



**SEA-MaP**

# **GUIDEBOOK ON COMMON METHODOLOGIES FOR ASSESSMENT AND MONITORING OF PLASTIC POLLUTION**

An ASEAN project supported by the World Bank



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# EXECUTIVE SUMMARY

## Summary

This Guidebook serves as a comprehensive resource for ASEAN Member States (AMS) to assess and monitor plastic pollution across the Southeast Asian region building on existing capacities and providing opportunities for global leadership on plastic pollution monitoring. Designed to support the [\*ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States \(2021 - 2025\)\*](#), the Guidebook provides a structured, interactive five-step framework that enables countries to understand plastic pollution fundamentals, select appropriate indicators, choose suitable methodologies, and establish monitoring and reporting systems. The primary aim of the Guidebook is to equip AMS with standardized approaches and practical tools to measure macroplastics across their lifecycle, from products placed on the market, waste generation, waste collection coverage, recycling rates, and environmental emissions. By offering multiple assessment methodologies, the Guidebook enables countries to select approaches that align with their specific contexts and capacity levels while contributing to regional coherence in plastic pollution monitoring.

## Value and need for this Guidebook

The Guidebook aims to address a critical gap in standardized plastic pollution assessment across Southeast Asia, where AMS have varying levels of technical capacity, data availability and consistency, and institutional frameworks for environmental monitoring. The Guidebook hopes to remove barriers by providing consistent indicators and measurement approaches that accommodate different national circumstances while ensuring regional comparability. This systematic approach enables countries to establish baselines, track progress toward targets, and make evidence-based policy decisions. It supports the *ASEAN Regional Action Plan* (ASEAN RAP) objectives by creating a foundation for regional coordination, data sharing, and collective action against marine plastic pollution.

## How to Use this Guidebook

The Guidebook's Step 1 ('Understanding the basics') section provides foundational knowledge to implement the Guidebook. Step 2 ('Selecting indicators for monitoring') is a prioritization system that guides users to select from eight different indicators based on country specific needs and capacities. Step 3 ('Selecting a methodology') offers seven methodological approaches enabling AMS to choose methods that match their technical capabilities, personnel, equipment availability, data systems, and institutional expertise, which are unevenly distributed across the region. Step 4 ('How to apply the methodologies') provides flexibility for AMS to follow a phased approach: initiating a foundational methodology and proxy data to capture the bulk of the recommended monitoring protocol, and to progressively adopt more resource intensive and customized methodologies, as resources become available. Step 5 ('Monitoring and reporting') provides a common set of approaches for multi-stakeholder engagement responsive to varying national priorities, regulatory frameworks, and political contexts. The Guidebook's framework is designed to allow for adaptation based on national capacity, and the hope for sharing knowledge to build regional capacity for the different national contexts of each of the AMS.

## Looking forward

The successful implementation of the Indicators and Methodologies presented in this Guidebook is a critical step toward establishing Southeast Asia as a leader in systematic plastic pollution assessment and monitoring. Moving forward, sustained commitment from ASEAN leadership, AMS governments, international partnerships, and funding mechanisms will be essential for achieving the Guidebook's full potential. Regional capacity building initiatives, including training programs, technical exchanges, and knowledge and data sharing platforms, should be prioritized to ensure consistent and effective implementation across all AMS. The development of regional data sharing protocols and harmonized reporting standards will enhance the value of individual country assessments and support evidence-based policy development that is coherent across the region. As countries gain experience with these methodologies, opportunities will emerge for refining approaches, developing new assessment tools, and expanding monitoring capabilities. Ultimately, this Guidebook provides the foundation for transforming Southeast Asia's approach to plastic pollution management, enabling the region to develop targeted, effective interventions that protect marine ecosystems, while supporting sustainable economic development and improved quality of life for all of the communities in the region.



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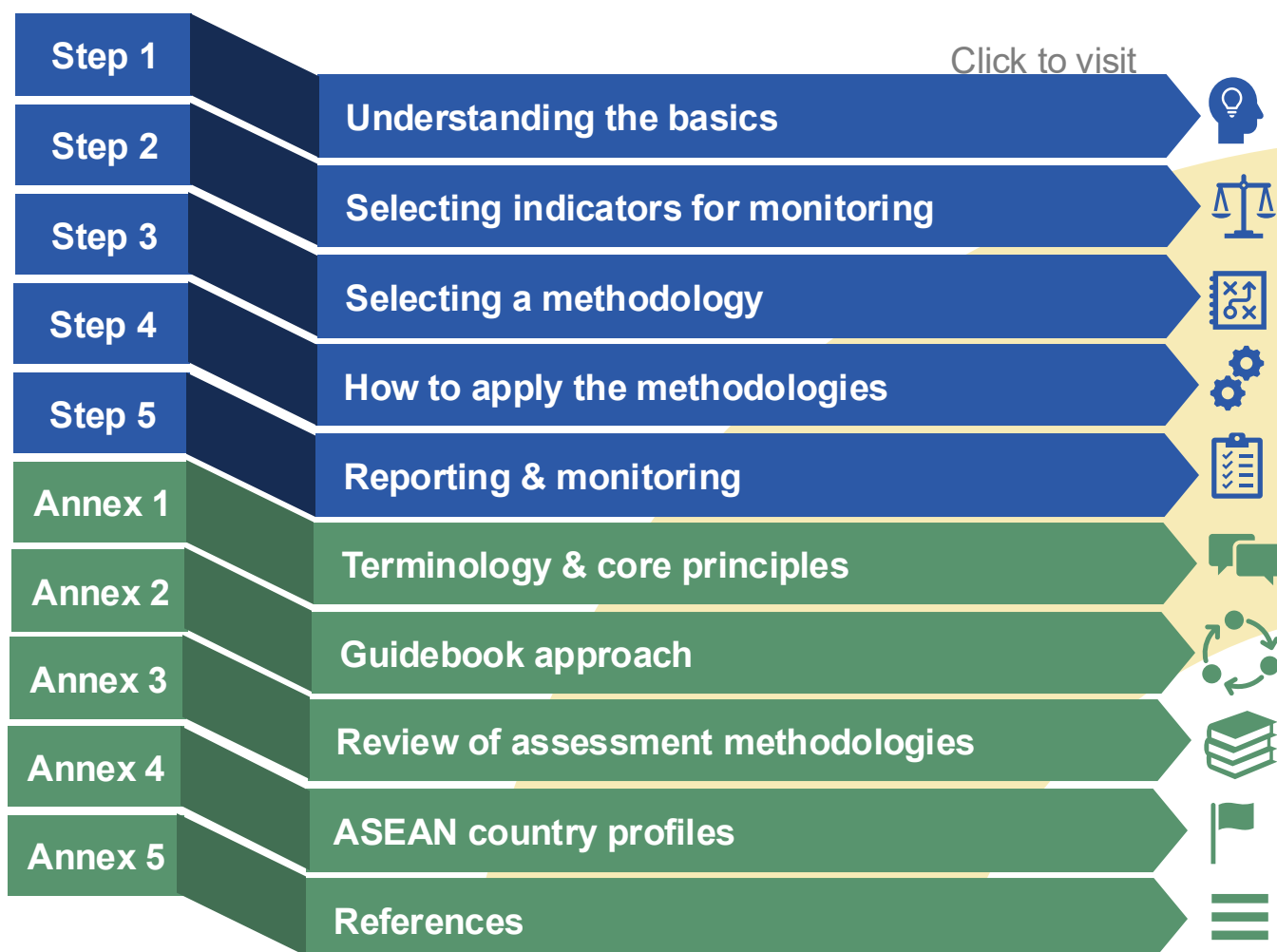
# OVERVIEW

Marine plastic pollution is a global problem arising from the way plastics are currently produced, used and managed. With an estimated 80% of marine plastic debris originating on land, combating marine plastic debris requires coordinated international action across the full plastics life cycle to realize the benefits of a circular economy, tackle the major sources and prevent plastic pollution.

ASEAN demonstrated its commitment to combating marine debris by adopting the *Bangkok Declaration on Combating Marine Debris in ASEAN Region* in 2019. It was accompanied by the *ASEAN Framework of Action on Marine Debris*, which articulates the need for regional and national actions. Building on these documents, the *ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States (ASEAN RAP)* was endorsed in 2021 (ASEAN, 2021). The goal of the ASEAN RAP is to enhance coordination at the regional and international levels for achieving sustainable management of coastal and marine environments through responding to marine plastic pollution. Action 7 of the ASEAN RAP calls for the development of this *Guidebook on Common Methodologies for Assessment and Monitoring of Plastic Pollution*. This Guidebook will support AMS in monitoring and mitigating plastic pollution across the region by ensuring a harmonized, systematic approach is available. Further details of the SEA-MaP Regional Project and aims of the Guidebook are discussed in the '[Background](#)' section under [Step 1: Understanding the basics](#).

The Guidebook is presented as five sequential steps that guide the user through the process of: (1) understanding how to use the Guidebook, (2) prioritizing indicators to monitor macroplastic pollution, (3) selecting a suitable methodology to measure the selected indicators, (4) applying the selected methodology in a harmonized manner, and (5) providing guidance around monitoring and reporting.

The Guidebook aims to be interactive so that it supports users through each of the five steps and only shows information that is relevant to their selected indicators and methodologies. Users can navigate through each step by selecting the step from the diagram below and using the controls in the bottom left of the page. If preferred, the Guidebook can also be used in non-interactive format, by scrolling through as one would do with a standard report. To accommodate this, detailed information such as the method behind the development of the Guidebook has been placed as annexes.



# STEP 1: UNDERSTANDING THE BASICS





# STEP 1: UNDERSTANDING THE BASICS

Step 1 aims to introduce the user to the necessary information required to understand and use the Guidebook. This includes the [Background](#) section which introduces the ASEAN RAP and SEA-MaP Regional Project and explains how the Guidebook supports these. Guidance on [how to use the Guidebook](#) is also provided to outline who the intended users are and assist them in navigating and using the Guidebook. A [summary of the approach behind development of the Guidebook](#) is also provided, including discussion on what the Guidebook can and cannot do to facilitate harmonized assessment. Details on the core concepts and terminology ([Annex 1](#)) and the full approach behind the creation of the Guidebook ([Annex 2](#)) are found in the annexes. This includes the detailed evidence base behind the review and selection of which indicators and methodologies were to be included in the Guidebook. In-depth reviews of plastic pollution assessment methodologies ([Annex 3](#)) and existing policies, regulations, targets and monitoring programs for plastic pollution in the ASEAN region ([Annex 4](#)) are also provided.

## BACKGROUND

[Click to visit](#)



- Introduction to SEA-MaP Regional Action Plan (RAP)
- Aim of the Guidebook

1.1

## HOW TO USE

[Click to visit](#)



- Interactive nature of the Guidebook
- Who is it for and how to use it?
- Further support & capacity building

1.2

## GUIDEBOOK APPROACH

[Click to visit](#)



- Selection of indicators
- Selection of methodologies
- Supporting toolkits

1.3

## TERMINOLOGY

[Click to visit](#)



- Key terminology & glossary
- Core principles
- Available as an annex to the Guidebook

1.4

## NEXT STEP

[Click to visit](#)



- Proceed to Step 2: Selecting indicators for monitoring



## ASEAN REGIONAL ACTION PLAN FOR COMBATTING MARINE DEBRIS

Plastic is an important material that provides benefits throughout society due to its unique properties, versatility and comparatively low cost. The 'success' of plastic materials has seen their global production grow rapidly, from 156 million tonnes (Mt) in 2000 to 460 Mt in 2019 (OECD, 2022a). One major application of plastics is in the production of packaging, much of which is designed to be used only once (single-use) before becoming waste. Of the 353 Mt of plastics that became waste in 2019, only 9% was recycled (OECD, 2022a). The remainder was either incinerated, disposed of in landfills or open dumpsites, or released into the natural environment. Once in the environment, plastics do not readily decompose. Instead, they accumulate on land and in oceans, breaking down into microplastics over time. Plastic pollution (in all its forms) poses risks to ecosystems, the environment, built infrastructure and human health. Tackling this global issue requires action to be taken across the full life cycle of plastics, by increasing its circularity and improving solid waste management to mitigate its release into the environment.

The volume of solid waste and marine debris generated across Southeast Asia has rapidly increased in recent years. To address this, in November 2017, the ASEAN Conference on Reducing Marine Debris (held in Thailand) recommended an integrated land-to-sea policy approach by developing and implementing the ASEAN [Regional Action Plan for Combating Marine Debris in the Region](#) (ASEAN, 2021). Subsequently, in June 2019, the 34th ASEAN Summit adopted both the *Bangkok Declaration on Combating Marine Debris in the ASEAN Region* and the *ASEAN Framework of Action on Marine Debris*.

The ASEAN RAP was built upon other regional action plans, such as the [COBSEA Action Plan on Marine Litter 2019](#), and the United Nations Environment Programme (UNEP) [Sea Circular Project](#) to promote synergy and avoid overlapping efforts. The ASEAN RAP aims to enhance coordination at the regional and international levels and combat land and sea-based plastic pollution at three key stages of the plastic waste value chain:

- 1.Reducing plastics consumption
- 2.Increasing recycling
- 3.Minimizing leakages

The actions proposed in the ASEAN RAP are divided between four framework components: (1) Policy support and planning, (2) Research, innovation and capacity building (3) Private sector engagement, and (4) Public awareness, education and outreach. Action 7 of the ASEAN RAP falls under the research, innovation and capacity building component. It calls for the development of a *Guidebook for Common Methodologies for Assessment and Monitoring of Marine Litter*, (hereinafter referred to as the 'Guidebook').

## THE 'GUIDEBOOK'

This Guidebook outlines a common set of indicators that could be adopted by AMS to support the harmonized monitoring of plastic pollution across the ASEAN region. The indicators recommended aim to cover the full plastics life cycle, align with AMS national strategies and targets, and cover both land-based plastic pollution and marine debris. The methodologies recommended were chosen based on their suitability for informing on the indicators, allowing measurement in a harmonized manner, and being suitable for the ASEAN context and capacity. (Full justification for the indicators and methodologies recommended are provided in the [Guidebook approach of Annex 2](#)).

The Guidebook is designed to support AMS through the process of: (1) understanding the requirements for monitoring, (2) prioritizing which indicators to monitor, (3) selecting an appropriate plastic pollution assessment methodology, (4) implementing the methodology in a harmonized manner, and finally, (5) reporting the results in a way that is consistent and suitable for continual monitoring. Each of these steps is addressed systematically in the Guidebook, as shown on the [Overview page](#). Given the complex nature of these steps, and the fact that AMS may



# BACKGROUND

prioritize indicators differently, the Guidebook was designed to be interactive in its navigation, thereby only showing the information relevant to each AMS. Further explanation on how to use and navigate the Guidebook is provided in the [How to use the Guidebook](#) section.

## SCOPE

The scope of this Guidebook focuses predominantly on macroplastic pollution (as opposed to microplastics). No definitive bound is set for what constitutes a microplastic; instead, it uses the definitions set by each of the recommended methodologies. The indicators and methodologies included in this Guidebook were recommended for the ASEAN region based on their experience, resources, and requirements. As such, no guidance is provided for other regions or countries outside of the AMS. Finally, the indicators recommended relate to those where methodologies currently exist to measure them in a harmonized manner, and which provide value for monitoring plastic across the full plastic life cycle. It should be noted that while other indicators and metrics may exist and also be relevant to measure or qualitatively describe plastic pollution, methodologies may not be currently available to achieve this in a harmonized manner, or to account for the available resources. The scope of indicators covered in the Guidebook was informed by and directly linked to the [Synthesis Report: Recommendations for a Plastic Pollution Indicator Framework for ASEAN](#), adopted by the SEA-MaP PSC in August 2024.





# HOW TO USE THE GUIDEBOOK

## STRUCTURE AND NAVIGATION OF THE GUIDEBOOK

The Guidebook is presented as five steps that guide the user through the process of: (1) understanding the basics such as how to use the Guidebook, (2) selecting indicators for monitoring, (3) selecting a suitable methodology to measure the selected indicators, (4) applying the selected methodology in a harmonized manner, and (5) guiding monitoring and reporting.

Five detailed Annexes support the content: (1) Terminology and core principles, (2) Guidebook approach, (3) Review of the assessment methodologies, (4) ASEAN country profiles, and (5) References.

