Digging Through:

an inside look at municipal waste management in Myanmar

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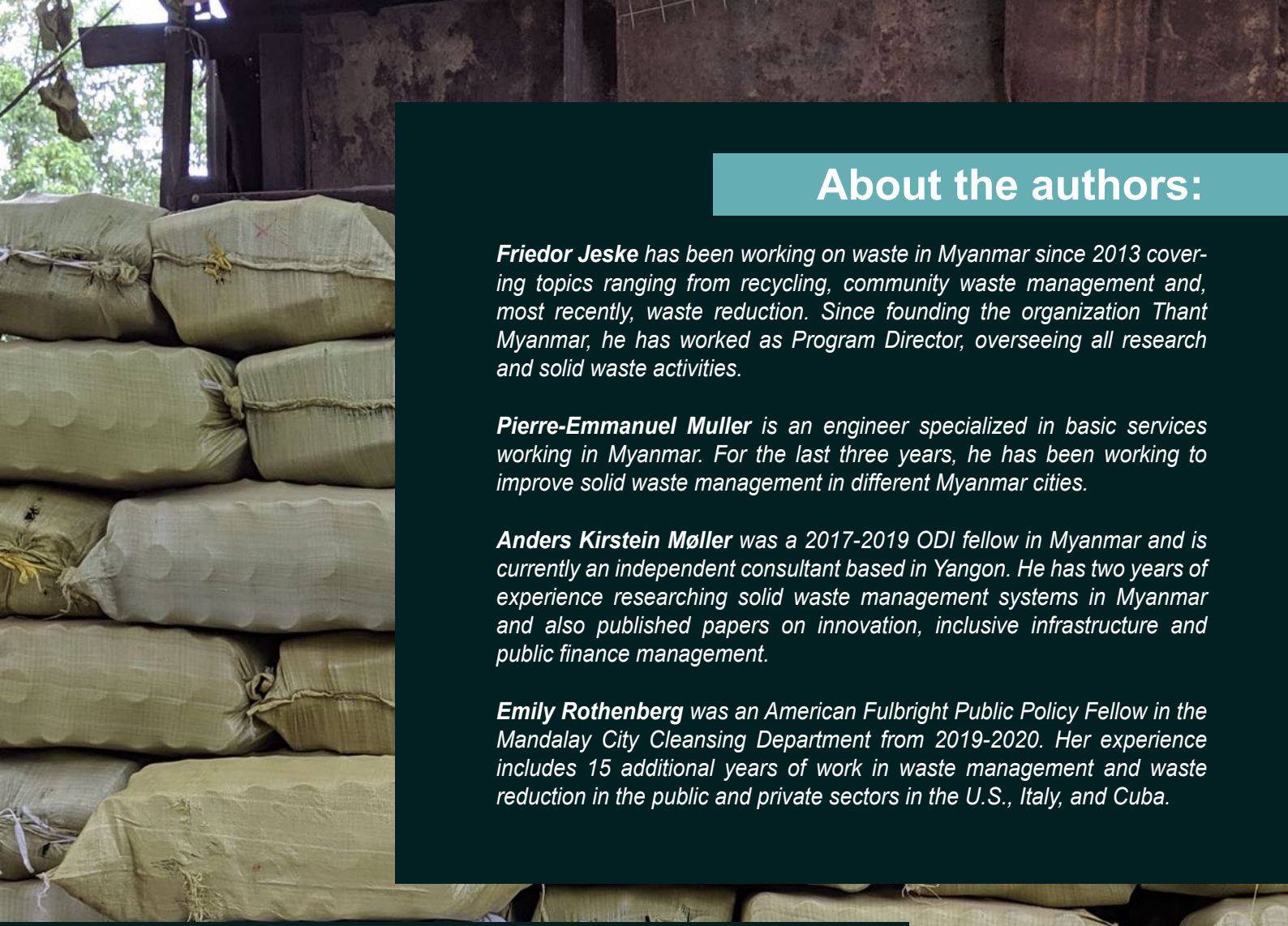
ABSTRACT

Understanding Myanmar's solid waste systems presents a challenge for anyone working in the sector. While waste collection and disposal challenges faced by Myanmar's cities and towns share similarities, strategies to overcome them evolve locally and are often not well-communicated between different local government bodies. Data on the country's solid wasted is inconsistent and sometimes unreliable, with figures based on proxy indicators, extrapolated from regional estimates, or outdated without clear methodology indications. This report – focusing specifically on Myanmar's urban areas – categorizes different solid waste management governance and collection structures found in the country and seeks to present a consistent picture of Myanmar's urban waste situation through a combined and comparative analysis of existing, verified waste data from NGOs, development partners and municipal bodies. While the analysis focuses primarily on secondary cities, it includes some data from primary cities as points of reference. Recent, on-the-ground waste audits from Mandalay (a major city) and from five secondary cities provide the baseline for urban waste generation (0.58kg/capita/day) and yield a national waste generation estimate of 0.38kg/capita/day. Data on disposal practices was collected and analyzed in areas that collectively represent 75% of Myanmar's urban population, revealing that 17% of urban waste generated is leaking into the environment, consisting mainly of plastics. Finally, the paper compares its findings with global waste data published in the World Bank's 2018 "What a Waste 2.0" report, as well as with data from other regional towns (in Laos and Cambodia). Particularly when comparing disposal methods, this final analysis suggests that Myanmar would be more accurately considered a low-income rather than lower-middle-income country for purposes of waste trend assumptions and that Myanmar's waste composition and disposal practices closer approximate those of the South Asia region than those of East Asia and Pacific.

Note: Currently there are multiple research projects analyzing the waste situation in Myanmar. Under the following link we will have the most recent updates of figures and tables presented in this report: https://www.thantmyanmar.com/en/documents/solid-waste-audits



About the authors:

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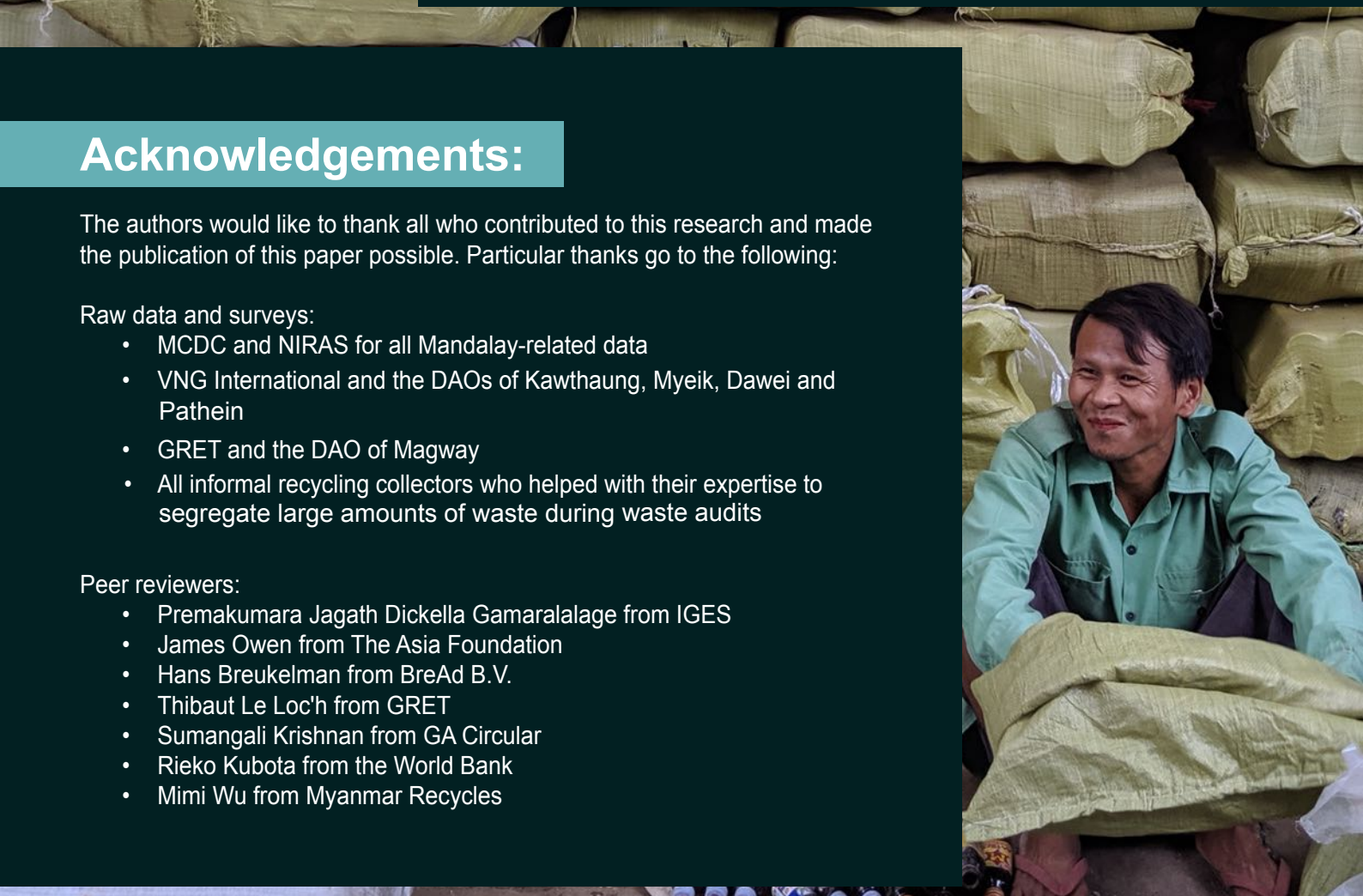

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Foreword

IGES

IGES Centre Collaborating with UNEP on Environmental Technologies (CCET) has been providing technical support to the Government of Myanmar to mainstream waste management into national and local polices and plans. As a result, the Ministry of Natural Resources and Environmental Conservation (MONREC) has formulated the National Waste Management Strategy and Master Plan, the country's first guiding document that seeks to address waste management in a more holistic and integrated manner. In addition, Mandalay City Development Committee (MCDC) has formulated the City Waste Management Strategy and Action Plan identifying short, medium and long-term goals and key actions to achieve a resource efficient and zero waste society by 2030. Following that, other City Development Committees (CDCs) and Development Affairs Organizations (DAOs) have also begun drafting their local waste management plans and actions with ambitious targets.

However, this requires sufficient technical capacity, supportive financial mechanisms, sound policies, and robust institutional and monitoring frameworks for the successful implementation of these national and local plans. Among all, having adequate capacity on reliable data and knowledge management at national and local levels is an important factor for evidence-based decision-making, monitoring and reporting. I hope that this report jointly published by Thant Myanmar and CCET contributes to filling this need in the country.

Kazunobu Onogawa
Director, IGES Centre Collaborating with UNEP on Environmental Technologies (CCET)

Thant Myanmar

Data is critical when it comes to sound decisions to improve SWM in Myanmar. While different organizations as well as individual research projects have addressed specific topics or regions regarding solid waste in the past, often the results were not integrated into a complete or consistent picture. Therefore, data frequently showed contradicting results.

All four authors have substantial experience in the specific Myanmar waste context, and this work is their voluntary contribution to share their knowledge. Thant Myanmar hopes that through their combined efforts – and all others who contributed through reviewing or providing data to this paper – a consistent body of research can be available for government, organizations, and researchers to rely on in their own fields of work.

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Abbreviations

CCTV: Closed-Circuit Television
CDC: City Development Committee
CSO: Civil Society Organization
DAO: Development Affairs Organizations
DRD: Department of Rural Development
ECD: Environmental Conservation Department
EO: Executive Officer
FFI: Fauna and Flora International
FY: Fiscal Year
GNI: Gross National Income
HDPE: High-Density Polyethylene
IGES: Institute for Global Environmental Strategies
LDPE: Low-Density Polyethylene
M&E: Monitoring and Evaluation
MCDC: Mandalay City Development Committee
MMK: ISO 4217 code for the Burmese kyat, the currency of Myanmar
MoALI: Ministry of Agriculture, Livestock and Irrigation
MONREC: Ministry of Natural Resources and Environmental Conservation
MSW: Municipal Solid Waste
NGO: Non-Governmental Organization
NWMSAP: National Waste Management Strategy and Action Plan
PCD: Pollution Control Division
PET: Polyethylene Terephthalate
PP: Polypropylene
SWM: Solid Waste Management
SWMSAP: Solid Waste Management Strategy and Action Plan
TDC (TDAC): Township Development Committee
UNDP: United Nations Development Program
UNEP: United Nations Environment Program
W-t-E: Waste-to-Energy
WaW: World Bank's What a Waste publication, original in 2012 and What a Waste 2.0 in 2018
YCDC: Yangon City Development Committee

Contents

Contents

1.Introduction

The purpose of this paper is to provide an up-to-date analysis of urban SWM practices and the latest waste data in Myanmar.

Solid Waste Management (SWM) is a growing problem in Myanmar. The country is currently undergoing a historic transition towards a market-based economy and accelerating urbanization. This means that average waste generation per capita is quickly rising while the proportion of single-use plastic and other non-biodegradable materials is increasing. Combined with a lack of proper management infrastructure, the rise in waste generation presents significant economic, environmental and health challenges for Myanmar. Municipal governments have precious few resources to spare on providing services, while the country is experiencing increasing levels of soil and water pollution, and uncollected waste creates additional public health hazards.

SWM issues in Myanmar are currently garnering more attention. Many municipal governments cite waste management as one of their chief concerns, as do local communities. According to the 2018 City Life Survey by the Asia Foundation, 76.7% of 2,414 residents across five cities either strongly agreed or somewhat agreed that open dumping of waste was a problem in their urban ward (neighborhood). Unfortunately, there is a lack of publicly available solid waste data that can properly inform development practitioners and policy makers on solutions. Nevertheless, field research on SWM issues in Myanmar began about a decade ago and has recently experienced growing attention. The investigations of various organizations into both urban and rural waste management in Myanmar have led to an increased availability of raw data and a more structured methodology of addressing the issue. However, despite the fact that Myanmar's majority rural population struggles with a lack of infrastructure and resources for managing solid waste, very little data exists on rural waste in Myanmar. This analysis therefore focuses on the data that is available for urban areas, addressing rural waste management only in comparison to urban trends.[1]

The purpose of this paper is to provide an up-to-date analysis of urban SWM practices and the latest SWM data in Myanmar for use by various stakeholders, especially international development consultants and municipalities. Urban governance structures in Myanmar differ greatly between Myanmar's three largest cities of Yangon, Mandalay and Nay Pyi Taw – which each hosts a governing City Development Committee (CDC) with a dedicated Cleansing Department for waste management[2] – and secondary cities, which operate through a more simplified municipal body called a Development Affairs Organization (DAO). While the focus of this paper is Myanmar's secondary cities, SWM data from primary cities are in some cases included as points of comparison or case studies. For the purposes of this report, "municipalities" refers to all municipal bodies, including both CDCs and DAOs.

Generally, this paper aims to:

1. Provide an overview of current SWM structures and challenges in Myanmar;

2. Collate and analyze the most up-to-date SWM data from across the country, which can provide an empirical basis for better municipal SWM planning for both development specialists and policy makers;

3. Compare this local field data with global predictions for Myanmar and other data from the surrounding regions, highlighting key differences between the two.

[1] Working in 30 villages over a period of five years, the nonprofit Thant Myanmar created a toolkit for building solid waste management systems from the ground up in Myanmar, particularly in rural or remote villages. This methodology for small-scale, community waste management has been applied to some of the urban SWM issues considered in this paper.
See: https://www.thantmyanmar.com/en/documents/community-swm-guide

[2] The City Development Committees of Yangon, Mandalay and Nay Pyi Taw are referred to as YCDC, MCDC and NCDC, respectively.

Methodological approach:

The authors of this paper are all SWM experts who collectively have over 13 years of experience working in Myanmar. This paper presents an extensive analysis of Myanmar's SWM sector based on a wide variety of qualitative and quantitative research methods:

- Collection methods and governance structures descriptions rely upon firsthand information and stakeholder interviews gathered in 15 cities in the country.
- Analysis of waste disposal management systems reflects data collected from areas that together represent over 75% of Myanmar's urban population.
- Waste generation, composition and density analyses rely on in-depth waste assessments from six cities (Mandalay and 5 secondary cities) in Myanmar that together represent 14% of the country's total urban population.
- Recycling analyses rely mainly upon first-hand qualitative observations and on an external study on PET and aluminum cans for quantitative estimations (study by GA Circular, 2018).
- Waste leakage is qualitatively well-assessed but relies on assumptions drawn from the comparison of predicted waste generation against actual disposed waste.

For a further discussion on methodology and data limitations, see Chapter 6.

Structural Overview

Chapter 1 discusses a brief background on waste issues in Myanmar and addresses the scope of the paper.

Chapter 2 provides a brief overview of how the SWM sector in Myanmar is governed, with insights into the different management structures, including the informal and recycling sectors. The chapter analyzes and compares the different forms of collection systems currently found in Myanmar.

Chapter 3 analyzes waste generation data for urban areas, disposal practices compared by different levels of urbanization, and leakage of waste into the environment.

Chapter 4 presents an analysis of a series of waste audits from five secondary cities around the country plus Mandalay (a primary city), providing a current picture of waste composition, waste density, and increase of waste over the last three years.

Chapter 5 demonstrates that Myanmar most closely resembles a low-income country in regards to waste management.

Chapter 6 concludes by considering data limitations and the need for further research as well as listing the main stakeholders working on different SWM topics in Myanmar.

Annex I offers a case study on the expanded use of stationary collection bins in Mandalay City.
Annex II includes all data and source tables for the analyses presented in Chapters 3 and 4.
Annex III compiles a list of active waste stakeholders in Myanmar with relevant contact information.

2 Urban Collection Structures

> Urban areas rely on multiple forms of formal and informal systems to manage their waste

2. Urban collection structures

This section gives a brief overview of how solid waste is managed in Myanmar, focusing on collection systems and how they are governed. Myanmar's solid waste sector has three main flows from producers to final disposal, as summarized in Figure 1 below:

1. A formal waste collection structure overseen and mostly implemented by local authorities, often receiving support from different types of informal collection structures operating against a fee by the waste producer;
2. An informal recycling system that extracts valuable materials from the waste stream and directs it into the formal sector. Repairable and reusable items are relatively circular on the local level, while recyclables are either sold domestically or exported;
3. Uncollected waste is either openly burned in communities or directly disposed of in the environment, typically in waterways.

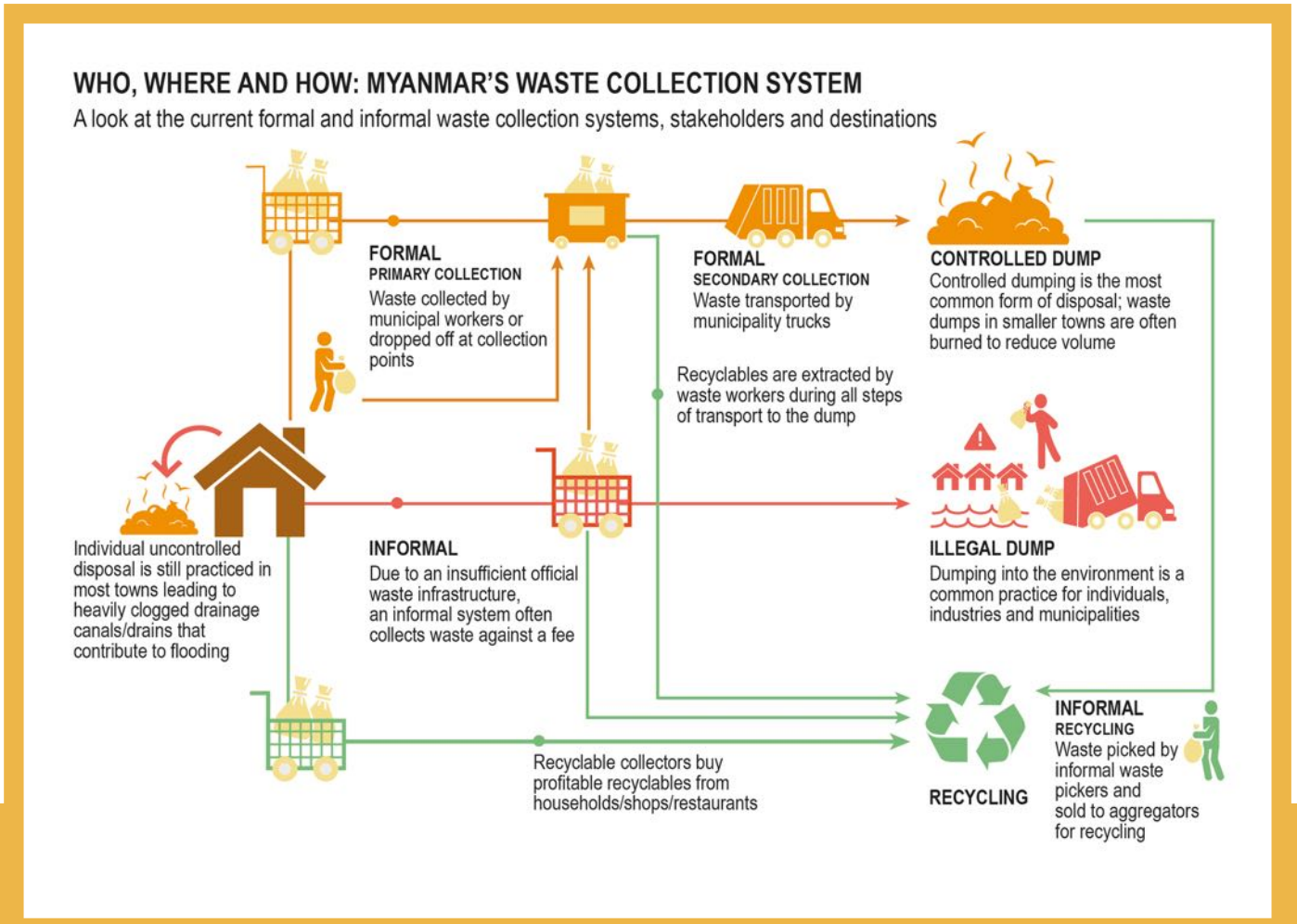


Figure 1: An overview of Myanmar's waste collection system.

Waste generated though formal collection mostly ends up in open dumps managed by municipalities. Waste reaching formal dumpsites is either stored in piles, burned, and/or leaked into the environment. Liquid leachate is rarely collected or controlled. Waste collected by informal collectors (including private community waste collectors) either feeds into the official system or ends up in informal dumps. Recyclables are extracted at any point along the collection chain and at the final dumpsite. Waste leakage to the environment occurs predominantly at source near where it is generated or at formal and informal unmanaged dump sites. However, leakage is common along every step of collection and recycling. Uncollected waste is often burned in combination with fallen leaves in neighborhood piles. Source: Thant Myanmar (2020).

