.

Channel (*chain*) **–** an ensemble of successive steps involved in making a product that is linked by a flow of exchanges and which includes all of the enterprises and other actors that contribute to the elaboration of a product or to the valorisation of a raw material from upstream to downstream.

Characterisation – Technique used to determine the composition of a territory's stock of waste or waste stream according to its constituents and the corresponding contents and size-grading.

Clean Development Mechanism (CDM) - An international institutional mechanism that allows industrialized countries that have targets under the Kyoto Protocol to invest in emission reductions in developing countries and count those reductions towards their own legal commitments. A CDM project is issued with certified emission reductions, which may then be traded.

Collection – One of the stages in the waste disposal chain. Collection is the transport of waste from the drop-off points (door-to-door, voluntary drop-off or small transfer points) to transfer stations or waste management sinks. The collection is generally ensured by trucks, mainly container trucks and compactor trucks.

Compactor truck – Vehicle equipped with a hydraulically powered compression system that reduces the volume of waste transported.

Composition - Quantitative description of the materials that are found within a particular waste stream in the form of a list of materials and their absolute quantities per day or per year, or as a percentage of total materials.

Compost – Compost is an organic amendment produced by composting (cf. definition) or, in other words, a product rich in stabilised organic material that mainly acts on soil structure (role of physical fertiliser). Like all amendments, compost contains small quantities of nitrogen (N), phosphorous (P) and potassium (K). As it mineralises over time, compost also has a secondary function of organic fertiliser (role of chemical fertiliser with the addition of N-P-K and trace elements for plants).

Compostable waste (*Bio-waste, green waste, organic waste*) – Waste composed exclusively of biodegradable organic materials. It is usually treated through composting or methanation. This includes green wastes, kitchen and garden wastes, paper and cardboard

Composter *(composting bin)* – Equipment used for composting family (domestic) waste.

Composting *(Organic waste management, aerobic decomposition*) – A biological process that decomposes organic materials in the presence of oxygen, producing compost that can be used in agriculture. Composting can be carried out on a "raw" (mixed) waste stream or a stream of segregated organic waste.

Composting plant – A medium-sized industrial or artisanal site where organic waste is converted to compost.

Construction and demolition waste *(Debris, C&D, rubble, contractor waste)* – Waste generated by the construction, demolition or repair of houses, commercial buildings, roads, bridges, etc.

Container – Storage equipment for different sizes of waste. Household bin (*dustbin, waste bin, garbage can*) < 100L < communal bin < $1m^3$< skip container < $10m^3$ < container.

Container truck (*skip truck*) – Vehicle allowing loading/unloading and transport of skips and containers. Container trucks can be equipped with the so-called Ampliroll or Marrel (registered trademarks) hooklift system.

Conveyor belt – Horizontal equipment for transporting waste, which can be at the same time used for waste sorting.

Dealer (*merchant, trader)* – Agents, legal or illegal, sedentary (stand, local shop) or itinerant.

Direct collection – Waste disposal is organised in a single stage that ensures the transport of waste from its collection points (door-to-door, voluntary drop-off points) to the final sink in the waste management chain, which often involves landfill or dumpsites.

Disposal site – Place where waste is deposited. This is the point of final sink in the solid waste management chain. Only ultimate waste (cf. definition) should be deposited there. This glossary proposes a classification the different non-hazardous solid waste disposal sites found in developing countries. Five categories of disposal sites are proposed, ranging from the least to the most equipped: sanitary landfill, landfill, controlled, authorised and wild dumpsites. This is in no way a regulatory classification. The criteria required for each category are listed below. If a disposal site meets more criteria than are in its own category but not all of the criteria of the following category, its specific feature may be described. For example, a "controlled dumpsite using cell-based operations", or "engineered sanitary-type landfill with biogas capture".

Minimum required criteria	Sanitary landfill	Waste disposal sites			
		Landfill	Controlled dumpsite	Authorised dumpsite	Wild dumpsite
Burial of non-hazardous waste	X	X	X	X	X
Authorised by the relevant authority	X	X	X	X	
Control of incoming waste	X	X	X		
Recording of incoming waste	X	X	X		
Weighbridge on arrival	X	X			
Favourable geological and hydrological context	X	X			
Impermeability of the site	X	X			
Drainage and collection of leachate	X				
Treatment of liquid discharges before their release into the natural environment	X				
Management of surface runoff both outside and inside the site	X				
Methane capture	X				
Perimeter fencing	X	X	X		
Cell-based operations	X	X			
Recovery activities prohibited in the operating zone; authorised in areas designed for this purpose	X				
Cells covered as soon as the filling operation has ended	X	X			
Monitoring after the site has ceased to operate	X				

** The criteria for sanitary landfills (SLs) are those of the French regulations in force, applied to facilities for storing non-hazardous waste.*

Diversion (*recovery, avoided disposal*) – The process or result of keeping materials out of a dumpsite / landfill / storage facility.

Door to door (D2D) – A pre-collection or collection system whereby waste is picked up from residents' dwellings. This system differs from voluntary drop-off.

Energy recovery (*waste-to-energy*) – A process that uses of the calorific value of wastes by burning them and recovering the energy as heat or electricity (notably, incineration and anaerobic digestion).

Fee for household refuse collection (FHRC) – Fees that help to finance, wholly or in part, household waste management within a territory. Unlike the tax levied on taxpayers, this fee is collected from users of the service.

Final waste *(ultimate waste)* – Preliminary remark: the definition proposed here is taken from French legislation (Article L 541-1, Environmental Code) and seems transposable to other contexts: "ultimate waste is defined as waste, either resulting or not from the treatment of waste, which is not likely to be treated under the technical and economic conditions of the moment, notably by the extraction of the reusable part or by the reduction of its pollutant or hazardous character".