### Who is the Guidebook for?

This Guidebook is designed for country level plastic pollution assessment and monitoring teams. Aligned with Action 7 of the ASEAN RAP, the Guidebook underscores linkages between the RAP and diverse national targets, policies, and regulations. The Guidebook is designed for users across the AMS as a technical resource to strengthen coordinated approaches to monitoring, increase AMS knowledge and build technical capacity, and create a foundation for a cohesive approach to assessment and monitoring plastic pollution.

### How it works

The recommended approach is to begin by reading through Step 1 ('Understanding the basics') and to read the Guidebook in full. This will help users to understand all that it has to offer, including linking up concepts such as the life cycle stages, how these stages are linked to the eight Indicators selected, and how the seven Methodologies can be implemented. The five supporting Annexes will allow users to understand how the Guidebook was built, with AMS inputs, and which terminology is needed to understand the approaches presented.

How this Guidebook relates to the AMS national and regional contexts is important and is shared with users in the Annexes (See '[ASEAN country profiles](#)' and '[Guidebook approach](#)'). As this Guidebook was built upon feedback from AMS governmental and non-governmental experts, it contains the recommendations from their experiences as well as expert recommendations from previously published work on these topics adapted to the AMS context to align to Action 7 of the ASEAN RAP.

The Guidebook can be used as a regular PDF, but it is also designed to allow users to move between the overview page at the beginning, the start of each of the five steps, and between previous and next pages using the navigation buttons on the bottom left of the pages. Users are encouraged to explore how the navigation works and adapt their use accordingly. The navigation feature has been designed to enable users to adjust individual country approaches for each of the AMS contexts based on existing capacity and policy priorities. Each AMS will be different based on the existing skills and needs related to the life cycle stage, the Indicators, the Methodologies, and the Monitoring steps at the very end. Ideally, the Guidebook should be used to structure a national monitoring and assessment framework, in collaboration with all AMS, creating a forward-moving approach to plastic assessment and monitoring in the coming years.



# HOW TO USE THE GUIDEBOOK

## FURTHER SUPPORT AND CAPACITY BUILDING

### Supporting toolkits

The Supporting Toolkits are supplemental to this Guidebook and are meant to be used to support AMS in implementing the Guidebook. There are two Supporting Toolkits available:

1. An Excel based tool to help calculate budget and resource requirements for the methodologies. This displays what approximate costs could be for each methodology and requires inputs from the technical and management teams in each AMS. This tool is designed to provide a model for each AMS and would need to be integrated into annual budgeting and planning processes in each country.
2. An Excel based tool to aid AMS in reporting the indicator along with all relevant metadata. This metadata is important to facilitate a harmonized approach by allowing the context and methodological details behind the indicator to be reported alongside it.

Both Supporting Toolkits can be downloaded alongside this Guidebook from <https://seamap-asean.org/>

### Communication and dissemination materials

The communications and dissemination materials also supplement the Guidebook. The objective of the communications package is to support the wider Communications Strategy of SEA-MaP and its four main objectives as they relate to the Guidebook and Supporting Toolkits. The communication package further aims to establish unified understanding and agreement on the Guidebook's recommended indicators and monitoring methodologies across AMS. Keeping in mind [SEA-MaP's commitment](#) to "creating and institutionalizing Platforms for innovation, investment, knowledge sharing, and partnerships across ASEAN to address plastic pollution" the communications package emphasizes taking a harmonized approach to monitoring and assessment in support of national and regional goals.



The following summarizes the approach used to develop the Guidebook and Supporting Toolkits. The core component was to build an evidence-base that could be used as a foundation to recommend indicators for monitoring, as well as the most suitable methodologies for measuring these indicators. This evidence-base was developed as part of a stock-taking exercise that followed five stages, as shown in Figure 1 below:

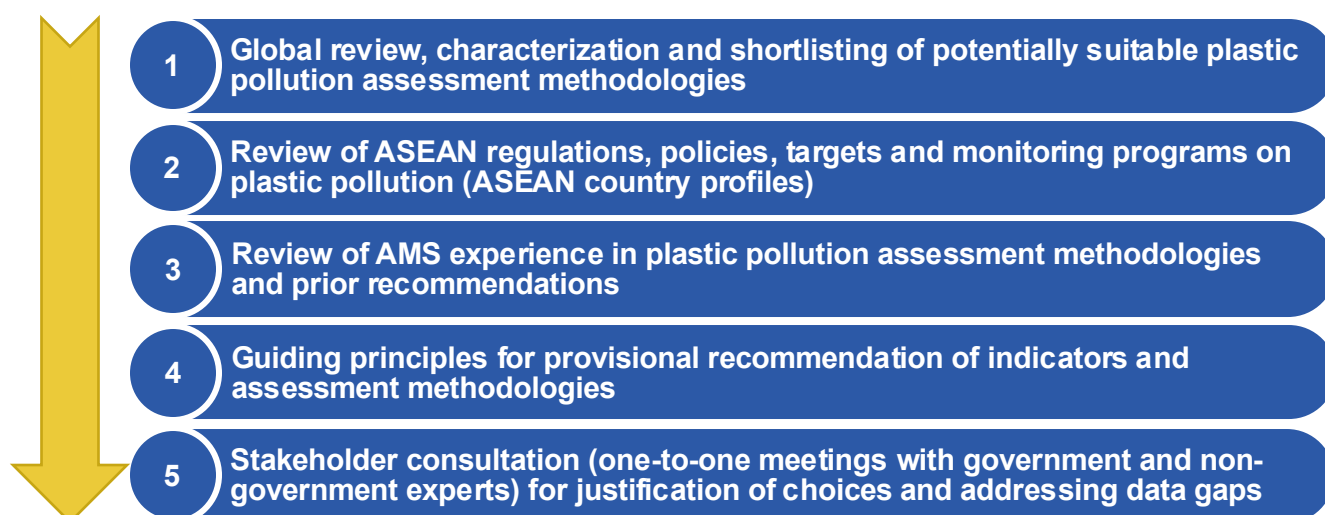


Figure 1: Methodological stages in the development of the Guidebook

## Stage 1

The first stage of the approach involved reviewing and characterizing the plastic pollution assessment methodologies that are currently available. This stock-taking and characterization of methodologies aimed to shortlist the wealth of methodologies to those that would be potentially suitable for the ASEAN region and ensure key information was collected (such as the lifecycle stage and spatial scope they operate in, the breadth of their application across the world, and the metrics they quantify). (Results of this stage can be viewed in [Annex 3](#) of this Guidebook.)

## Stage 2

The second stage involved reviewing the regulations, policies, targets and monitoring programs relating to plastic pollution for each of the 10 AMS. (This information is summarized in the 'ASEAN country profiles' and can be viewed in [Annex 4](#) of this Guidebook.) The aim of this stage was twofold. Firstly, the review of plastic pollution regulations, policies and targets was used to inform the recommendation of indicators for AMS to monitor by ensuring that these align with the on-going efforts and focus of the region. Secondly, the review of monitoring programs allowed an assessment of what is already being monitored by the AMS to complement existing efforts and understand the availability of monitoring data.

## Stage 3

To support the national efforts of stage 2, an additional review was performed that focused on high-level regional recommendations (such as those produced for COBSEA) and scientific best practices. (Details of this are provided in the Guidebook approach of [Annex 2](#).)

## Stage 4

The information from stages 1 – 3 shaped the creation of the 'guiding principles', which inform and justify the chosen recommendation of indicators and accompanying assessment methodologies. For example, indicators were recommended based on alignment with the monitoring needs of the AMS and value that they provided in tackling plastic pollution across its full lifecycle. Likewise, the guiding principles shaping the recommendation of



methodologies included the suitability of the methods to measure the indicators in a harmonized way, and the experience and capacity of AMS to implement them.

## Stage 5

The Guidebook was developed collaboratively with AMS. This was achieved by holding one-to-one meetings with AMS governments and non-governmental experts. These consultations aimed to: fill any data gaps from stage 1 – 3, introduce the recommended indicators and methodologies from stage 4 and obtain feedback on them, and get suggestions for where additional technical support and capacity building may be required to finalize the development of the Guidebook's accompanying Supporting Toolkits.

### Note:

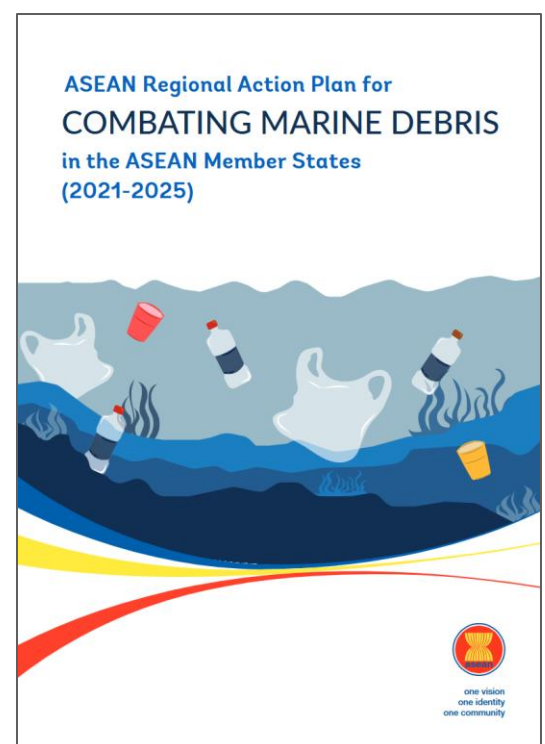
A core part in the development of the Guidebook was to ensure that existing efforts, needs and resources of the AMS were accounted for. Whilst the Guidebook achieves this, it is important to recognize that further capacity building and support may be required to fulfil all the monitoring recommendations that the Guidebook establishes. The use of proxy data has been incorporated, where possible, to facilitate widespread immediate monitoring whilst additional capacity is developed; however, this has limitations for long-term monitoring.

## Accounting for the needs, resources, context and existing efforts of the ASEAN region

The ASEAN region has been at the forefront of efforts to tackle plastic pollution. This was exemplified in 2019, with the ratification of the *ASEAN Regional Action Plan (RAP) for Combatting Marine Debris in the ASEAN Member States* (Figure 2). This collaborative effort aims to enhance coordination at the regional and international levels and combat land and sea-based plastic pollution across its full life cycle. This Guidebook forms a core action of the ASEAN RAP. The Guidebook's aim to achieve a harmonized approach for monitoring plastic pollution is pioneering, particularly given scientific developments on monitoring plastic pollution are still in their infancy.

To date, much of the core scientific development, testing and pilot scale implementation of macroplastic pollution assessment methodologies has focused on the ASEAN region (see review of methodologies in [Annex 3](#)). AMS have also been key drivers in the adoption of plastic pollution regulations, policies, targets and monitoring programs, as evidenced by the ASEAN country profiles in [Annex 4](#).

Whilst these efforts should be commended, there is also recognition that methodologies and data collection across the ASEAN region have often been highly segmented, which has inhibited harmonization. Additional challenges around data availability, reliability, and resource constraints were highlighted as barriers to harmonization in the one-to-one stakeholder consultations with AMS ([Annex 2](#)).



**Figure 2: The ASEAN Regional Action Plan for Combatting Marine Debris in the ASEAN Member States (2021 – 2025) (ASEAN, 2021)**





To overcome these existing barriers to harmonization, there is a need to adapt data collection and assessment techniques to ones using consistent scientific methodologies. Whilst this will undoubtedly require extra effort from the AMS, it also provides a unique opportunity for countries to come together and adapt their segmented approaches to plastic pollution to create a truly, harmonized approach. On the other hand, it is also important to build upon the already established experience, data and technical capacity AMS have amassed.

This Guidebook attempts to integrate both these requirements, as outlined in the ‘guiding principles’, which justify the recommendation of indicators and methodologies in this Guidebook (see ‘Guidebook approach’ of [Annex 2](#)). For example, while the Guidebook recommends new primary data collection to support harmonized, long-term monitoring, it also considers the needs, resources, local context, and existing efforts of the AMS when defining the recommended approach. This includes:

- Selecting indicators that align with countries’ targets, policies, monitoring programs, and strategic goals; and
- Recommending methodologies based on their suitability for the ASEAN region, including:
  - Accounting for the often-limited resource availability of government departments;
  - Considering unique ASEAN cultural contexts (e.g., presence of informal recycling sector); and
  - Building on the existing experience of AMS in using assessment methodologies—four of the seven recommended methodologies have already been applied extensively in the ASEAN region. (The remaining three are relatively new, which explains the limited experience.)

## The use of a phased approach and proxy data

It is unlikely that AMS can operationalize the monitoring of all eight indicators immediately, despite the above accommodations. This would likely be true for any region in the world, as developing regional harmonized monitoring takes time to build technical capacity, regardless of the resource availability. To support the AMS in monitoring indicators as quickly possible, a phased approach is recommended (see [prioritizing indicators page](#)). The phased approach is one where ‘proxy data’ can be initially utilized to immediately report on the recommended indicators for the solid waste management stage. (Unfortunately, proxy data is not available for the remaining three indicators as there are either no available alternative proxies, or they rely on measuring plastic in the environment and, therefore, no proxies are suitable.)

This phased approach would enable AMS to report on over 60% of the recommended indicators in a harmonized way, whilst technical capacity and resources are established for monitoring either the remaining indicators or to replace the use of solid waste management proxies. Given the existing AMS experience with these methodologies—and recognizing that the use of secondary data proxies is not a viable, nor recommended long-term strategy—this transition to primary data collection and monitoring is expected to be achievable within a reasonable timeframe.

If adopted, this Guidebook paves the way for the ASEAN region to pioneer widespread harmonized monitoring of plastic pollution using primary data collection methods that follow systematic scientific methodologies. Such an approach is crucial for supporting countries in the fight against plastic pollution.



# STEP 2: SELECTING INDICATORS FOR MONITORING



# STEP 2: SELECTING INDICATORS

The second step of the Guidebook focuses on the selection of indicators to monitor. (For further guidance on understanding what is referred to in this Guidebook as an indicator, please see the [Terminology](#) annex.) There are three components to Step 2 that should be navigated in order. Firstly, [Step 2.1](#) provides an overview of the eight available indicators, how they are distributed across the plastics life cycle and how they link to AMS targets and strategies. (Details on how these eight indicators were recommended is provided in the [Guidebook approach](#) annex.) [Step 2.2](#) describes each of the eight indicators in turn at a high level of detail to demonstrate the value provided by the indicator for mitigating plastic pollution. [Step 2.3](#) guides users on how to prioritize indicators in resource constrained contexts.

## OVERVIEW OF INDICATORS

Click to visit



- Overview of the 8 indicators
- Distribution of indicators by plastics life cycle
- Links to AMS targets & strategies

2.1

## DETAILED GUIDE TO INDICATORS

Click to visit



- Value provided by indicator
- Variations and sub-indicators
- Units and scale

2.2

## PRIORITIZING INDICATORS

Click to visit



- Five questions to help users prioritize indicators to monitor.

2.3

## NEXT STEP

Click to visit



- Proceed to Step 3: Selecting an assessment methodology



# INDICATOR OVERVIEW

The Guidebook recommends eight indicators for monitoring, with brief descriptions of each listed below. Click on an indicator for more detailed insight. Although eight indicators are recommended, it may not be feasible or high priority for every AMS to measure all indicators. (For further guidance on prioritizing the indicators to monitor, please see the '[Prioritizing of indicators](#)' section.)