2.1 Governance

At the Union level, SWM is overseen by the Ministry of Natural Resources and Environmental Conservation (MONREC). Specifically, the Pollution Control Division (PCD) of the Environmental Conservation Department (ECD) is responsible for oversight of national waste management policies, strategies, and legislation. However, the PCD currently has no dedicated field staff monitoring SWM practices[3], and there are no national or regional-level Monitoring and Evaluation (M&E) mechanisms in place to implement SWM standards or reforms.[4]

MONREC recently adopted a National Waste Management Strategy and Action Plan (NWMSAP), developed through a consultative process with multi-sector cooperation, published in 2019 and officially adopted by the Office of the President as of January 2020. The NWMSAP was built on the same model as Mandalay City's waste plan, published in late 2017 and developed collaboratively with guidance from the Institute for Global Environmental Strategies (IGES) and support from the United Nations Environment Program (UNEP) and the Government of Japan. The NWMSAP cites Myanmar's Environmental Conservation Law of 2012, which assigns MONREC as the agency "responsible for formulating national or regional strategies and action plans relating to environmental conservation and management." The document also proposes that all local and State/Region governments be required to prepare their own waste management strategies. Although the proposed mandate has not yet been implemented, MONREC has requested that all State/Region governments prepare regional SWM Strategy and Actions Plans (SWMSAPs). By 2019, at least one jurisdiction (Mon State) had prepared its SWMSAP, with support from UNDP. Some smaller towns have also begun drafting local waste management plans, although they tend to be less ambitious or strategic than the national plan.

Municipal SWM in secondary cities is the responsibility of local municipal authorities called Development Affairs Organizations (DAOs), or *si-bin tha-ya-ye apwe* in the Myanmar language.[5] DAOs are unique in the governance structure of Myanmar for their relative independence from the Union government. DAOs, themselves, consist of two bodies:

1. A township DAO office, which is usually led by an Executive Officer (EO) and oversees day to day municipal governance;
2. A Township Development Affairs Committee (TDC or TDAC), which has decision-making power and oversight of the DAO office. The relative influence and importance of the DAO and TDC leadership structures vary amongst townships, which is why the terms are often used interchangeably (see Arnold et al., 2015).[6]

In Myanmar's three primary cities of Yangon, Mandalay and Nay Pyi Taw, responsibility for SWM falls under the Cleansing Department of each respective City Development Committee.

The jurisdiction of municipalities only covers urban wards. Each State and Region in Myanmar is divided into districts, which are composed of a group of townships. In turn, a township consists of urban and peri-urban wards, each of which have their own appointed Ward Administrator, and so-called "village tracts" of rural areas. DAOs do not have jurisdiction over village tracts, which therefore go largely unserviced for SWM infrastructure needs. However, the Department of Rural Development (DRD) under the Ministry of Agriculture, Livestock and Irrigation (MoALI) is gradually taking over responsibility for addressing waste management in rural areas.

Municipal bodies are largely dependent upon raising their own funds, although smaller towns might receive more significant support from State/Region governments. The main sources of revenue for larger cities include monopoly license auctions (e.g. slaughterhouses), business permits, property taxes, income tax revenue sharing (5% of collected income tax), and transfers from Union and State/Region governments.

[3] World Bank (2019). "Financing Solid Waste Management: Improving Financial and Environmental Sustainability of a Key Urban Service," *Chapter 5 of Subnational Public Expenditure Review 2019: Fostering Decentralization in Myanmar.* p. 135.
[4] However, plastic waste management legislation is expected by 2021, and a major hiring effort of ECD field staff over the next several years might boost the enforcement capacity of the agency.
[5] The three largest cities of Yangon, Mandalay and Nay Pyi Taw have unique municipal structures, which are referred to as City Development Committees (CDCs), or YCDC, MCDC and NCDC respectively.
[6] Arnold, M. et al. (2015). "Municipal Governance in Myanmar: An Overview of Development Affairs Organizations." *Policy Dialogue Series no. 7.*

For SWM, State/Region transfers are usually for investment in trucks and infrastructure, but also for operational costs in case of large deficits.[7] The property tax composition and itemized rates vary between cities but usually include three or four line items, including waste collection. However, the property tax system stems from a colonial-era method that chronically underestimates property values, which means that most households pay a nominal rate of only a few hundred or few thousand MMK every six months (see McDonald and Hein 2017).[8,9]

Cities struggle to cover the cost of waste collection. Income from property taxes is extremely low, and most municipal "Cleansing Departments" have historically run a consistent operational deficit, despite low waste collection costs in Myanmar compared to neighboring countries. An analysis from UNDP for Rakhine and Mon States concludes that collection costs per ton are 8,000 and 5,000 MMK, respectively.[10] In small cities like Magway, it has been estimated to cost about 8,500 MMK to collect and dispose of one ton of garbage, while in Mandalay City, estimates for operational costs vary between approximately 15,000 and 20,000 MMK per ton.[11] With residents typically paying a nominal percentage of income toward taxes or fees that would cover waste collection services, the burden is mostly carried by already strained municipal budgets (when capital expenditure is included, the deficit becomes even larger). In general, Cleansing Department "revenues" from property taxes in secondary cities tend to cover only 20% or less of operational expenses. Municipalities are effectively subsidizing waste collection from their general budget, thus limiting resources for other essential service provision (see World Bank 2019).[12]

Most municipalities struggle to invest in capital improvements. In addition to a lack of funding options for SWM systems, Union-level regulations do not yet allow for multi-year budgeting amongst public agencies. Without the ability to set aside funding for capital investments over multiple budget cycles, DAOs are often forced to rely on purchasing second-hand machinery and to make ad hoc infrastructure improvements from their own budgets. Alternatively, DAOs might need to wait for intermittent equipment donations from their respective State/Region governments, which allocate such assets somewhat inconsistently to different townships. In some cases, development agencies and private sector actors have donated equipment to CDCs and DAOs, such as diggers and garbage collection trucks.

A general lack of funding and proper equipment leads to low waste collection rates in secondary cities. Conservative estimates provided by DAOs suggest that around 70% of the waste generated in urban areas is collected (see Chapter 3).[13] Uncollected waste piles up at markets, creeks, and near underserviced collection points. A low level of service provision erodes public trust, which has historically led to a low-tax equilibrium in which urban residents in secondary cities have tended to resist tax increases (McDonald and Hein 2017). Municipal authorities have, in turn, been weary of increasing taxes or introducing waste collection fees. However, newer studies suggest that a majority of urban citizens (74%) are willing to pay more in taxes if the increase is accompanied by an improvement of service (City Life Survey 2018).[14]

Some cities are experimenting with new ways of financing waste collection. Recent experience in Myanmar show that the public has tolerated significant tax reform; several towns including Kalaw have marginally increased taxes in the last few years, and both Mawlamyine and Taunggyi – in the wake of significant administrative reforms – are planning to more than double their property taxes in 2020.[15] Some cities such as Yangon, Mandalay, and Pyin-Oo-Lwin have taken an alternative approach and successfully introduced a

[7] Even with locally generated revenue, municipalities are required to submit annual budget requests to their respective State/Region bodies for approval. High-level budgetary assignments have tended to favor more popular development projects such as lighting, roads, and modernization over the issue of waste collection, despite citizens and municipalities citing it as a matter of high concern.
[8] McDonald, L. and A. Hein (2017). *Managing the Challenge of Rapid Urbanization: A Review of the Property Tax System in Myanmar.*
[9] Taunggyi has managed to reform its property tax system by updating its property valuation rubric.
[10] Data not yet published.
[11] These estimates use extrapolated data from the MCDC Cleansing Department and do not include separate expenses from the Motor Vehicle and Workshop Department. When major capital expenditures of FY2018-19 are included, the 2019 figure for total cost per ton doubles to over 30,000 MMK. This is consistent with MCDC estimates cited by the World Bank (2019).
[12] World Bank (2019). Subnational Public Expenditure Review.
[13] However, waste collection rates are systematically overestimated because townships typically rely on 2014 census data to estimate waste generation and on simple vehicle tonnage to figure collection rates.
[14] The Asia Foundation (2019). *Insight into Urban Well-being in Myanmar: 2018 City Life Survey.* https://asiafoundation.org/publication/city-life-survey-2018/
[15] Renaissance Institute (2020a). "How Changes in Tax Policy can Make Property Taxes Fairer and More Sustainable." *Policy Note Series: Property Tax Reform in Practice*, and Renaissance Institute (2020b). "The Practicalities of Reforming Property Tax Administration in Myanmar." *Policy Note Series: Property Tax Reform in Practice.*

separate waste collection fee in lieu of the property tax line item, typically 1,000 - 5,000 MMK per month depending on the size/waste generation of the household or business (see Text Box 1 below).

A few cities have looked to the private sector to reform waste collection. In Taunggyi, for example, the new waste fee in 2015 was introduced with the municipality's outsourcing of collection to a local private contractor. Outsourcing is practiced mostly in the form of giving a concession for waste and fee collection.[16] Nearly a dozen municipalities around the country have outsourced waste collection services or are considering it, although these experiments have seen mixed to poor results due to poor contract design and weak private sector capacity. Pyin-Oo-Lwin and Monywa, for example, have both tried outsourcing options, only to revert back to full public service provision (see Møller 2020).[17] However, certain towns where local community groups have initiated collection using voluntary contributions and then transformed themselves into a private collection company have seen significant improvements in waste management, with examples including Nyaung Shwe, Dawei, and Myeik.

Text Box 1: Mandalay City's implementation of waste collection fees in 2019

In late 2017, MCDC approved a Waste Management Strategy and Action Plan for 2017-2030, the first city in the country to do so. As part of the plan's goal to increase the efficiency of collection services, in FY 2018-19 MCDC implemented a stand-alone household waste collection fee (referred to by MCDC as a "sanitary tax") based on a monthly rate and collected bi-annually by township Development Committee staff.

Whereas the previous property tax system included a waste tax line item based on property values, the new system assigns specific fee brackets based on housing construction type and number of stories, accounting for a degree of equity in service costs while also serving as a proxy for anticipated waste generation. Although this system does not equate to a "pay as you throw" model (which would require more specific waste audit data to implement), it has nevertheless improved cost recovery. In tandem with the residential fee reforms, commercial waste collection rates were also updated to reflect waste generation, with monthly fee brackets that correspond directly to estimated daily tonnage for food establishments. Only hotels pay a flat, annual fee based upon the number of rooms, while private medical facilities pay a monthly flat rate for the collection of medical waste, and private hospitals pay on a per bed basis (see Annex II 8.7 for a summary of Mandalay City's residential and commercial waste fee rate schedule).

Collectively, the reforms were projected to increase Cleansing Department revenues by over 3.6 billion MMK per year.[18] The new revenues would reduce a chronic budget deficit of approximately 3 to 5 billion MMK over each of the past three fiscal years to just 1 billion MMK within the first year of implementation.[19] In addition to adjusting fees proportionally, the reforms also expanded the Cleansing Department's revenue base. By separating the waste fee from the property tax, the Department is now able to collect service fees from the many households and occupants who do not hold legal title to their dwellings but nevertheless live and consume public services in Mandalay City. Furthermore, taxing residents rather than owners avoids the common issue of outdated household registration records that might not account for current occupancies.[20]

The MCDC Cleansing Department reports that it enjoyed broad stakeholder support for the new fee structure. In public survey responses, citizens overwhelmingly supported paying more for improved waste collection service. Public trust in both MCDC and its Cleansing Department has increased during reformist Mayor Ye Lwin's tenure, leading to a

[16] Myanmar presents a unique model in which private waste contractors are commonly required to pay a monthly fee to municipalities for the right to collect waste and user fees. This arrangement sets up an unsustainable business model for most potential private sector players.
[17] Møller, A. (2020). An Economic Analysis of Solid Waste Management Outsourcing in Myanmar. Yangon: Asia Foundation.
[18] Previously, MCDC Cleansing Dept. revenue ranged from 300-400 million MMK per year. With new waste collection fees, the Department should collect just over 4 billion MMK per year by the end of FY 2019-20. Source: Rothenberg, E., Interview with MCDC, Oct. 2019.
[19] MCDC Cleansing Department (2019, Nov.). *Solid Waste Management in Mandalay City*. Intended to be presented at the Mayoral Conference in Seoul, S. Korea, although Mayor Ye Lwin's attendance was cancelled.
[20] The MCDC Cleansing Department has still not been able to collect fees from the entire revenue base, estimating that it collects payment from approximately 80% of households in its jurisdiction. However, MCDC is preparing to introduce an online payment system for all municipal taxes and fees, recently having implemented a system of zip codes to facilitate this. The Cleansing Department hopes that "smart" municipal system upgrades can expand its capacity to both collect fees from and provide service to 100% of city residents.

a more cooperative environment between stakeholders and the city government. After the Mayor started his own Facebook page for citizen feedback, Facebook became a primary tool for participatory governance and government accountability. The Cleansing Department now maintains its own page and regularly responds to reports of overdue collections and illegal dumping, as well as receiving online praise for its services. In addition to raising revenue for service improvements, MCDC's Cleansing Department envisioned that separate waste collection fees could empower citizens as patrons of the Department's services. Although the public has demonstrated willingness to pay, popular support could fluctuate with changes in income and is dependent upon the continued provision of reliable waste management services.

Fines for illegal dumping exist but are rarely enforced. Municipalities usually advertise fines on signboards found at hotspots or close to water sources. However, enforcement is usually too weak to ensure a behavioral change.[21] Moreover, high fines are effectively unenforceable for the majority of the population and often open the door for corruption or negligence from authorities. Lower fines (for example, for simple roadside littering) could potentially mitigate this risk while generating revenue for better enforcement.

The informal sector plays a significant role in recycling collections and extraction, but its relationship with municipal authorities is complex. The informal recycling sector in Myanmar is a multi-layered, decentralized system that succeeds in extracting most valuables out of the waste stream and funneling them to aggregators and recyclers. Although the informal sector provides an invaluable service to the community by reducing waste that goes to landfills, municipalities often resist collaboration for several reasons:

1. The informal recycling sector is seen as reflecting poorly upon cities through the mess of neighborhood junk shops, the use of child labor, and the visible poverty of people sorting through waste in unhygienic conditions;
2. The sector tends to be dominated by marginalized communities;
3. Junk shops and recyclers often work without licenses or occupy public land, as authorities often do not approve operating permits.[22]

Image: Informal waste collector

[21] MCDC's fine for commercial illegal dumping is 200,000 MMK. Although the standard collection fee for a single truckload of industrial or construction waste is 35,000 MMK, many businesses still take the risk of dumping illegally. The MCDC Cleansing Department staff includes designated waste inspectors for every township, but fines are rarely issued.
[22] Operating licenses require the approval of neighboring businesses, which are often averse to waste-related enterprises in their immediate vicinity.

Some towns have experimented with community-based collection or support systems that supplement formal services. These formal and informal systems have mostly increased fee collection and service coverage but often lack transparency in financial management. Various alternatives to fully centralized collection can be found today in Myanmar, grouped generally into the following different mechanisms:

A. **Individual informal waste collectors:** In large cities, individuals who own or rent a push cart collect waste from households in exchange for a "pay as you drop" fee of 100 to 500 MMK per bag, depending on the amount and the effort required by the collector to pick up the waste. Collectors then drop the waste into transfer stations mostly against a fee (1000 MMK per push cart). These informal, private collectors fill an essential role where residents do not have easy access to roadside pick-ups, such as in high-density areas with high-rise buildings (where running to a collection point is inconvenient and trucks tend to pass during working hours)[23] or in underserved areas of cities and towns where municipalities provide only central collection points.

B. **Grassroots community initiatives,** in which informal sector workers, neighborhood organizations, and street or ward authorities collaborate to manage their waste collection without additional public support, sometimes in collaboration with Non-Governmental Organizations (NGOs). Examples of this mechanism exist in several parts of Yangon, Hpa-An, Dawei and many towns, where waste is gathered privately and handed to municipal workers for secondary collection or ends up at municipal dumps. While such a system effectively integrates citizen stakeholders and informal workers, it does not channel collection fees back into the formal SWM system unless a formal agreement is set between collectors and the municipality that makes costs and revenue transparent.

C. **Local government initiatives,** in which Ward Administrators take over collection responsibility in parts of or an entire town, either buying or renting a truck and hiring private crews. This arrangement sometimes occurs with in-kind support from the municipality. Examples include Kawthaung, Myeik, Monywa, Hpa-An, Yangon, and small pockets of Mandalay City. Because the fee collection is informal, it does not need to be approved by a city council and can be enforced locally. These highly localized models increase revenues to cover collection costs and avoids the problem of free-riding. Service quality may also be better monitored by citizens. In some cases, highly localized collection might even

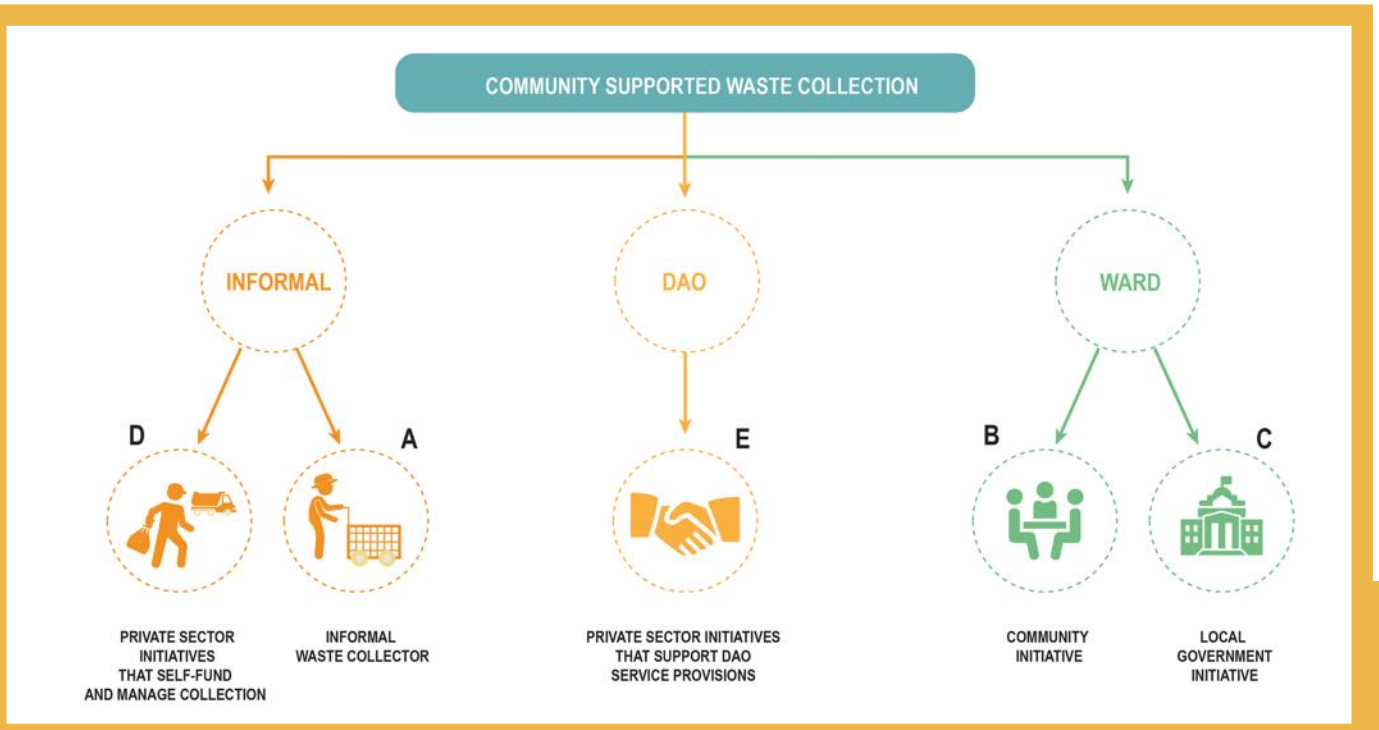


Figure 2: Illustrates the different forms of cooperation that can exist between the private sector and municipalities for waste management.

[23] Some working residents in cities like Yangon and Mandalay pay runners to take waste from the upper floor units of apartment buildings down to the street or to the formal collection truck when it passes.

support the greater municipal infrastructure if wards pay the municipality for secondary collection.

D. **Private sector initiatives that self-fund and manage collection:** Private sector associations – usually in the tourism industry – initiate their own waste collection service where it is absent, but with limited coverage. The chief examples currently are the Ngwe Saung and Ngapali Beach resort areas. While such privately initiated services fill an immediate need, they do not necessarily take responsibility for final disposal costs, including dump site management, and may not integrate well with public systems nor cover the full range of public needs.

E. **Private sector initiatives that support DAO service provisions:** Businesses in some towns donate trucks or labor to support the work of the DAO, or might even contribute toward a property purchase for a formal dumpsite (e.g. Kawthaung and Maung Shwe Lay, south of Ngapali Beach). In some special cases, businesses have lobbied their municipality for an increase of commercial waste fees to support DAOs in providing waste collection services, the chief example being Kalaw, which covers costs with a special waste fee from hotels and restaurants. While injections of funds from the private sector are useful, only a model that supports self-sustaining finance schemes like in Kalaw sets up DAOs to make sustainable improvements to their SWM systems.

2.2 Collection Methods

Collection methods and equipment vary widely between cities. Even within each municipality, there is typically a wide variety of vehicles employed, from manual carts and three-wheelers to small tipper trucks and flatbed hook trucks. Figure 3 shows six of the most common types of collection vehicles used in Myanmar. Larger cities and towns have increasingly switched to compactors in an attempt to increase vehicle efficiency, although efficiency in compaction is limited given the small proportion of inorganic material (which is more compactible) in the waste stream. Additionally, waste collectors tend to segregate recyclables for personal sale during the loading phase instead of during transport (as compactor vehicles are shut once material goes in), either increasing collection time when practiced or decreasing recycling recovery rates when ignored. Large mobile tanks (mostly around 20m^3) are the preferred infrastructures in peri-urban areas. Collection vehicles are often referred to by their brand name, such as Skat, FAW or TATA.

With the exception of Mandalay and Yangon, there are no other cities in the country that formally distinguish between primary and secondary collection.[24] Manual push-carts and tricycles occasionally move their content into mechanized vehicles on roadsides, but this is not strategically planned nor intentionally consolidated into large trucks for transport to dump sites. Some cities may achieve efficiency gains from developing secondary collection infrastructure, and rudimentary transfer stations can potentially provide the foundation for improved waste segregation systems in the future.[25]

Image: Waste collection truck in Dawei's privatized system

[24] Primary collection refers to the collection of solid waste at the source of generation, e.g. households, businesses and wet markets. Secondary collection refers to the collection of consolidated solid waste at transfer stations, which is then ferried to disposal sites. Without secondary collection systems, waste in Myanmar is virtually always ferried directly to the landfill by the primary collection vehicle.