Formal sector – Encompasses all activities whose income is reported to the government and that are included within a country's gross national product; such activities are normally taxed and follow requisite rules and regulations with regards to monitoring and reporting.

Formal waste sector (*Solid waste system, solid waste authorities, government, materials recovery facility*) – Solid waste management activities planned, sponsored, financed, carried out or regulated and/or recognised by the formal materials recovery facility, local authorities or their agents, usually through contracts, licences or concessions.

Green coal (*bio-coal)* – Coal produced by a carbonisation process using agricultural and/or household organic wastes. The product is similar to wood charcoal in its appearance and use.

Green waste – This includes garden wastes, leaves, branches, grass cuttings, waste from green spaces, etc.

Hazardous waste (*toxic wastes, special industrial wastes***)** – Materials that pose substantial or potential threats to public health or the environment and generally exhibit one or more of these characteristics: ignitable; oxidant; corrosive; radioactive; explosive; toxic; carcinogenic; disease vector. Hazardous waste includes: infectious healthcare waste (IHCW), certain WEEE (cf. definition), batteries, paints, varnishes, solvents, phytosanitary products, etc.). They can be generated by households, industry, hospitals, etc.

Household and similar wastes – Wastes generated by households and wastes of a similar nature (the latter includes waste from industrial and commercial activities which can be collected together with household wastes, given their characteristics and quantities, without any specific technical constraints. This includes wastes from artisans, tradespeople, services sector, etc., collected in the same conditions as household wastes).

Illegal dump (*dump, fly-tip, littering*) – An illegal dump is created by individuals or companies without authorisation. These are small-sized dumps where municipal waste from a neighbourhood accumulates regularly over several days. It is sometimes cleared away (*unlike wild dumpsites where the waste is never removed*).

Incentive fee – A way of having users finance the service, which provides an incentive to reduce waste and/or encourage sorting (e.g., billing the service according to the quantity of waste thrown away by the user).

Incineration (*burning, combustion*) – Controlled process by which wastes are burnt and converted into gases, heat and solid residues.

Informal sector – Individuals or businesses whose economic activities are not accounted in a country's gross national product (GNP); such activities are not taxed; exchange of goods or services is on a cash basis; and the activities are not monitored by the government. The most telling indication is that the activities are not registered and not regulated by the public

authorities. It is characterised notably by the small size of structures, small-scale interventions, highly labour-intensive operations and low amounts of capital used.

Informal recovery sector (*informal waste sector)* – Individuals or enterprises who are involved in waste activities but are not sponsored, financed, recognized or allowed by the formal solid waste authorities, or who operate alongside or in competition with those set up by the formal authorities.

Itinerant waste buyer (*itinerant junk buyer, itinerant waste collector*) – Woman, man, child, family or enterprise who purchases or barters source-separated waste materials from households usually focusing on one specific material or type of materials.

Local trader – (*sedentary dealer*) – Small business or shop that buys, sorts, stores and sells on recyclable materials, generally with little processing.

Materials recovery – Area of activities encompassing the capture, re-use and recycling of materials extracted from waste (notably: recycling and composting).

Municipal solid waste (MSW) – encompasses all the wastes that the local authority is responsible for managing (household waste and wastes of a similar nature generated by commercial and industrial activities and collected in the same way as household waste, referred to as “similar wastes”).

Non-hazardous waste (NHW) (*general waste*) – This can be generated by households, commercial premises, administrations, industry, hospitals, etc.

Organic fraction of waste (OFW) (*bio-waste*) – The organic content of waste of whatever type.

Organic fraction of household waste (OFHW) (*household bio-waste*) – The organic content of household waste.

Organic waste (*Bio-waste, green waste, organic waste, organics*) – Waste composed exclusively of biodegradable organic materials. It is usually treated through composting or anaerobic digestion. This includes green wastes, kitchen and garden wastes, paper and cardboard…

Prevention (*waste avoidance*) – All measures and actions involved in designing, producing, distributing and consuming a commodity, aimed at (i) reducing the quantity of waste generated, (ii) reducing its harmfulness, (iii) improving its potential for valorisation following the rationale of resource conservation.

Primary collection (*pre-collection*) – Sub-stage in the waste disposal chain. Transfer of waste from the source of generation (usually households) up to a transfer point. Primary collection only exists in a two-stage scheme: primary collection + secondary collection. In single-stage schemes only the secondary collection stage is involved. Primary collection differs from secondary collection in that the vehicles used are smaller and the distances covered shorter.

Primary collection + transport: – Disposal is organised into two stages. The first is primary collection, which ensures the transfer of users’ waste, collected door-to-door, up to the transit points (*transfer stations*). The second stage involves transporting the waste from the transfer centres to the final sinks in the waste management chain, which are often landfills or dumpsites.

Recovery (*scavenging*, *skimming-off*) – Process of extracting materials from a waste stock, which can be re-used to produce economic value. An activity often carried out by informals.

Recycling (*valorisation, materials recovery*) – Recycling involves processing and transforming waste materials and introducing them into a value chain of equivalent or different products. Recycling also involves recovering organic waste materials as compost.

Reduction at source – Waste prevention actions taken by the designer, producer and distributor of a product.

Rejects – Materials that are scrapped during a valorisation process because they cannot be recycled or composted, or because they are viewed as having no or little monetary value.

Refuse-derived fuel (RDF) – non-hazardous solid wastes for use as fuel. RDFs generally comprise plastics, wood, fabrics and organic waste. RDFs are used in industry to generate energy, notably to power cement kilns or incinerators.

Re-use (*second-hand use*) – The use of a discarded product or material with its original or different form or function, and may include a system to repair/refurbish items.

Residual household waste (RHW)

Screen – Equipment for separating waste on the basis grain size. Trommels are revolving screens.

Screened dump waste – (*terreau*) Decomposed organic matter produced several years after the waste has been dumped. It is obtained by screening old waste. The screened dump waste is often used as an organic amendment. It has a lower organic content than compost and does not ensure stability, hygienisation or harmlessness.