[Click for more info.](#)

## INDICATOR 1: Plastic consumption

**Life cycle stage:** Production, trade, distribution, sale and consumption  
**Unit:** kg/capita/year  
**Scale:** National  
**Description:** Measures the mass of plastics used on a per-capita basis in a country



[Click for more info.](#)

## INDICATOR 2: Plastic waste generation rate

**Life cycle stage:** Waste management  
**Unit:** kg/capita/year  
**Scale:** Local or National  
**Description:** Measures the mass of plastic generated as waste per person in a year



[Click for more info.](#)

## INDICATOR 3 Municipal solid waste collection coverage

**Life cycle stage:** Waste management  
**Unit:** %weight of MSW generated  
**Scale:** Municipal or National  
**Description:** Measures the proportion of municipal solid waste (MSW) by weight that is collected by formal and informal sectors



[Click for more info.](#)

## INDICATOR 4 SDG11.6.1 - MSW collected and managed in controlled facilities

**Life cycle stage:** Waste management  
**Unit:** %weight of MSW generated  
**Scale:** Municipal or National  
**Description:** Measures the proportion of MSW by weight that is collected and managed in 'controlled' facilities (e.g., landfills)



[Click for more info.](#)

## INDICATOR 5 Municipal plastic recycling rate

**Life cycle stage:** Waste management  
**Unit:** %weight of MSW plastic generated  
**Scale:** Municipal or National  
**Description:** Measures the proportion of municipal plastic waste by mass that is sorted for recycling compared to that generated



[Click for more info.](#)

## INDICATOR 6 Municipal plastic emissions to environment

**Life cycle stage:** Waste management & Pollution  
**Unit:** kg/capita/year  
**Scale:** Municipal or National  
**Description:** Measures the mass of municipal plastic waste that becomes unmanaged in the environment per person in a year



[Click for more info.](#)

## INDICATOR 7 Plastic riverine flux

**Life cycle stage:** Pollution  
**Unit:** items/hour  
**Scale:** Local (River)  
**Description:** Measures the number of plastic items transferring down a river at a given reference location



[Click for more info.](#)

## INDICATOR 8 Plastic debris density on land

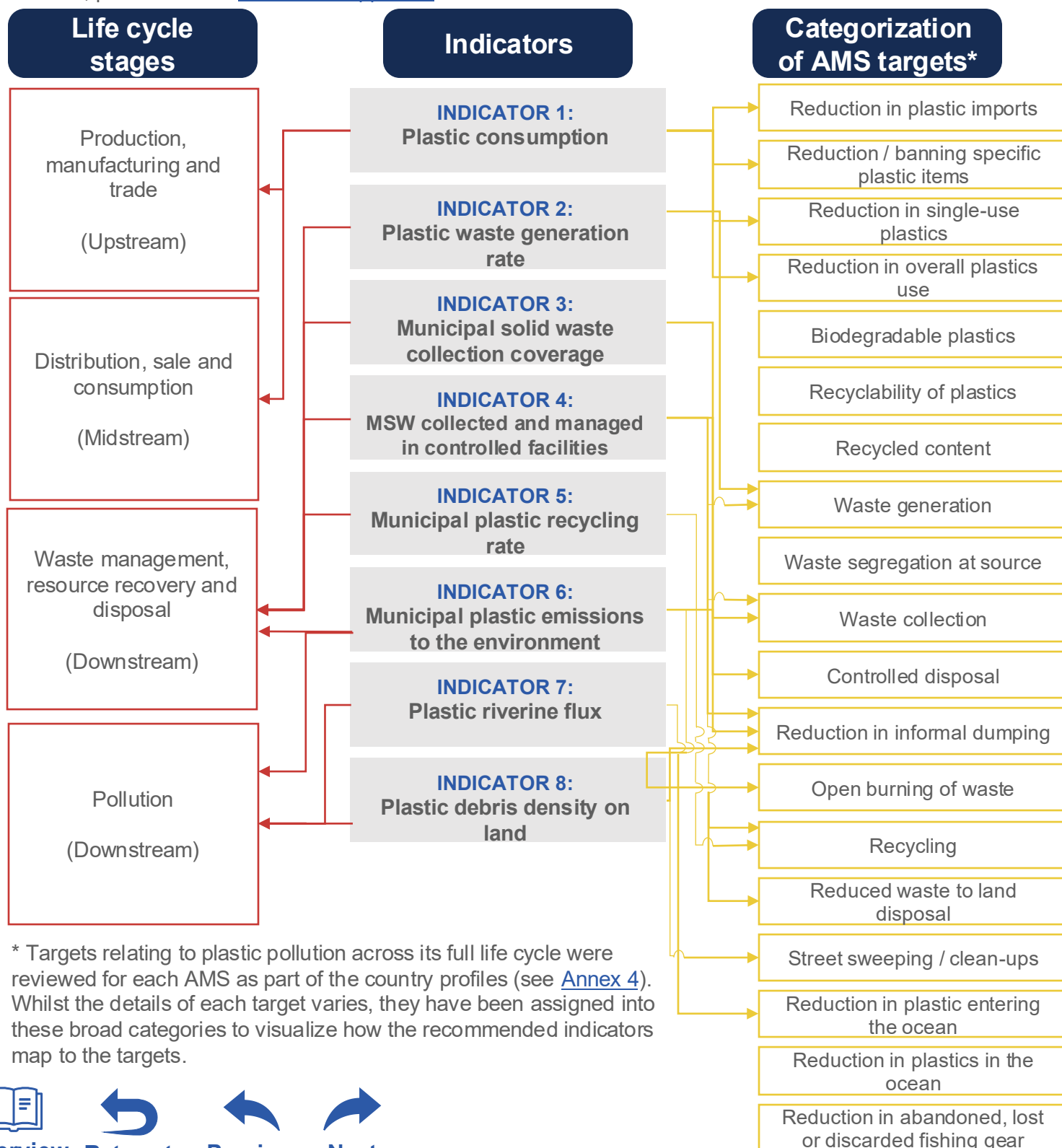
**Life cycle stage:** Pollution  
**Unit:** items/m<sup>2</sup>  
**Scale:** Local / Provincial  
**Description:** Measures the accumulation of plastic items in the terrestrial environment (on land and riverbanks)



# INDICATOR OVERVIEW

## DISTRIBUTION OF INDICATORS BY LIFE CYCLE STAGE AND BY AMS TARGETS

The eight indicators span the full plastics life cycle and cover the majority of AMS's official quantitative targets. Therefore, it is anticipated that the monitoring of the indicators will assist AMS in evaluating progress towards their targets. One way AMS may prioritize which indicators to monitor is by selecting those that inform on targets relevant to their country. Further guidance is provided in the [Prioritizing Indicators](#) section. For a detailed breakdown of the targets, strategies and monitoring programs of the AMS, including mapping these to the eight indicators, please see the [Guidebook approach](#) annex.





# INDICATOR 1

## PLASTIC CONSUMPTION

### Description of indicator

The use of plastics globally has grown from 156 million tonnes (Mt) in 2000 to 460 Mt in 2019 (OECD, 2022a). If current growth rates and policies continue, plastic use is projected to triple by 2060 to an estimated 1,321 Mt (OECD, 2022b). Plastics cause pollution throughout their full life cycle (Jambeck and Walker-Franklin, 2023). Plastic reduction is therefore a potential solution to mitigate this pollution in all forms, although other interventions across the life cycle will likely be required in combination with plastics reduction to have meaningful impact (Lau et al., 2020).

Indicator 1, 'plastic consumption', aims to provide a broad assessment of the quantity of plastics in use in an economy. This indicator is associated with the upstream life cycle stages of 'plastic production and trade' and 'distribution, sale and consumption'. When monitored over time, the indicator can be useful to assess trends in overall plastics usage. Similarly, the broad scope of this indicator provides value in that it aims to account for all plastic used in a country across all major sectors, applications and occurrence alongside other materials (e.g. products made with a combination of materials of which plastic is one element, such as electronics).

The actual quantity of plastics consumed in a country is challenging to measure. As such, a proxy called 'apparent consumption' is often used to estimate the actual consumption. Apparent consumption accounts for the quantity of plastics imported into a country, domestically produced in the country and exported out of the country over a given period, typically a year, as shown in equation 1:

$$\text{Apparent consumption} = \text{Imports} + \text{Domestic Production} - \text{Exports} \quad (\text{Eq. 1})$$

'Apparent consumption' is only a proxy for actual consumption, as it does not include any stocks of material, such as surplus production of plastic items carried over from previous years.

### Value provided by indicator

As explained above, the main value provided by the 'apparent consumption' indicator is that it gives a broad picture of the total quantity of plastics used (consumed) in an economy, across all sectors and applications. AMS would therefore find this indicator useful to assess how widely used plastics are in their country and to monitor policies or targets related to reducing the production and use of plastics. This indicator can also help assess the potential significance of plastic pollution beyond macroplastics and marine debris (e.g., impacts related to chemicals of concern, greenhouse gas emissions, and the release of primary microplastics). Unlike the other indicators recommended in the Guidebook, this indicator is naturally suited to direct measurement at the national level due to the reliance of trade data in the apparent consumption formula.

A further merit of this indicator is the fact that the methodologies used to calculate the apparent consumption formula (see '[Selecting a method](#)' section) are often able to distribute plastic consumption between polymer types, sectors (e.g., packaging, construction) and in some cases item types (e.g. plastic bags). This stems from the data inputs being primarily derived from the use of Harmonized System (HS) codes or Custom Procedure Codes (CPC). When data is available at such a resolution, it allows for specific insights on polymers, sectors, and item types to be monitored (for e.g., the reduction in plastic packaging).

### Challenges associated with Indicator

A holistic approach is required when monitoring plastic pollution that covers all plastic life cycle stages. As discussed in the 'value provided by this indicator' section, Indicator 1 provides a broad overview of plastic consumption at the upstream stage, which can be useful to assess how plastics are being used in a country, and therefore inform policy decisions. However, this indicator is not always a useful proxy to understand the amount or sources of any macroplastic pollution or marine plastic debris. For example, Indicator 1 incorporates sectors such as building and construction or industrial machinery in its measurement where the chances of macroplastic



# INDICATOR 1

release into the environment are less relevant than other sectors, such as plastic packaging. As such, care should be taken on how the results of this indicator are generalized.

Additional challenges associated with this indicator relate to the data requirements of the methodologies used to measure it. As discussed previously, these methodologies typically rely on trade data, which are complex and were originally collected by statistical agencies to measure the monetary value of goods and services. As a result, users often must convert data reported in monetary terms into mass-based estimates using market- and product-specific conversion factors, a process that can be both complex and time-consuming.

Further challenges arise in determining the proportion of plastic within traded items. This is particularly relevant for multi-material products (e.g., laptops), where plastic represents only one of several constituent materials, as well as for packaged goods, where trade statistics may report the combined mass of both the product and its packaging (e.g., imported bottled water, which include the mass of both the plastic bottle and the water).

## **Related / alternative metrics**

There are additional metrics related to Indicator 1 for upstream monitoring, such as the amount of plastics imported and exported over a set period (trade statistics), domestic production of plastics, and apparent consumption by polymer type and by sectors, such as packaging, building and construction, and industrial applications. The indicator can additionally be extended to estimate plastic waste generation by assigning product lifetimes to each item and sector. Such information may be useful to identify consumption patterns of plastic (e.g., single-use plastics) and inform initiatives such as Extended Producer Responsibility and sustainable production, design and consumption.



# INDICATOR 2

## PLASTIC WASTE GENERATION RATE

### Description of indicator

The Basel Convention defines “wastes” as “substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law” (Basel Convention, 2012). Waste can be categorized in several ways, for example, the type or fraction of the waste (such as plastic, paper, glass etc.), the source or origins of the waste (such as municipal solid waste, construction and demolition, industrial, etc.), and its character (e.g., hazardous).

Indicator 2, ‘Plastic waste generation rate’, is used to assess the rate at which plastic becomes waste. The value measured for this waste generation rate depends on what sectors it includes (e.g., municipal solid waste, building and construction waste, industrial waste). In this Guidebook, Indicator 2 measures plastic waste generation in relation to municipal solid waste (MSW), as this waste stream has the most direct link to macroplastic pollution in the environment.

This indicator can be measured on in absolute terms (e.g., tonnes of plastic waste), but often it is more useful for monitoring and comparison with others to normalize this either to a per capita basis or by the amount of MSW generated (% of MSW). The unit of measurement should always be clearly specified and reported alongside the indicator.

### Value provided by indicator

This indicator can be useful for designing solid waste management plans and strategies for which data on waste generation is central. For example, this foundational information proves invaluable for designing comprehensive solid waste management plans and strategies by ensuring that infrastructure and resources are appropriately scaled to handle actual waste flows. However, it is also important to remember that plastic waste is unlikely to exist in isolation and instead will likely be mixed with other waste materials (e.g., as a fraction of MSW, or within a source segregated recycling stream). Therefore, solid waste management planning should consider the full waste stream, of which plastic is one element.

Depending on the measurement methodology employed, this indicator can deliver insights into specific plastic item categories, including bags, bottles, and single-use plastics that are entering the waste stream. For instance, waste characterization exercises are often employed to obtain this information. This data enables evidence-based policy interventions to be designed or improved, such as bans, specialized collection systems, extended producer responsibility schemes, and public education campaigns.

Data on plastic waste generation rate is also useful to inform AMS strategies and targets related to reducing (plastic) waste generation. This metric can also help establish a clear baseline for measuring SDG progress by aligning with the SDG 12.5 target of substantially reducing waste generation through prevention, reduction, recycling and reuse by 2030.

### Challenges associated with indicator

Several challenges exist when using this indicator. If measuring MSW plastic generation through waste characterization studies (as discussed later under [Methodology 2](#)), the data can typically only be collected at a local level, making extrapolation to national estimates challenging, though still possible. These waste characterization studies are also resource-intensive, particularly when monitoring requires large scale sampling or detailed item-level composition categories. While household waste characterization studies are designed to measure representative samples effectively, extending this methodology to other MSW sources like commercial and institutional waste proves more difficult due to the large variation in establishment sizes and types, making representative sampling harder to achieve.

### Related / alternative metrics

Municipal plastic waste generation is often measured alongside the overall municipal solid waste; therefore, the MSW generation rate is a closely align indicator. Whilst this Guidebook recommends the units of kg/capita/year for the plastic waste generation rate indicator, this can also be converted to a percentage of municipal solid



# INDICATOR 2

waste, as is also commonly reported. This proportion can also be further distributed by the types of plastic items being generated (e.g., the single-use plastic waste generation rate, or the percentage of sachets in the plastic waste). These alternative metrics can provide insights to improve waste management strategies and help in the design of effective upstream and downstream interventions. Likewise, for effective waste management planning and resource optimization in the AMS countries, comparing overall MSW generation rate with plastic waste generation per capita allows for targeted interventions (including targeted geographic areas of intervention) to reduce waste, improve recycling, and promote sustainable consumption patterns.



## MUNICIPAL SOLID WASTE COLLECTION COVERAGE

### Description of indicator

Waste collection services are provided across the ASEAN region by both the formal and informal sectors (e.g., waste pickers), typically a combination of the two. The proportional reach of these services is referred to as the 'collection coverage'. Indicator 3 – municipal solid waste (MSW) collection coverage measures the extent of these collection services in relation to MSW. Ideally, the indicator is measured based on the mass of MSW collected compared to the total mass of MSW generated. Occasionally, however, other units are measured such as the geographical extent of collection services compared to total area of a municipality, or the proportion of the population (or households) with collection services compared to the total population (or number of households). The methods proposed in this Guidebook for measuring MSW collection coverage suggest to use the unit of weight % (i.e. mass of MSW collected divided by the mass MSW generated) to most accurately reflect material flows that are also measured on a mass basis. Any deviation from this unit should be clearly stated to enable harmonization and wider comparison.

### Value provided by indicator

Uncollected waste is the largest source of plastic pollution globally (Cottom et al., 2024). Waste which is not collected must be self-managed by the generator of the waste. Often this leads to direct pollution via informal dumping (sometimes this is also referred to as illegal dumping; however, we refrain from using this terminology here as residents without waste collection often have no alternatives than to dump or burn their waste, openly burning the waste, or burying it self-dug pits). The lack of waste collection is therefore directly linked to the level of plastic pollution.

Given the importance of uncollected waste as a source of plastic pollution, it becomes obvious that measuring the quantity and locations of this source are crucial for mitigating plastic pollution. Indicator 3, municipal solid waste collection coverage, is the inverse of uncollected waste and is therefore useful for measuring the amount of uncollected waste. AMS may also find this indicator useful to aid in the design of municipal solid waste management system plans. This is particularly the case if the indicator is measured at a local level (with subsequent aggregation to national level) as it can aid in selecting locations and municipalities where collection services should be extended.

Aspirations for a circular economy are difficult to achieve without effective initial waste collection. Moreover, even small gaps in collection coverage can result in significant plastic pollution. Therefore, Indicator 3 is valuable for prioritizing targeted interventions.

### Challenges associated with indicator

Collection coverage is typically measured at a local (municipal level). One challenge with this indicator is that measuring it at the national level requires a method to extrapolate the local level measurements. Where municipal-level data is not consistently collected / reported, or where data gaps are common, such extrapolation introduces uncertainty.