[25] As part of its SWM strategic plan for 2017-2030, Mandalay developed three new transfer stations and six smaller reception

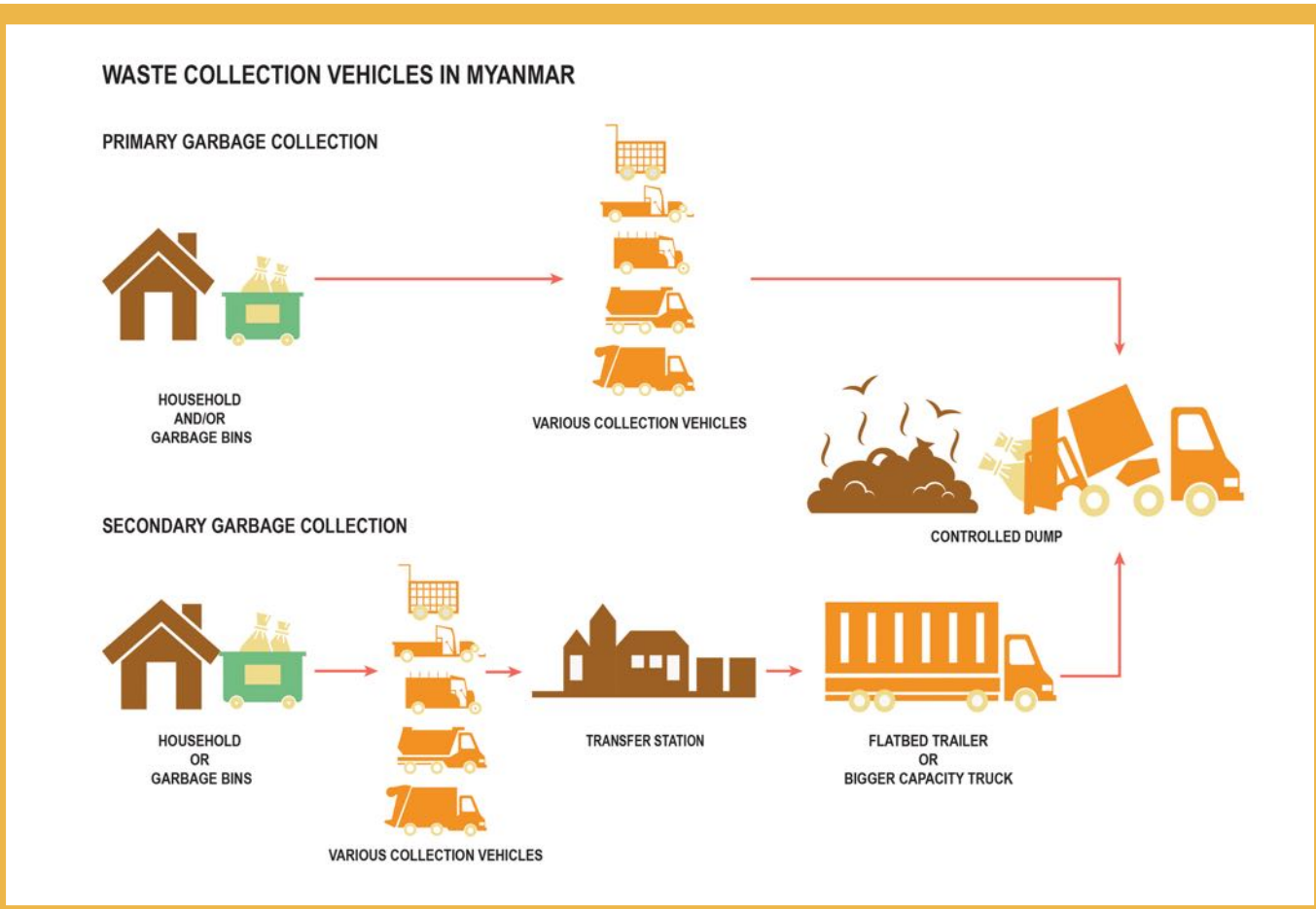


Figure 3: Waste can arrive at a final dumpsite either directly from the source of generation (primary collection) or via secondary collection through a transfer station. Common waste collection vehicles in Myanmar include: wheel carts (lat-thoon-hle), mini-tractors (htaw-lar-gyi), three-wheelers (thone-bein), and tipping trucks (pa-zin-khaung). Source: Møller (2020).

Most towns rely upon the bell-ringing system to notify residents of the passing collection truck. Smaller cities tend to employ small trucks, stopping either at each street or household, passing the same area either daily or a few times a week. In some bigger cities, high-density areas may be covered up to three times per day in order to give all residents an opportunity to catch the truck, a redundancy that reduces operational efficiency. Collection routes mostly employ manual labor, usually including one driver and two 'runners' per truck.[26] Many residential areas in Myanmar, even in the large cities, have streets that are too narrow or unfinished for trucks to pass. Municipalities often use three-wheelers *(thone-bein)* to provide service coverage to these areas, though routes are more flexible and pick-ups tend to be less frequent than that of truck collections. In some cases, stationary collection dumpsters or smaller bins are seen as a means to fill service coverage gaps for wards or neighborhoods that do not easily fit into regular collection routes.

Perspectives on the use of communal collection points have shifted through the years. Up until ten years ago, primary collection was organized mainly through communal collection points, usually open piles or brick tanks. However, the odor and pest problems from Myanmar's heat and ubiquitous street dogs, limited municipal capacity for collection, and frequent illegal dumping between collection points all led to a structural shift in favor of the bell-ringing system. Although now preferred by most communities, the bell-ringing system presents disadvantages for residents of multi-level apartment buildings, full-time workers who might miss collection hours, and roadside vendors.[27]

[26] A larger truck can require as many as six laborers to collect waste from designated open piles (E. Rothenberg, Interview with MCDC Cleansing Department, 2020).
[27] Roadside vendors are part of the informal economy and are considered illegal by some municipalities; their stalls are therefore rarely covered by municipal waste collection services, contributing to illegal dumping into roadside drainage canals as vendors seek to unload their day's waste.

Problems with the bell-ringing system have led to a revival in the use of roadside, communal collection containers in dense cities like Yangon. This is primarily in the form of 600L skip bins. Generally, residential bins must be sized to accommodate additional waste dumped by residents coming from peripheral areas as well as by small street vendors. Municipalities must be able to ensure regular collection and gain stakeholder support in order for bin systems to succeed. In addition, labor and equipment must be available to collect from large tanks, which are often manually emptied and reloaded onto collection trucks. Despite common challenges (see Text Box 2), even relatively simple communal collection systems such as brick or hook-lift bins can provide a low-cost, centralized collection point, often also acting as a de facto sorting station for recyclables collected by informal workers. Large hook-lift bins are the preferred choice, as they ensure a cleaner environment compared to brick tanks and also reduce the labor during transfer. Yangon and Mandalay increasingly use mobile 'tanks' in markets, residential areas with limited truck service, and certain mixed-use areas with high volumes of waste generation (see Annex I for a case study on the use of communal waste bins in Mandalay City).

Image: Urban curb side "bin" invention in a community waste collection area.

Text Box 2: Common Challenges with Communal Collection Bins

Communal collection points with tanks or bins for mixed waste and recyclables can increase collection service coverage and efficiency. However, municipalities might face community resistance and struggle to identify suitable locations because of several common issues:

1. Attraction of stray animals (namely dogs) that scatter and tear waste apart, presenting both safety and health hazards;
2. Irregular pick-ups by the municipality, leaving an overflowing and littered area;
3. Odor and pests that bother nearby residents;
4. Unsightly occupation of space in the immediate vicinity of households.[28]

Effective community engagement and local monitoring can prevent or mitigate some of these pitfalls. As an example, one ward in Mahar Aung Myay Township of Mandalay City raised its own funds to purchase residential waste bins for centralized locations (e.g. behind a local pagoda) and installed CCTV cameras on nearby buildings to monitor for illegal dumping. The areas around the tanks have remained clean, and residents have shown a high level of satisfaction and compliance with the new system.

[28] In denser cities, stationary waste bins might occupy road space where vendors would otherwise illegally park carts to sell their goods, inspiring some resistance on the part of roadside vendors.

2.3 Recycling practices

There are currently no formal municipal programs for source-separated collection of valuable waste streams in Myanmar (i.e. recyclables, organics), with the exception of Yangon's unenforced wet and dry household segregation system.[29] The common mixing of wet and dry waste increases the collection burden on municipalities and the effort required to extract recyclables, in addition to presenting a health hazard to collection workers (both formal and informal) who pick out recyclables for personal sale. While there are no large-scale private initiatives that source-separate municipal waste, a handful of social enterprises are popping up to leverage technology and public outreach for materials recovery.[30] In addition, while the traditional practice of using food waste for animal feed is dying out in urban areas, in peri-urban areas and rural villages, people still commonly divert organic waste for livestock feed, either using it themselves or selling or donating the material to pig and fish farmers.

Because of the relatively high proportion of organic material in Myanmar's waste (see Section 3.3.2 on waste composition), some towns and communities are considering new interventions. The city of Magway, for example, is planning to begin separating organic waste at the town's five wet markets for a new municipal composting program under a French-funded project implemented by the NGO GRET.[31] It is worth noting that some industrial sectors whose operations yield large amounts of organic waste, such as sugar processing, forestry, and distilleries, have established for-profit composting operations as well as biogas recovery.[32]

Myanmar's decentralized recycling sector is centered around large aggregator zones in Yangon and Mandalay, with arms stretching into most rural areas.[33] Valuable items such as broken household goods or construction material are often reused or repurposed locally. Recyclable materials (metal, rigid plastics, and glass) are sorted and sold through multiple middlemen to large aggregators before being sold domestically to recycling/refill plants or exported (primarily to China and Thailand).[34] Recyclables are extracted from the waste stream at three main points:

1. Direct purchase from waste generators (primarily commercial and industrial sources, and to a lesser extent households), which represents the largest point of extraction;

2. Extraction by formal and informal waste workers during primary collection, at communal collection points or transfer stations, and during secondary collection where open trucks are used;

3. Extraction by informal waste scavengers at the final dumpsite.

[29] Yangon has stood out in its promotion of different-colored bags for wet and dry waste since 2012, although adoption remains negligible. The MCDC Cleansing Department collected vegetable waste separately from Mandalay's wet markets for Bokashi composting until late 2019 but discontinued the program, citing a diversion of resources to a new transfer station at the former composting site, as well as the anticipated capacities of a new "sorting center" at the city's new northern landfill.
[30] RecyGlo and Bokashi Myanmar, both based in Yangon, have pioneered models for private-sector-led recovery of recyclables and organics, respectively. Both employ collection fees and emphasize public outreach and education for waste reduction, though only Bokashi Myanmar does its own waste processing on owned Bokashi composting sites. Another for-profit start-up, Recycle Myanmar, seeks to connect recyclable waste producers with buyers through a smartphone app, thus far deployed primarily in Mandalay.
[31] The system anticipates double-sorting, with separate bins for source segregation at the markets and further sorting at the landfill to remove any remaining contamination before being fed through a windrow composting facility.
[32] Great Wall Group, with headquarters in Mandalay, produces high-quality organic fertilizer from its sugar processing waste. A distillery in the industrial zone of Mandalay processes its waste in an on-site biodigester.
[33] The informal recycling sector in Myanmar operates on a for-profit basis and creates thin profit margins at each step along the chain. Where collection or transportation costs exceed potential earnings, the material effectively becomes waste.
[34] Metals and refillable glass bottles hold the highest profit margins, while low-grade paper and plastics have lower values and are collected only in close vicinity to aggregators.

The informal recycling sector extracts the majority of valuable recyclables in Myanmar's cities. Although it is difficult to quantify precisely,[35] a study by GA Circular has shown that the recovery rate for PET and aluminum in Myanmar's largest urban centers is between 74% to 82% and 86% to 91%, respectively.[36] (See Figure 4.) This indicates that Myanmar has a far higher recovery rate than other ASEAN countries and is comparable with South Asian countries.

The large scale of the recycling sector is a consequence of Myanmar's long-lasting economic isolation, which necessitated a high level of materials re-uptake.

Because the sector developed informally, however, it is not supported systemically – and often even suppressed – by government institutions.[37] Furthermore, the informal recycling sector collaborates with various actors in the formal sector to extract valuable materials from the waste stream. The sectors overlap where formal collection workers along with family members pick recyclables from primary or secondary collection points, providing a critical source of supplemental income to their municipal salaries. Some municipalities encourage this practice and might therefore resist implementing separate recycling collection routes for fear of upsetting delicate worker livelihoods.[38]

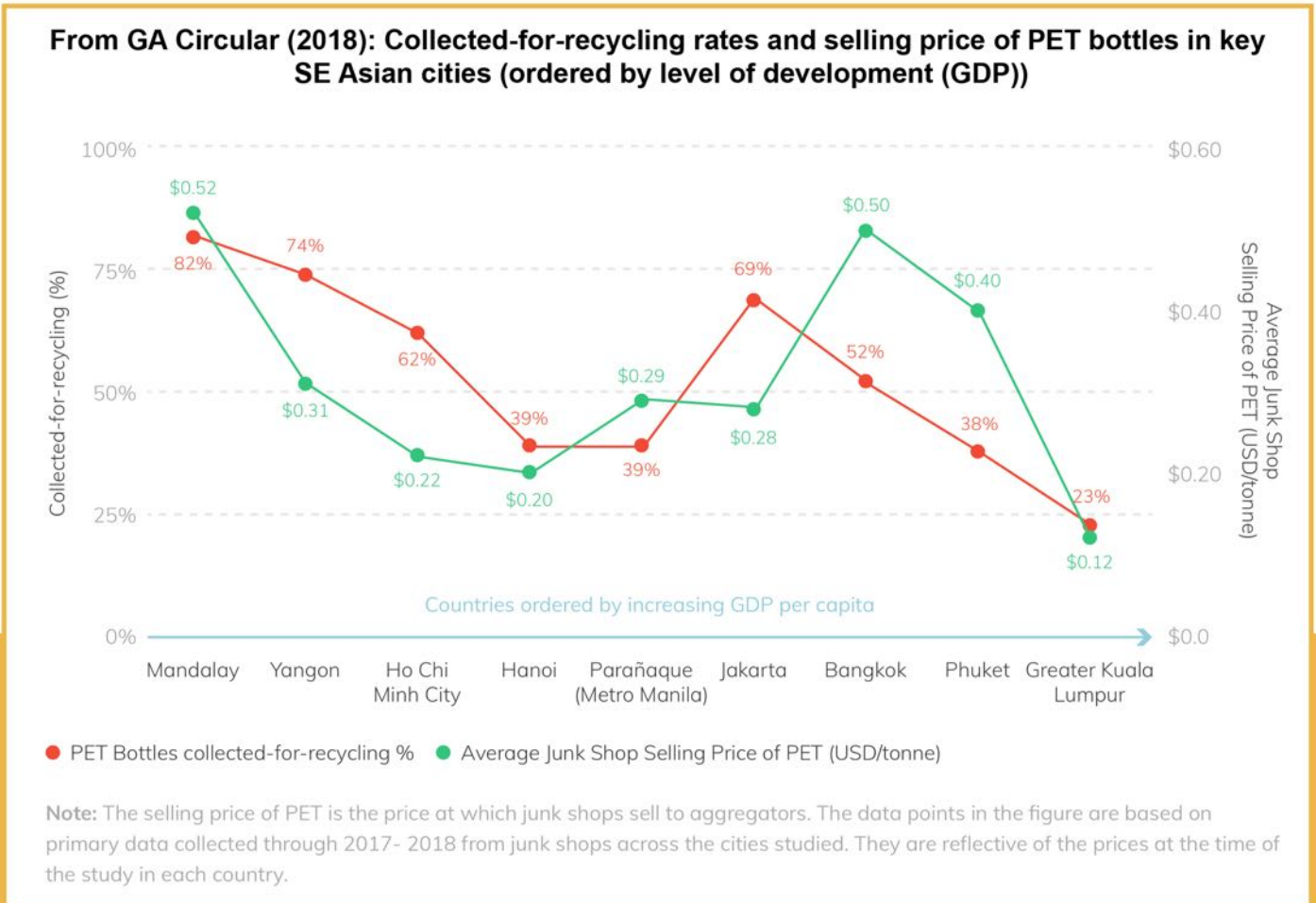


Figure 4: Recycling rates in Myanmar's two biggest cities are the highest amongst other big cities in Southeast Asia. Source: GA Circular (2018).

[35] See Section 6.2 on the need for further research.
[36] GA Circular (2018). *Material Flow and Value Chain Analysis for PET Bottles and Aluminum Cans in Myanmar.* Study from Yangon and Mandalay. Figure 8.
[37] The export of material to China continued on a large scale informally until 2019. Still, both Yangon and Mandalay have made efforts since 2018 to gain independence from the export market by supporting local recycling.
[38] Private interviews by the authors with Cleansing Department officials revealed resistance to centralized source separation based on concern for their formal laborers' access to recyclables in the mixed municipal waste stream for later private sale.

3 Waste Generation & Composition

> Urban Myanmar generates over 9,000 tons of waste per day, with organic waste as the largest component

3. Waste generation and composition

Waste generation and composition audits are still scarce in Myanmar, leaving municipalities and their advisors to rely on general assumptions or proxy data from other countries. This chapter aggregates existing data on the quantity of solid waste in Myanmar and presents the most recent data available on waste generation and characterization.

The new data findings (mostly gathered between 2019 and 2020) reflect a collection of seven independently-conducted waste audits, all the first of their kind in each location.[39] Together, the results offer an updated quantitative basis for the future development of SWM systems in Myanmar's cities and towns.

3.1 Existing data on waste generation

Waste generation or disposal data for Myanmar can be found across various reports from the last 25 years. The data that is available was either communicated by municipalities – particularly DAOs – or obtained directly through a waste audit, usually as part of a development support project (see Section 3.2 for generalizations on waste audit methodologies commonly employed by DAOs and for the methodology of the independent studies referenced in this report). Table 1 below aggregates all ascertainable data on the quantity of waste in Myanmar dating from 1993 to present.[40]

Prior to the publication of this report, waste generation data was only available for six cities in Myanmar (non-bold data in Table 1), highlighting a chronic lack of accurate data on the country's waste situation. Moreover, the various reports that do provide data on waste generation often do not clarify methodology or sampling locations. In most cases, waste generation estimates are based on audits conducted at a final disposal site, in which case data actually reflects waste disposed and not waste generated. Because measurements at the point of final disposal do not account for material extracted before or during collection or leaked waste that is never collected, the apparent trend in

Image: Waste composition audit in Mandalay by ALARM

[39] Audits were conducted in the secondary cities of Kawthaung, Dawei, Myeik and Pathein by Yangon-based Thant Myanmar in cooperation with VNG International, and GRET conducted an audit in the secondary city of Magway. In primary cities, Thant Myanmar independently conducted one waste audit at the local transfer station of a Mandalay ward near Thin Ga Zar creek (2019), another at both of Mandalay's two final dumpsites (2017), and a third in one informal settlement in Dagon Seikkan, Yangon (2018). Together, the audits cover areas representing over 14% of Myanmar's total urban population.

[40] For Mandalay City, data appearing in presentations without clear sources have not been taken into account.

countrywide waste generation over time based on the available data does not correspond with a known, consistent trend of growth and economic development in Myanmar.

The existing data presented in Table 1 below should be taken with caution and considered within the context of the original sources in order to understand the limitations of the data's applicability. The only major conclusion that can be drawn from an aggregation of all available sources is that the waste generation rates of various Myanmar cities from 2014 onward fall between 0.28 and 0.79 kg/cap/day. The chronological table illustrates that even credible data sources show significant inconsistencies over the last 25 years, bearing in mind that the waste generation rate would be expected to follow a clear trend alongside Myanmar's GDP increase, strong growth in trade, and subsequent shift to more prepackaged consumption.

Table 1: Aggregation of all available waste generation rate estimates for various places in Myanmar from credible sources (see full data set, including all sources, in Annex II 8.8). The color-coding indicates whether the data reflects waste generated or collected, often treated interchangeably despite providing different measurements.
Due to high levels of recycling extraction and environmental leakage, actual waste generation is likely to be around 25% higher than disposal rates. Estimates based on the most recent audits presented in this study are noted in bold font.

	Collection/Generation Rate (kg/cap/day)									
Year	1993	1995	2000	2012	2014	2015	2016	2017	2019	Unknown
Myanmar Average		0.45	0.28	0.44			0.39		0.53 / 0.56	
Yangon	0.45				0.4		0.43 - 0.5	0.8	0.6 - 0.8	
Mandalay				0.35		0.74 - 0.79		**0.64**	**0.74**	
Mawlamyine							0.55			
Monywa						0.44				
Pathein									**0.43**	
Hpa-Han						0.55	0.67			
Magway							0.56		**0.46**	
Dawei									**0.36**	
Kawthaung									**0.34**	
Myeik									**0.28**	
Myawaddy					0.68	0.55				
Bagan										0.45

	Based on waste collected
	Based on waste generated
In bold	Audit findings by the authors of this report

3.2 Audit methodology

Methodologies vary widely depending on the organization conducting a waste audit. Most reports on solid waste in Myanmar rely on municipal data. While Yangon and Mandalay have more sophisticated methods of measurement, DAOs rely mainly upon the methods described below:

Common DAO methodology:

- **Waste quantity and density:** Because most DAOs do not have a weighing station (except Yangon and Mandalay) at the final disposal site or en route, figures for waste collected are typically based on a combination of total truckloads disposed and maximum truck weight capacity. However, because average waste loads have a fairly low density of around 0.2 t/m^3 (see Section 3.3.1), this method of calculation leads to an overestimation of waste generation. On the other hand, the municipal figures do not account for waste tonnage that is disposed of privately by industries or community groups.
- **Waste characterization:** DAOs generally do not gather waste characterization data and mostly rely on assumptions or the work of development consultants to gather this information. CDCs in Yangon

and Mandalay currently have a combination of their own data and data gathered through collaborations with development partners.

- **Collection rates:** DAOs/CDCs typically calculate collection coverage by a rough estimate of the proportion of total wards that receive collection service, rather than an actual percentage of households covered. These figures do not include illegally dumped waste in covered areas.

The recent urban waste audits presented in this report roughly follow the methodology below (full data set in Annex II 8.2):

- **Waste quantity and density:** In Kawthaung, Dawei, Myeik, Pathein, audits were conducted at the final dumpsite. These studies measured the volume of waste from every truck entering the dumpsite during a single day. The audit performed by GRET in Magway was conducted at the final dumping site over the course of one week. Audits in Mandalay sampled a single ward's transfer station during one day in 2019 and both of the city's final dumpsites for 3 days each during one week in 2017.[41] An audit in Yangon studied waste generation at source in an informal settlement (during a 7-day household audit), and the Yangon disposal data included in the analysis was reported by YCDC. As trucks are mostly fully loaded, an assumption of maximum loading capacity was used to estimate the general waste volume generated when weighing bridges were not available. From the few audits where volume and weight could both be measured (Mandalay, Magway), the density was calculated. Density can be also estimated by depositing all weighed audit samples into dumpsters of a predefined size (usually 200L or 600L). This method was used in Pathein. **Note:** Where rural waste generation is estimated for the purposes of suggesting a national total (see Figure 6), it assumes that waste in rural areas is generated at 50% the rate of the average of all urban areas (as per this paper's finding: 0.58kg/capita/day) and that the rural population comprises 70% of Myanmar's total population.
- **Waste characterization:** Audits were performed as rapid classification on samples arriving at the dumpsite (two to three 50L rice sacks of content sampled per truckload). The samples were segregated and then categorized and weighed. For secondary cities, this was done for one full day, while the audit at Mandalay's two dumpsites analyzed waste characterization for 3 days at each site, at Mandalay's Than Lyet Maw (East) ward for one day, and in the Yangon informal settlement during 7 days.
- **Collection rates:** The analysis here follows collection coverage rates provided by DAOs/CDCs where available.