Separate collection (*segregated collection, selective collection*) Collection of a stream of waste that has been pre-sorted to keep the different types of waste separate to facilitate their specific treatment.

Sink – A sink is the opposite of a source, a place where the output of a system can be accommodated. It is a man-made or natural process at the end of the material life cycle that receives material flows and stores these materials for a certain time period.

Skip – (cf. container)

Sorting (facility) – A medium-sized industrial facility in which machines and/or manual workers segregate the wastes collected according to their composition and the instructions issued by the relevant authorities. The activities of a sorting facility generally include some transformation (crushing, compacting) and packaging of recyclable materials in view of their resale.

Source separation (*segregation at source*) – Actions taken to keep and store certain materials separately from mixed waste at the point of generation. (in households, administrations or enterprises).

Street cleaner (*street sweeper*) – Person assigned by the city authority to remove litter from streets.

Tax on household refuse collection (THRC) – A tax that helps to finance, wholly or in part, household waste management within a territory. Unlike the fee paid by service users, this tax is levied on taxpayers, whether or not they benefit from the service.

Transfer *(transit, collection point, depot)* – The operation where wastes from collection vehicles are offloaded onto transport trucks. It thus enables higher volumes of waste to be aggregated in view of long-distance transport. Transfer stage often includes compacting.

Transfer point – Any place (legal or illegal) that regularly receives a load of household or similar waste and which is regularly collected by the public authorities. Transfer points are fed by waste from primary collection, which is then removed by secondary collection.

Transfer station (transit station) – A place that ensures the transition between the collection stage and transport. It is often in the form of a covered ramp that enables a load to be discharged into a skip placed at a lower level. The skip may include a compacting system to optimise the loading.

Transport – The last stage in the waste disposal chain, this involves transporting waste from transfer centres to the final sink in the waste management chain, often a landfill site. The transport is organised so as to optimise waste shipments over long distances. It follows on from the secondary collection stop and uses trucks with a higher-capacity than collection trucks.

Treatment – Manual or mechanical methods to reduce the risk of exposure or to reduce the impacts upon the environment of toxic or hazardous materials associated with the waste stream; in some cases, can concurrently capture and increase the economic value of specific waste stream components' value-added.

Undifferentiated collection (*combined stream collection*) – Collection of multi-material waste.

Valorisation (*recovery*) – The entire process of extracting, storing, collecting, or processing materials from the waste stream in order to extract and divert value and direct the material to a value-added stream..

Valorisation facility – A facility that carries out waste valorisation activities (see definition).

Voluntary drop-off – A system of primary or secondary collection whereby users take their waste to a dedicated area (sometimes a transfer point). This method differs from door-to-door collection.

Waste disposal (*waste removal*, *refuse disposal, garbage disposal*) – A general term denoting the transport of waste from the areas where it is generated or stored to the final sink in the waste management chain. The waste disposal process can be subdivided into several successive stages: primary collection, secondary collection, and transport. The capacity of the vehicles used increases from primary collection to the transport stage. Several types of schemes are found, the main ones are described above.

Waste electrical and electronic equipment (WEEE) – WEEE includes computers, mobile phones, household appliances, etc.

Wastepicker (*dump-picker, street-picker, rag-picker, scavenger, recovery actor*) – Often informal, they salvage various materials from waste stocks in order to reuse, process and/or (most often) sell them on. They mainly operate in the street, at transfer points and waste disposal sites.

Waste stock (*stock of waste*) – Understood in a general sense in this report as the total quantity of waste generated in a defined territory (city, region, industrial zone, etc.). Note: In Chapter 5, section III, "Managing waste as a common resource", the term "stock is used in the Ostromian "common pool resources" framework of "stocks" and "flows".

Appendix 3: The actors of waste recovery and recycling

Recovery actors

- **Waste loaders** or **street sweepers:** these are municipal employees tasked with keeping public spaces clean. They generally take advantage of their street rounds to pick up waste that has market value. In Comas, waste loaders working at the rear of household refuse collection vehicles, systematically pick out the obviously recyclable materials (the largest pieces, intact or almost, visible in the bags of refuse); in Delhi, this practice is carried out more by street sweepers.
- **Primary collectors:** while paid by households to remove all refuse, they are usually the best-placed to recover recyclable waste, whether or not this has been pre-sorted by the household. They play a key role in Antananarivo, Lomé and Delhi.
- **Dump-pickers** (*wastepickers*): these rummage through waste stocks or transfer points (sometimes with a hook). They generally sell on to local traders, but sometimes store their own waste for resale to semi-wholesalers. Dump-pickers have almost disappeared in Lima and Bogotá, but are still very present everywhere else. They live and work in often extremely precarious conditions. In Antananarivo notably, an individual or family, dubbed "*4'mis*", will stake a claim to recyclables from skips in a specific neighbourhood.
- **Street-pickers** (*wastepickers*): these go around the city streets, often at night-time before the municipal waste truck passes for door-to-door collection, to pick waste directly out of household dustbins. Their relations with residents may be more or less hostile. They are held in great contempt by citizens and hounded by the authorities.
- **Itinerant waste buyers:** these go around the streets buying (high-value) waste from households and businesses. They are often equipped with a small vehicle (to transport their booty) and scales (as they pay households by weight). This little-documented practice exists in all the cities in the study.