Indicator 3 on collection coverage also uses the total mass of MSW as the denominator. However, it is challenging to measure this total waste as much of the waste may never be collected by formal routes. When waste generation is measured at the point of disposal — as is often the case due to resource restraints that limit source-based waste characterization studies — only collected waste is captured, resulting in artificially high estimates of collection coverage. Consequently, reliable measurement of waste collection coverage requires a corresponding and reliable estimate of total waste generation. Where this is not feasible, proxy measures (such as the proportion of households with access to collection services) may be used, although these proxies may have inherent limitations.

Collection coverage, as defined for Indicator 3, is in relation to MSW, but this can sometimes be challenging to measure in practice as waste sources are often mixed. This is particularly the case if the measurement of collected waste come from recordings at a disposal site where trucks may be arriving from non-municipal sources, have a combination of sources collected, or come from a neighbouring municipality.





# INDICATOR 3

For the most accurate measurement of uncollected waste, the collection coverage should ideally include both formal and informal sector collection contributions (such as door-to-door collection by waste pickers / itinerant buyers). However, the informal sector activities are rarely measured, and it is challenging to do so at a high level of accuracy. As such, it is typical for only the formal sector of the collection coverage to be measured. The informal sector activities may instead have to be modeled, although uncertainty is generally high.

## Related / alternative metrics

Municipal solid waste collection coverage can be measured in multiple units. This Guidebook recommends reporting collection coverage on a weight percentage:

- Municipal solid waste collection coverage (% of geographical area)
- Municipal solid waste collection coverage (% of population served)
- Municipal solid waste collection coverage (% of households served)

These alternatives are useful because they provide a nuanced understanding of how well a community is being served by waste collection services, allowing also for enhanced approaches to waste collection. Assessing efficient collection methods and routes in underserved areas (urban vs rural) may also prove useful to AMS countries when monitoring this indicator. Additionally, metrics related to the presence of source segregated collection may also prove useful for the design and implementation of recycling systems.



# INDICATOR 4

## MSW COLLECTED AND MANAGED IN CONTROLLED FACILITIES

### Description of indicator

Indicator 4 measures the Sustainable Development Goal (SDG) 11.6.1, defined as the “proportion of municipal solid waste collected and managed in controlled facilities out of total municipal solid waste generated” (UN-Habitat, 2021). This indicator aims to give an overview of the performance of a solid waste management system in preventing plastic pollution. It incorporates the MSW generation, collection, recovery and disposal aspects, with the latter two also distributed by controlled and uncontrolled facilities, as shown in the Figure 3 below:

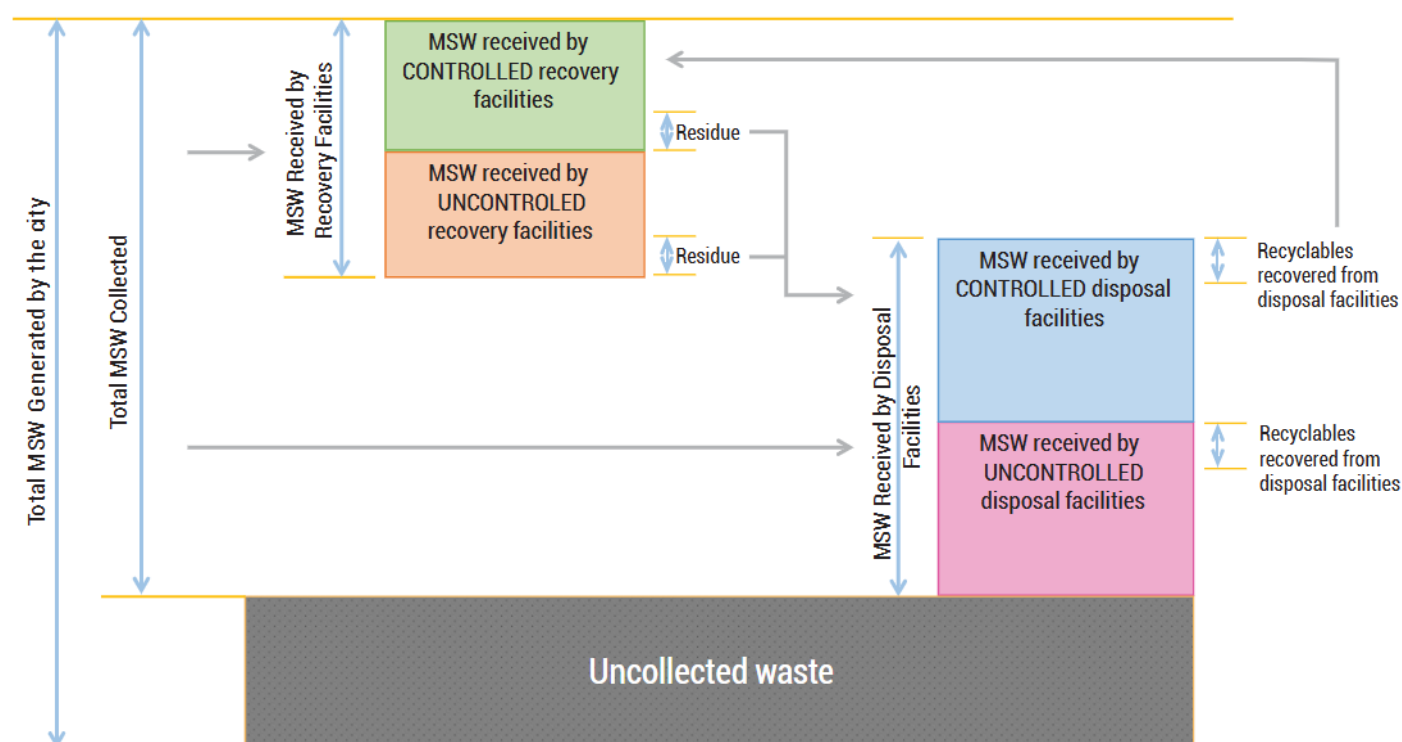


Figure 3: Schematic of the components measured in the Waste Wise Cities Tool (UN-Habitat, 2021)

Indicator 4, SDG 11.6.1 is calculated as:

$$\text{SDG 11.6.1} = \frac{\text{Total MSW collected and managed in controlled facilities}}{\text{Total MSW generated}} \times 100 \quad (\text{Eq. 2})$$

### Value provided by indicator

The value of this indicator is that it provides a single measure of the performance of a MSW system. It captures the key parts of the waste management chain relating to plastic pollution including waste generation, collection coverage, and the degree of control exercised at treatment and disposal facilities. This indicator also offers other advantages over the more commonly used measure of ‘mismanaged waste’, which is ill-defined and open to interpretation. By contrast, this indicator sets clear, measurable criteria for what constitutes ‘controlled’ management when measured using the Waste Wise Cities Tool (a recommended methodology of this Guidebook, as discussed more under Methodology 2). Furthermore, its positive framing and focus on what is “managed in controlled facilities” (rather than what is “mismanaged”) creates a constructive foundation for setting targets and ambitions, encouraging progress toward improved waste management outcomes rather than simply highlighting deficiencies in existing systems.



# INDICATOR 4

## Challenges associated with indicator

This indicator poses a few challenges in that it requires both Indicators 2 and 3 to be measured, including extending Indicator 3 to all MSW generation, rather than just plastic generation. Measuring recovery can also be challenging as it often includes contributions from both the formal and informal sectors. Finally, this indicator is typically measured at a municipal level, so therefore would require a method to extrapolate it to the national level for reporting.

## Related / alternative metrics

The measurement of Indicator 4 provides an opportunity to also report on several sub-metrics that can offer targeted insights into specific components of these systems. These include:

- MSW generated
- MSW collected
- MSW recovered by controlled / uncontrolled recovery facilities
- MSW received by controlled / uncontrolled disposal facilities



# INDICATOR 5

## MUNICIPAL PLASTIC RECYCLING RATE

### Description of indicator

Indicator 5 measures the proportion of municipal plastic waste generation that is recycled. It is linked to SDG 12.5 definition, "the quantity of material recycled in the country plus quantities exported for recycling minus material imported intended for recycling out of total waste generated in the country" (UN Stats, 2024). Recycling in this case includes codigestion/anaerobic digestion and composting/aerobic process but not controlled combustion (incineration/waste to energy) or land application. The recycling rate indicator does not differentiate between how the material was initially collected; therefore, both formal and informal sector collection for recycling are included in the assessment. This said, users may choose additional metrics to quantify these separately.

### Value provided by indicator

Recycling plays a crucial role in the transition towards a circular economy. Therefore, monitoring this indicator provides valuable information on progress towards achieving circularity and can aid countries to plan waste collection and recycling schemes. This indicator may also help inform the national recycling rate for SDG 12.5, (although it should be noted that it does not directly align given that SDG 12.5 covers all waste fractions rather than just plastic). When combined with Indicator 1, this indicator may also enable comparison of quantities domestically recycled versus those imported or exported.

The indicator strongly aligns with ASEAN priorities for monitoring as all AMS have targets or national action plans / strategies related to recycling in some form, as documented in the ASEAN country profiles shown in [Annex 4](#).

### Challenges associated with indicator

The recycling value chain is complex and can involve several steps of material sorting, refinement, processing and rejection. The point in this value chain where the recycling rate is measured can have a large impact on the value reported. The recycling rate is ideally measured based on the material leaving the reprocessing stage at which point the material is reprocessed into new products or converted to a form to be sent to manufacturers (Figure 4). Measuring earlier in the value chain, such as based on the amount collected for recycling, is likely to include material which will be rejected during sorting, and therefore not recycled. Data is not always readily available across the value chain; therefore, any values reported should clearly state the point at which they were measured to facilitate comparison and harmonization.

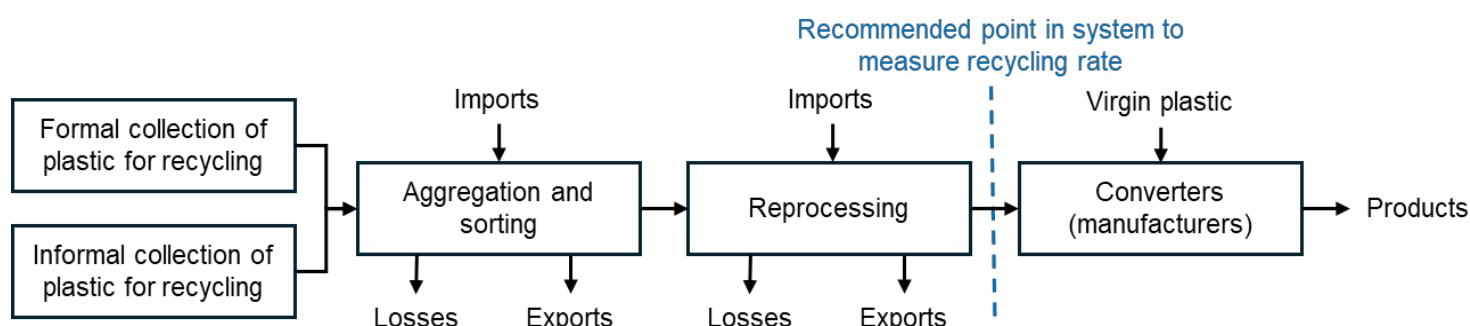


Figure 4: Plastic reprocessing diagram showing the recommended point in the system for measuring the plastic recycling rate is based on the mass leaving the reprocessing stage.



# INDICATOR 5

## MUNICIPAL PLASTIC RECYCLING RATE

The informal sector collects significant amounts of plastics for recycling in the ASEAN region with this material to be included in the calculation of the plastic recycling rate. However, data on the informal sector is often lacking, making it difficult to understand how much the informal sector contributes. This means that estimates must rely on modeling to fill this data gap. In practice, informally collected waste becomes integrated into the formal collection system the further along the recycling chain it goes. As such, care must also be taken to ensure that the material is not being double counted when measuring at different points in the system.

### Related / alternative metrics

There are several related metrics to the municipal plastic recycling rate. Firstly, the national MSW recycling rate is closely aligned, although it covers all waste fractions rather than plastics alone. In addition, some methodologies recommended in this Guidebook enable differentiation between formal and informal sector contributions to material collected for recycling. Accordingly, sub-metrics may include separate formal and informal (plastic) recycling rates. These sub-indicators can be expressed as percentages to facilitate comparison with the overall recycling rate.



# INDICATOR 6

## MUNICIPAL PLASTIC EMISSIONS TO THE ENVIRONMENT

### Description of indicator

Plastic emission is defined as “plastic material that has moved from the managed or mismanaged systems (in which waste is subject to a form of control, however basic; contained state) to the unmanaged system (the environment; uncontained state) with no control” (Cottom et al., 2024), as illustrated in Figure 5. Accordingly, Indicator 6, ‘Municipal plastic emissions to the environment’, measures the rate at which plastic pollution enters the environment from the plastic fraction of municipal solid waste.

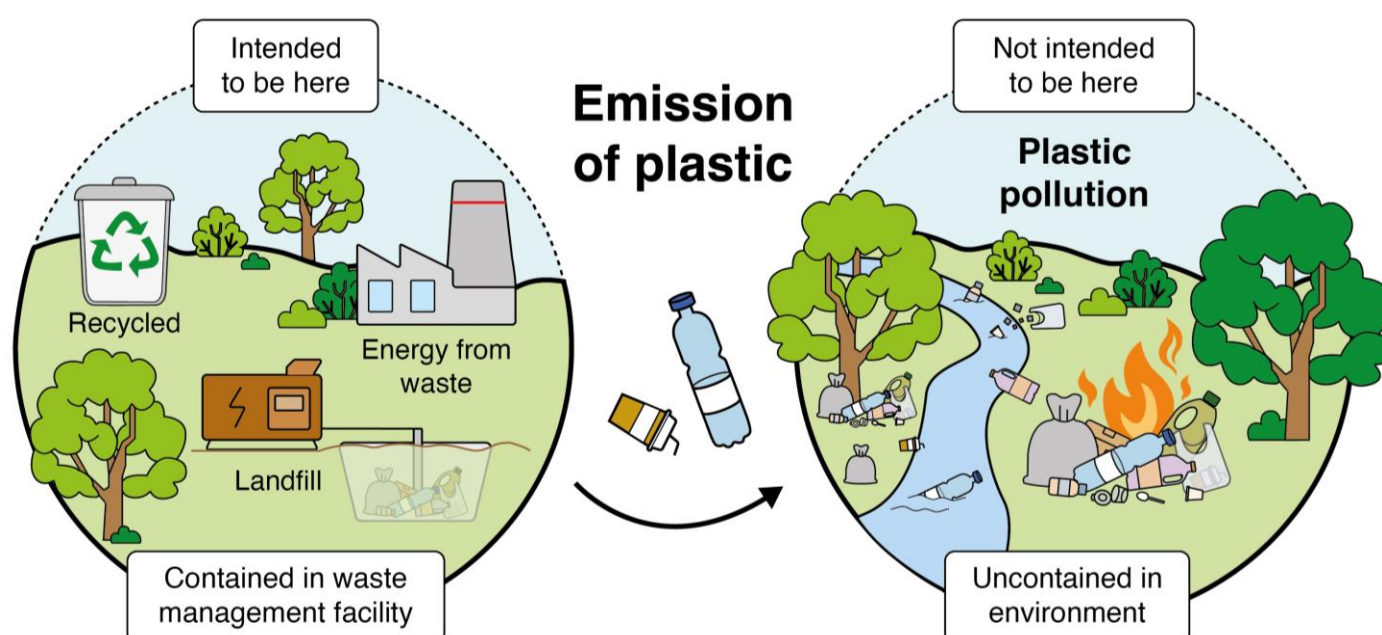


Figure 5: Illustration of a plastic emission (Source: Cottom et al., 2024)

‘Plastic emission’ is similar in definition to ‘plastic leakage’; however, emission includes both debris emissions (physical items) and open burned emissions (mass of plastic burned in open uncontrolled fires). In contrast, the term ‘plastic leakage’ has been used inconsistently throughout literature (e.g., plastic entering terrestrial environment, plastic entering oceans, plastic going to open dumpsites) and has predominantly only referred to the debris element of plastic emission. Similarly, ‘plastic emission’ differs from the widely used term ‘mismanaged plastic waste’. Plastic emission excludes material that remains contained within open dumpsites and instead include only waste that leaks from such sites (e.g., wind-blown debris, openly burned waste) and becomes uncontrolled in the environment. Although open dumpsites are considered mismanaged from a municipal solid waste perspective (i.e., not aligned with good environmental practice), waste material within an open dumpsite is unlikely to move to other areas of the environment. (Further detailed descriptions of all terminology is available in the [‘Terminology’](#) annex.)