3.3 Data analysis results

This section presents results from the independent audits in Mandalay, Yangon, and the five secondary cities, offering both individual comparisons and a consolidated look at urban trends. The nation-level estimates and comparisons (Figure 6) rely on data from these audits in combination with the surveys as described in Chapter 4.

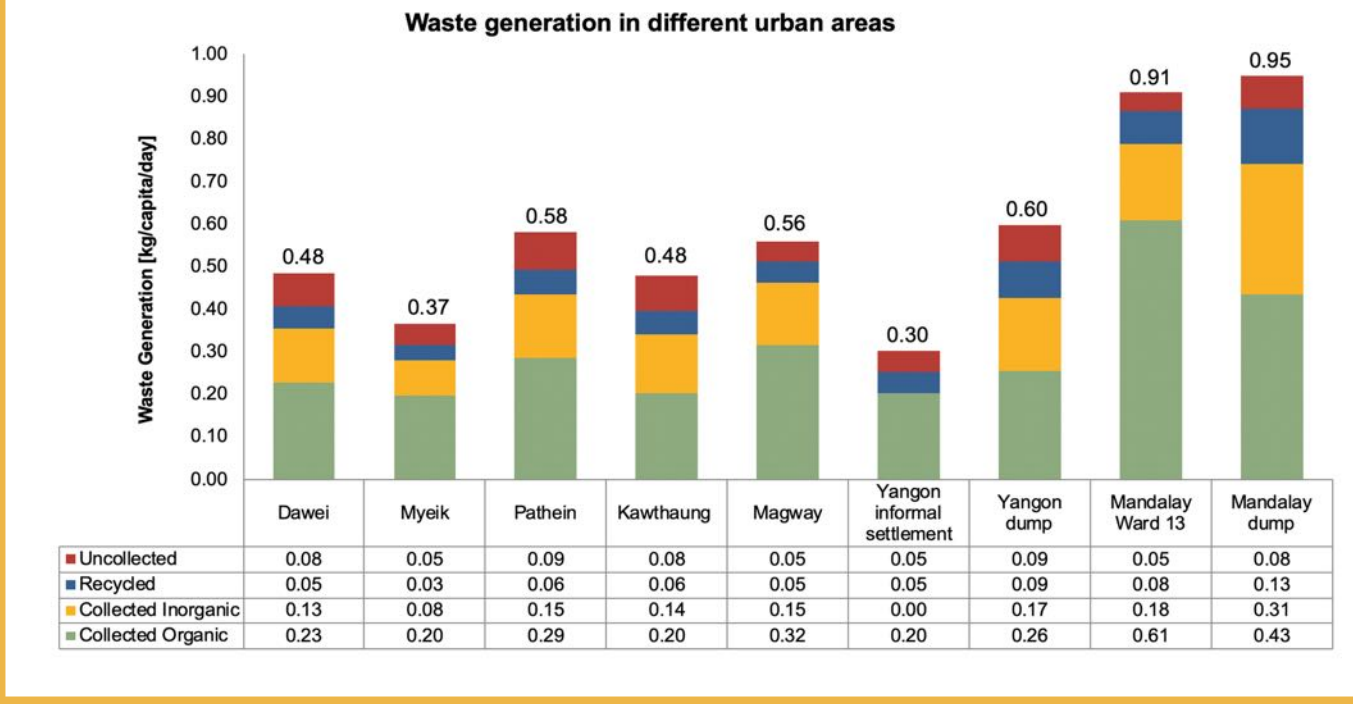
3.3.1 Waste Generation and disposal

Waste generation per capita rates[42] shown in Figure 5 reflect the combination of waste entering controlled dumpsites, recycled waste sold into the informal sector, and waste leaking into the environment. Categories of waste are considered as follows:

- **Collected waste (organic and inorganic):[43]** All waste that enters an official dumpsite from within a defined area (town), regardless of whether loads originate from official or private collectors.
- **Recycled waste:** Waste that gets extracted both before and during collection and at final dumpsites. The quantity of recycled waste can be only estimated and comprises around 20% to 25% of all inorganic waste (see Chapter 4).
- **Uncollected waste:[44]** Waste that is not collected, which is the most difficult category to quantify. Organic material is not considered as leaking, as fallen leaves would have to be included. The actual

[41] While the audits at the final dumpsites in Magway and Mandalay City assessed waste quantity over the course of one week, waste characterization was studied for one day in each site.
[42] Population estimates were taken from the most recent official data, mainly the 2014 Population and Housing Census.
[43] Refers to Section 4.1, disposal practices 2 and 3 (a), (b) and (c).
[44] Refers to Section 4.1, disposal practice 3 (d).

amount of uncollected waste is therefore calculated as the total amount of inorganic waste multiplied by the estimated leakage rate (see Section 4.1).



	Dawei	Myeik	Pathein	Kawthaung	Magway	Yangon informal settlement	Yangon dump	Mandalay Ward 13	Mandalay dump
Uncollected	0.08	0.05	0.09	0.08	0.05	0.05	0.09	0.05	0.08
Recycled	0.05	0.03	0.06	0.06	0.05	0.05	0.09	0.08	0.13
Collected Inorganic	0.13	0.08	0.15	0.14	0.15	0.00	0.17	0.18	0.31
Collected Organic	0.23	0.20	0.29	0.20	0.32	0.20	0.26	0.61	0.43

Figure 5: Summary of the different components of waste generated for cities where audits were conducted (and for the "Yangon dump," where official YCDC data was used). Recycling and waste leakage are estimated percentual on the waste disposed, where recycling is 20% to 25%, and leakage is 15% to 30% of the inorganic fraction of waste (depending on the data available).

Waste density is an important value used to estimate waste disposal weight at dumpsites, as direct weighing is often challenging, while the volume is easily available. The most reliable estimate comes from Mandalay, where weight and volume of approximately 3,000 tons of SWM waste were measured during a six-day audit of the city's two main dumpsites, revealing an average density of 0.215 tons/m^3.[45] The data also reflects a remarkable difference in density of 0.025 tons/m^3 between the two dumps (see Figure 7) due to a 10% larger organic waste component at the northern dumpsite.[46] Reliable numbers from secondary cities come from Magway (0.19 t/m^3) and Pathein (0.2 tons/m^3). Despite higher organic composition in their waste loads, these towns show a lower waste density than in Mandalay City, where MCDC uses compactor trucks and manual compression at transfer stations. Where density could not be measured, this study sets it to 0.2 t/m^3 for DAOs and 0.215 t/m^3 for CDCs, following dump audit findings.

[45] While Jeske, F. (2017). Waste audit report for Mandalay's two dumpsites, Dec. 2017.
[46] "Kyar Nyi Kan" official dump.

The following Figures 6 and 7 use the urban audit findings to extrapolate larger trends and compare the waste generation and density of different areas by population size, or level of urbanization:

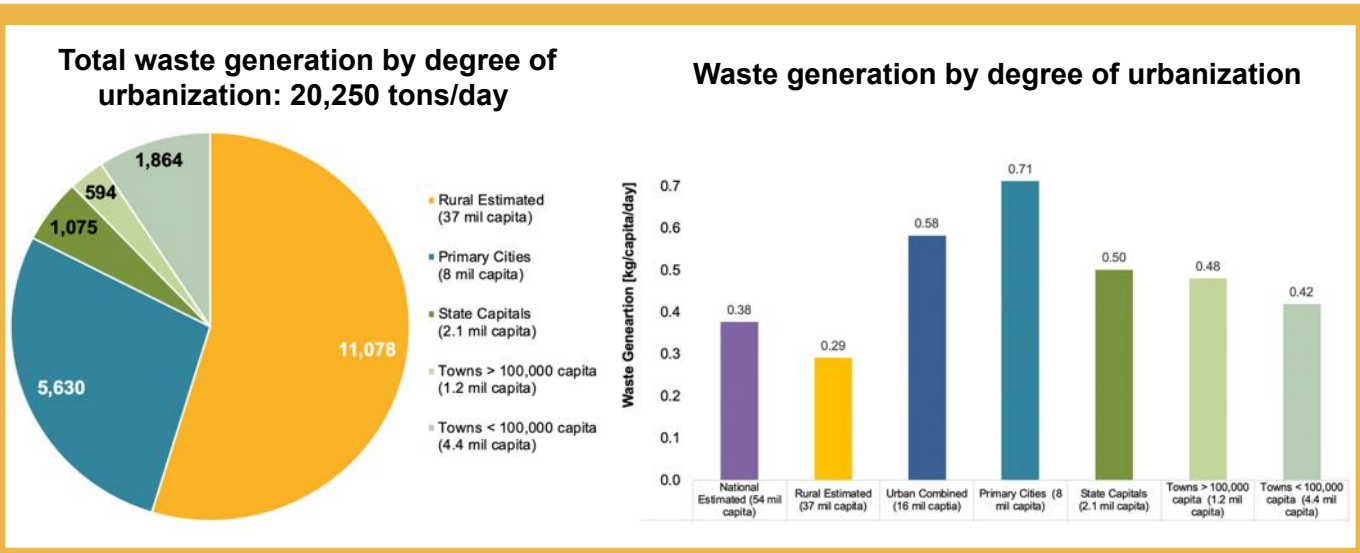


Figure 6 LEFT: Estimates waste generated in Myanmar by different degrees of urbanization and a total estimated national tonnage. The largest amount comes from the rural areas, as the rural population still makes up around 70% of the total. See Section 3.2 for rural waste estimation methodology. RIGHT: The waste generation per capita differs largely between the different degrees of urbanization.

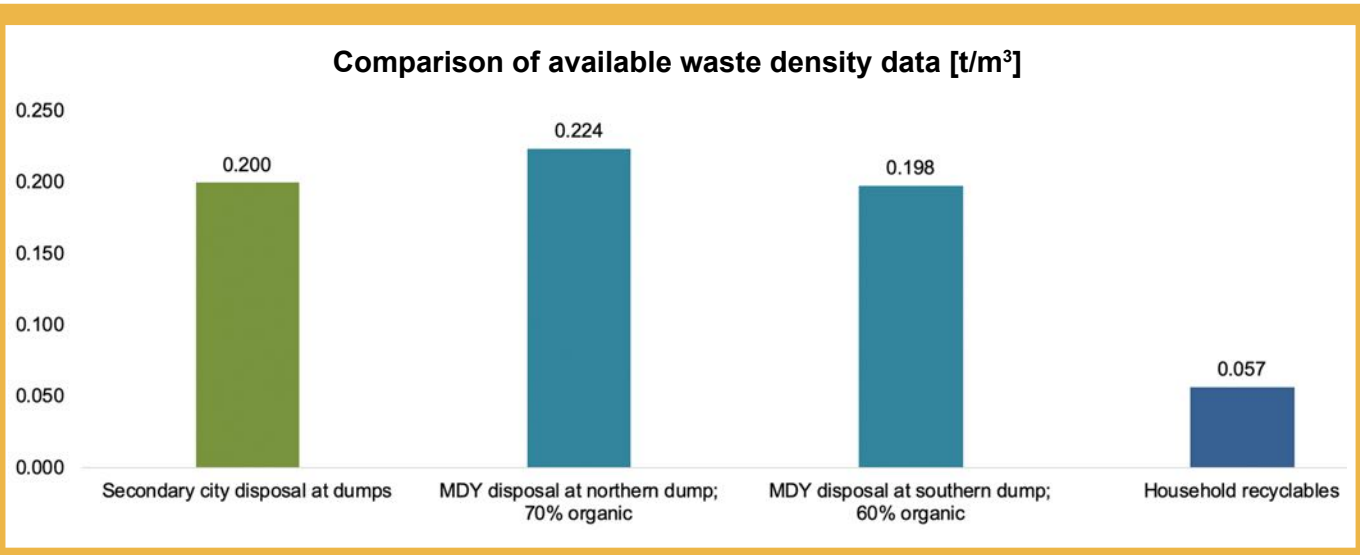


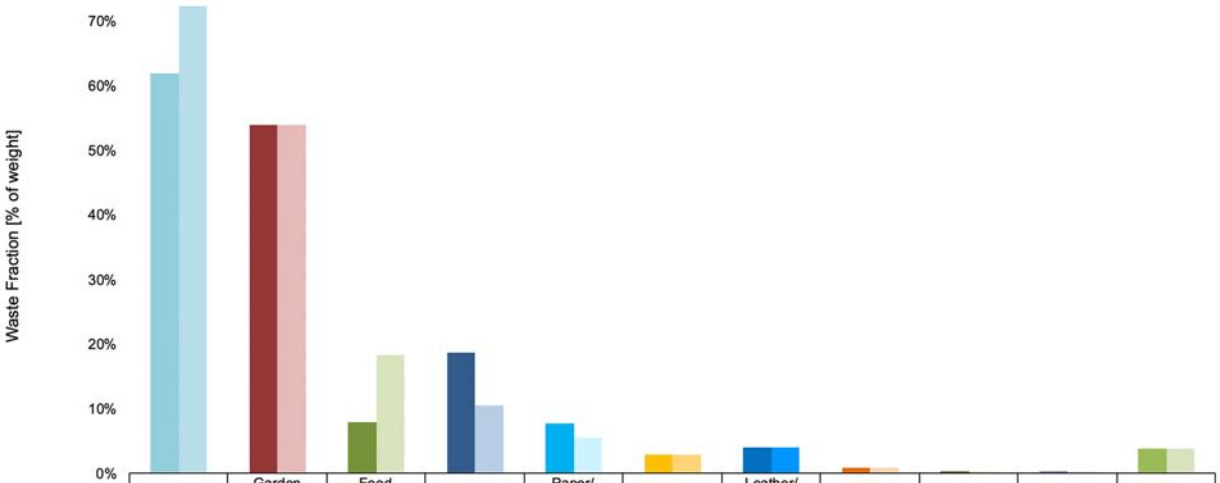
Figure 7: Credible density calculations from audits in Magway, Pathein and Mandalay are set as proxies for secondary and primary cities. A difference of 0.025 tons/m3 in density can be seen between Mandalay's two dumps, which have significantly different organic components. The density of recycled material is very low due to mostly uncompressed plastic and reflects more commercial and household recyclables (PET, HDPE, aluminum cans, etc.) than industrial recycling streams, which see higher metal components.

3.3.2 Composition of disposed waste

Waste characterization studies are not standard practice for any DAO or CDC in Myanmar. Where available, the data comes from assessments for SWM improvement projects (see Annex II 8.8). Therefore, there is no evolutionary data on changing waste composition in Myanmar. Anecdotal information from discussions with DAOs suggests that the amount of plastics in the waste stream has increased exponentially following a change in consumption habits and increased imports, forcing DAOs to expand dump capacity more often than they used to.

Due to high contamination of some items with organic material or water, composition figures tend to be largely overestimated for inorganic material. This tendency is particularly true for plastics and paper: bags and packaging are highly polluted by organic material and tissue is heavily soaked with water. Figure 8 below presents a comparison of waste composition data adjusted for contamination versus the raw figures (see weight adjustment factor in data table in Annex II 8.5).

Comparing measured waste composition with adjusted waste composition



	All Organic	Garden Waste	Food Waste	All Plastics	Paper/ Cardboard	Glass	Leather/ Fabric	All Metal	Hazardous	Medical	Others
Myanmar urban (average)	62.0%	54.1%	7.9%	18.7%	7.8%	2.9%	3.9%	0.9%	0.30%	0.02%	3.9%
Myanmar urban (average adjusted)	72.3%	54.1%	18.2%	10.5%	5.4%	2.9%	3.9%	0.9%	0.3%	0.0%	3.9%

Figure 8: Due to high contamination of certain materials, waste audits frequently overestimate the inorganic fraction. During the final dumpsite audits in Mandalay,[47] a sample of inorganic material was cleaned from contamination; the adjusted results have been applied to the other urban audit results for a more likely picture of average urban waste composition in Myanmar.

Image: Waste audit at Magway final dumping site by GRET

[47] Jeske, F. (2017).

The average urban waste composition in Figure 9 shows the raw results of all available audits assessed at dumpsites (full data table in Annex II 8.2). Figure 10 below compares the data from secondary cities with that of Mandalay, demonstrating the difference in waste composition between primary and secondary cities. While the higher level of organics and lower level of plastics in towns seem obvious, more interesting is the lower presence of glass and paper in Mandalay's waste, reflecting the efficiency of the informal recycling sector in the large city environment.

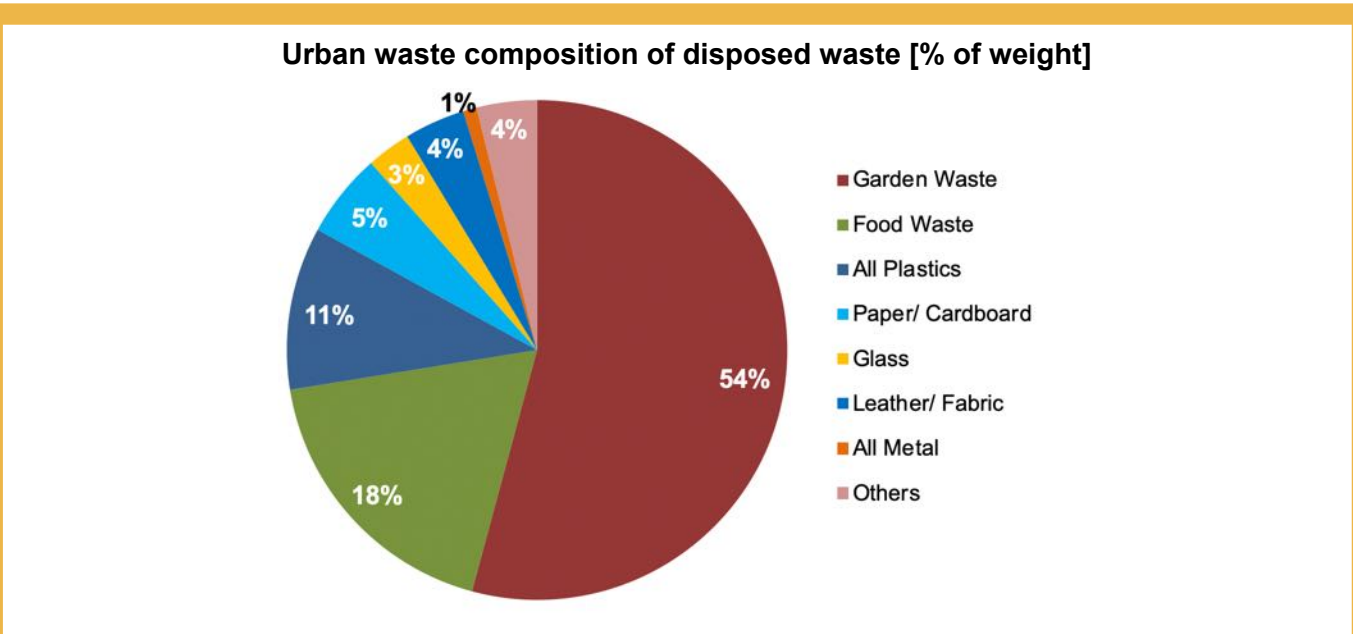
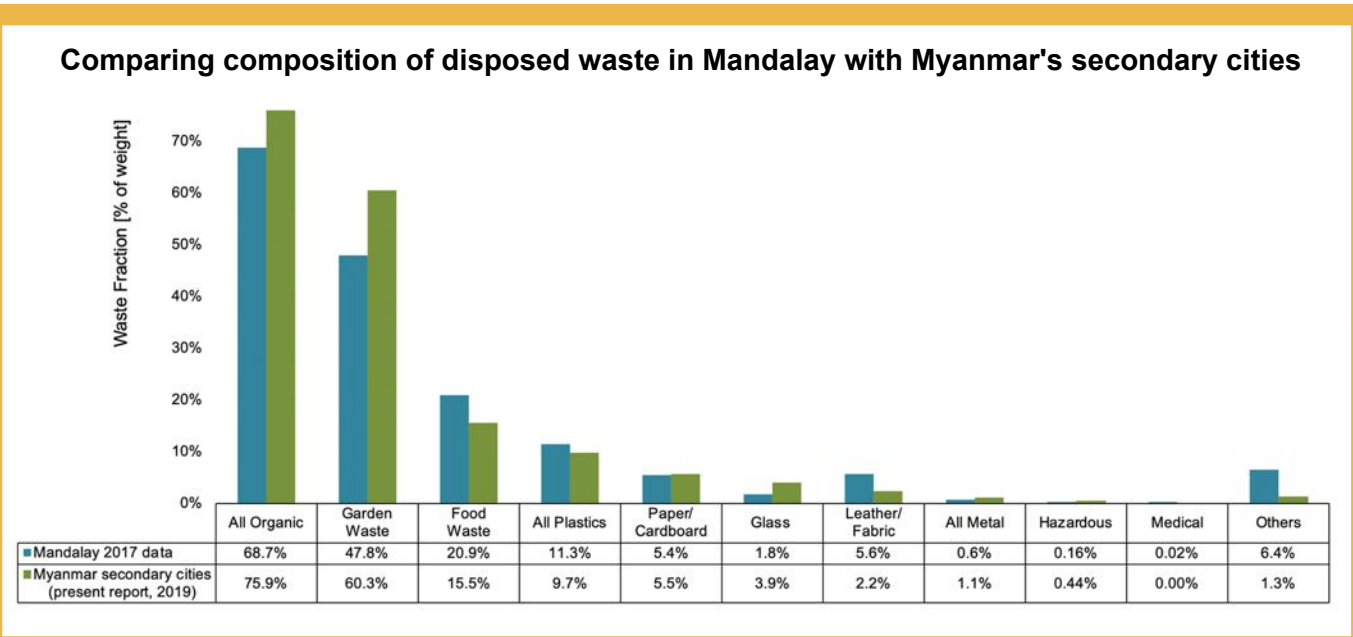


Figure 9: Averaged composition data of all urban waste audits. Organic waste is by far the largest component of disposed waste at 72%, followed by plastics at 11%.



	All Organic	Garden Waste	Food Waste	All Plastics	Paper/ Cardboard	Glass	Leather/ Fabric	All Metal	Hazardous	Medical	Others
Mandalay 2017 data	68.7%	47.8%	20.9%	11.3%	5.4%	1.8%	5.6%	0.6%	0.16%	0.02%	6.4%
Myanmar secondary cities (present report, 2019)	75.9%	60.3%	15.5%	9.7%	5.5%	3.9%	2.2%	1.1%	0.44%	0.00%	1.3%

Figure 10: Based on the urban audit findings, secondary cities show a much higher garden waste component and lower food waste and plastic components than the primary city of Mandalay. Paper and glass are lower in Mandalay due to higher recovery rates.