Dealers

- **Local traders:** these actors have premises (or simply a patch of vacant land) where they buy waste from various recovery actors, store it and aggregate larger quantities before selling on to wholesalers. They may sometimes upgrade or process the waste, for example, by sorting it more finely or cleaning products. Depending on their storage capacity, they can sell the waste on to one of the actors described below. This actor, like those above, are informal. They use a third-party transporter to travel and sell their waste.
- **Semi-wholesalers:** these are generally groupings of several sedentary traders, which enables them to buy a truck or obtain larger premises. They carry out the same operations as local traders, the main difference being that they dispose of more financial resources and larger storage capacities. This allows them to assume the cost of transporting their goods to wholesalers and recycling industries (they are not exporters). As they are in a position to buy the stocks of local traders, they can handle

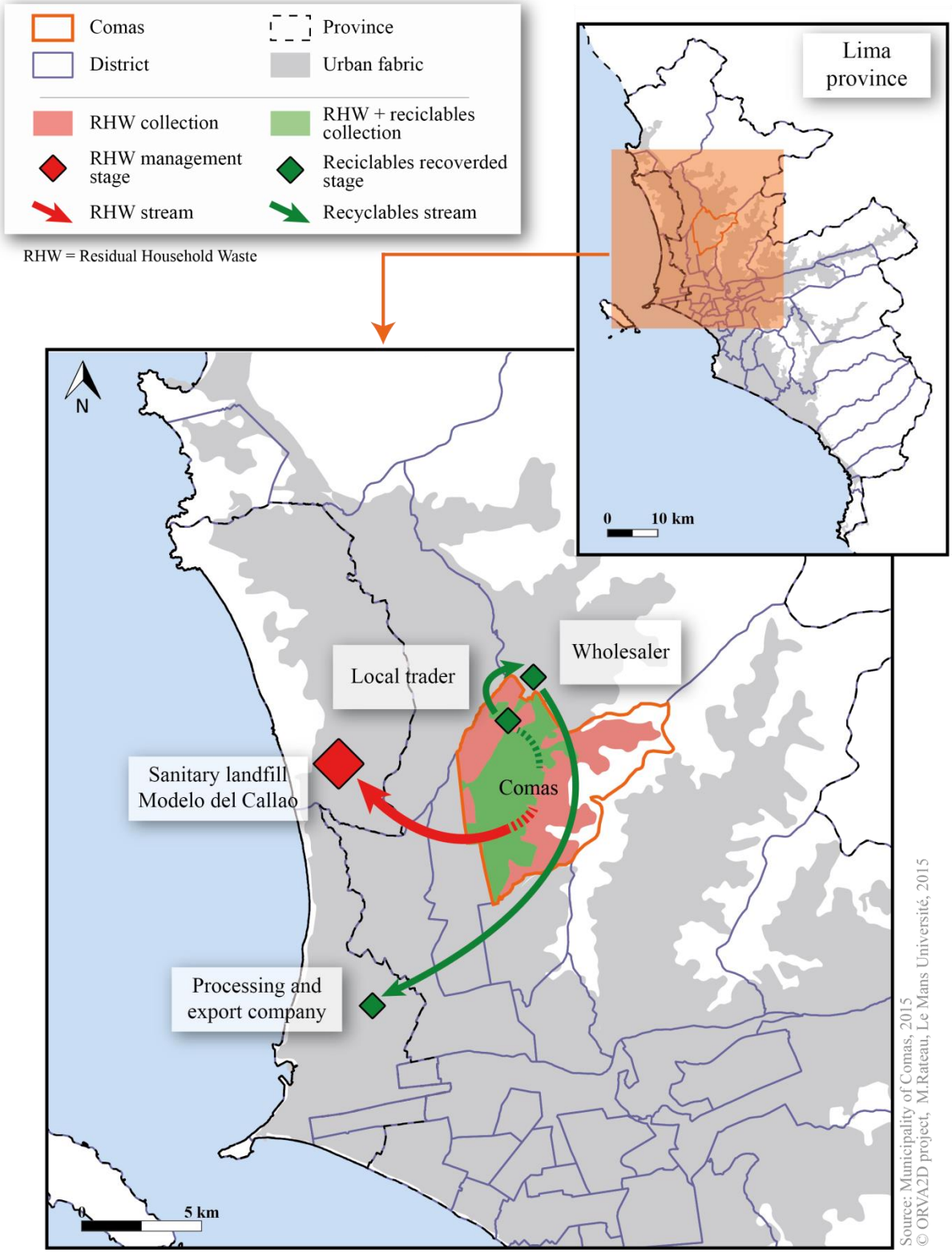
greater volumes of waste. Like the local trader, they can carry out finer sorting, cleaning and/or packaging of materials. They are still often informal.

- **Wholesalers**: These actors buy and recover waste from local traders or semi-wholesalers. They store large quantities of waste, sort it more finely and package materials before selling them on to the recycling industries or sending them on for export. For instance, in Surabaya, wholesalers sort plastics into 12 categories, which are further sorted into 90 sub-categories by industry. At this level of operation, the activity is always formal and carried out by real waste entrepreneurs. Wholesalers most often specialise in one type of material, whereas the other buyers above deal with multiple materials.
-

Processors and exporters

- **Artisanal recyclers:** these actors remain informal. They transform some materials directly into consumer goods. For example, they buy scrap metal from the above actors and melt it down using traditional methods to produce pans, or transform plastic into bags. Sometimes, they simply shred the waste into smaller items (e.g., rubber pellets) to sell on to industry (for this, they may again use the services of a wholesaler).
- **Recycling industries:** these actors buy large homogenous waste stocks for use as secondary raw materials in their industrial production processes. For these industries, the materials are simply possible substitutes for virgin materials. In Lomé and Antananarivo, this type of industry is very rare, the preference being to export them to more industrialised countries (notably, China).
- **Exporters:** these are companies, often foreign-owned, that load recovered raw materials into containers for export by land or sea.

Appendix 4: Lima: a study of three cities in one



Lima: three cities in one

Lima, the capital of Peru, comprises 50 districts[1] grouped within two provinces (Lima and Callao). Each district has its own town hall, its own budget, its own public services and its own waste management service. Although each of the two provinces also has its own local authority, the latter has far fewer responsibilities and resources. The metropolitan area is characterised by extreme socio-economic segregation. The municipal budgets per capita range from 1 to 100 between the most affluent districts and the poorest districts (Durand, 2015). This characteristic strongly impacts public policies and gives each territory very different possibilities for its choice of waste management model.