### Value provided by indicator

This indicator measures the rate of plastic pollution in the environment and distinguishes between the sources of plastic pollution (e.g., blown from dumpsites, uncollected waste, littering). This provides countries with crucial information to understand what the most problematic sources and locations of plastic pollution are, and where interventions should be directed, as a result. Furthermore, this indicator can also distinguish between whether the plastic pollution is in the form of plastic debris (physical items) or openly burned plastic. Both types of pollution are important to consider but have very different consequences and solutions. Understanding this distinction aids in designing effective interventions.





## MUNICIPAL PLASTIC EMISSIONS TO THE ENVIRONMENT

This indicator also allows for the creation of an emission inventory (which is widely used in fields such as climate change) to monitor emission sources and track progress toward mitigating the pollution. Such an inventory provides a structure for monitoring and improves transparency and harmonization of data reporting.

### Challenges associated with indicator

Empirical measurements of the rate of plastic emission by different sources are not available. This is partly due to the difficulty of linking plastic found in the environment back to its emission source. Certain types of plastic pollution, such as open burning, are equally hard to quantify; due to the material having been combusted, it is no longer available for observation when performing field surveys. To overcome these challenges, emission factors (the rate of emission per source) must be largely modeled or assumed, leading to high uncertainty. Although this lack of empirical evidence is a concern, tools such as material flow analysis and conceptual modeling can be used to understand approximate emission factors, as recommended within this Guidebook.

### Related / alternative metrics

Related metrics for Indicator 6 include 'plastic debris emissions' (physical plastic items), 'openly burned plastic emissions', and 'plastic emissions by format' (rigid plastics vs flexible plastics). Plastic debris emissions can help make a connection between plastic found in the environment and its potential source, whereas openly burned plastic emissions can be used to estimate the release of air pollutants and greenhouse gases emissions. Plastic emissions can also be quantified by the emission source and by format of the plastic (rigid plastics vs flexible plastics) using the methodologies recommended in this Guidebook. Units of kg/capita/yr can be used for these alternate metrics to align with Indicator 6.



## MACROPLASTIC RIVERINE FLUX

### Description of indicator

Rivers are regarded as the major conduit by which plastic travels from the pollution sources on land to oceans. Indicator 7 - 'Plastic riverine flux', measures the amount of plastic moving down a river over a given period of one hour. The indicator is measured at a sub-national (river basin) level rather than national level; however, AMS can monitor multiple rivers if required and as resources allow. Further details of how to choose rivers to sample are discussed alongside the recommended methodology for measuring this indicator. Indicator 7 enables an assessment of how polluted the sampled rivers are. When measured close to a river's estuary, this indicator can be used as a proxy for the amount of plastic entering the ocean and can therefore demonstrate the river's contributions to marine plastic litter.

### Value provided by indicator

Many AMS have targets related to reducing marine litter or plastic entering oceans. This indicator allows for an assessment of the rate of plastic entering oceans if done close to an estuary, and considering major limitations as explained in the 'Challenges associated with Indicator' section below. The indicator may prove useful for AMS wanting to understand how polluted rivers are within their country, or for identifying locations where interventions can be directed (for e.g., river booms, clean-ups or improvements to the surrounding areas solid waste management system). Depending on the method selected to monitor this indicator, it may be possible to understand the type of plastic items in the rivers. This information may be useful for identifying upstream solutions targeted at problematic and prevalent item types.

Furthermore, Sustainable Development Goal, Target 14.1 notes: "by 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution". Therefore, monitoring for Indicator 7 is potentially useful for monitoring progress towards this SDG. By monitoring flux at different times in the year, it is also possible to track the impact of climate and hydrological conditions (e.g., monsoon season) or assess the impact of time-limited events such as religious festivals.

### Challenges associated with indicator

Although measuring this indicator close to a river estuary can provide a proxy for the amount of plastic entering oceans, it should be noted that there are also major limitations with this approach. For instance, estuaries can have complex hydrological flow patterns based on the tides (Schreyers et al., 2024). If the indicator is measured within this tidal zone, it is possible for measurements to record plastic flowing upstream. Additionally, estuaries have been found to readily accumulate plastic (Kurniawan and Imron, 2019, Schreyers et al., 2024); therefore, measurement of the indicator upstream of an estuary does not necessarily mean all the plastic enters the ocean. River obstructions (e.g. dams), or riparian vegetation such as hyacinths, have also been found to act as sinks for plastic (Schreyers et al., 2021). Measurement of the indicator after such obstructions can potentially lead to artificially low measurements of the plastic pollution.

Practical challenges also exist with this indicator. The methodologies for measuring plastic riverine flux vary from simple observation of floating plastic, to complex automated monitoring using cameras and artificial intelligence (van Lieshout et al., 2020). The choice of methodology often depends on resources available and objectives of the assessment; however, comparison between these methods can be challenging. For example, if the indicator is measured with a visual observation method, then it will only record floating plastic debris; however, if it is measured using river booms or nets, then sub-surface plastic debris may also be measured. Variations of plastic flux by the time of year, or even day-to-day can also be drastic, making reliable sampling and wider harmonization challenging.

Lastly, although the information obtained from the indicator can be useful for identifying hotspots for plastic movement or problematic items, it is challenging to relate this pollution back to the source activity that caused it to enter the environment in the first place. Major forms of plastic pollution, such as openly burned plastic, cannot be monitored via this indicator.



## MACROPLASTIC RIVERINE FLUX

### Related / alternative metrics

Sub-indicators for macroplastic riverine flux can also potentially be measured depending on the exact methodology used. For example, floating plastic riverine flux is a sub-metric that quantifies the visible plastic pollution at the surface of rivers and can be measured using observation techniques (as discussed more in the [‘How to apply the methodologies’](#) section). Sub-surface plastic riverine flux measures hidden underwater plastic transport and can be significant but typically requires the use of nets to sample. As discussed above, if Indicator 7 is measured close to a river’s estuary, it may also allow the estimation of plastic flux to oceans, which is essential for mitigating ocean plastic pollution. Lastly, the composition of plastic riverine flux is a further sub-indicator that can be measured alongside Indicator 7 and identifies the types of plastic in waterways. This can be useful for creating targeted, item-level prevention strategies and policy interventions.



## PLASTIC DEBRIS DENSITY ON LAND

### Description of indicator

‘Plastic debris density on land’ refers to the physical concentration of plastic items / pieces on land. This indicator differs from Indicator 6 (plastic emissions into the environment) as it measures the accumulation of plastic on land over a specified area (i.e., a density) measured in items per m<sup>2</sup>, whereas Indicator 6 records the rate at which plastic enters the environment measured in mass per time (e.g., tonnes/year). This indicator therefore allows a measurement of how polluted an area is from historic plastic emissions. Other environmental compartments such as rivers and oceans may also be measured alongside Indicator 8. However, for the purposes of this Guidebook, only the land compartment is recommended given that Indicator 7 already focuses on the riverine compartment. The size of plastic items that are counted toward this indicator depend on the specific methodology used.

Measurement of this indicator usually involves sampling in the environment. As such, Indicator 8 is typically recorded at a sub-national / local level, although this can be extended to multiple locations if resources allow.

### Value provided by indicator

Indicator 8 provides a measurement of the current levels of plastic pollution on land at a given moment in time. This is useful for understanding how polluted the land is with plastic, which in turn helps identify potential risks to ecosystems, public health and infrastructure. If the indicator is measured across multiple sites or a large enough area, it also allows for the identification of hotspot areas which can be prioritized for action, including remediation efforts.

Recording the composition of plastic waste in the environment during sampling can provide additional value by helping AMS understand what the most polluted and problematic items are. Such information can be used to develop upstream interventions that mitigate the emission of the item to the environment in the first instance (e.g., bans, EPR schemes, educational campaigns). Monitoring of plastic debris density on land can also aid in understanding if progress is being made to end plastic pollution and directly aligns with AMS targets around ending plastic pollution. As such, this indicator can be used to inform the success of initiatives and policies put in place to tackle plastic pollution.

### Challenges associated with indicator

A core challenge with this indicator is ensuring that a representative sample is measured in the environment. This is made more difficult by the fact that plastic is not homogeneously distributed in the environment. Instead, plastic tends to become aggregated at certain locations more than others. This can be due to meteorological conditions (e.g., wind blowing waste a certain direction), land use factors (e.g., plastic being entangled in vegetation), or to humans selectively dumping waste in certain locations (e.g., informal dumpsites). Therefore, careful selection of the sampling site, accounting for factors such as land use, are required to ensure representativeness of the sampling. As with all sampling, there is always an inherent trade-off between effort and accuracy.

Similarly to Indicator 7 – ‘Plastic riverine flux’, Indicator 8 is also unable to easily identify the source of the pollution; therefore, the interventions that can be recommended from it are potentially limited to those that focus on identified problematic items. Other challenges with measuring this indicator include accounting for seasonal fluctuations in pollution levels, with plastic generally accumulating on land during dry-seasons, before being washed by rivers into oceans during rainy seasons. Physical sampling in the environment can also miss the less visible sources of pollution, such as dumping on private and inaccessible land, or the open burning of waste.

### Related / alternative metrics

Related sub-metrics include the composition of plastic debris as a percentage of overall plastic. This is typically measured alongside Indicator 8 (if resources allow) and can be used to identify problematic items or categories with a high propensity to become pollution. Depending on the method, sub-indicators on the pollution levels by land use can also be measured, or analysis performed to link pollution to infrastructure or policies.



## HOW TO PRIORITIZE THE INDICATORS TO MONITOR?

Although eight indicators are recommended for monitoring as part of this Guidebook, it is unlikely that all AMS have the capability to monitor all eight to begin with. Instead, indicators should be prioritized. Such prioritization will allow AMS to begin monitoring the indicators most useful or achievable for them in the beginning, whilst additional capacity development and support is assembled for monitoring the remaining indicators.

A phased approach is recommended to be used when resource constraints are the main limiting factor to all indicators being monitored. A phased approach that maximizes the reporting of indicators is as follows:

**Phase 1:** Indicators 2-6 are monitored by using existing estimates from the SPOT model (see [Methodology 5A](#)); therefore, no resources are required for primary data collection and sampling, and indicators can be immediately reported as a result.

**Phase 2:** An indicator is selected for monitoring based on national priorities for reporting on a particular lifecycle phase or activity. The five questions presented below should be discussed internally by each of the AMS to help decide how to prioritize monitoring of the indicator(s) for their own unique needs.

**Phase 3:** The monitoring of indicators is gradually expanded as resources and expertise permit, until all indicators are monitored.

Prioritizing indicators in this phased way allows for immediate reporting of most indicators (>60% of indicators) while capacity for monitoring of the other indicators is established.

### What capacity do we already have in implementing the methodologies recommended for the indicator?

Read the stocktaking analysis in the '[Guidebook approach](#)' annex to help answer this question.

### How do the indicators align with our national targets and monitoring requirements?

See how the indicators map to current AMS targets and national strategies in the stocktaking analysis of the '[Guidebook approach](#)' annex.

### Do we have the resources and expertise to monitor the indicator?

Read the '[Overview of Methodologies](#)' section to help answer this question.

### What value do the indicators provide toward our national strategies?

Read the '[Indicator overview](#)' section to help answer this question.

### FIVE QUESTIONS FOR PRIORITIZING INDICATORS



### Can the methodology employed to measure this indicator be used to simultaneously measure other indicators?

See Step 3, '[Selecting a Methodology](#)' section to help answer this question.



# STEP 3: SELECTING A METHODOLOGY





# STEP 3: SELECTING A METHODOLOGY

The third step of the Guidebook focuses on the selection of methodologies. Each of the seven methodologies in this Guidebook are explained in the Overview of Methodologies section. Each methodology includes a description of where it is used in the life cycle stage (from production to waste management to pollution), its scale (local, provincial, or national), which of the eight indicators the methodology maps to, and the methodology developer. In the detailed '[overview](#)' pages, the methodologies are explained including discussion of data requirements. This will help users select the most appropriate methodology for monitoring a chosen indicator.

There are three components to Step 3 that should be navigated in order. Firstly, [Step 3.1](#) provides an overview of the methodologies, data requirements, and which indicators they measure. [Step 3.2](#) provides an illustration of how each methodology links to an Indicator and the scale of reporting. Finally, [Step 3.3](#) provides a decision tree to support AMS in selecting the most appropriate methodology for monitoring an indicator.

## OVERVIEW OF METHODOLOGIES

[Click to visit](#)



- Overview of the recommended methodologies
- Scale of methodology
- Indicators measured

3.1

## MAPPING METHODOLOGIES

[Click to visit](#)



- Illustration of how the recommended methodologies map against the indicators

3.2

## SELECT A METHODOLOGY

[Click to visit](#)



- Decision trees guiding user on how to select a methodology

3.3

## NEXT STEP

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- Proceed to Step 4: How to apply the methodologies



[Overview page](#)



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# OVERVIEW OF METHODOLOGIES



[Click for more info.](#)

## METHODOLOGY 1 Apparent Consumption of Plastic

**Life cycle stage:** Production & trade,  
Distribution, sale & consumption,  
Waste management  
**Scale:** National  
**Indicators:** Indicators 1 – 2  
**Developer:** UNITAR & UNEP



[Click for more info.](#)

## METHODOLOGY 2 Waste Wise Cities Tool

**Life cycle stage:** Waste management  
**Scale:** Local (Municipal)  
**Indicators:** Indicators 2 – 5  
**Developer:** UN-Habitat



[Click for more info.](#)

## METHODOLOGY 3 Waste Flow Diagram

**Life cycle stage:** Waste management  
**Scale:** Local (Municipal)  
**Indicators:** Indicators 2 – 6  
**Developer:** Deutsche Gesellschaft für  
Internationale Zusammenarbeit (GIZ)



[Click for more info.](#)

## METHODOLOGY 4 Material Flow Analysis Toolkit

**Life cycle stage:** Waste management  
**Scale:** Local (archetype) to National  
**Indicators:** Indicators 2 – 5  
**Developer:** Basel Convention



[Click for more info.](#)

## METHODOLOGY 5 SPOT Model

**Life cycle stage:** Waste management, Pollution  
**Scale:** Local (municipal) to National  
**Description:** Indicators 2 – 5  
**Developer:** University of Leeds (Cottom et. al.,  
2024)



[Click for more info.](#)

## METHODOLOGY 6 Riverine Macroplastic Flux Methodology

**Life cycle stage:** Pollution  
**Scale:** Local (riverine)  
**Indicators:** Indicator 7  
**Developer:** European Commission Joint Research  
Centre (JRC) (González-Fernández  
and Hanke, 2017)



[Click for more info.](#)

## METHODOLOGY 7 CSIRO Survey Methodology <sup>1</sup>

**Life cycle stage:** Pollution  
**Scale:** Local to Provincial  
**Indicators:** Indicator 8  
**Developer:** Commonwealth Scientific and  
Industrial Research Organisation  
(CSIRO) – (Schuyler et al., 2017)

1. The 'COBSEA Marine Litter Monitoring Methods Handbook', Part I outlines different approaches used internationally for monitoring plastic pollution. As part of this, the 'CSIRO Survey methodology' (CSIRO Global Plastic Leakage Baseline Project) is recommended as one of the preferred approaches for the ASEAN region. A detailed explanation of the CSIRO Survey methodology is presented as part of the COBSEA Marine Debris Monitoring Methods Handbook, Part II.