While Myanmar currently offers no institutionalized waste sorting, the details in Table 2 address existing practices for each major category of Myanmar's waste stream and highlight the potential for further waste extraction and diversion.

Table 2: In-depth look at the major categories composing waste at Myanmar's dumpsites with the existing and future potential for resource recovery.

Category	Disposed	Future Considerations	Existing Reduction or Recovery
Garden and Vegetable waste	The largest proportion is garden waste coming from leaves, small branches and flowers, along with vegetable waste from markets.	Over 60% of this organic material is bulky and less contaminated by other waste streams and could be recovered relatively easily for composting or biogas.	Community cold composting for leaves: https://bokashimyanmar.com/leaves-campaign/
			Manual segregation will be implemented at dump (Magway).
			Mechanical segregation at landfill (Mandalay, expected 2020).
			Anaerobic digestion (Yangon, planned).
Food waste	Food waste is defined as leftover cooked food and food prep scraps. Citizens commonly store small food waste in soft plastic bags to reduce the smell prior to disposal.	Plastic bags present a challenge to post-collection extraction of the organic material.	Bokashi household composting https://bokashimyanmar.com/
			Pig farming is the traditional form of food waste management. Now, the practice is only found in rural areas, small towns and outskirts of cities or low-income areas. At dumps in Mandalay and Yangon, scavengers recover a significant percentage of food waste for fish food (selling price around 30 MMK per liter).
Paper	Most paper waste found at the dump is wet tissue.	None.	Informal sector recovery of recyclable paper prior to dumping, especially for cardboard.
Fabric/ Shoes	Torn or discarded clothing and other textiles, or broken Myanmar slippers (traditional sandals).	None.	Textiles are repurposed as cleaning rags.
			Rubber from the soles of Myanmar sandals is recovered.
Plastics	*For a detailed breakdown of plastic composition at the dump see Figure 11.	Reduction policies for single-use plastic, collaboration with tourism sector and business associations, and voluntary or mandatory EPR.	Reduction campaigns for water bottles, plastic bags, straws and takeaway containers, but no active reduction policies in place:
			www.thantmyanmar.com
			https://www.facebook.com/cleanyangon/
			https://www.facebook.com/Clean-Mandalay-Campaign-183812978887133/
			Informal sector recovery of PET, HDPE, PP and some LDPE.
Metal	Tin and other alloys from bottle caps, broken cutlery, and a very small amount of aluminium and other high value metals.	None.	Informal sector recovery of all metals.
Hazardous	Light bulbs, batteries, electronics and chemicals.	Development of infrastructure for separate hazardous waste collection and markets for e-waste commodities.	Informal sector recovery and repurposing of e-waste, including cables and some batteries (Li, Pb).

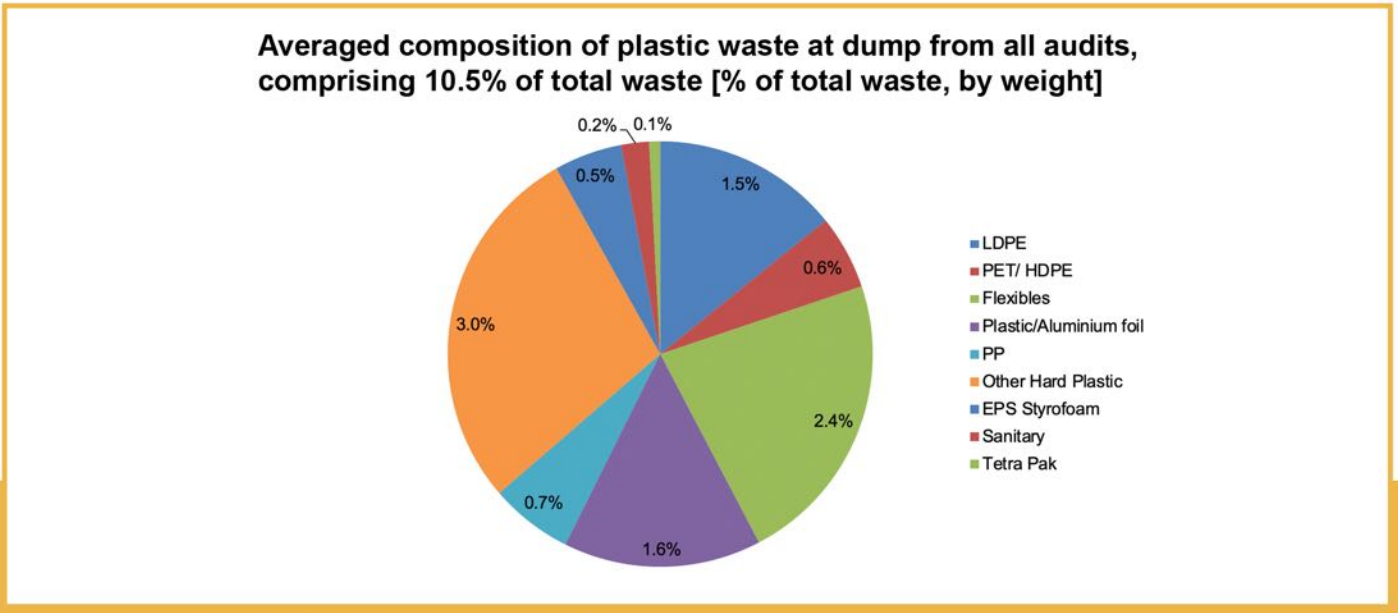


Figure 11: Demonstration of the specific composition of plastic waste as a percentage of total waste arriving at the dump, averaged from all audits. Plastic items in the audits were cleaned from organic material to prevent weight distortions (see Annex II 8.5 for contamination adjustment factor on inorganic waste). In total, plastics comprise 10.5% of total waste by weight by the time loads arrive at the dump. High-value plastics (HDPE, PET, etc.) are typically extracted before arriving at the final dumpsite and are therefore under-represented in the data as a percentage of the waste stream.

Image: Audit of roadside waste in Central Urban Yangon, divided into common recyclables (left) and disposed waste (right). Most of the items in both streams are forms of plastic.

Given the existing efficiency of the informal sector in recovering recyclables in Myanmar, potential gain from initiating formal recycling programs is low. This report uses audit data to calculate the potential recycling gains based on disposed waste measured before informal scavengers have extracted materials at final dumpsites and after both the informal sector and formal workers have recovered materials at source and during transfers. For municipalities, the gain from setting up formalized recycling next to existing informal systems, at best, sits at 2% to 3% of total disposed waste. Nevertheless, formal source segregation programs focusing on separating organic material from inorganic could increase the efficiency of the informal sector in extracting recyclables. In large cities, organic waste segregation programs at transfer stations would be the most effective and cost-effective measure to improve segregation and therefore recycling recovery rates.

Any project focusing on the improvement of the collection of recyclables should consider the efficiency of the existing informal sector.

The only audit done at source – and therefore including recyclable material before extraction by the informal sector – was conducted as a household audit in an informal settlement in Yangon. Recyclables made up as much as 50% of the inorganic waste stream, with most recovered at source, as households habitually segregate and sell recyclables to the informal sector. In general, it is estimated that the recyclable component of all inorganic waste generated in Myanmar's cities is less than 30%. The effective recovery rate on inorganic waste is likely 25% in areas close to urban recycling aggregators[48] and 20% in smaller towns, resulting in 15% and 10% recovery on the full waste volume, respectively.

The same Yangon audit of household waste showed that recyclable waste had a very low density of 60kg/m^3, meaning that recyclables require three times more space to collect than their weight would suggest. It follows, then, that without the informal recycling system, municipalities would have to increase their fleet volume by 30% to accommodate these materials. Volume reduction is particularly relevant, as waste volume – more than weight – drives the cost of urban waste collection. Municipalities often underestimate this relief that the informal recycling sector provides to formal collection systems.

3.3.3 Increasing generation and disposal rates

MCDC has measured daily waste disposed at the city's two formal dumps since January 2017. These detailed records[49] allow us to understand seasonal patterns and trends in waste generation over time. In Figure 12, seasonal patterns in Mandalay City's waste are visible for 2018 and 2019, where the wet season carries significantly more waste than the dry season (a difference of around 100 tons/day). During the rainy season, waste absorbs more water either sitting in open bins or collection vehicles, increasing the weight upon arrival at the dump.

Waste tonnage collected in Mandalay increased yearly by 9.5% per capita, with disposed waste growing from 0.55kg/capita/day to 0.77 kg/capita/day within three years (see Figure 12).[50] This increase is most likely attributable to both an improvement in collection and more wasteful consumption. Comparing Mandalay's increase in waste collected with the approximate national waste generation increase as predicted using the Word Bank's What a Waste 2.0 model[51] (seen in Figure 12 as a purple line: 2% increase), the dramatic difference between the expected increase in Myanmar's waste generation and the actual tonnage collected by MCDC over these years points to a significant improvement in Mandalay's collection rate. Another explanation could be that the estimated annual population growth rate of 1.56% applied here is actually too low.

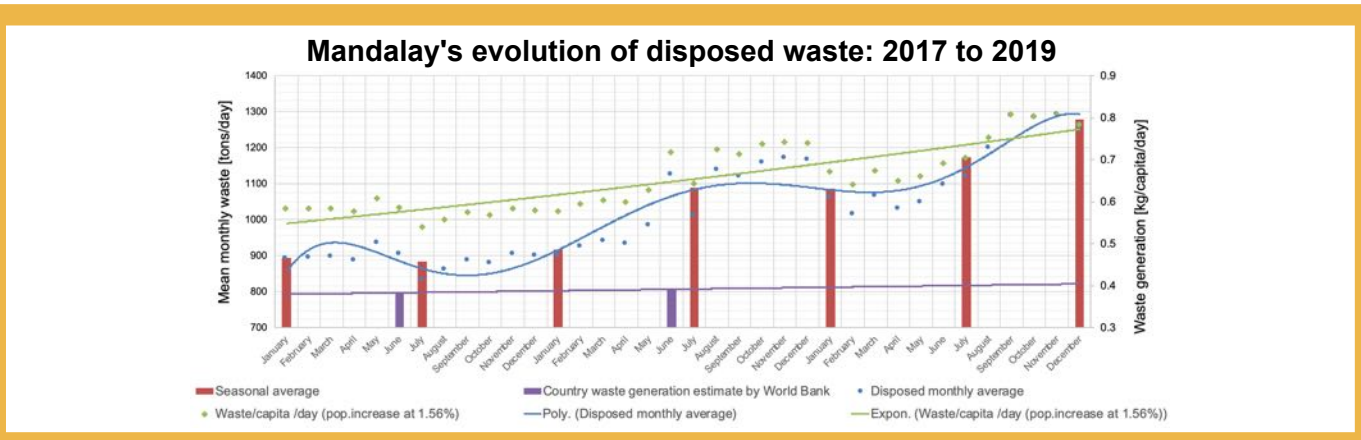


Figure 12: Plot of the monthly averaged disposed waste in Mandalay (black line), which shows a slight seasonal trend linked to soaked waste during the rainy months. This data is used to calculate per capita waste disposal (not generation) based on a population increase of 1.56%.[52] Through linear regression, the data shows that Mandalay has increased its collection rate per capita by 9.5%. Comparing this increase with the national predicted increase of waste generation from the What a Waste 2.0 model (yielding 2%), it appears that collection coverage has improved by about 7% every year.

[48] For a further study on recovery rates: Jeske, F. (2018). Development of the Recycling Sector in the Economical Isolated Environment of Myanmar. CESVI.
[49] The data include some potential discrepancies in weighing methods from the time the data starts in 2017 to the latter half of 2018 and 2019.
[50] Using a 1.56% median annual population growth rate, as per the Department of Urban Housing Development (DUHD).
[51] World Bank (2018). What a Waste 2.0, Box 2.1.
[52] DUHD.

4 Waste Disposal

> “Approximately 28% of urban waste in Myanmar is leaking directly into the environment, polluting waterways and air

4. Waste disposal

In 2020, Thant Myanmar conducted a wide survey of municipal waste disposal methods across Myanmar. The survey covered 54 cities and towns and was conducted through phone interviews of local authority officials or CSOs from the target areas. Interviews addressed two primary questions: "Is your dumpsite regularly burning?" and "Does waste leak into waterways during the monsoon period?" The areas that participated represent a collective population of nearly 12 million people. The results of this survey are extrapolated and combined with the urban audit data presented earlier to demonstrate the most up-to-date picture of urban waste disposal trends in Myanmar, showing a clear tendency toward controlled dumping in primary and secondary cities and a much higher practice of open-air burning in the smallest towns.

4.1 Disposal methods

Municipalities dispose of solid waste in different manners depending on their geographic location and local capacity. Larger cities tend to follow higher disposal standards, while smaller towns, especially those close to water sources or in mountainous areas, are more likely to allow waste to leak into the environment.

Classification of disposal practices: This report's analysis expands the classification of waste disposal methods used by the World Bank's *What a Waste 2.0* report to offer a more detailed picture of the specific SWM challenges faced in Myanmar:

1. **Recycling:** refers to valuable material that is diverted from the waste stream, mainly through informal collection. It includes reusable items, including glass bottles and materials sold for industrial recycling. Recycling rates are estimated as a proportion of the inorganic waste[53] by weight. For CDCs, rates reach 25%, and for DAOs, 20% on inorganic waste, resulting in a 10-12% recovery rate on total waste generated. (Further details on the recycling sector can be found in Sections 2.3 and 3.3.2. Commodities values are detailed in Annex II 8.6.)

2. **Sanitary landfills:** Some municipalities have started to build sanitary landfills with proper leachate protection and methane gas capture, including some formal waste segregation for materials recovery. Examples include Pyin-Oo-Lwin and Mandalay City.

3. **Open dumps:** Defined and undefined places where waste is stored without standard environmental protections. This is the most common method in the country and can be divided further into four subcategories:

   a. **Controlled dumping:** Waste is dumped without adequate protection but in a controlled manner, which might include occasional soil covering, bulldozing of piles, and/or rudimentary leachate collection. This is the most common form of disposal in larger towns and by the CDCs.

   b. **Open-air burning:** Uncontrolled burning of stored waste at the dumpsite in order to reduce waste volume. Waste is burned on a regular basis (continuously, after waste delivery or weekly), ignited either by waste workers or scavengers at the dumpsite. Note: For purposes of this data analysis, dumps that are reported to practice open-air burning *and* allow solid waste leakage into waterways are considered to burn roughly 60% of their waste (dry season) and to leak 40% into waterways (wet season).[54] Note: The topic of modern waste incineration is addressed in Text Box 3.

   c. **Leaking dumps:** Designated dumpsites where solid waste regularly leaks into the environment, mostly by being located either on a mountain slope or near a waterway. For dumpsites categorized as "leaking" in this study, the analysis assumes that 40% of overall waste disposed there leaks into waterways. Leakage occurs mostly during summer due to monsoon weather.

   d. **Uncollected (Illegal) dumping:** Waste is freely discarded by the community with no centralized management. This includes household burning and direct discarding of waste into waterways or on

[53] An analysis of recycling recovery rates was conducted in 2016. Recovery rates have since declined due to an increase of single-use plastics and a reduction in paper recovery. (Jeske (2018).)
[54] Controlled dumps with accidental fires due to methane combustion are not considered to fall under the category of open-air burning.

unused land. The waste disposal mechanisms of most village tracts and small river towns in Myanmar (together, rural areas account for around 55% of the country's total solid waste – see Figure 6). Whereas existing statistics from the World Bank's *Country Environmental Analysis for Myanmar* (2019) estimate a 47% waste leakage rate (uncollected waste) for Yangon, the present analysis assumes that 30% of waste in secondary cities goes uncollected and that 25% and 15% go uncollected in Yangon and Mandalay, respectively.[55] Note: Only inorganic waste is considered to be "uncollectable" and therefore leaking (e.g. leaves do not "leak"). The leakage rates on total waste generation are therefore much lower than the non-collection rates, as the organic component of the uncollected waste (60% to 70%) is not counted toward leaked waste.

Text Box 3: Growing interest in incineration as a disposal mechanism

Despite frequent discussion of waste-to-energy (W-t-E) infrastructure in foreign investment and development project proposals, Myanmar has seen only one small-scale incineration facility built to date. Inaugurated in 2017, a Japanese engineering firm developed an incinerator with a 60 ton/day capacity, contracted by YCDC and financed through a Japanese "Joint Crediting Mechanism" for low-carbon development. The facility is currently running. However, Myanmar's specific SWM context presents difficulties to expanding W-t-E as a form of treatment. First, Myanmar's notably high proportion of organic material in MSW streams and high moisture content from the long monsoon season make incineration for energy capture relatively inefficient. Additionally, Myanmar's low electricity prices might not provide adequate return on investment for the capital expenditure required to develop new facilities. Finally, with a relatively low capacity on the part of Myanmar's municipal authorities and even regional ECD extensions to manage and monitor "clean" incinerators, facilities unable to properly maintain exhaust filtering systems could present public health and environmental hazards. Future proposals to further develop W-t-E in Myanmar must consider these constraints.

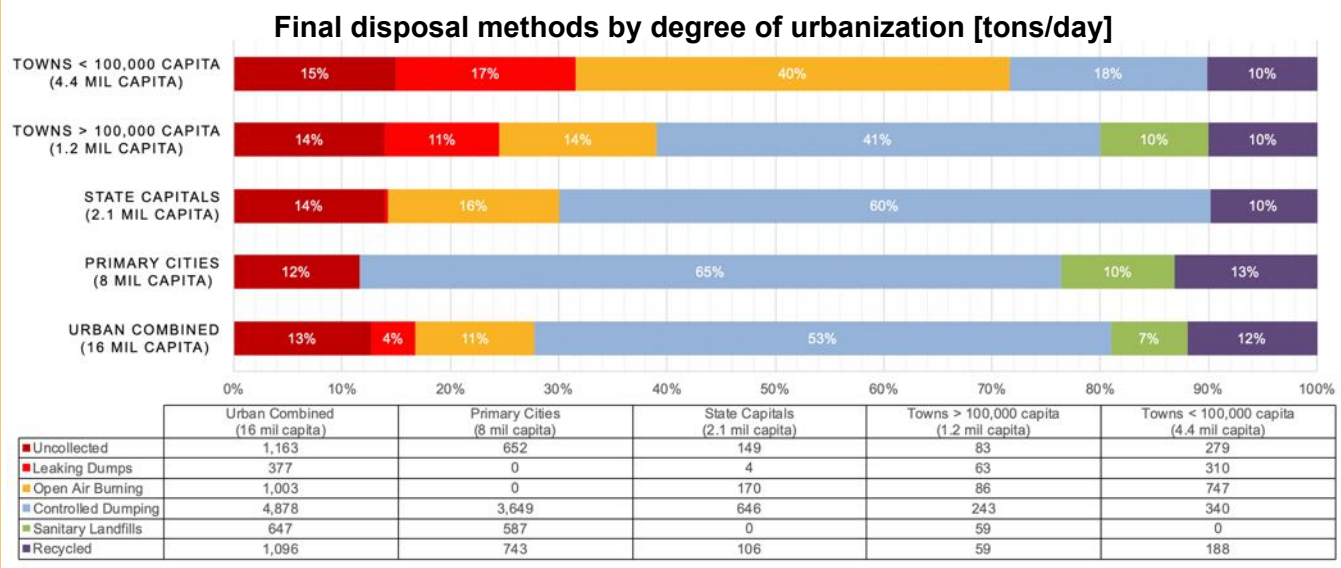
4.2 Data analysis results on waste disposal and leakage

Existing data on waste generation in Myanmar has been extrapolated to estimate generation rates for towns and cities by level of urbanization (i.e. population size). For Yangon and Mandalay, this analysis uses official data from MCDC and YCDC, while Nay Pyi Taw was set to have the same waste generation per capita as Mandalay City. For towns above 100,000 inhabitants, waste generation per capita was set to the average of all waste audit findings from secondary cities (0.49 kg/capita/day, see Section 3.3.1); for towns with fewer than 100,000 inhabitants, where data was not available, waste generation was set to 80% of the rate in large towns (0.42kg/capita/day). As the Thant Myanmar survey data represented only 20% of all smaller towns in Myanmar, the data was extrapolated to capture the waste production of the total urban population in Myanmar. While the survey did not include rural areas, the extensive experience of the authors suggests that most rural waste disposal falls mainly into the open-air burning and leaking dumps sub-categories of open dumping.

The extrapolated data suggests that Myanmar produces roughly 20,250 tons of waste per day, with a national per capita generation rate of 0.38 kg/capita/day, ranging from an estimated 0.28 kg/capita/day[56] in rural areas to an average of 0.67 kg/capita/day in the primary cities of Mandalay and Yangon (with Nay Pyi Taw considered equivalent).[57] Note: See data table in Annex II 8.1.

The total daily waste generation in urban areas in Myanmar is estimated at over 9,100 tons/day (See Figure 6, Section 3.3.1). Over 80% of this waste is disposed through methods that fall under the umbrella category of "open dumps," demonstrating the very minimal presence of sanitary landfills in Myanmar. In smaller towns, over 60% of waste handled in the "open dumps" category is either burned or leaks directly into the environment.

[55] This assumption is based on the estimated urban and rural collection rates for lower-middle-income countries in *What a Waste 2.0*, Figure 2.11, showing 67% uncollected in rural areas and 29% in urban. Anecdotal evidence from interviews with municipal officers in Myanmar's secondary cities supports these estimates.
[56] Based on What a Waste 2.0's assumption that rural waste generation is approximately 50% of urban generation, which is calculated here as 0.58 kg/cap/day.
[57] While officially reported tonnage numbers from YCDC for disposal are approximately 0.45 kg/cap/day, a much higher waste generation rate of over 0.8 kg/cap/day in Yangon is likely, given anecdotal input from township officials, who state that waste is accumulating at many informal dump sites around the city that do not feed into YCDC's official data.



	Urban Combined (16 mil capita)	Primary Cities (8 mil capita)	State Capitals (2.1 mil capita)	Towns > 100,000 capita (1.2 mil capita)	Towns < 100,000 capita (4.4 mil capita)
Uncollected	1,163	652	149	83	279
Leaking Dumps	377	0	4	63	310
Open Air Burning	1,003	0	170	86	747
Controlled Dumping	4,878	3,649	646	243	340
Sanitary Landfills	647	587	0	59	0
Recycled	1,096	743	106	59	188

Figure 13 shows the disposal methods for cities and towns at four different levels of urbanization (by population) and an overall urban average ("urban combined"). Disposal methods vary significantly between primary cities and smaller towns, the latter of which mismanage over 70% of their waste.

Open-air burning is a common method to reduce the volume of waste at dumpsites. Around 10% of all urban waste is burned after final disposal.[58] Smaller towns typically make more use of this practice, while most CDCs do not actively burn but have occasional accidental explosions due to uncontrolled methane emissions.[59] Even more than in small towns, rural communities rely primarily on burning to manage disposed waste.