The field study selected three socio-economically contrasted districts:

Surco[2] is the second wealthiest district in Metropolitan Lima. Located in the immediate vicinity of the city's business centre, it is a residential neighbourhood and home to most of the city's affluent residents. With a high-income population that is very open to global North countries, Surco has implemented a proactive waste management policy on a par with European cities, which warranted its inclusion in the study. The district has 355,986 residents.

Comas is one of the city's poorest districts. With 568,540 residents, it nonetheless has a proactive waste management policy. It is located on the city's northern outskirts, in a sector of several million inhabitants who initially lived in precarious informal settlements (today, in some zones, these are being formalised).

Villa Maria del Triunfo (VMT) has relatively similar characteristics to Comas, as it is a very poor peri-urban district with 464,176 residents. The local authority implemented an ambitious waste management policy ahead of Comas, but it proved a failure, so much so that its mayor was removed at the height of a public health crisis. The study of the district identified other logics.

As it was not very relevant to work on the whole city, we highlighted the specificities of each of the district studied.

[1] The city had only 49 districts until 2014, which accounts for the discrepancies that may appear on some location maps.

[2] Officially, Santiago de Surco

Appendix 5: Data collection tools developed for a comparative study

1. The general "waste management" grid (GDS)

The Excel file contains 14 tabs. At the top of each tab, there is a reminder of the general objective targeted by the tab relative to the study as a whole.

There is a progression on the grid: the further you move along the tabs from left to right, you advance from the general to the particular. In this sense, the grid is designed to guide investigators in the field by allowing them to gradually enter into greater detail.

Apart from this graduated feature, the grid is intended to be all-inclusive in order to help investigators to not forget certain aspects and to collect all the readily available data. This means that the grid envisages a greater number of possible cases than those actually present in a given field. For this reason, the grid includes a colour code to distinguish between the key data that must crucially be filled in and the secondary data to be used for analysis (orange cells).

The function each tab is specified in the table below.

Structure of the general survey grid

Tab name	Function
Introduction	Presentation of the grid and its manager
General country & city data	General characteristics of the city or country likely to influence solid waste management and recycling and recovery
Legal & institutional framework	Identification of the environment and actors in order to assess the margin of manoeuvre available for integrating recycling and recovery channels, or to identify the enabling factors for the innovation under study
Waste generation	Evaluation of the quantities of household and similar wastes generated at the different scales of the city, in order to identify the "waste stock" (quantities and location)
Waste characterisations	Description of household waste composition in order to identify management possibilities and the potential for recovery
City's SWM	Overview and "salient features" of the city's solid waste management
Informal sector	Assessment of the field of action and the extent of informal actors' involvement in the area of waste management in the city
Informal sector diagram	A standard diagram to be adapted so as to give an overview of all the actors in the informal recovery and recycling chain, and understand how they interact
Flowchart 1	This diagram is to be completed/adjusted and must give an overview of the waste flows at the metropolitan scale (this is not limited to the municipal service!). The idea is that it should show: the flows, actors and type of materials involved at each stage.
Primary and secondary collection	Description of the collection procedures in order to link the type of collection and the treatment modalities

Valorisation	Description of the existing valorisation chains and procedures
Disposal facilities	Description of the current state of disposal facilities and their cost, in order to identify the level of need to develop recycling and recovery chains
Flowchart 2	The collected quantitative information must now make it possible to complete Flowchart 1 with tonnage-related data.
Projects under development	Description of service changes envisaged in the near future in order to gauge their compatibility with existing chains

2. The socio-institutional grid

The Word document, "Socio-institutional Grid", is designed to provide a grid for the data to be collected, as well as practical instructions on how to proceed in order to obtain a snapshot of waste management in a given city.

This survey grid must be filled in in parallel with the general GDS grid: it reprises the same categories as those in the GDS grid. In addition to the quantitative/qualitative profile, the Word grid aims to help the investigator to avoid becoming bogged down in the detail of the Excel grid and is an ongoing reminder of the objective to be reached with the information collected. The question-based aspect of the matrix is designed to:

- facilitate the investigator's work
- allow for a more qualitative analysis than that using the Excel format
- simplify exploitation of the data and the drafting of the final synthesis

For each theme addressed (corresponding to each of the tabs on the GDS grid), the socio-institutional grid includes:

- a reminder of the overall objective
- practical instructions for the investigator
- a series of open questions, to be answered clearly and concisely

A colour code allows the questions directly related to the three study objectives to be displayed at any moment:

i. characterisation of the waste streams and organisation of the municipal public service
ii. granular knowledge of the recycling and recovery chains
iii. understanding of their interactions, potential incompatibilities and synergies

Three topics were added (at the end of the document) to the 14 topics covered in the GDS grid:

15. Integration of non-municipal waste management actors
16. Synthetic Results / Evaluation
17. Definitions and information specific to the city

3. The service & financing budget grid

Design of the economic and financial data collection sheets

The Technical and Economic sheets for waste collection and treatment

The Technical and Economic sheets were initially designed to collect data that would be useful in calculating production costs for the activities of managing household and similar wastes. This information included, on the one hand, data relating to primary collection, secondary collection, the transfer centre and transport and, on the other hand, data related to landfill, the composting unit and the sorting centre. It also included data on knowledge of the means of production and how these are organised, as well as data on the utilisation and performance of these means and infrastructures.

The economic data included investment costs and operating costs, a distinction being made between fixed and variable costs and maintenance, repair and replacement (MRR). The technical data aimed to describe the facility, the incoming waste stream and the operating conditions.