# OVERVIEW OF METHODOLOGIES

**Table 1: Recommended methodologies and indicators on which they inform, including a brief description and data requirements**

| Methodology                                                                                                                                       | Description                                                                                                                                                                                                                     | Data requirements                                                                                                                          | Indicators measured                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Apparent Consumption of Plastics Methodology (as included in UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle) | Used to estimate the amount of plastic goods (e.g. single-use plastics) consumed                                                                                                                                                | Requires data on mass of international trade and domestic production of plastic                                                            | 1. Plastic consumption                                                                           |
| Waste Wise Cities Tool (WaCT)                                                                                                                     | Methodology for understanding the amount/type of waste generated in a city and how it is managed (e.g., collected, recycled, disposed)                                                                                          | Data collected from performing waste characterization studies in cities and surveying waste facilities                                     | 2. MSW plastic generation                                                                        |
| Waste Flow Diagram (WFD)                                                                                                                          | Local-level methodology using material flow analysis and visual observation assessment of infrastructure to estimate plastic leakage (emission)                                                                                 | Uses WaCT data and visual observation assessments                                                                                          | 3. MSW collection coverage<br>4. SDG 11.6.1 - MSW collected and managed in controlled facilities |
| Basel, Rotterdam, Stockholm (BRS) Material Flow Analysis (MFA) Methodology                                                                        | Performs material flow analysis (MFA) to map how waste is managed at a national level. Can be combined with the Waste Wise Cities Tool, which acts as local data collection                                                     | Requires data on waste generation, composition, collection and plastic waste management across three 'archetypes' (e.g. City, Town, Rural) | 5. Plastic recycling rate                                                                        |
| SPOT Model                                                                                                                                        | Similar in scope to the BRS MFA methodology, but provides more detailed outputs, including plastic emissions into the environment. Can be combined with the Waste Wise Cities Tool or a countries existing solid waste database | Requires data on waste generation, composition, collection and management at a local (municipal) level                                     | 6. Plastic emissions to environment                                                              |
| Riverine Macroplastic Flux Methodology                                                                                                            | Estimates the amount of plastic in rivers by visual counting of items from bridges                                                                                                                                              | Data collected by visual observation.                                                                                                      | 7. Plastic riverine flux                                                                         |
| CSIRO Survey Methodology                                                                                                                          | Uses transect surveys on land, beaches, and riverbanks to estimate the amount of plastic debris in the environment                                                                                                              | Data collected from transect surveys.                                                                                                      | 8. Plastic debris density on land                                                                |



## APPARENT CONSUMPTION OF PLASTICS METHODOLOGY

### Methodology background

The consumption of a product and material within an economy (e.g., country or region) is often approximated in a top-down manner using a proxy known as the ‘apparent consumption’. Apparent consumption differs from actual consumption as it does not include any stocks of material, for example, surplus production of a plastic item from previous years. Apparent consumption is often easier to calculate as it aligns with data commonly collected by a country and follows the formula:

$$\text{Apparent consumption of products} = \text{Production} + \text{Imports} - \text{Exports} \tag{Eq. 3}$$

Each variable in the equation above is measured on a mass basis (such as tonnes) and is calculated over the period of a year.

In relation to plastics, calculation of apparent consumption follows the same generic formula; however, an additional challenge is that a distinction needs to be made to account for the fact that plastic occurs across many types of products and can be made into products that are solely produced from plastic (e.g., plastic bags) or multi-material products, in which plastic is only one component (e.g., laptops, which contain plastic in components, such as the casing and keyboard, alongside other materials such as metal and glass). Additionally, statistics commonly collected on production and trade use inconsistent categorization of products making harmonized inclusion of data in the apparent consumption method challenging.

To overcome these challenges, the ‘Plastic Key’ framework was developed by the United Nations Institute for Training and Research (UNITAR), as introduced by the Basel Convention and United Nations Environment Programme (UNEP, 2022). The Plastic Keys framework allows harmonization between data collected from statistical departments on plastic production and trade by categorising products into 59 categories across eight market sectors (Table 2). It further enables the conversion of total product weights into estimates of plastic content only.

The Plastic Keys framework has been recently incorporated into the UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle (UNEP & UNITAR, 2026). This methodology provides the most up-to-date guidance on calculating apparent consumption of plastic as well as extending this to map plastic flows across the full plastic life cycle. Although these UNEP Guidelines cover the full plastics life cycle, this Guidebook recommends alternative approaches for harmonized assessment of plastic pollution in downstream life cycle stages (i.e. waste management onwards) to ensure harmonization. As such, it is recommended that the UNEP Guidelines only be used for calculation of the apparent consumption of plastic indicator (Indicator 1). If required, the measurement of Indicator 1 can optionally also be extended to measure plastic waste generation (Indicator 2); however, this measurement would cover plastic waste generation from all sectors (shown in Table 2) and therefore is not equivalent to plastic waste generation calculated for the municipal waste stream using Methodologies 2-5. As such, we do not recommend that Indicator 2 (plastic waste generation) be measured using this methodology.

**Table 2: Market sector classifications used in Plastic Keys Framework (Wagner & Baldé, 2022)**

| No. | Market sector description         |
|-----|-----------------------------------|
| 1   | Packaging                         |
| 2   | Transportation                    |
| 3   | Building and Construction         |
| 4   | Electrical/ Electronic            |
| 5   | Consumer & Institutional Products |
| 6   | Industrial Machinery              |
| 7   | Textiles                          |
| 8   | Other                             |

# OVERVIEW: METHODOLOGY 1

## APPARENT CONSUMPTION OF PLASTICS METHODOLOGY

### Summary of data requirements

Calculation of Indicator 1 – plastic consumption requires data on the following:

- Data on the domestic production of plastic.
- Data on the international trade (import and export) of plastic.

Data on domestic production of plastic is typically classified by Central Product Classification (CPC) codes and recorded via surveys conducted by national statistics departments. Plastic production can include:

- Plastic in primary forms (e.g., polymers of ethylene – such as CPC V2.1 Group 347 ‘Plastic in primary forms’)
- Plastic in semi-finished products (e.g. products produced that are typically used as inputs to produce other products – such as CPC V2.1 Group 363 ‘Semi-manufactures of plastics’)
- Plastic in finished products (e.g. plastic products for final consumption, including both ‘pure’ plastic products and plastic containing products – such as Group 364 ‘Packaging products of plastics’ )

Data on international trade of plastic is typically collected as part of trade statistics and recorded based on Harmonized Commodity Description and Coding System (HS) codes and/or Standard International Trade Classification (SITC) codes. Data may be available through statistical departments of via the [UN Comtrade Database](#).



# OVERVIEW: METHODOLOGY 2

## WASTE WISE CITIES TOOL (WACT)

### Methodology

The Waste Wise Cities Tool (WaCT) was developed by UN-Habitat and partners in 2021 as part of the Waste Wise Cities program. It aims to provide a step-by-step guide to assess a City's Municipal Solid Waste Management Performance through monitoring of Sustainable Development Goal 11.6.1. SDG 11.6.1 measures the proportion of municipal solid waste collected and managed in controlled facilities. This SDG is reported as a percentage of the total municipal solid waste generated by the city.

Measuring municipal solid waste management performance also has ties to many other SDGs, for example:

- Access to basic services (Target 1.4)
- Eliminate dumping to improve water quality (Target 6.3)
- Food waste (Target 12.3)
- Chemicals and hazardous waste, including e-waste (Target 12.4)
- Recycling (Target 12.5)
- Marine litter (14.1). In addition, two closely related targets look at Domestic material consumption and material footprint (Targets 8.4 and 12.2)

WaCT is a data collection methodology that was designed to support cities with limited resources collect crucial data on municipal solid waste management. The principle of the methodology is that waste is measured across different parts of the system to build up a holistic picture of the municipal solid waste management. [Introductory videos](#) on the Waste Wise Cities Tool are available for further information.

### Summary of data requirements

WaCT is a data collection methodology; therefore, the data requirements discussed here relate to the types of data that need to be measured during the fieldwork. This includes:

- **Household waste characterization studies** to measure waste generation and composition
- **Non-household MSW** to measure generation and composition from commercial establishments (shops, hotels, markets etc.), institutions (schools, government buildings, hospitals etc.) and public waste (parks, public spaces etc.) (A proxy can be used to substantially reduce the effort required to measure non-household MSW.)
- **MSW received by recovery facilities and control level of recovery facilities** to quantify aspects such as material collected for recycling, informal recycling sector, sorting rejects and operational practices
- **MSW received by disposal facilities and control level of disposal facilities** to quantify aspects such as amount of MSW arriving at disposal sites and control levels of disposal sites
- **Waste composition at disposal facilities**
- Data on the **demographics** of the city

Details on how to collect and process the above data is provided in the WaCT User Manual (UN-Habitat, 2021) (Figure 8). Further guidance is available through the Waste Wise Cities Data Portal, available at: <https://unh.rwm.global/>. This includes information on:

- Previous case studies and city reports
- An interactive 'Data Collection Application' (DCA)
- Frequently asked questions



Figure 6: Waste Wise Cities Logo (UN-Habitat, 2021)



Figure 7: Links between solid waste management and Sustainable Development Goals (UN-Habitat, 2021)

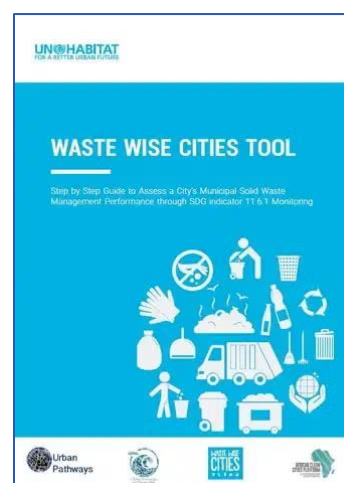


Figure 8: Waste Wise Cities Tool User Manual (UN-Habitat, 2021)



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# OVERVIEW: METHODOLOGY 3

## WASTE FLOW DIAGRAM (WFD)

### Methodology background

The Waste Flow Diagram (WFD) was developed by GIZ, University of Leeds, Eawag-Sandec, Wasteaware and David Newby Associates (DNA) in 2020. The WFD is a material flow analysis methodology designed to allow rapid assessments of a city's municipal solid waste flows and plastic leakage (emission). A unique observational based approach is used to quantify leakages whereby the assessor observes what infrastructure and practices are being used to handle waste throughout the SWM system. These observations then link to emission factors using structured decision trees.

The WFD is the most widely applied macroplastic pollution assessment methodology to date with >200 applications globally. There is a wide community of practitioners to call upon that can share their experiences using it, as well as extensive training material and support. Training material includes a detailed user manual (Figure 10), training videos (Figure 11) and a user forum – all available through <https://wfd.rwm.global/>. A [WFD data portal and application](#) has also been developed to allow easier application of the WFD and sharing of results.

Aside from measuring plastic leakage and MSW flows in a city, the WFD also includes a '[measures catalogue](#)' that provides high-level suggestions of possible interventions that may help reduce plastic leakage depending on the dominant sources. Outputs of the WFD include a material flow analysis diagram for each of the main waste fractions, a simplified Sankey diagram showing the main fates of material, and a summary of key indicators for the city, including plastic emissions (Indicator 6).

### Summary of data requirements

Data is required on two components:

1. Data on municipal solid waste management in the city
2. Observation data on infrastructure and practices used in the city

Data for component 1 can be collected using the Waste Wise Cities Tool, for which the WFD is integrated, or secondary data can be used. Specific data requirements include:

- City population
- Waste generation rates
- Waste composition
- Quantities and composition of waste arriving at disposal sites
- Quantities and composition of waste collected for recycling by the formal and informal sector
- Reject rates from formal and informal sorting facilities
- Level of control of sorting and disposal facilities

Observational data requirements are relatively simple: users are only required to do fieldwork to understand the types of infrastructure and practices used to handle waste and identify where waste is commonly found in the environment.



Figure 9: Waste Flow Diagram logo

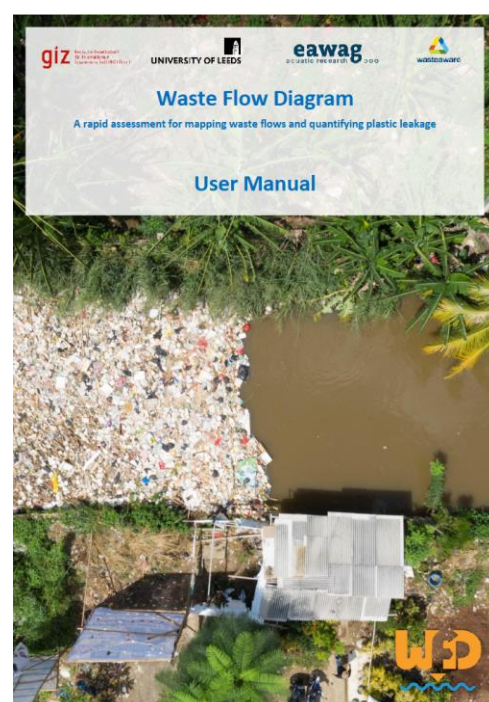


Figure 10: Waste Flow Diagram User Manual (GIZ et al., 2020)



Figure 11: Screenshot of the WFD training videos



# OVERVIEW: METHODOLOGY 4

## BRS MATERIAL FLOW ANALYSIS TOOLKIT

### Methodology background

The Material Flow Analysis (MFA) Toolkit was developed by Resource Futures on behalf of the Basel, Rotterdam Stockholm (BRS) Convention in 2021. The methodology aims to quantify waste flows and plastic leakage at the national level. Its principle for measuring at the national level is to split a country up into three archetypes:

1. Mega – Large metropolitan urban areas
2. Medium – Smaller urban areas
3. Small – Small towns and rural areas

The methodology is structured around the Waste Flow Diagram, although it has some deviations such as an adjusted MFA diagram (Figure 13), inclusion of imports and exports, only quantifying plastic waste flows, and the archetypal nature of aggregating to the national level. Although the BRS MFA methodology can measure plastic leakage (emissions), we do not recommend it be used for this purpose due to challenges with harmonization and extrapolation of visual observations to the national level.

The model is developed using Microsoft Excel and can be downloaded along with the accompanying user manual (Figure 12) from the [Basel Convention](#).

### Summary of data requirements

Data requirements focus on municipal solid waste management data and demographics for each of the three archetypes, for example:

- Population
- Waste generation rates
- Proportion of plastic in MSW
- Quantities of plastic waste arriving at disposal sites
- Quantities of plastic collected for recycling by the formal and informal sector
- Plastic reject rates from formal and informal sorting facilities
- Mass of plastic imports and exports

Either secondary data or primary data collection (preferred) can be used.

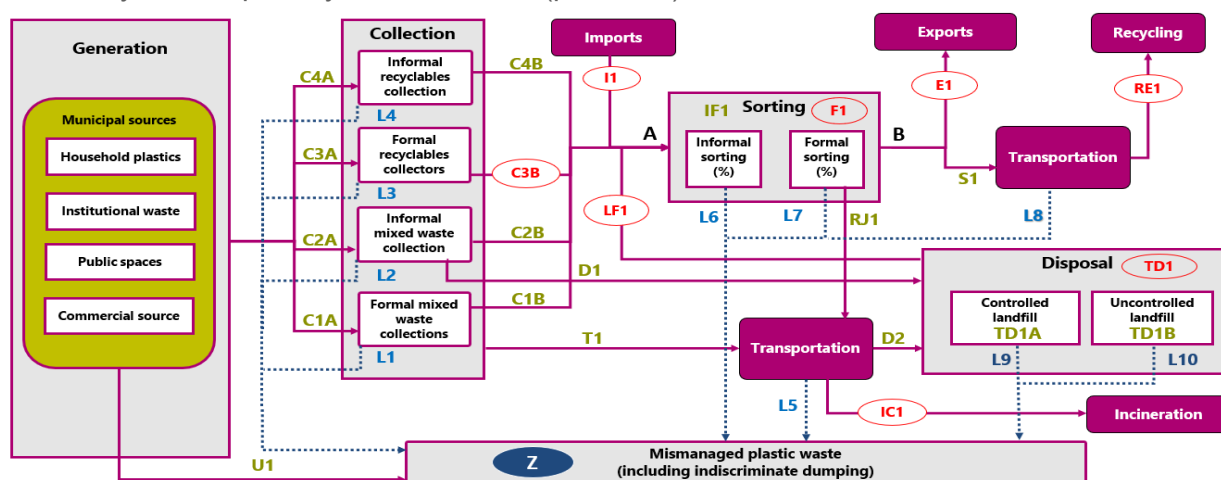


Figure 13: Material Flow Analysis (MFA) diagram used in the BRS MFA methodology (Pisharody and Lerpiniere, 2021)

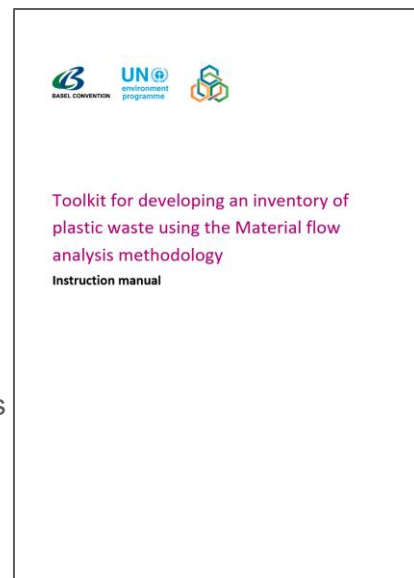


Figure 12: User manual for the BRS Material Flow Analysis methodology (Pisharody and Lerpiniere, 2021)



# OVERVIEW: METHODOLOGY 5

## SPOT MODEL

### Methodology background

The 'Spatio-temporal quantification of plastic pollution origins and transport' (SPOT) model was developed at the University of Leeds and released in 2024 (Cottom et al., 2024). SPOT is a material flow analysis model that maps the flows of municipal solid waste (including quantification of Indicators 2-5), and emissions of plastic into the environment (Indicator 6). A unique feature of SPOT is that it is a local-to-global model whereby results are calculated for every municipality in a country, before aggregating these to the national level or beyond.