Around 17% of all urban waste effectively leaks as solid waste into the environment, either through being uncollected or carried away from dumps into waterways. Figure 13 above illustrates the frequency of these two primary sources of leakage. As defined in 3 (d) above, around 30% of Myanmar's total waste stream remains uncollected. From this 30%, only 35% is inorganic material, resulting in 13% effectively leaked waste (organic waste is not considered to be leaking). Regarding dumpsite leakage, 63% of dumps from smaller towns and 33% of dumps from larger towns are situated in or close to water sources (see Table 3), resulting in respective leakage rates of 17% and 11% of total waste generated.[60] (Estimation methodology detailed in Section 4.1 3(c) and (d).)

Table 3: Breakdown of disposal methods employed by municipal authorities in the cities and towns included in survey by Thant Myanmar.

City	No. of municipalities surveyed	Sanitary landfills	Controlled dumping	Open-air incineration	Leaking dumps
CDCs	3	33%	100%	0%	0%
State capitals ex. CDCs	12	0%	69%	33%	8%
Towns > 100,000 capita	9	11%	44%	33%	33%
Towns < 100,000 capita	30	0%	13%	77%	63%

Note: A new sanitary landfill has been constructed in Mandalay City and will begin operating in 2020, prepared to accept waste from at least half of the city. This waste is accounted for in sanitary landfill disposal figures.

[58] Waste burning is conducted by authorities, waste workers and informal collectors, alike. Since it heavily reduces the land needed for waste disposal, open burning is commonly accepted as a form of waste treatment.
[59] With the exception of open-air burning of medical waste at dumpsites, such as in Mandalay City.
[60] Leakage of chemicals, hazardous materials or methane gas are not considered here.

4.3 Composition and sources of leaked waste

A 2017 study on river plastic emissions[61] estimates that the Ayeyarwady River carries around 100 tons of plastic waste down the river every day, making it the 9th-most polluted river on the planet. This number was confirmed by a study from Fauna & Flora International (FFI) (Jeske, 2019).[62] Better understood is the composition of Myanmar's leaked waste, which was surveyed through soil and beach audits by the World Bank that focus on the presence and frequency of various types of plastic waste items found in the environment.[63] (Figure 14)

Uncollected waste enters the environment mainly through the practices of neighborhood-level burning and direct disposal into waterways. Individuals as well as markets, businesses, schools, and other institutions all participate in these forms of disposal. In a 2018 survey by GRET in Magway City,[64] 18% of respondents reported burning their waste. From the authors' experience, it can safely be assumed that village tracts (representing nearly 70% of the country's population) are relying either on local waste burning or direct littering to the environment as their sole form of waste disposal.

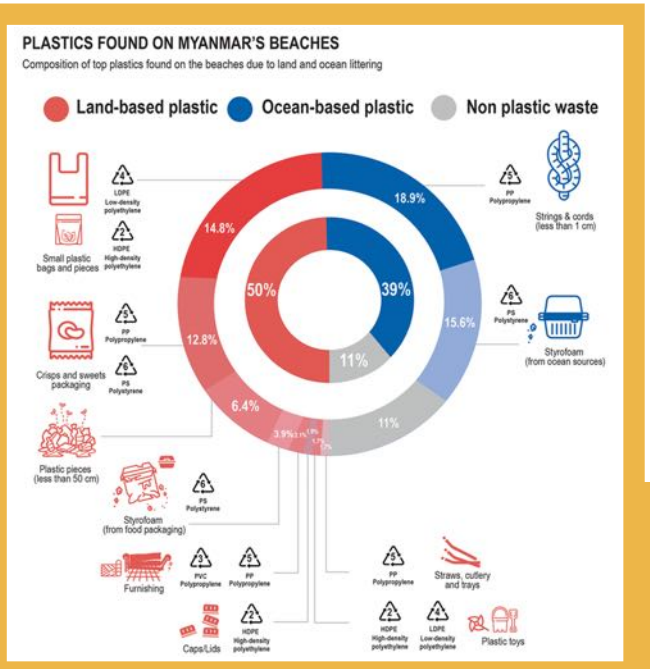


Figure 14: Results of scientific beach debris audits conducted in Myanmar by Thant Myanmar and the World Bank. Plastic from land-based sources, consisting mainly of single-use plastics, comprised around 50% of the total debris found by frequency. These materials reach the ocean mainly by way of Myanmar's rivers.

Image: Burning of roadside waste in Sittwe, leaves mixed with littered plastics.

Image: Waste is systematically dumped into the Ayeyarwady river in Pyay, Bago Region.

[61] Lebreton et. al. (2017). "River plastic emissions to the world's oceans." *Nature Communications*. Retrieved from https://www.nature.com/articles/ncomms15611
[62] Jeske, F. (2019). Plastic in the Ayeyarwaddy. *FFI.* https://www.thantmyanmar.com/en/riversurvey
[63] Study contracted by the World Bank and conducted by Thant Myanmar in 2020 (publication forthcoming).
[64] The survey was carried out within the framework of the ROSAMUR project to study the behavior of Magway residents, in which 4.4% of the population was interviewed.

5 Comparison with Other Regional and Global Data

> **Myanmar's waste profile most closely reflects that of low-income, South Asian countries.**

5 Comparison with other regional and global data

This chapter situates Myanmar's municipal data in a global and regional context. The first part of the chapter is dedicated to the comparison of this report's latest data findings with the World Bank's *What a Waste 2.0* report, while the second part compares secondary city data from Myanmar with cities in Laos and Cambodia.

5.1 Comparison with World Bank estimates

The lack of data on solid waste in Myanmar makes the World Bank's 2018 *What a Waste 2.0* a common reference for waste practitioners in the country. The *WaW 2.0* report offers three different datasets that can be used to portray Myanmar's waste situation, namely by GNI per capita (with Myanmar defined as a lower-middle-income country), by geographical region (with Myanmar categorized in East Asia and Pacific)[65] and by extrapolation of existing data in Myanmar. The following sections compare *WaW 2.0's* income-based and regional estimates for Myanmar's waste generation, composition and disposal practices with the data findings published in this report to offer a new perspective of Myanmar's current waste context.

This comparison suggests that Myanmar would be more accurately considered a low-income country from a waste management perspective (despite a GNI that falls within the World Bank's category of lower-middle-income) and that Myanmar's waste practices more closely resemble *WaW 2.0's* South Asia region than the East Asia and Pacific region, which includes several more developed countries.

5.1.1 Comparing waste generation per capita

The present report's aggregated data yields an overall waste generation rate for Myanmar of 0.38 kg/cap/day in 2019, using the following assumptions:

- Waste generation in rural areas is taken to be half that of urban areas;
- The split in rural and urban populations is assumed to be 70% and 30%,[66] respectively.

Figure 15 below illustrates waste generation rate projections for Myanmar and for low-income and lower-middle-income country categories following *WaW 2.0's* growth model and compares these rates with the figures proposed in this report. Following the *WaW 2.0* model for waste generation growth (based on GDP growth), the predicted 2019 value for Myanmar's waste generation rate would be 0.41 kg/cap/day, which is fairly consistent with this report's estimated national rate of 0.38 kg/capita/day for the same year.

However, *WaW 2.0* offers contradictory values for the country's waste generation rate when considered by income level and regional averages. Several existing reports on waste management in Myanmar reference the *WaW 2.0* data despite these discrepancies (including between *WaW 2.0* and other World Bank analyses), identified as follows:

- Several development organization sources refer to Myanmar's waste generation as 0.53 kg/capita/day, following *WaW 2.0's* categorization of the country as lower-middle-income, despite this figure being significantly higher than the same *WaW* report's 2016[67] projected rate for Myanmar of 0.39 kg/cap/day.[68]

[65] WaW 2.0's income categories include: low, lower-middle, upper-middle and high; regions include East Asia and Pacific, South Asia, Europe and Central Asia, Middle East and North Africa, Sub-Saharan Africa, North America, and Latin America and the Caribbean.
[66] Around 15 million people live in Myanmar's urban areas. World Bank (2019). *Myanmar's Urbanization (Vol. 3) Creating Opportunities for All - Full Report (English).*
[67] WaW 2.0 figures follow a waste generation projection model that adjusts original data to 2016. World Bank (2018). *What a Waste 2.0*, Box 2.1.
[68] The *What a Waste 2.0* waste generation rate projections for Myanmar - set to year 2016 - were modeled using national data from Thein (2010), which itself was set to a base year of 2000. See: Thein, U. (2013, March 18-20). Country Analysis Paper on 3R Practice in Myanmar. Paper presented at Fourth Regional 3R Forum in Asia. Ha Noi, Vietnam: United Nations Centre for Regional Development. Retrieved from http://www.uncrd.or.jp/content/documents/Country%20Analysis%20Paper_Myanmar.pdf

- The World Bank's 2019 Subnational Public Expenditure Review[69] refers to the WaW 2.0 Myanmar waste generation rate of 0.39 kg/capita/day (for 2016) but simultaneously lists 0.56 kg/cap/day as a national average, citing as sources both the WaW 2.0 report and the author's calculations. The likeliest explanation for the 0.56kg figure is that it originates from WaW 2.0's East Asia and Pacific regional estimate. The Expenditure Review then compares this regional estimate next to WaW 2.0's average for lower-middle-income countries of 0.53kg/cap/day, both of which paint a different picture than the WaW 2.0 national estimate.

- The World Bank's 2019 Country Environmental Analysis Study[70] does not refer to the WaW 2.0 Myanmar national generation rate but rather relies on the East Asia and Pacific regional average, setting Myanmar's national waste generation, again, at 0.56 kg/capita/day. This figure is clearly higher than a more likely estimated range of 0.38 kg/cap/day (this report) to 0.41 kg/cap/day (2019 projection using WaW 2.0's growth model).

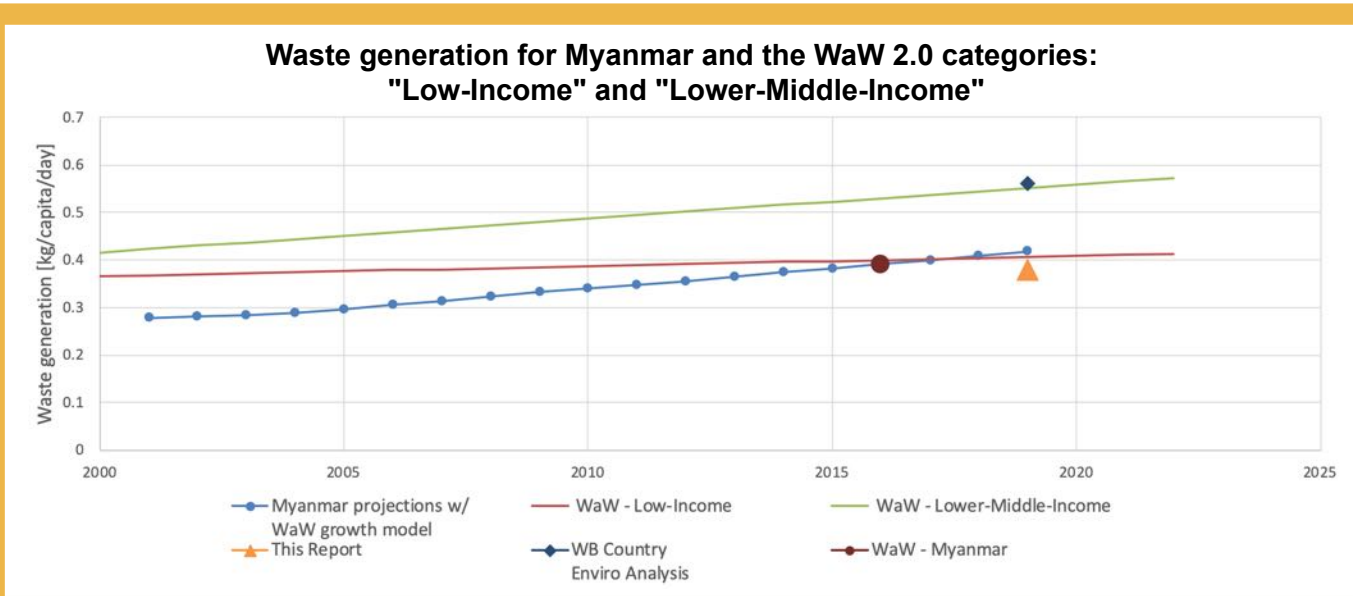


Figure 15: The projection of Myanmar's waste generation (blue line) as predicted through the WaW 2.0 growth model[71] is compared with WaW's "low-income" (red line) and "lower-middle-income" (green line).[72] As Myanmar shows strong economic growth, this analysis predicts that waste generation will grow faster than WaW 2.0's "low-income" generation rate and would exceed the low-income growth threshold in 2018. The projected rates for lower-middle-income countries (as WaW 2.0 categorizes Myanmar) and the national estimate cited in the World Bank's 2019 Environmental Analysis[73] are clearly well above this report's findings for Myanmar in 2019. This report puts Myanmar at 0.38 kg/capita/day instead of 0.41 kg/capita/day for 2019, as would be predicted by the WaW 2.0 growth model. The two data points show congruence despite being assessed by two very different methodologies.

[69] World Bank (2019). *Subnational Public Expenditure Review.*
[70] World Bank (2019). *Myanmar Country Environmental Analysis: A Road Towards Sustainability, Peace, and Prosperity.* Synthesis Report. Chapter 4.
[71] Thein, M. (2010). "GHG Emissions from Waste Sector of INC of Myanmar." Paper presented at the Eighth Workshop on GHG Inventories in Asia (WGIA8), Vientiane, Lao PDR, July 13-16. Estimates 0.278 kg/cap/day, which was used as a baseline data input for the WaW 2.0 model.
[72] Low-income and lower-middle-income country waste generation figures have been calculated by linear interpolation with the WaW 2.0 data.
[73] World Bank (2019). Myanmar Country Environmental Analysis.

5.1.2 Comparing waste composition figures

While *WaW 2.0* classifies Myanmar as a lower-middle-income country and as part of the East Asia and Pacific region, the findings from the aggregated audit data presented in this report suggest that **Myanmar's waste composition better fits the profiles of WaW 2.0's low-income and South Asia categories, which show a higher presence of organics.**

The estimates in *What a Waste 2.0* refer to waste generated in both rural and urban areas. However, the data published in this report refers to waste disposed exclusively in urban areas. In order to compare the data, it can be assumed that:

- The organic fraction of waste in rural areas is higher than in urban areas, so the organic component for Myanmar at large is likely underestimated;
- Leaked waste includes an organic component resulting from food waste, which – although not considered part of net leaked waste (as leaves are also not, see Section 3.3.1) – adds to the organic waste component of household waste (see Figure 16);
- Disposed waste includes less cardboard, paper, metal and plastic than the waste generated, as recyclables would already have been extracted through various channels before arriving at a final dumpsite.

Taking these considerations into account, Figure 16 below reflects how the characteristics of Myanmar's urban waste, with an overall 56% organic fraction, fall closer to *WaW 2.0's* low-income country category – also showing an average 56% organic composition – than they do with *WaW 2.0's* lower-middle-income category, with an average of 54% organic.

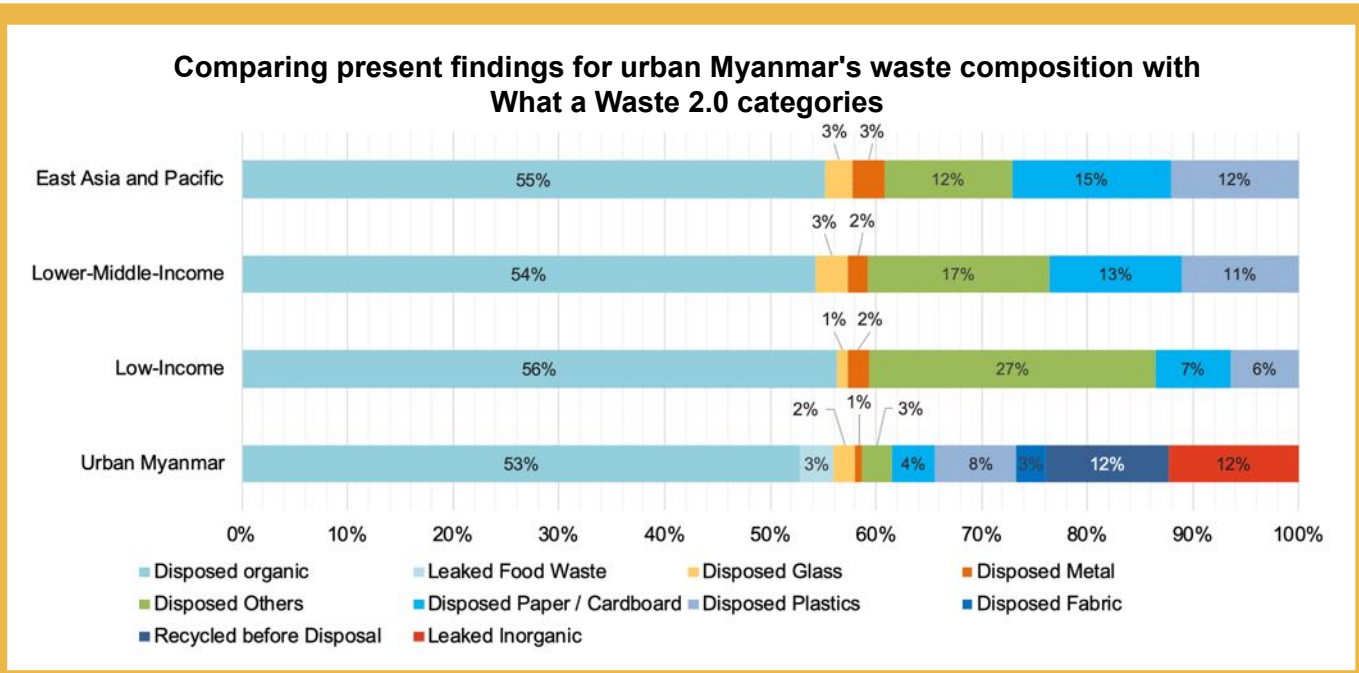


Figure 16: Comparison of the composition of generated waste by WaW 2.0's country income level categories and East Asia and Pacific region (World Bank 2018)[74] with the present findings for Myanmar's urban waste. For Myanmar, the inorganic component is comprised of inorganic material found at the site of disposal, along with recycled and leaked waste.[75]

[74] World Bank (2018). *What a Waste 2.0.*
[75] As recyclables are extracted by the informal sector at various points along the waste chain, this report's audits conducted at the site of final disposal could not accurately distinguish between separate leaked waste and recycled waste. Leaked waste also could not be separated into its various components, as no reliable data is available. Leaked waste typically consists of an inorganic fraction, with plastics being the most visible category, and some food waste. Section 3.1.1 explains this report's methodology for "leaked waste," that it considers only the inorganic component.

5.1.3 Comparing waste disposal methods

When comparing the results of this report's data on Myanmar's waste disposal methods with the What a Waste 2.0 report, it becomes clear again that Myanmar's habits more closely approximate South Asian and low-income country trends than those of the East Asia and Pacific and lower-middle-income categories.

This report's data considers several subcategories of untreated waste that WaW 2.0 groups under one waste treatment category called "Open Dump" (see Section 4.1). Table 4 below compares WaW 2.0's waste disposal method classifications with those of this report:

Table 4: Comparison of waste treatment categories in WaW 2.0 and this report.

What a Waste 2.0 (2018)	This Report (2020)
Open Dump	Controlled Dumping Open-Air Burning Leaking Dumps Uncollected
Landfill (Unspecified) Controlled Landfill Sanitary Landfill	Sanitary Landfill
Anaerobic Digestion	N/A
Incineration	Incineration
Composting	Composting
Recycling	Recycling

Myanmar relies mostly upon various kinds of "open dumping" as *WaW 2.0* defines it, here including: uncollected waste, leaking dump sites, open-air burning and controlled dumping. Sanitary landfills and recycling make up only a small portion of Myanmar's waste disposal breakdown (see Section 4.2), while composting and formal incineration are not practiced large-scale in any municipalities in Myanmar,[76] though informal burning and some organic waste diversion do occur at the household level (see Sections 2.2 and 3.3.2, Table 2).

While over 80% of urban Myanmar's waste is disposed in "open dumps", more than 10% of overall urban waste is recycled. These characteristics are comparable with conditions in neighboring India, where limited managed disposal methods are combined with relatively high recycling rates. As Figure 17 illustrates, whereas WaW 2.0's analysis shows an 18% sanitary landfill treatment rate for lower-middle-income countries, this report's data for urban Myanmar reveal a minimal 7% landfill treatment rate (which undoubtedly skews lower at a countrywide level including rural areas). Compared regionally, WaW 2.0's East Asia and Pacific region on the whole enjoy a dramatically higher sanitary landfill treatment rate – at nearly 50% – than urban Myanmar. The prevalence of open dumping in Myanmar makes it closer to the World Bank's low-income and South Asia[77] categories.

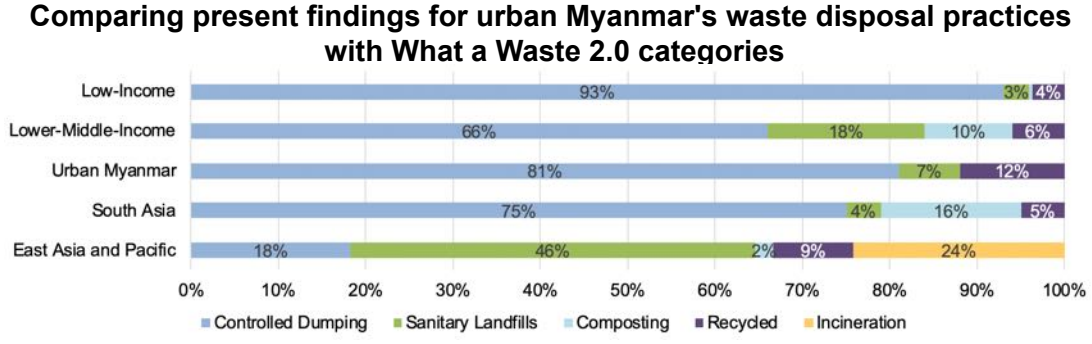


Figure 17 compares the categories of waste disposal from Myanmar's urban areas with country income level and regional averages from WaW 2.0. Myanmar shows a very clear low-income disposal pattern, even without considering rural waste treatment practices.

[76] Yangon operates a 60 tons/day incinerator. (See incineration Text Box)
[77] WaW 2.0's South Asia region includes India and immediately surrounding countries.

5.2 Comparison with studies in Laos and Cambodia

The purpose of this section is to compare Myanmar's waste data with that of other cities in the region. To date, there has been a lack of comparative analysis of waste management across Southeast Asia, and the studies that have been conducted do not follow a consistent methodology. In this analysis, Laos and Cambodia have been chosen for a comparative perspective of Myanmar's national and local waste data because of these countries' geographical proximity and comparable levels of development (particularly in terms of GNI/capita).