The **Technical and Economic sheets** were designed to determine the production costs of the activities, based on the three following methods: the *Full-Cost Accounting Method,* the *Production-factor and Unit-cost Method* and the *Techno-economic Modelling Method (cf. Appendix 6).* They were then adapted so that they could be used empirically on the fields studied and integrate informal activities in particular.

The Service & Financing Budget sheet

This sheet has a detailed version (activities–nature of costs matrix) and a simplified version (activities–nature of waste streams matrix) showing total expenditure on the service. A tab on the different sources of financing and a specific tab on financing by users of the service.

The **Service & Financing Budget sheet** was designed to establish both the cost of providing the service and the method used to apply pricing to service users, based on the *Full-Cost Accounting Method* to establish the service provision cost. This method is described in Appendix 6.

Simplification of the sheets

The team found that the original sheets were too precise and exhaustive, given the information likely to be available in developing countries, and would be too time-consuming for the study. Various items were simplified, which thus reduced the possibilities of data analysis

Only the sheet for the Budget for the service and financing was kept, with the tabs for primary collection and secondary collection merged, as were those for transfer and transport, disposal and administrative expenses. The tabs for composting and sorting centre were removed. The relevance of differentiating between fixed and variable costs was no longer taken into account.

To conclude, the techno-economic modelling method ceased to be applicable, especially since the data on utilisation and operating conditions and performance were inaccessible for the two cases studied.

4. Application of the tools

Relatively long field missions were conducted to implement the various evaluation tools.

Organisation of ORVA2D field missions

Case study	Duration of the mission	Team work that can serve as a basis	Local partner
Antananarivo	5 months in the field, in 2015 – A. Pierrat, Clémence Lecointre and Romain Breselec	On-site work by the NGO Gevalor	Antananarivo Municipality
Lima	5 months in the field, in 2015 – M. Rateau	Previous work by M. Durand (Durand, 2010, 2015) and M. Rateau (Rateau, 2014)	Instituto Francés de Estudios Andinos (IFEA); NGO Alternativa; Comas Municipality
Bogotá	3 months in the field, in 2016, two people – M. Rateau and Heduen Estrella Burgos	Previous work by M. Durand (Durand, 2007)	Instituto Francés de Estudios Andinos (IFEA); Universidad Nacional de Colombia; NGO Basura Cero
Delhi	3 months in the field, in November-December 2014 and January 2016, two people – R. De Bercegol and S. Gowda	Previous on-site work by R. De Bercegol sur place (De Bercegol, 2012)	French Research Center Delhi (CSH); Center for Policy Research Delhi; NGO Chintan
Lomé	4 months in the field, in 2016 – J. Garnier	On-site work by the NGO Gevalor	Lomé Municipality
Surabaya	2 on-site missions lasting for a total of over 3 months, October-November 2015, then March-April 2016 – J. Cavé	None	Institut Teknologi Sepuluh Nopember

In most of the cities, the lack of consolidated data was a major hurdle to completing the grids appropriately, especially for the large metropolitan areas. Economic data, in particular, was very difficult to obtain or reconstitute.

Appendix 6: Measuring the production cost of the waste management service

Definition of "production cost"

The concept of production cost, observed at the level of the producer of an activity (collection, transport, treatment or disposal), corresponds to the cost incurred by the use of the factors of production or, in other words, the direct costs incurred in acquiring and operating them. It could be qualified as a "technical cost". This means that indirect costs such as financial expenses, overheads and administrative costs must be excluded. The production cost is thus the sum of the operating cost, *E*, and the infrastructure cost, *I*, for a given activity, *i:*

$$CP_i = E_i + I_i$$

The total production cost (CP) corresponds to the direct costs that the producer must pay to have the use of the factors of production. It is linked to production by the unit costs of the factors of production, as well as by the intensity of their utilisation (notion of productivity). In the short term, the total production cost has two components: fixed costs (CF) and variable costs (CV):

- Fixed costs (CF) represent the costs of the irreducible factors required to ensure production, whatever the level of output (within the limits of installed production capacity). Fixed costs are thus independent from the quantities produced.
- Variable costs (CV) are the costs that vary depending on the volume of output or the quantities produced.

The production cost allows us to measure the technical efficiency of waste collection-transport and treatment activities using an economic performance indicator: the production cost expressed as the tonne collected/treated.

Methods for calculating the production cost

For developing countries, two ex-ante methods are possible:

- one based on an accounting document, such as the actual budget, known as the "full-cost accounting" method,
- the other based on knowledge of the equipment and its use, known as the "production-factor and unit-cost" method.

Full-cost accounting method

For a local authority or city that has a "household waste" budget (either subsidiary or separate), the expenses are classified by nature. The methodology thus involves analysing the flow and purpose of the costs, then classifying them by activity (primary collection, secondary collection, transport, treatment, disposal). This classification of costs by activity comes from knowledge of the operations and components required for the smooth running of equipment, distinguishing equipment and infrastructure expenses from operating expenses. The matrix-based analytical approaches akin to "ComptaCoût" and " Full-Cost Accounting" (FCA) can be applied depending on the level of detail of available data.

Applying this method requires knowledge of the costs of the activity in question and the associated revenue (sale of materials, energy, etc.) or the expenditure on a private operator's service provision. This method was used for Lima, Bogotá and Surabaya. The difficulty lies in identifying the costs and assigning them to a single activity studied.*

Production-factor and unit-cost method

To dispose of waste, the municipality or its collection provider buys the services of the factors of production on the markets where labour, capital and raw materials are negotiated. The costs incurred constitute production costs. By combining these factors in compliance with the technical standards in force, the enterprise manufactures cleanliness. For this method, knowledge of the means of production, the conditions of their utilisation and their performance makes it possible to model the functioning of the activity and thus calculate its production cost.