A global application of SPOT was implemented by the methodology developers (Cottom et al., 2024) for the year 2020. Machine learning was used to fill data gaps (Figure 14) thereby providing estimates of municipal solid waste management and emissions for over 50,000 municipalities across all countries in the world.

The SPOT model can be used in two ways:

- A. Existing results from the global application of the SPOT model can be used as proxies when resources and data availability is limited. These results will be periodically updated by the methodology developers.
- B. SPOT can be applied for a country when data on solid waste management is available at a municipal level.

Further details of both types of application are discussed in [Step 4: Apply Methodology](#) section.

### Summary of data requirements

If existing estimates of SPOT are being used, no data is required. If SPOT is to be applied to a new country case study, data is required on solid waste management (SWM) at a municipal level (waste generation rates, collection coverage, controlled disposal, energy from waste, formal recycling, etc.), such as that collected through a national SWM database.

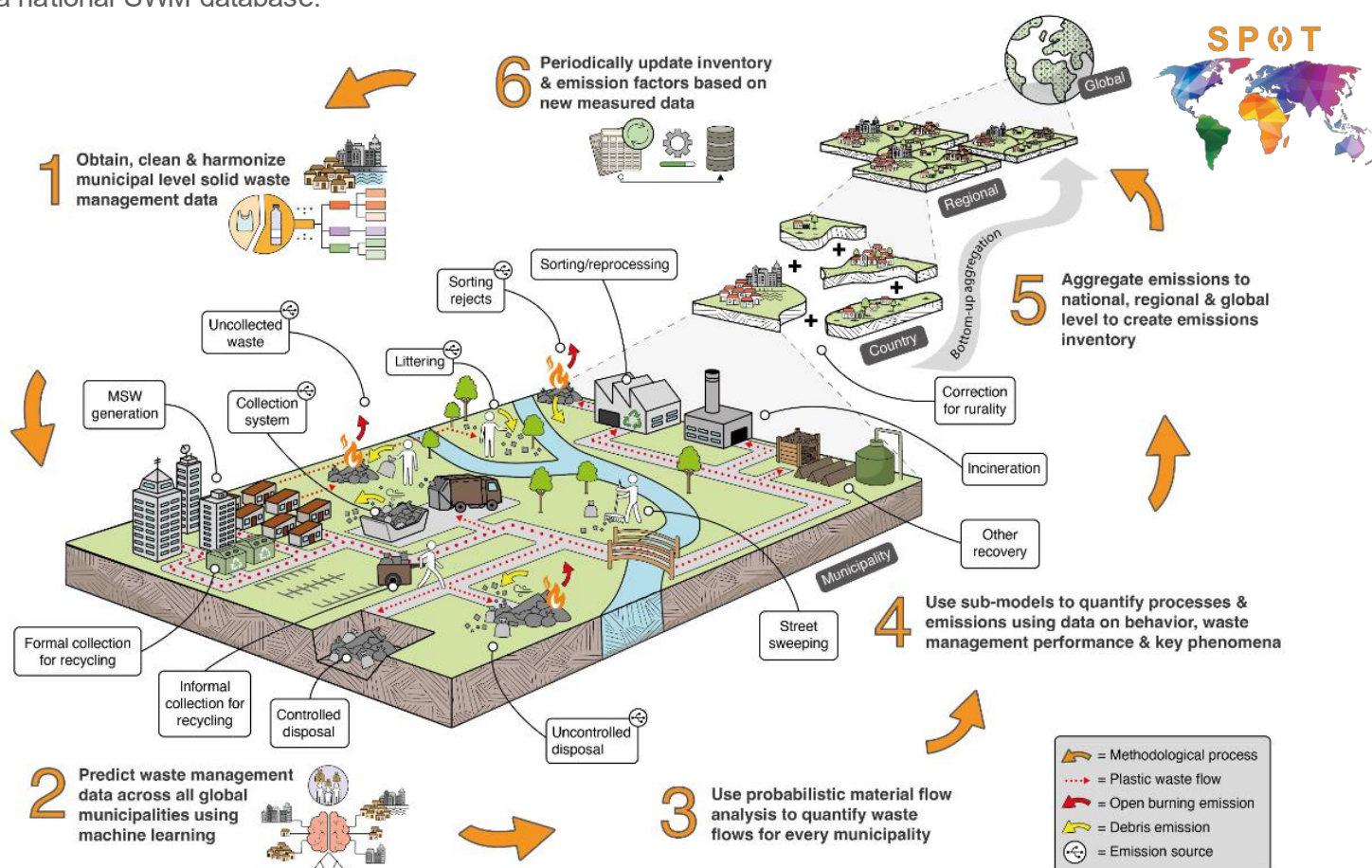


Figure 14: Methodological steps for the global implementation of the SPOT model (Cottom et al., 2024)





## RIVERINE MACROPLASTIC FLUX METHODOLOGY

### Methodology background

A visual observation approach for monitoring floating macroplastic litter in rivers and oceans was developed by González-Fernández and Hanke (2017) for the European Commission Joint Research Centre as part of the 'riverine and marine floating macro litter monitoring and environmental loading' (RIMMEL) observation network (EC JRC, 2016). The method was later adapted by van Emmerik et al. (2018) to include multiple measurement points along the river width and optionally extrapolating to an annual timeframe. Although originally developed for European rivers, the methodology (or similar adaptations) has been widely applied across the ASEAN region, including in Myanmar (Hurley et al., 2025), Vietnam (van Emmerik et al., 2018), Indonesia (van Emmerik et al., 2019), Malaysia (van Emmerik et al., 2020) and The Philippines (Talavera et al., 2024).

The methodology is designed to not require any specialized equipment, instead relying solely on visual observation of floating plastic items from bridges or riverbanks. If performed close to a river estuary, this measurement can be used as a proxy for the amount of plastic entering oceans, although there are several considerations to be recognized for this, as discussed in more detail in '[Step 4: Applying Methodologies](#)' section.

A data collection application is available to assist users in recording data (European Commission Joint Research Centre, 2025), or alternatively, manual methods can be used if preferred. Optional adaptations can also be applied: for example, combining the visual observation with the use of nets to help quantify compositions of floating litter, sample below the river surface or more accurately convert from item counts to mass.

### Summary of data requirements

This methodology collects data in the field and therefore does not require any secondary data. Examples of data points, which will be collected using this methodology include:

- Item flux in rivers (items / hour) – the macroplastic proportion measured by Indicator 7
- Composition of floating litter
- River characteristics (width, depth, velocity, discharge, visible depth)



**Figure 15: Illustration of a visual observation assessment of floating macroplastic debris. Source: Adapted from Hurley et al. (2023).**



# OVERVIEW: METHODOLOGY 7

## CSIRO SURVEY METHODOLOGY

### Methodology background

A plastics leakage survey methodology was developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2018 – referred to hereafter as the ‘CSIRO Survey Methodology’. The methodology is comprised of four different survey methods: coastal surveys, ocean trawls, river surveys and inland surveys; however, in this Guidebook only the inland survey portion of the methodology is discussed as it applies to the monitoring of Indicator 8 – Plastic debris density on land. The methodology was carefully designed to balance effort and accuracy and has been extensively applied in the ASEAN region, including Cambodia, Indonesia, Malaysia, Philippines, Thailand and Viet Nam (CSIRO and COBSEA, 2024). The methodology works by selecting sites for sampling based on random stratified sampling. Multiple transects of typically 12.5 x 2m in size are then performed at each site, with the types and amount of debris observable from standing height recorded. If a lot of debris is found in a transect, sub-sampling is used to make the measurement feasible. A dedicated application has recently been released to make recording of data easier.



Figure 16: Logo of the Commonwealth Scientific and Industrial Research Organisation (CSIRO)

### Summary of data requirements (Not applicable)

This methodology collects data in the field and therefore does not rely on secondary data. Examples of data points which will be collected using this methodology include:

- Composition of items found in the environment
- Plastic density on land (Indicator 8)
- Debris density by land use



Figure 17: Example of the four survey types available with the CSIRO Survey Methodology. This Guidebook focuses on inland sampling only (COBSEA & CSIRO, 2022b)

# MAPPING INDICATORS TO METHODOLOGIES

The seven recommended methodologies are mapped against the indicators that they inform on in the table below. Methodologies which do not inform the respective indicators at the national scale are also identified. These methodologies are either local data collection methodologies (i.e. Waste Wise Cities Tool) to assist AMS in collecting quality harmonized data, or they rely on sampling the plastic pollution in the environment and therefore operate at a local scale for resource and practicality reasons.

|                                                                                                                                                                       | INDICATOR 1<br>Plastic consumption | INDICATOR 2<br>Plastic waste generation rate | INDICATOR 3<br>Municipal solid waste collection coverage | INDICATOR 4<br>MSW collected and managed in controlled facilities | INDICATOR 5<br>Municipal plastic recycling rate | INDICATOR 6<br>Municipal plastic emissions to environment | INDICATOR 7<br>Plastic riverine flux | INDICATOR 8<br>Plastic debris density on land |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|----------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------|--------------------------------------|-----------------------------------------------|
| <br> |                                    |                                              |                                                          |                                                                   |                                                 |                                                           |                                      |                                               |
| <b>METHODOLOGY 1</b><br>Apparent Consumption of Plastics Methodology                                                                                                  |                                    | See footnote 1                               |                                                          |                                                                   |                                                 |                                                           |                                      |                                               |
| <b>METHODOLOGY 2</b><br>Waste Wise Cities Tool                                                                                                                        |                                    | Local level only                             | Local level only                                         | Local level only                                                  | Local level only                                |                                                           |                                      |                                               |
| <b>METHODOLOGY 3</b><br>Waste Flow Diagram                                                                                                                            |                                    | Local level only                             | Local level only                                         | Local level only                                                  | Local level only                                | Local level only                                          |                                      |                                               |
| <b>METHODOLOGY 4</b><br>Material Flow Analysis Toolkit                                                                                                                |                                    |                                              |                                                          |                                                                   |                                                 | See footnote 2                                            |                                      |                                               |
| <b>METHODOLOGY 5</b><br>SPOT model                                                                                                                                    |                                    |                                              |                                                          |                                                                   |                                                 |                                                           |                                      |                                               |
| <b>METHODOLOGY 6</b><br>Riverine Macroplastic Flux Methodology                                                                                                        |                                    |                                              |                                                          |                                                                   |                                                 |                                                           | Local level only                     |                                               |
| <b>METHODOLOGY 7</b><br>CSIRO Survey Methodology                                                                                                                      |                                    |                                              |                                                          |                                                                   |                                                 |                                                           |                                      | Local level only                              |

**Key:**  Measures at national level  Measures at sub-national level  Possible to measure at national level but not recommended - see footnotes

**Footnote 1:** Methodologies 2 – 5 assess municipal solid waste generation and management. As such, measurements of Indicator 2 relate only to municipal plastic waste generation (the waste stream responsible for most plastic pollution). In contrast, apparent consumption of plastics (Methodology 1), can be expanded to measure plastic waste generation by economic sectors (e.g. transport, construction and demolition, packaging) and cannot differentiate by the municipal waste stream. **Measurements of Indicator 2 using Methodology 1 are therefore incomparable with measurements of Indicator 2 measured with Methodologies 2 - 5. We highlight the option to measure Indicator 2 with Methodology 1 only for information purposes. We do not recommend AMS report Indicator 2 using Methodology 1.**

**Footnote 2:** We do not recommend that the BRS Material Flow Analysis Tool (Methodology 4) be used to quantify plastic leakage (emission) at the national level, despite this being stated as an objective of the methodology. The reasons for this are: (1) leakage is based off the Waste Flow Diagram factors which requires observational assessment, yet no guidance is provided on how to achieve this at the national level; and (2) the three archetypes it uses for aggregation are considered insufficient at representing the diverse types of waste management infrastructure and practices used across a country. Instead, we propose the SPOT model (Methodology 5) for quantifying plastic emissions at national level





# SELECT A METHODOLOGY

## HOW TO SELECT THE MOST APPROPRIATE METHODOLOGY?

The illustration below outlines which methodologies should be applied for measuring a chosen indicator. Multiple solid waste management indicators are typically measured simultaneously by a methodology with the decision around the most suitable methodology dependent on several factors. To aid in this selection, a decision tree has been developed for the waste management methodologies. A Supporting Toolkit to this Guidebook further aids in the selecting of methodologies by helping countries understand the financial requirements of each method. This can be downloaded alongside this Guidebook from <https://seamap-asean.org/>



### Indicator 1:

Plastic consumption

### Indicator 2:

Plastic waste generation rate

### Indicator 3:

Municipal solid waste collection coverage

### Indicator 4:

MSW collected and managed in controlled facilities

### Indicator 5:

Plastic recycling rate

### Indicator 6:

Plastic emissions to the environment

### Indicator 7:

Plastic riverine flux

### Indicator 8:

Plastic debris density on land



Click to learn how to apply (Step 4)

### Methodology 1:

Apparent Consumption of Plastics Methodology

### Methodology 2:

Waste Wise Cities Tool

### Methodology 3:

Waste Flow Diagram (WFD)

### Methodology 4:

BRS Material Flow Analysis Toolkit

### Methodology 5:

SPOT Model

Click to learn how to apply (Step 4)

### Methodology 6:

Riverine Macroplastic Flux to Ocean Methodology

Click to learn how to apply (Step 4)

### Methodology 7:

CSIRO Survey Methodology

Click to choose most suitable methods

The solid waste management Indicators 2 – 6 can be measured in unison at either the national or sub-national scale using a combination of Methodologies 2 – 5.