Laos and Cambodia share the same lack of reliable and current waste data as Myanmar. The *What a Waste 2.0* report estimates that the national waste generation rates for Cambodia and Laos in 2016 were 0.20 kg/cap/day and 0.15 kg/cap/day, respectively. However, the most recent urban waste audits from the region (shown in Figure 18)[78] reflect significantly higher rates. Although these studies in Laos and Cambodia focus only on urban and semi-urban areas, the data provide a relevant benchmark for comparison to *WaW 2.0's* national figures.

When compared to the *WaW 2.0* data for Laos and Cambodia, Myanmar appears to have a higher per capita waste generation rate, despite a comparable level of development. However, the on-the-ground waste audits from Laos and Cambodia indicate that the *WaW 2.0* projections considerably underestimate these countries' waste generation and that, in fact, their overall urban waste generation rates might exceed that of Myanmar.

The existing urban waste studies for Laos and Cambodia have been compared with national figures for Myanmar in Figure 18, including a 2018 household survey carried out by GRET in Laos as well as data cited by IGES and the ADB. The household-level audit carried out in in the peri-urban Champasak District of Laos (68,000 inhabitants) found a waste generation rate of 0.58 kg/cap/day, similar to this report's aggregated audit data for urban Myanmar. Nevertheless, the average waste generated in secondary cities in Laos is likely to be higher than 0.58 kg/cap/day, as Champasak District includes both rural and urban areas. In Cambodia, waste generation in Battamabang (160,000 inhabitants) is estimated at 0.81 kg/cap/day, far higher than the 0.58 kg/cap/day average estimate for urban areas in Myanmar.

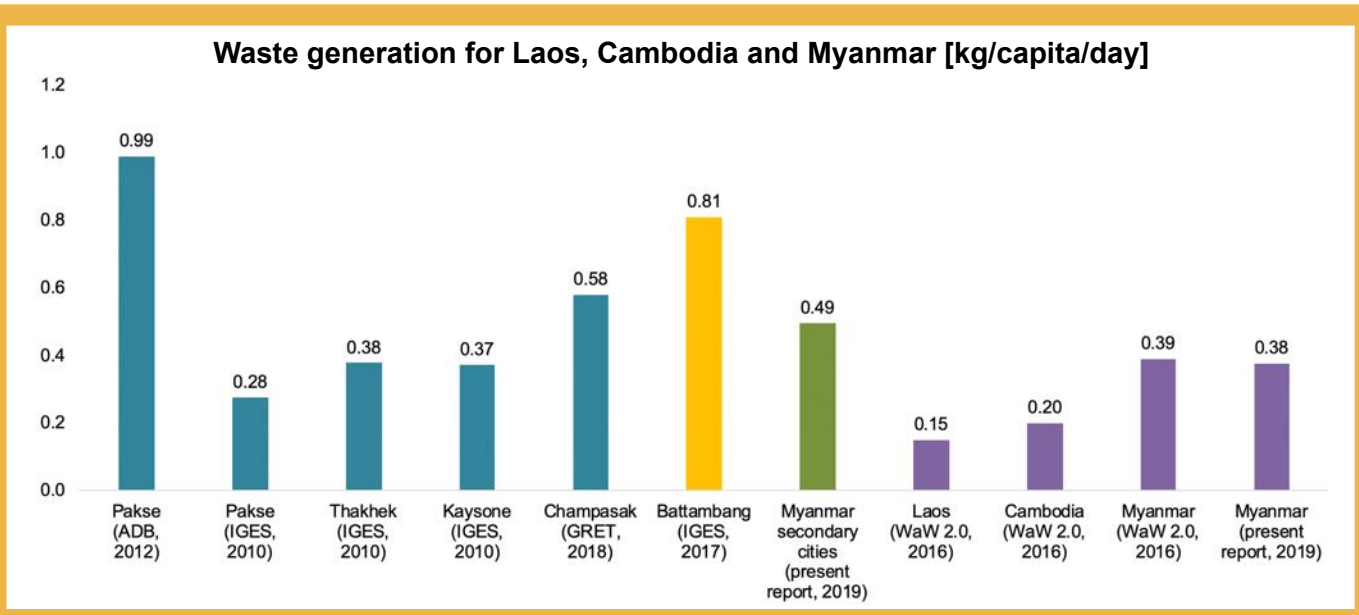
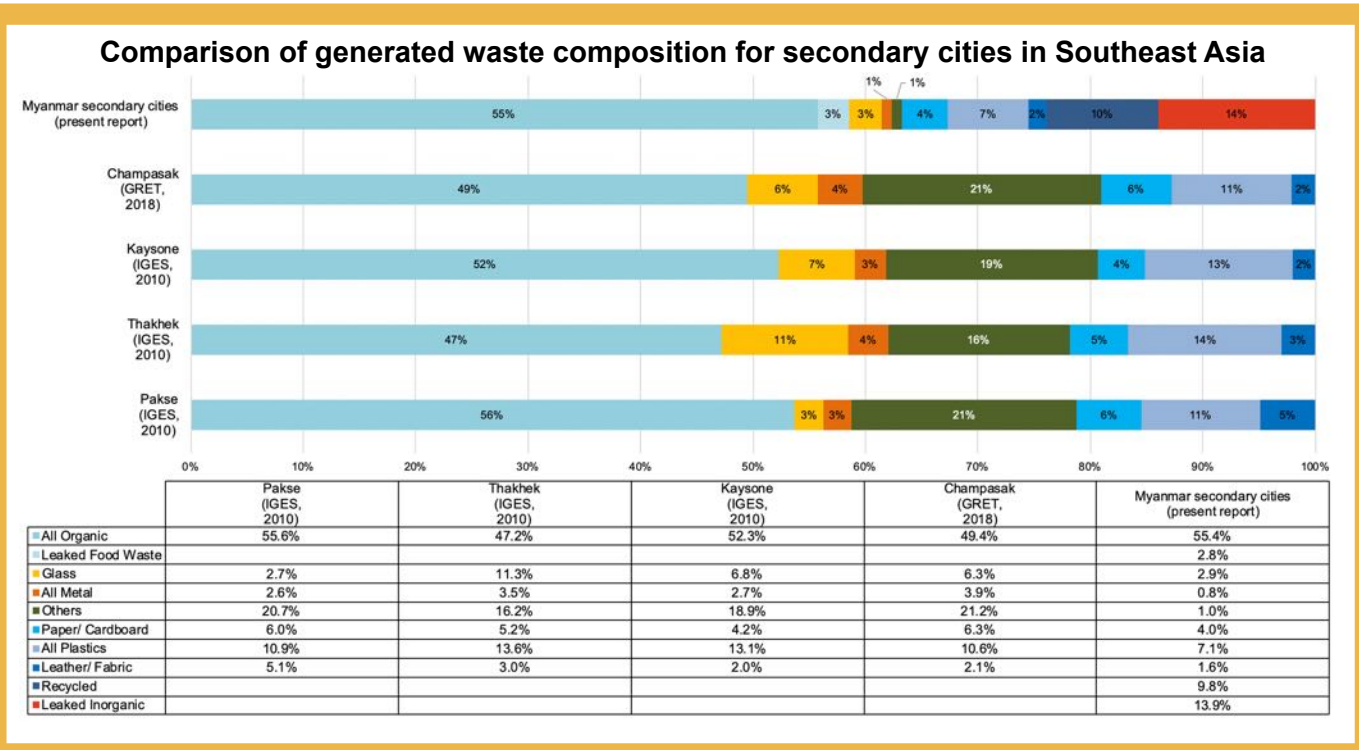


Figure 18 displays different waste generation rates for towns in Laos (blue), Cambodia (orange) and secondary cities in Myanmar (green). These urban rates are compared with each country's national waste generation rate as figured by WaW 2.0 and by the present report.

[78] The data examined in this section originates from studies carried out by the international agencies GRET, IGES and ADB:
ADB (2012). *Updated Technical Report on Pakse Solid Waste Management.* Pakse Urban Environmental Improvement Project (RRP LAO 43316).
GRET (2018). *Solid Waste Management Diagnosis in Champasak District and Protected Area.*
Phonekeo, T. and Inthavong, P. (2010). *Solid Waste Management in Laos.* Presentation at IGES-sponsored event.

Waste composition data can also be compared between Laos and Myanmar (see Figure 19). Evaluating the sources reviewed for Laos in Thakhek, Champasak and Kaysone, waste composition is close to the figures indicated in WaW 2.0 for lower-middle-income countries and for the East Asia and Pacific region (see Section 5.1.2, Figure 16), with organics comprising 47% to 52% of total waste on the low end. Interestingly, the second largest Laotian city of Pakse shows a much higher organic waste presence at over 55%, with a waste composition closer to the lower-income and South Asian categories as in the case of Myanmar.



	Pakse (IGES, 2010)	Thakhek (IGES, 2010)	Kaysone (IGES, 2010)	Champasak (GRET, 2018)	Myanmar secondary cities (present report)
All Organic	55.6%	47.2%	52.3%	49.4%	55.4%
Leaked Food Waste					2.8%
Glass	2.7%	11.3%	6.8%	6.3%	2.9%
All Metal	2.6%	3.5%	2.7%	3.9%	0.8%
Others	20.7%	16.2%	18.9%	21.2%	1.0%
Paper/ Cardboard	6.0%	5.2%	4.2%	6.3%	4.0%
All Plastics	10.9%	13.6%	13.1%	10.6%	7.1%
Leather/ Fabric	5.1%	3.0%	2.0%	2.1%	1.6%
Recycled					9.8%
Leaked Inorganic					13.9%

Figure 19: Waste composition from different audits in the Southeast Asia region. The organic component is slightly higher in Myanmar, while the inorganic components are difficult to compare given the fact that the "Other," "Leaked Inorganic" and "Recycled" categories contain a mix of inorganic material.

6 Data Considerations

> Certain essential studies are still needed to gain a clearer view of the waste situation in Myanmar and to define appropriate policies

6 Data considerations

Certain essential studies are still needed to gain a clearer view of the waste situation in Myanmar and to define appropriate policies.

6.1 Data limitations

The data presented in this report partially fills the information gaps for waste data in Myanmar. Nevertheless, this data has its own limitations. The results presented here are based on waste audits carried out in secondary cities (and Mandalay) with the waste that is collected and disposed at public facilities. This method of measurement does not fully represent the waste stream, because a portion of the waste never arrives at final disposal sites, either getting extracted for recycling, reuse or repurpose; leaking into the environment; or being burned.

The limited data available has been extrapolated to get generalized data at a city scale for waste generation per capita and waste composition, making significant assumptions to estimate waste leakage rates at 30% and recycling rates at 20% of all inorganic urban waste. Although the data is consistent across the cities audited, the error margins are still high. These considerations must be taken into account when applying the estimated figures presented in this report.

Image: Community waste collection at the Shwe Myintzu pagoda festival

6.2 Need for further research

Certain essential studies are still needed in order to gain a clearer view of the waste situation in Myanmar and to define appropriate policies and plans to manage the country's waste challenges. The primary topics of waste management data missing in Myanmar include:

- **Recycling rates:** The quantity and the composition of recyclables that are recovered between the point of waste generation at household, commercial or market level and the point of disposal at illegal dumpsites or landfills should be assessed more clearly. As recyclables pass through many informal junk shops, which partly feed into small-scale recyclers or spare parts shops, a recycling analysis needs to include local junk shops, aggregators that buy from transfer stations, and dumpsites, while keeping in mind that materials could enter the stream from outside the assessed area.

- **Leakage rates:** Quantifying leakage rates is extremely challenging. Qualitative analyses have been undertaken by the World Bank and are measured to a decent precision. A quantitative analysis was undertaken on the Ayeyarwady River in 2019 but assessed only floating and sub-floating debris, which do not include land-based leakage.

- **Rural waste generation and composition:** The existing studies about solid waste in Myanmar focus primarily on urban areas that are not representative of all of Myanmar, as only 30% of the total population is urban. The characteristics of rural waste generation are largely unknown and should be explored further. Expanded data on rural waste in Myanmar would allow for a clearer picture of the extent of mismanaged waste and the infrastructure needed to improve SWM across the country.

Image: Inspecting waste collection systems

- **Industrial waste:** Industrial and construction waste is usually managed without any control or intervention of municipal agencies, leading to an important lack of information about waste types that, in most countries, represent the largest portion of the waste stream.

- **Household waste generation:** As so few audits have been conducted at the source of waste generation in Myanmar, a study of household waste quantity and composition would provide data that could not only improve urban waste collection services but also provide a stronger quantitative basis for assessing disposal, recycling and waste leakage rates against actual waste generation.

Image: Testing waste sorting at Mandalay's new landfill

- **Organic waste at source:** With a high percentage of organic material in its waste stream, Myanmar could be recovering valuable resources for its agricultural sector while reducing waste collection and disposal costs. A study on the weight and volume of organic waste generated at source (primarily from plant waste/leaves, but also market and pre-consumer food scraps) could help municipalities quantify the portion of waste management costs that go toward collecting and hauling heavy or voluminous organic waste. If quantified, these funds could be diverted to support pilots for private composting enterprises or even community-scale digesters for sites with heavy food processing or preparation (e.g. monasteries). Quantifying total plant matter in the waste stream at source could also support initiatives to reduce or eliminate the widespread practice of leaf burning that contributes to air pollution across the country.

7 ANNEX I: Mandalay bin reform case study

As of the end of 2017, Mandalay City had over 70 primary collection points with designated hook-lift bins ("tank carriers") to collect market, business and residential waste between truck passes or in areas not covered by bell-ringing routes.[79] Following goals set by its new Waste Management Strategy and Action Plan in 2017, MCDC budgeted 100 million MMK for FY2019-20 to introduce user-friendly bins of various types across the city that would institutionalize the separation of recyclable versus non-recyclable waste.[80] The new bins would provide formalized collection points in the following targeted areas:

1. Public areas and institutions (e.g. schools, popular pagodas, parks and walkways, train station);
2. "Total cleansing areas," or main roads where MCDC focuses extra attention on more frequent collection routes and adequate receptacles;
3. *"Ah ponh kyone,"* or designated open piles along streets and residential areas with no tank or bin but scheduled pick-ups;
4. Residential areas along small or narrow roads where MCDC trucks do not pass.

The primary goals of waste bin expansion were to reduce littering and open dumping in residential and public areas and to increase recycling diversion. The public could be sensitized to the widespread practice of source-separated recycling for the first time through sorted waste bins. At the same time, well-functioning primary collection points could empower residents to dispose of their own waste, reducing labor demands and reducing opportunities for corruption in the collection system, particularly amongst collection truck drivers.[81]

For bin or tank placement, MCDC created a standard that every household without regular truck service should have access to a waste receptacle within ½ block (60 meters). This effort is still in progress. After extensive community consultation, in 2018, an external funder launched a pro-poor, community-driven waste management pilot that allowed citizen stakeholders to determine their own infrastructure needs in selected wards. In response, the program installed over 90 large, lidded, steel bins with side-by-side recyclable and non-recyclable sections in the pilot wards. Because the pilot program began providing reliable truck collection (bell-ringing) in the same wards just one month later, residents came to prefer immediate disposal into the truck, and the bins soon became obsolete. Furthermore, to prevent residents from outside wards eager to dump waste in the new bins, community leaders of the pilot wards had locked access to their bins, rendering them unusable to local residents at most times. The bins remained locked and mostly unused months later. This example underscores the idea that bin design, as well as placement, are critical to the success of a communal collection point program. Well-designed bins placed in strategic locations based on overall waste management system design (including recycling) will play a key role in functioning systems. Design points to consider can include:

- Lids or shelters, which should prioritize ease of use to discourage dumping alongside bins;
- Locks, which must not impede 24/7 accessibility for residents;
- Protection from rain, vermin, and stray animals, and containment of odors;
- Ease of maintenance (collection and cleaning by laborers);

[79] MCDC (2017). *Waste Management Strategy and Action Plan for Mandalay City (2017-2030.)* p.8.
[80] The MCDC Executive Committee voted upon these classifications for future waste collection in Mandalay, in contrast to YCDC's method of sorting "wet" from "dry" waste. The policy reflects Mandalay's emphasis upon expanding the recycling sector in the city.
[81] In Mandalay City, waste collection truck drivers are employees of MCDC's Motor Vehicle Department, while other collection laborers fall under the Cleansing Department, leading to an awkward power dynamic between workers and the two departments.

- Specifically-shaped entry slots to encourage source-separation of recyclables and discourage contamination by mixed waste (e.g. circular holes for plastic bottles and aluminum cans; narrow slots for paper).
- Easily identifiable symbols or imagery to identify which type of waste belongs in the bin.

This case study from Mandalay demonstrates that, while stakeholder consultation during pre-planning is critical, municipalities might need to determine target policy outcomes and apply best practices for bin designs before delegating waste management and expenditure decisions to citizen-led groups.

8 ANNEX II: waste data tables and notes

8.1 Urban dump waste disposal methods data table (Chapter 4)

Place	Population	Waste per capita	Total waste	Recycled		Sanitary Landfills			Controlled Dumping			Open Air Burning			Leaking Dumps			Uncollected	
National combined	53,710,000	0.38	20,480	11%	2,225		3%	647		30%	6,105		21%	4,382		18%	3,711	17%	3,410
Rural estimated	38,075,383	0.30	11,245	10%	1,124		0%	0		10%	1,124		30%	3,373		30%	3,373	20%	2,249
Urban combined	15,634,617	0.59	9,235	12%	1,101	7%	8%	647	37%	54%	4,980	54%	11%	1,009	42%	4%	338	13%	1,161
Primary cities	7,925,653	0.71	5,640	13%	744	33%	12%	587	75%	72%	3,649	25%	0%	4	0%	0%	3	12%	653
State capitals	1,113,474	0.48	532	10%	54	11%	13%	59	46%	59%	280	33%	7%	36	33%	5%	27	14%	76
Towns > 100,000 capita	2,256,940	0.49	1,109	10%	110	9%	0%	0	45%	53%	584	45%	19%	215	18%	4%	46	14%	155
Towns < 100,000 capita	4,338,550	0.45	1,953	10%	194	0%	0%	0	19%	24%	467	74%	39%	754	59%	13%	261	14%	276
Yangon	5,160,512	0.60	3,080	25%	440	no			yes	100%	2,200	no	0%	-	no		0	25%	440
NPT	1,160,000	0.95	1,101	20%	99	no			yes	100%	862	no	0%	-	no	0%	0.00	30%	90
Mandalay	1,580,907	0.95	1,500	25%	204	yes	50%	587.15	yes	50%	587	no	0%		no		0	15%	122
Madaya	24,234	0.40	10	20%	1	no		0	no	0%	-	Yes	60%	4	yes	40%	2.90	30%	1
Pwin Oo Lin	158,783	0.49	78	20%	8	yes	100%	59.48	yes	0%	-	no	0%	-	no	0%	0.00	30%	11
Miketila	111,522	0.49	55	20%	6	no			no	60%	25	No	0%	-	yes	40%	16.71	30%	8
Nyaung U	48,528	0.49	24	20%	2	no			no	0%	-	Yes	100%	18	no	0%	0.00	30%	3

Place	Population	Waste per capita	Total waste	Recycled		Sanitary Landfills			Controlled Dumping			Open Air Burning			Leaking Dumps			Uncollected	
Pathein	237,089	0.49	117	20%	12	no			Yes	100%	89	No	0%	-	no	0%	0.00	30%	16
Ngwe Saung	14,489	0.49	7	20%	1	no			no	0%	-	Yes	60%	3	yes	40%	2.17	30%	1
Pyapon	49,128	0.40	19	20%	2	no			no	60%	9	No	0%	-	yes	40%	5.89	30%	3
Sagaing	81,432	0.49	40	20%	4	no			Yes	100%	31	no	0%	-	no	0%	0.00	30%	6
Shwe Bo	69,036	0.40	27	20%	3	no			yes	100%	21	NO	0%	-	no	0%	0.00	30%	4
Kawlinn	21,431	0.40	8	20%	1	no			no	0%	-	yes	60%	4	yes	40%	2.57	30%	1
Monywa	207,489	0.49	102	20%	10	no			yes	100%	78	No	0%	-	No	0%	0.00	30%	14
Dawei	80,117	0.48	39	20%	4	no			yes	100%	29	no	0%	-	no	0%	0.00	30%	6
Ye	34,430	0.40	14	20%	1	no			no	0%	-	yes	100%	10	no	0%	0.00	30%	2
Kaw Thaung	57,949	0.48	28	20%	3	no			yes	100%	20	no	0%	-	no	0%	0.00	30%	5
Myeik	115,141	0.37	42	20%	4	no			no	100%	32	no	0%	-	no	0%	0.00	30%	6
Loikaw	51,349	0.49	25	20%	3	no			yes	0%	-	no	100%	19	no	0%	0.00	30%	4
Magwe	90,038	0.56	50	20%	4	no			no	60%	25	yes	40%	17	no	0%	0.00	20%	4
Pakokku	110,842	0.49	55	20%	6	no			yes	100%	42	no	0%	-	no	0%	0.00	30%	7
Thaunggyi	264,804	0.49	131	20%	13	no			yes	100%	99	no	0%	-	no	0%	0.00	30%	18
Aung Ba + Kalaw	57,797	0.49	29	20%	3	no			no	0%	-	yes	100%	22	no	0%	0.00	30%	4
Hsipaw	20,897	0.40	8	20%	1	no			no	60%	4	no	0%	-	yes	40%	2.50	30%	1
Musal	74,313	0.40	29	20%	3	no			no	0%	-	yes	60%	13	yes	40%	8.91	30%	4
Lashoe	174,335	0.49	86	20%	9	no			no	0%	-	yes	60%	39	yes	40%	26.12	30%	12
Tar Chi late	51,553	0.40	20	20%	2	no			no	0%	-	yes	60%	9	yes	40%	6.18	30%	3
Naung Shwe	16,208	0.49	8	20%	1	no			yes	100%	6	no	0%	-	no	0%	0.00	30%	1
Mawlamyine	400,000	0.52	208	20%	19	no			yes	100%	160	no	0%	-	no	0%	0.00	30%	29
Kim pon Camp	10,000	0.40	4	20%	0	no			no	0%	-	yes	60%	2	yes	40%	1.20	30%	1
Kyaik Hto	35,224	0.40	14	20%	1	no			no	60%	6	no	0%	-	yes	40%	4.22	30%	2
Thaton	55,047	0.40	22	20%	2	no			no	0%	-	Yes	60%	10	yes	40%	6.60	30%	3
Hakha	24,926	0.49	12	20%	1	no			no	0%	-	yes	60%	6	yes	40%	3.73	30%	2

Place	Population	Waste per capita	Total waste	Recycled		Sanitary Landfills			Controlled Dumping			Open Air Burning			Leaking Dumps			Uncollected	
Hpa an	75,141	0.53	40	20%	4	no			yes	100%	30	no	0%	-	no	0%	0.00	30%	6
Myawady	113,155	0.49	56	20%	6	no			yes	100%	42	no	0%	-	no	0%	0.00	30%	8
Thandaung Gyi	16,056	0.40	6	20%	1	no			no	0%	-	Yes	60%	3	yes	40%	1.92	30%	1
Sittwe	100,748	0.49	50	20%	5	no			no	0%	-	yes	100%	38	no	0%	0.00	30%	7
Kyauk Phyu	20,866	0.40	8	20%	1	no			no	0%	-	yes	100%	6	no	0%	0.00	30%	1
Mrauk Oo	36,139	0.40	14	20%	1	no			no	0%	-	yes	60%	6	yes	40%	4.33	30%	2
Maungdaw	11,742	0.40	5	20%	0	no			no	0%	-	yes	60%	2	yes	40%	1.41	30%	1
Pon Na Kyun	5,000	0.40	2	20%	0	no			no	0%	-	yes	60%	1	yes	40%	0.60	30%	0
Myebon	11,566	0.40	5	20%	0	no			no	0%	-	yes	60%	2	yes	40%	1.39	30%	1
Taungup	28,652	0.40	11	20%	1	no			no	0%	-	yes	60%	5	yes	40%	3.43	30%	2
Baw	5,000	0.40	2	20%	0	no			no	0%	-	yes	100%	1	no	0%	0.00	30%	0
Thandwe	14,327	0.40	6	20%	1	no			yes	60%	3	no	0%	-	yes	40%	1.72	30%	1
Ngapali beach	10,000	0.49	5	20%	0	no			no	0%	-	yes	60%	2	yes	40%	1.50	30%	1
Mann Aung	5,246	0.40	2	20%	0	no			no	0%	-	yes	60%	1	no	40%	0.63	30%	0
Myitkina	243,031	0.49	120	20%	12	no			no	0%	-	yes	100%	91	no	0%	0.00	30%	17
Ba Maw	58,696	0.40	23	20%	2	no			no	0%	-	Yes	100%	18	No	0%	0.00	30%	3
Nanmon	8,000	0.40	3	20%	0	no			no	0%	-	yes	100%	2	no	0%	0.00	30%	0
Putaro	15,978	0.40	6	20%	1	no			no	0%	-	yes	60%	3	yes	40%	1.92	30%	1
Bago	491,434	0.49	243	20%	24	no			yes	100%	184	no	0%	-	no	0%	0.00	30%	34
Taungoo	108,589	0.49	54	20%	5	no			no	60%	24	Yes	40%	16	no	0%	0.00	30%	8
Pyay	134,861	0.49	67	20%	7	no			no	0%	-	yes	60%	30	yes	40%	20.21	30%	9.4

8.2 Recent waste audits in Myanmar compared

Note: The data provided here is the raw data as measured during the audit. It does not include adjustments made due to contamination of certain categories. This is done to allow an immediate reference to other waste audits in a similar situation. All final data in the report uses adjusted data to be comparable with international data.