Applying this method depends on estimating the factors of production allocated to municipal waste management. This involves:

- on the one hand, quantifying equipment, waste recipients and vehicles and their operation (consumption, maintenance, etc.) and collection personnel (drivers and waste loaders); and
- on the other hand, quantifying their unit costs.

The result is the evaluation of the total production cost of the service, which can then be used to compare similar situations. This method was used for Antananarivo and Lomé.

Calculating the production cost

The production cost, or *direct costs (C_d),* denotes the costs incurred by the acquisition and operation of the factors of production, such as vehicles and crews, independently from the indirect costs. It is expressed as:

- the sum of vehicle costs and crew costs as follows: $C_d = (CF_V + CV_V) + L$
- or as the sum of fixed costs and variable costs: $C_d = CF + CV$.

Fixed costs: CF = L + CFv

where: ***L*** = $l_d + n_c * l_c$ *:* denotes personnel costs, notably:

- l_d: annual salary cost of a driver
- l_c : annual salary cost of a loader
- n_c*:* number of waste collectors or loaders.

CFv = *A* + *a:* denotes the fixed cost of the vehicle, notably:

- *A:* depreciation for vehicle wear and tear: $A = I_V/d$
  - I_V: amount of investment in the vehicle
  - *d*: the vehicle lifetime
- *a:* fixed costs relating to ownership of the vehicle (insurance)

Variable costs*:* $CV_v = cv_v * D$ denotes the variable costs for the vehicle, with:

- cv_v*:* vehicle running cost per kilometre (fuel, oil, tyres and maintenance) which can be included as an energy budget item.
- *D:* the annual distance travelled.

The direct production cost is thus: $C_d = L + CF_v + CV_v$

$C_d = I_d + n_c * I_c + (A + a) + (cv_v * D)$

Which costs should we include to calculate the production costs for waste management activities? Determining the costs by activity implies having knowledge about the operations and the elements required for the smooth running of equipment. The distinction between equipment/infrastructure costs and operating costs are presented below under each activity.

Identification of the components of production costs by activity

Primary collection costs

Capital expenditure. Investments are limited to:

- purchase of storage equipment: bags, wheelie bins, sealed dustbins, containers
- installations to stabilise waste recipients on the ground (platforms, supporting elements).

Operating expenditure includes:

- distribution of waste recipients
- cleaning of recipients (washing, disinfection, graffiti)
- maintenance supplies (wheels, pins, lids, hinges, etc.)
- recipient rental, if applicable
- recipient handling (switching, entry-exit)

Secondary collection costs

Capital expenditure. Investments are limited to the acquisition of the collection vehicle:

- purchase of the chassis and skip
- waste recipient lifting gear (bin- or container-lifting)

Operating expenditure

- Fixed components:
  - Personnel: - direct: drivers, refuse collectors, seasonal workers, maintenance.
    - management: operations manager, supervisors
  - Clothing, cleaning products, sundry supplies (office, tools)
  - Taxes and insurance for the vehicles and other
- Proportional components:
  - Routine expenses: fuel, oil, grease, tyres, batteries
  - Minor day-to-day maintenance
- Maintenance: - vehicle servicing and repairs

Transfer–transport costs

Capital expenditure. Investments are:

- Station infrastructure (engineering works, outfitting, roads and services)
- Fixed equipment: compactor, loader, etc.
- Mobile equipment: containers

Operating expenditure for the transfer station

- Fixed components:
  - Staff: watchman
  - Other fixed expenses (insurance, taxes, cleaning, security)
- Proportional components:
  - Consumption: energy
  - Minor day-to-day maintenance
- Maintenance: maintenance of fixed equipment (compactor, containers, etc.)

Operating expenditure for the transport vehicle

- Fixed components:
  . Personnel: drivers
  . Clothing, cleaning products, sundry supplies (office, tools)
  . Taxes and insurance for vehicles and other
- Proportional components:
  . Routine expenses: fuel, oil, grease, tyres, batteries
  . Minor day-to-day maintenance
- Maintenance: Vehicle servicing and repair

Illustrations

Figures

Tables

Maps

Photos

Already published in the collection

Notes techniques n°1	Panorama des inégalités hommes – femmes dans le monde (Juin 2015)
Notes techniques n°2	La Commission du Mékong face à un tournant – Quelle place pour l'aide française (Septembre 2015)
Notes techniques n°3	Quelle efficacité environnementale de la certification pêche et aquaculture « durable » ? (Septembre 2015)
Notes techniques n°4	Vérité des prix ou socialisation de la couverture des coûts ? (Octobre 2015)
Notes techniques n°5	Accompagnement technique et renforcement des capacités: leçons de l'expérience (Octobre 2015)
Technical Reports No 6	Actors and networks of agroecology in the Greater Mekong Subregion (October 2015)
Technical Reports No.7	Creating Alliances to Accelerate Commercially Viable Sanitation (November 2015)
Notes techniques n°8	La recherche française sur l'éducation dans les pays en développement: un état des lieux (Novembre 2015)
Technical Reports No.9	Facilitating green skills and jobs in developing countries
Notes techniques n°10	Étude sur le développement de l'entreprenariat social à Madagascar
Notes techniques n°11	Ecole et Santé de la reproduction Une recherche-action dans les départements du Littoral et de l'Atlantique au Bénin (nov. 2014 – juil. 2015)

Notes techniques n°12	Observation spatiale pour l'agriculture en Afrique: potentiels et défis
Notes techniques n°13	Améliorer la prise en compte de la nutrition dans les projets de développement rural et de santé
Notes techniques n°14	Villes et stratégies climatiques: cinq cas d'études
Notes techniques n°15	Jeunesses sahéliennes: dynamiques d'exclusion, moyen d'insertion
Technical Reports No.16	Supporting Access to and Retention in Employment for Women by Enhancing Child Care Services in Turkey
Notes techniques n°17	Méthode de suivi de l'impact climat des investissements (MRV) appliquée aux projets agricoles et forestiers des Banques Nationales de Développement
Notes techniques n°18	Gestion des ressources en eau souterraines comme biens communs
Notes techniques n°19	Eau des villes, assainissement et précarités – des réalités contrastées à Ouagadougou (Burkina Faso) et Niamey (Niger)
Technical Reports No.20	The effectiveness of an environmental credit line in Egypt: Synergies between market incentive and binding regulations
Notes techniques n°21	Développement rural à co-bénéfices - Gouvernance, suivi, certification
Notes techniques n°22	Dynamiques des systèmes agraires et devenirs de l'agriculture familiale en guinée