Item	Unit	Dawei	Myeik	Pathein	Kawthaung	Magway	Yangon informal settlement	Yangon dump	Mandalay Ward 13	Mandalay dump
Audit date		Apr 19	Apr 19	Dec 19	Apr 19	2019	Oct 18	2018	Jun 19	2019
Location of audit		Final Dump	Final Dump	Final Dump	Final Dump	Final Dump	HH audit	YCDC official	Transfer station	2 Final Dumps
Population	capita	125,000	288,000	237,089	49,301	75,744	20,000	5,160,512	27,555	1,580,907
Waste Disposed	[kg/cap/day]	0.36	0.28	0.43	0.34	0.46	0.3	0.43	0.79	0.74
Leakage to Environment	%	30%	30%	30%	30%	20%	50%	25%	15%	15%
Recycling on Inorganic	%	20%	20%	20%	20%	20%	50%	25%	25%	25%
Inorganic Waste Generated	[kg/cap/day]	0.26	0.17	0.29	0.28	0.24	0.10	0.34	0.30	0.52
Uncollected	[kg/cap/day]	0.08	0.05	0.09	0.08	0.05	0.05	0.09	0.05	0.08
Recycled	[kg/cap/day]	0.05	0.03	0.06	0.06	0.05	0.05	0.09	0.08	0.13
Recycling on Full Waste	%	11%	9%	10%	12%	9%	17%	14%	8%	14%
Waste Generation	[kg/cap/day]	0.48	0.37	0.58	0.48	0.56	0.30	0.60	0.91	0.95
Waste Generation	[t/day]	61	105	138	24	42	6	3080	25	1500
Collected Inorganic	[kg/cap/day]	0.13	0.08	0.15	0.14	0.15	0.00	0.17	0.18	0.31
Collected Organic	[kg/cap/day]	0.23	0.20	0.29	0.20	0.32	0.20	0.26	0.61	0.43
Disposal at dumps	[t/day]	44	80	103	17	35	6.2	2200	21.64	1174
Density	[ton/m3]	0.20		0.20	0.21	0.19	0.180		0.200	0.215
Household recyclables	%	7.0%	N/A	5.7%	9.5%	3.0%	7.7%	N/A	3.2%	3.4%
Organic		63.9%	70.1%	66.2%	59.1%	68.2%	67.2%		76.9%	58.4%
Plastics		13.0%	15.6%	17.9%	21.9%	19.7%	18.8%		13.5%	19.8%
Paper/ Cardboard		15.4%	5.9%	13.9%	7.5%	1.3%	1.9%		3.3%	7.7%
Glass		2.7%	5.2%	0.4%	10.6%	2.1%	10.0%		1.5%	1.8%
Leather/ Fabric		5.0%	1.3%	0.4%	0.6%	4.5%	1.2%		0.8%	5.6%
All Metal		0.8%	1.0%	1.2%	1.7%	1.6%	0.4%		0.7%	0.6%
Hazardous		0.00%	0.00%	0.01%	0.00%	0.40%	0.00%		0.07%	0.16%
Medical										0.02%
Others		0.0%	0.8%	1.6%	0.0%	2.1%	0.0%		2.4%	6.4%

*Red marked data are estimates or calculations partly relying on estimates as used and described in the report

8.3 Table for Averaged Waste Characterization chart (average of all audits) (Section 3.3.2)

Item	Myanmar secondary cities (average)						
Location of audit	Myanmar urban (average)	Secondary Cities ASEAN	Material Contamination Factor	Secondary Cities disposed (adjusted)	Secondary Cities generated	Myanmar urban disposed (average adjusted)	Urban Myanmar Generated
All Organic	**62.0%**	**54.9%**	**1.0**	**75.9%**	**55.4%**	**72.3%**	**53%**
Garden Waste	54.1%	29.1%	1.0	60.3%	44.1%	54.1%	40%
Food Waste	7.9%	22.6%		15.5%	11.3%	18.2%	13%
All Plastics	**18.7%**	**12.1%**	**1.0**	**9.7%**	**7.1%**	**10.5%**	**8%**
LDPE	6.5%		0.2	1.4%	1.0%	1.5%	1%
PET/ HDPE	0.6%		1.0	1.2%	0.9%	0.6%	0%
Flexibles	4.3%		0.6	2.1%	1.5%	2.4%	2%
Plastic/Aluminum foil	1.6%		1.0	1.5%	1.1%	1.6%	1%
PP	0.8%		0.8	0.7%	0.5%	0.7%	0%
Other Hard Plastic	3.0%		1.0	2.0%	1.4%	3.0%	2%
EPS Styrofoam	0.5%		1.0	0.4%	0.3%	0.5%	0%
Sanitary	1.1%		0.2	0.2%	0.2%	0.2%	0%
Tetra Pak	0.1%		1.0	0.2%	0.1%	0.1%	0%
Paper/ Cardboard	**7.8%**	**5.5%**	**0.7**	**5.5%**	**4.0%**	**5.4%**	**4%**
Glass	**2.9%**	**6.5%**	**1.0**	**3.9%**	**2.9%**	**2.9%**	**2%**
Leather/ Fabric	**3.9%**	**3.1%**	**1.0**	**2.2%**	**1.6%**	**3.9%**	**3%**
All Metal	**0.9%**	**3.2%**	**1.0**	**1.1%**	**0.8%**	**0.9%**	**1%**
Aluminum	0.2%	0.1%	1.0	0.3%	0.2%	0.2%	0%
Other Metal	0.7%	3.8%	1.0	0.7%	0.5%	0.7%	0%
Hazardous	**0.30%**	**0.20%**	**1.00**	**0.44%**	**0.3%**	**0.3%**	**0%**
Medical	**0.02%**		**1.00**	**0.00%**	**0.0%**	**0.0%**	**0%**
Others	**3.9%**	**21.5%**	**1.0**	**1.3%**	**1.0%**	**3.9%**	**3%**
Recycled					9.8%		12%
Leaked Inorganic					13.9%		12%
Leaked Food Waste					2.8%		3%

8.4 Averaged SWM audits from multiple sources including adjustments for statistical errors (Section: 3.3.1 Table 1)

Place	Waste gen [kg/cap/d]	Source	Year	Comment	Waste gen [kg/cap/d]	Source	Year	Comment	Waste gen [kg/cap/d]	Source	Year	Waste gen [kg/cap/d]	Source	Year	Waste gen [kg/cap/d]	Source	Year
Myanmar Scale	0.45	Asian Development Bank. Toward sustainable municipal organic waste management in South Asia: A guidebook for policy makers and practitioners. Mandaluyong City, Philippines: Asian Development Bank, 2011.	1995		0.278	Thein, M. 2010. "GHG Emissions from Waste Sector of INC of Myanmar." Paper presented at the Eighth Workshop on GHG Inventories in Asia (WGIA8), Vientiane, Lao PDR, July 13–16.	2000		0.44	Daniel Hoornweg and Perinaz Bhada-Tata. 2012. *What a Waste A Global Review of Solid Waste Management*. Urban Development. Washington, DC: World Bank	2012	0.39	Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development. Washington, DC: World Bank	2016	0.56	World Bank (2019), "Financing Solid Waste Management: Improving Financial and Environmental Sustainability of a Key Urban Service." Chapter 5 of Subnational Public Expenditure Review 2019: Fostering Decentralization in Myanmar.	2019
Yangon	0.45	(1999) *What a Waste: Solid Waste Management in Asia*, Urban Development. Washington, DC: World Bank	1993		0.396	IGES (no original report) quoted in: -2015 *Report on City Assessment of Municipal Solid Waste in Yangon City*, CCAC, Municipal Solid Waste Initiative Project	2014	Data from YCDC	0.45 0.5	2018, *City-to-City Collaboration Project for Low Carbon City Development (2018), Waste to Energy Plant for Yangon City in Myanmar Final Report March*, JFE Engineering Corporation Kawasaki City (Data from YCDC) Daw Saw Sandar Oo 2016, *Transformation of Urban Management - Part I Capacity Building of Urban Management*, YCDC with the support of ADB, Japan Fund for Poverty Reduction, UNDP	2016	0.8	H.Huisman, H.Breukelman, B. Keesman (2017), *Myanmar Waste Scoping Misssion Report*, Netherlands Entreprise Agency	2017	0.6-0.8	World Bank (2019), "Financing Solid Waste Management: Improving Financial and Environmental Sustainability of a Key Urban Service." Chapter 5 of Subnational Public Expenditure Review 2019: Fostering Decentralization in Myanmar.	2019

8.4 Averaged SWM audits from multiple sources including adjustments for statistical errors (Section: 3.3.1 Table 1)

Place	Waste gen [kg/cap/d]	Source	Year	Comment	Waste gen [kg/cap/d]	Source	Year	Comment	Waste gen [kg/cap/d]	Source	Year	Waste gen [kg/cap/d]	Source	Year	Waste gen [kg/cap/d]	Source	Year
Monywa	0.44	Le Loc'h (GRET), 2016, *Data collection of Urban Services Business Operations Plans Report on Monywa Solid Waste Management Service*	2015	Based on a calculation by the author: wastes collected divided by the number of people													
Hpa-Han	0.55	ADB (2016) Preparing Third Great Mekong Sub-region Corridor Towns Development Project Final Report, Kayin State Report	2015		0.67	ADB (2016) Preparing Third Great Mekong Sub-region Corridor Towns Development Project Final Report, Kayin State Report	2016	Based on a calculation by the author: wastes produced divided by the number of people									
Magway	0.56	Le Loc'h (GRET), 2016, *Water Supply, Sanitation and Solid Waste Management services in Magway City Assessment report*	2016	Based on a calculation by the author: wastes collected divided by the number of people													

8.5 Audit form used for surveys conducted by Thant Myanmar

https://drive.google.com/file/d/18mFjDH-prFD9pxgZ95GBSj5F1oQBqoOr/view?usp=sharing
(available in English and Myanmar)

All yellow fields have to be completed by the auditor. If the fields are not enough you have to add more columns and add them to the sum.

*Contamination Factor = adjustment factor used to account for organic waste contamination on inorganic waste components

Date			
General Data		Population	Density

	Recyclable	Weight/pers [kg/d]	Weight [tons]	Density	Sum Volume [m^3]	V	L[feet]	M[feet]	H[feet]	V	L[feet]	M[feet]	H[feet]
Number of trucks	0												
Volume of truck [m^3]													

Item	Percentage	SUM [kg]	Contamination factor	Weight of sample [kg]	Weight of bin [kg]	Data fill in [kg]							
SUM													
all organic													
Garden waste													
Food waste													
All Plastics													
Plastic bags			0.23										
PET/HDPE													
plastic package			0.55										
Plastic/Alu composite (Chips)													
Rice /cement bag													
Other Plastic													
Styrofoam													
Sanitary			0.30										
Tetra Pack													
Paper/cardboard			0.70										
Glass													
Leather and Fabric													
All Metal													
Aluminum													
Other Metal													
Hazardous													
Other waste + Ceramic													

8.6 Recycling commodities values, bought at source of generation

Item	Unit	min [kyat]	max [kyat]
Paper	kg	100	200
Cardboard	kg	250	400
PET	kg	200	250
HDPE	kg	200	300
LDPE	kg	300	500
PP	kg	400	600
PVC	kg	150	200
Tin	kg	100	160
Alu	kg	300	1,200
Iron	kg	100	500
Glass	pc	20	100
E-waste	pc	8,000	15,000

The increase in value of the items through various middleman is around 30% per level for urban areas. Outside it various strongly with the distance to the recycling plant

8.7 Residential and Commercial Waste Collection Fee Schedule for Mandalay City

Construction Type	# of Stories	Monthly Fee (MMK)	
Bamboo building	1	500	
Bamboo building	2	600	
Wooden building	1	900	
Wooden building	2	1	
Brick building	1	1,200	
Brick + wood/bamboo combo	2 - 3	1,500	
Reinforced concrete building	1 - 2	2,000	*Rate goes up by 500 MMK for every additional story, up to 12.
"Housing estate"	n/a	2,000 / residential apartment	

Commercial Waste Collection Fee Schedule for MDY City

Type of Business	Business Classification	Measurement Scale	Rate (MMK)
Hotels		per room, per year	20,000/year
*Restaurants & Food Shops	Class 1	>4.50 tpd	100,000/mo.
	Class 2	3.01-4.5 tpd	60,000/mo.
	Class 3	1.51 - 3 tpd	30,000/mo.
	Class 4	0.621 - 1.5 tpd	10,000/mo.
	Class 5	0.215 - 0.62 tpd	5,000/mo.
	Class 6	0.01 - 0.214 tpd	1,500/mo.
Private health care facility	Operation Theater	10,000/mo./facility	120,000/year
	Lab/Diagnostic Facility	10,000/mo./facility	120,000/year
	Patient Bed	1,500/mo./bed	18,000/year

Source: MCDC, 2019

8.8 Waste data sources

Year	1993		1995		2000		2012		2014	
Myanmar Average			0.45	Asian Development Bank. Toward sustainable municipal organic waste management in South Asia: A guidebook for policy makers and practitioners. Mandaluyong City, Philippines: Asian Development Bank, 2011.	0.28	Thein, M. 2010. "GHG Emissions from Waste Sector of INC of Myanmar." Paper presented at the Eighth Workshop on GHG Inventories in Asia (WGIA8), Vientiane, Lao PDR, July 13–16.	0.44	Daniel Hoornweg and Perinaz Bhada-Tata. 2012. *What a Waste A Global Review of Solid Waste Management*. Urban Development. Washington, DC: World Bank		
Yangon	0.45	(1999) What a Waste: Solid Waste Management in Asia, Urban Development. Washington, DC: World Bank							0.4	IGES (no original report) quoted in: -2015 *Report on City Assessment of Municipal Solid Waste in Yangon City*, CCAC, Municipal Solid Waste Initiative Project
Mandalay							0.35	MCDC through FASEP		
Mawlamyine										
onywa										
Pathein										
Hpa-Han										
Magway										
Dawei										
Kawthaung										
Myeik										
Myawaddy									0.68	ADB (2016) Preparing Third Great Mekong Sub-region Corridor Towns Development Project Final Report, Kayin State Report
Bagan										

Year	2015		2016		2017		2019	Unknown	
Myanmar Average			0.39	Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development. Washington, DC: World Bank			0.53, 0.56	World Bank (2019), "Financing Solid Waste Management: Improving Financial and Environmental Sustainability of a Key Urban Service." Chapter 5 of Subnational Public Expenditure Review 2019: Fostering Decentralization in Myanmar. World Bank (2019), "Country Environmental Analysis: A Road towards Sustainability, Peace, and Prosperity, Synthesis Report." Chapter 4, "Solid Waste, Plastic, and Air Pollution."		
Yangon			0.43	2018, City-to-City Collaboration Project for Low Carbon City Development (2018), Waste to Energy Plant for Yangon City in Myanmar Final Report March, JFE Engineering Corporation Kawasaki City (Data from YCDC)	0.8	H.Huisman, H.Breukelman, B. Keesman (2017), Myanmar Waste Scoping Misssion Report, Netherlands Entreprise Agency	0.6-0.8	World Bank (2019), "Financing Solid Waste Management: Improving Financial and Environmental Sustainability of a Key Urban Service." Chapter 5 of Subnational Public Expenditure Review 2019: Fostering Decentralization in Myanmar.		
			0.5	Daw Saw Sandar Oo 2016, Transformation of Urban Management - Part I Capacity Building of Urban Management, YCDC with the support of ADB, Japan Fund for Poverty Reduction, UNDP						
Mandalay	0.74	FASEP			0.64	*MCDC and ECD (2017): City Waste Management Strategy and Action Plan for Mandalay, the Republic of the Union of Myanmar, Mandalay, Myanmar*	0.8	World Bank (2019), "Financing Solid Waste Management: Improving Financial and Environmental Sustainability of a Key Urban Service." Chapter 5 of Subnational Public Expenditure Review 2019: Fostering Decentralization in Myanmar.		
	0.79	Le Loc'h (GRET), 2016, *Data collection of Urban Services Business Operations Plans Report on Mandalay Solid Waste Management Service*			**0.64**	**Data collected by the authors**	**0.74**	**Data collected by the authors**		
Mawlamyine			0.55	ADB (2016) Preparing Third Great Mekong Sub-region Corridor Towns Development Project Final Report, Mon State Report						

Year	2015		2016		2017		2019		Unknown	
Monywa	0.44	Le Loc'h (GRET), 2016, Data collection of Urban Services Business Operations Plans Report on Monywa Solid Waste Management Service Based on a calculation by the authors: wastes collected divided by the number of people								
Pathein							**0.43**	**Data collected by the authors**		
Hpa-Han	0.55	ADB (2016) Preparing Third Great Mekong Sub-region Corridor Towns Development Project Final Report, Kayin State Report	0.67	ADB (2016) Preparing Third Great Mekong Sub-region Corridor Towns Development Project Final Report, Kayin State Report Based on a calculation by the authors: wastes produced divided by the number of people						
Magway			0.56	Le Loc'h (GRET), 2016, *Water Supply, Sanitation and Solid Waste Management services in Magway City Assessment report* Based on a calculation by the authors: wastes produced divided by the number of people	**0.46**	**Data collected by the authors**				
Dawei							**0.36**	**Data collected by the authors**		
Kawthaung							**0.34**	**Data collected by the authors**		
Myeik							**0.28**	**Data collected by the authors**		
Myawaddy	0.55	ADB (2016) Preparing Third Great Mekong Sub-region Corridor Towns Development Project Final Report, Kayin State Report								
Bagan									0.45	U Mann, Ohnmar Myint, *Community-based 3Rs Practiced in Myanmar*

9 ANNEX III: main SWM stakeholders in Myanmar

Type	Institution	Main intervention	Contact person	Position	Contact
Government	MONREC/ Environmental Conservation Dept. (ECD)	Pollution oversight			
	Ministry of Agriculture/ Dept. of Rural Development	Rural SWM			
	CDCs	SWM			
	DAOs	SWM			
Development Cooperation	World Bank	Infrastructure, research, policy support	Tao Wang	Sr. Environmental and Climate Change Specialist	twang2@worldbank.org
	ADB	Infrastructure, structural improvement (main focus Mandalay)	Kyaw Thu	Infrastructure Specialist	kthu@adb.org
	BreAd B.V. (consultant for UNDP)	Reginal SWM master planning	Hans Breukelman	Consultant	hans@breukelman.nl
Companies and NGOs	IGES	Research, SWM roadmaps and action plans	Premakumara Jagath Dickella Gamaralalage	Deputy Director	premakumara@iges.or.jp
	GRET	SWM with the DAO of Magway	Thibaut Le Loc'h	Projects Officer (drinking water, sanitation and waste management)	le-loch@gret.org
	Thant Myanmar	Reduction, research, SWM support (rural and urban)	FriedorJeske	Program Director	fjeske@gmail.com

9 ANNEX III: main SWM stakeholders in Myanmar

Type	Institution	Main intervention	Contact person	Position	Contact
Companies and NGOs	Orgaworld	Organic waste (large-scale)	Julius de Jong	Managing Director	j.dejong@orgaworld-asia.com
	Bokashi Myanmar	Organic waste (small-scale)	Jenny Harlen	Founder	jenny.harlen@gmail.com
	Building Markets	Support to informal recycling sector	Karen Hsu	Country Director	hsu@buildingmarkets.org
	GA Circular	Circular economy and private sector support	Sumangali Krishnan	Chief Business Officer	sumangali@gacircular.com
	RecyGlo	Recycling company	Okka Phyu Maung	CFO/CMO	okkaphyomaung@recyglo.com
	Myanmar Recycles	Plastic recycling	Mimi Wu	CEO	hellomimiwu@gmail.com
	Recycle Myanmar	Recycling trading platform	Pon Nya	Founder	ponnya@recyclemm.com
CSOs	Clean Mandalay Campaign	Community-based SWM, waste reduction, outreach, clean-ups	Thant Zaw	Board Member	Cleanmandalaycampaign@gmail.com
	Clean Yangon	Clean-ups, awareness, waste reduction			
	Clean Dawei	Community-based SWM, waste reduction, outreach			
	Trash Hero	Clean-ups, awareness, waste reduction			

သန့်မြန်မာ

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