Notes techniques n°23	Évaluation de la politique d'aménagement du territoire en Tunisie de 1995 à 2010
Notes techniques n°24	Cocoa farmers' agricultural practices and livelihoods in Côte d'Ivoire
Notes techniques n°25	Vulnérabilité sociophysique aux inondations au Sénégal
Technical reports No.25	Socio-physical Vulnerability to Flooding in Senegal
Notes techniques n°26	Revenus et trajectoires agricoles en Afrique d'ici 2050: vers un trop-plein d'agriculteurs ?
Notes techniques n°27	Comprendre le processus d'installation des jeunes en agriculture pour mieux l'accompagner - Grille d'analyse et premiers résultats
Notes techniques n°28	Les dynamiques d'inclusion / exclusion de la jeunesse en zone MED
Notes techniques n°29	Quelle compétitivité de la Côte d'Ivoire, du Sénégal et de la Tunisie ? - Un état des lieux à partir des nouvelles données de l'Observatoire de la Compétitivité Durable
Notes techniques n°30	Urgences et crises sanitaires dans les pays à ressources limitées: de la préparation à la réponse
Notes techniques n°31	Capitalisation des actions de formation-insertion des jeunes conduites par les organisations non gouvernementales
Notes techniques n°32	L'accès et le maintien des femmes à l'emploi de qualité au Maroc, en Tunisie et en Turquie

Notes techniques n°33	Le financement participatif et l'aide publique au développement: état des lieux et recommandations
Technical Reports No.34	Outlooks for flare reduction in Nigeria
Notes techniques n°35	Risque d'inondation et villes des pays en développement
Technical Reports No.35	Flood risk and cities in developing countries
Notas Técnicas N°35	El riesgo de inundación y las ciudades en los países en desarrollo
Notes techniques n°36	Etude de capitalisation: Impact et mise en œuvre de programmes à haute intensité de main d'œuvre (HIMO) en Afrique subsaharienne
Notes techniques n°37	Etude de capitalisation: Impact et mise en œuvre de programmes de soutien à l'entrepreneuriat en Afrique subsaharienne
Notes techniques n°38	Etude prospective: quel impact des dynamiques démographiques sur l'offre sanitaire et médico-sociale de la Guyane ?
Technical Reports No.39	Assessing and Addressing Climate Governance Challenges in Low- and Middle-Income Countries
Notes techniques n°40	Réformer les per diem par le dialogue
Notes techniques n°41	Analyse rétrospective du secteur urbain de l'eau potable au Sénégal: un partenariat public-privé à l'épreuve du temps

Technical Reports No.41	Retrospective Analysis of the Urban Water Supply Sector in Senegal: A Public-Private Partnership Over Time
Notes techniques n°42	L'assainissement et ses enjeux
Technical Reports No.42	Challenges in Sanitation
Notes techniques n°43	Utiliser les indications géographiques comme outil de développement - Guide pour le choix des produits illustré par les cas du miel blanc d'Oku et du poivre de Penja, Cameroun
Notes techniques n°44	Vingt ans d'aménagements rizicoles dans les territoires de mangrove en Guinée maritime Quel développement agricole durable?
Notes techniques n°45	Territoires de l'eau et communs en Bolivie - Les cas de Hampaturí (La Paz) et de Sacaba (Cochabamba)
Notes techniques n°46	Gouvernance des services d'eau et d'assainissement des villes boliviennes Analyse du modèle de gestion coopérative au travers de l'exemple de SAGUAPAC (Santa Cruz de la Sierra, Bolivie)
Notes techniques n°47	Mutations de la gouvernance des systèmes alimentaires urbains Le cas de l'agglomération de Rabat-Salé
Notes techniques n°48	Contribution des systèmes de distribution alimentaire à la sécurité alimentaire des villes: étude de cas sur l'agglomération de Rabat (Maroc)
Notes techniques n°49	Contribution des systèmes de distribution alimentaire à la sécurité alimentaire des villes: étude de cas sur l'agglomération d'Abidjan (Côte d'Ivoire)
Notes techniques n°50	Systèmes d'approvisionnement et de distribution alimentaires Étude de cas sur la ville de Niamey (Niger)

Notes techniques n°51	Les systèmes de distribution alimentaire dans les pays d'Afrique méditerranéenne et Sub-saharienne
Notes techniques n°52	Recherches africaines et rôles de l'aide internationale: le cas des sciences sociales
Notes techniques n°53	Les branchements sociaux: intérêt et limites de différentes stratégies de ciblage des ménages vulnérables

What is AFD?

AFD is an inclusive public institution and the main actor in France's development policy. It makes commitments to projects that genuinely improve the everyday lives of people in developing and emerging countries and in the French overseas territories.

AFD works in many sectors – energy, health, biodiversity, water, digital technologies, training – and supports the transition to a safer, more equitable and more sustainable world: a world in common. Its action is fully in line with the Sustainable Development Goals (SDGs).

Through its network of 85 agencies, AFD operates in 115 countries and is currently supporting over 4,000 development projects. In 2018, it earmarked EUR 11.4bn to finance these projects.

Agence Française de Développement

5 rue Roland Barthes – 75598 Paris Cedex 12

Tel: +33 1 53 44 48 86 – **www.afd.fr**