[Click here](#) to use a decision-tree approach to decide which methodologies to apply (or navigate to next page)



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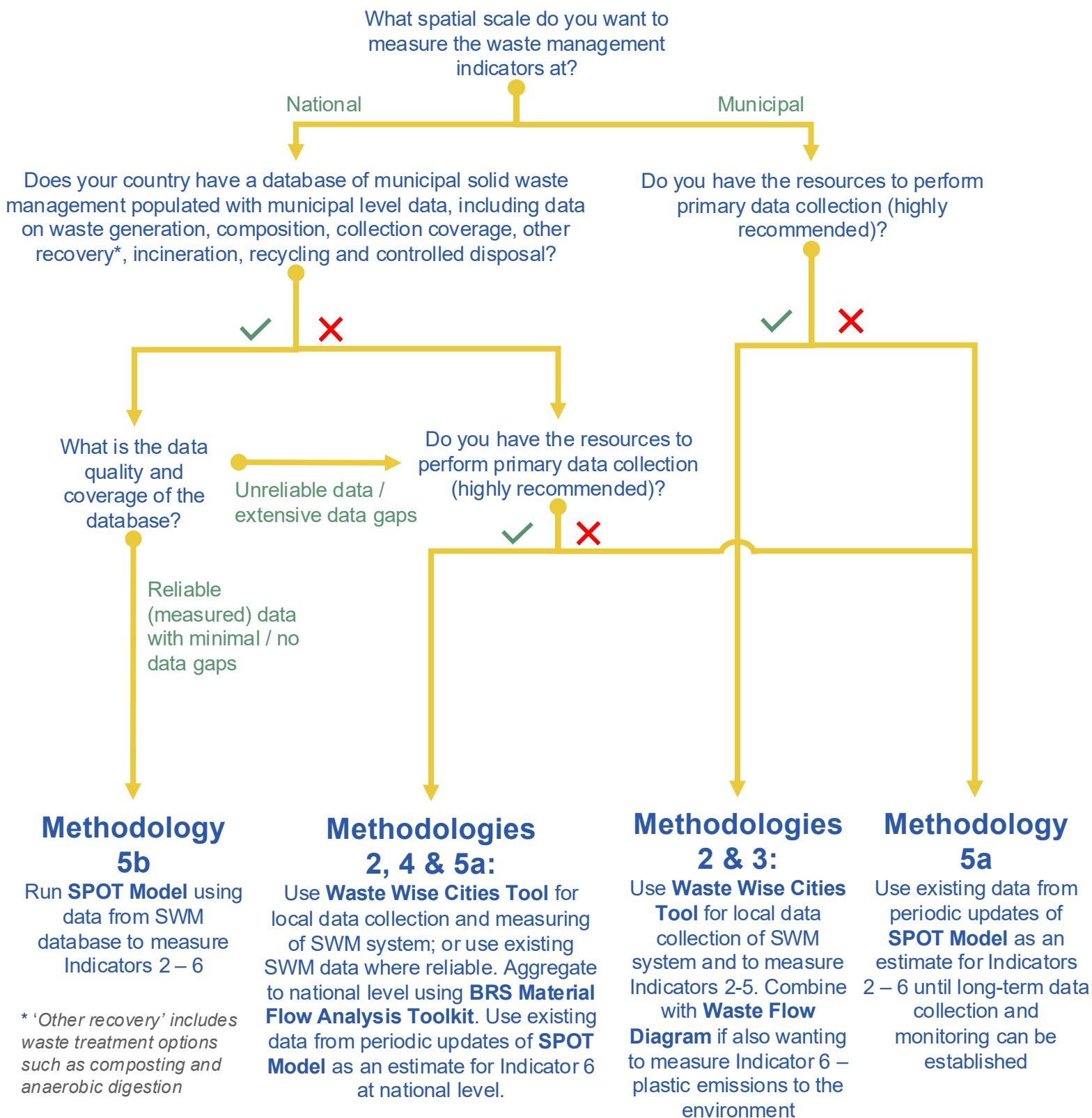


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Step 4

# SELECT A METHODOLOGY

## METHODOLOGY SELECTION FOR WASTE MANAGEMENT AND EMISSION INDICATORS (INDICATORS 2 – 6)

Use the decision tree below to guide selection of the most appropriate methodology for a chosen indicator.



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page



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Step 3



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Go to  
Step 4

# STEP 4: HOW TO APPLY THE METHODOLOGIES



# STEP 4: APPLYING METHODOLOGY

Select a methodology, or series of methodologies, from the list below to learn how to apply them, including recommendations for ensuring harmonization. Note, this guidance is for introductory purposes only and does not replace the need for any formal training or thorough reading of user manuals / guides.



Click to learn how to apply

**METHODOLOGY 1**  
**Apparent Consumption of Plastics Methodology**



Click to learn how to apply

**METODOLOGY 2 & 3**  
**Waste Wise Cities Tool & Waste Flow Diagram**



Click to learn how to apply

**METHODOLOGY 2, 4 & 5A**  
**Waste Wise Cities Tool, BRS Material Flow Analysis and SPOT model**



Click to learn how to apply

**METHODOLOGY 5A**  
**SPOT Model**  
**(using existing estimates)**



Click to learn how to apply

**METHODOLOGY 5B**  
**SPOT Model**  
**(modeling new estimates)**



Click to learn how to apply

**METHODOLOGY 6**  
**Riverine Macroplastic Flux Methodology**



Click to learn how to apply

**METHODOLOGY 7**  
**CSIRO Survey Methodology**

## NEXT STEP

Click to visit



- Proceed to Step 5: Monitoring and reporting



# How to Apply Methodology 1: Apparent Consumption of Plastics Methodology



# HOW TO APPLY METHODOLOGY 1

## APPARENT CONSUMPTION OF PLASTICS METHODOLOGY

### REQUIREMENTS FOR APPLYING THIS METHODOLOGY

Methodology 1 involves performing data analysis on plastic production and trade data to calculate the apparent consumption of plastic at the national level. As such, the primary requirements for implementing this methodology include 1-2 technical experts who are skilled in understanding and analyzing trade data, plus access to data management and analysis software (e.g., Microsoft Excel). The time required depends on the resolution of the input data and whether it is provided in the correct formats or requires conversion. An estimated 1-3 days is likely required to complete the analysis. This is in addition to any training required, such as reading the Statistical Guidelines (UNEP & UNITAR, 2026).

### GUIDE TO IMPLEMENTING THE METHODOLOGY

#### Measuring flows of plastic throughout the life cycle

The UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle (UNEP & UNITAR, 2026) provides guidance on calculating plastic flows across the full plastic life cycle (Figure 18). This Guidebook addresses only part of the UNEP Guidance, that relating to measuring Indicator 1 – Plastic consumption. Whilst subsequent steps of the UNEP Guidance can be followed if desired by an AMS (for example calculating plastic waste generation, treatment and leakage), this Guidebook does not recommend following these steps to report on Indicators 2-8, due to challenges with achieving harmonized data collection and reporting.

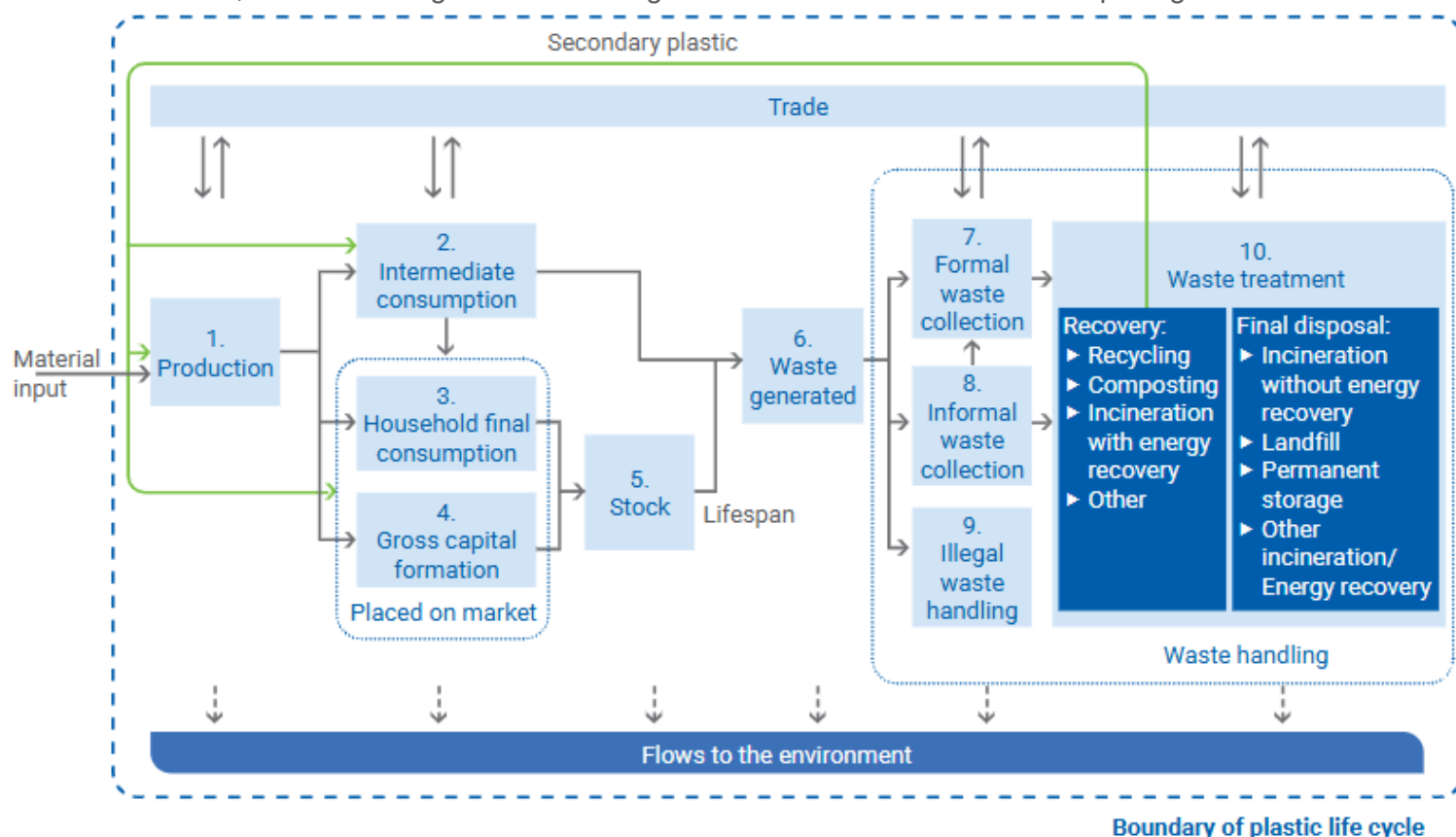


Figure 18: Plastic flows across the full life cycle including system boundary used in the UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle (UNEP & UNITAR, 2026)





## APPARENT CONSUMPTION OF PLASTICS METHODOLOGY

### APPARENT CONSUMPTION METHOD

As explained in the '[Overview of Methodology 1](#)' section, apparent consumption of a product is a proxy for the actual consumption (use) of a product within a country. It is calculated at the national level using a top-down mass balance approach that considers the amount of the product domestically produced and imported into a country, compared to mass of the product exported:

$$\text{Apparent consumption of products} = \text{Domestic production} + \text{Imports} - \text{Exports} \quad (\text{Eq. 4})$$

When calculating apparent consumption of plastics, a distinction needs to be made to account for the fact that products can either be purely made of plastic (e.g., plastic bags) or have a fraction of the product made from plastic (e.g., laptops), so called 'plastic-containing products'. The fraction of plastic embedded in a product ( $f$ ) varies between one for pure plastic products, to close to zero for products where plastic is a minor constituent by mass. It is important to only include the plastic proportion of products; therefore, the apparent consumption of a given plastic product becomes:

$$\begin{aligned} \text{Apparent consumption of plastic product} &= f^D \times \text{Production of plastic product} + f^T \times \\ &\text{Imports of plastic product} - f^T \times \text{Exports of plastic product} \end{aligned} \quad (\text{Eq.5})$$

Where  $f^D$  represents the plastic fractions in the domestically produced plastic products, and  $f^T$  represents plastic fractions in the imported and exported plastic products. The plastic fraction  $f^D$  and  $f^T$  for production and trade are represented by different parameters because production and trade data are collected with different classification systems; as a result, the corresponding plastic fraction is not always the same. The total apparent national consumption of plastics is then the summation of the apparent consumption for all plastic and plastic-containing products:

$$\text{Apparent consumption of plastics} = \sum_{p=P_{101}}^{P_{809}} \text{Apparent consumption of plastic product}^p \quad (\text{Eq. 6})$$

The superscript  $p$  (above) refers to a given plastic product or plastic-containing product, as categorized by the 'Plastic Keys Framework' (see below).

Production and trade data records plastic products in three different forms:

- (1) Plastic in primary forms – e.g., production of polymers that are eventually converted into other plastic products
- (2) Plastic in semi-finished plastic products – e.g., production of products that go to subsequent manufacturing
- (3) Plastic in finished products – e.g., products that do not undergo any further manufacturing.

If the apparent consumption were summed up across all these three product types it would lead to double counting. For example, some of the plastic produced in primary forms will be used to form semi-finished or finished plastic products, whilst plastic in semi-finished forms will also be used to produce finished plastic products. To avoid this, only the finished plastic products are included in calculating the apparent consumption, as represented by the Plastic Key categories P101 – P809 in equation 6.

The Plastic Keys framework (Figure 19) was developed by UNITAR to assist users in determining which products to include in the calculation of apparent consumption, aid in harmonization between the varying categories used between production and trade data and assign estimates of plastic fractions for plastic-containing products (UNEP, 2022). Plastic Keys also allow the assignment of product lifespans which can be used to estimate plastic waste generation; however, this is not recommended as part of this Guidebook.



# HOW TO APPLY METHODOLOGY 1

## APPARENT CONSUMPTION OF PLASTICS METHODOLOGY

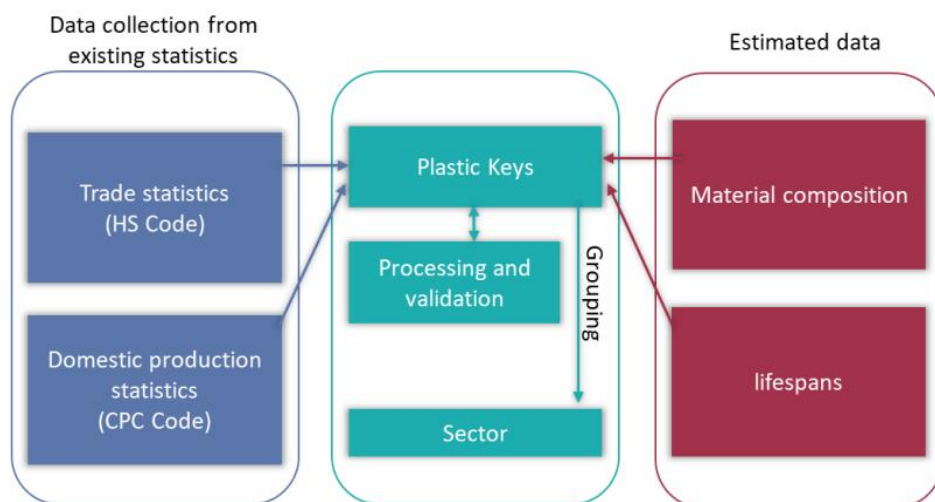


Figure 19: Illustration of how the Plastic Keys Framework links to data collected by statistical authorities (HS codes and CPC codes), material compositions (plastic fractions), and plastic lifespans (UNEP, 2022).

Plastic Keys are organised into eight groups, each of which represents an economic sector:

- P1 'Packaging'
- P2 'Transport'
- P3 'Building and construction'
- P4 'Electrical and electronic equipment'
- P5 'Consumer and institutional products'
- P6 'Industrial machinery'
- P7 'Apparel and textile furnishing articles'
- P8 'Other'

### DATA COLLECTION

**Domestic plastic production data:** Data on domestic plastic production is commonly available via national statistical departments as part of economic statistics. The 'monitoring' sections of the ASEAN country profiles shown in [Annex 4](#) provide a country-by-country review of what data is believed to be currently collected by statistical departments, and the resolution and reporting frequency thereof. Unfortunately, at present, only Thailand and Indonesia are collecting domestic plastic production data on a mass basis, as required by the apparent consumption methodology. By contrast, the remaining AMS are reporting the data in monetary terms, number of establishments or persons employed. Frequently, the data is only being reported at a coarse resolution (e.g., only by 'Manufacture of rubber and plastics products') and/or at infrequent time steps that are not suitable for the recommended methodology.

Alternative potential data sources for domestic production include the [UNSD Industrial Commodity Statistics](#), with Volume 1 providing data on a mass basis for multiple years and countries up to 2016 (United Nations, 2019). However, this yearbook does not contain data for AMS, except for some sporadic plastic-related product codes being reported for Viet Nam and Malaysia, and there have been no updates since 2016.

**Plastic trade data:** Data on the import and exports of plastic products is collected by national statistic departments. The 'monitoring' sections of the ASEAN country profiles shown in [Annex 4](#) provide a country-by-country review of what data is believed to be currently collected by statistical departments, and the resolution and reporting frequency thereof. As with domestic production data, AMS are currently collecting this information in an inconsistent way with varying levels of reporting groups used. Likewise, data is reported almost exclusively on a monetary basis (except for Indonesia) making it unsuitable for the Apparent Consumption of Plastics Methodology.

Alternative data sources for plastic trade include the [UN Comtrade database](#). Comtrade includes data on both imports and exports by HS or SITC codes. This data is widely available for ASEAN countries and predominately records trade in both monetary and mass values, therefore making it suitable for use in the Apparent Consumption of Plastics Methodology. Data on plastic trade is also presented as part of the [ASEANstats data portal](#); however, at present, this is only recorded in monetary terms and is therefore not suitable.



# HOW TO APPLY METHODOLOGY 1

## APPARENT CONSUMPTION OF PLASTICS METHODOLOGY

### CALCULATION OF APPARENT CONSUMPTION OF PLASTICS

Assuming the necessary data has been collected on domestic plastic production and plastic trade, the plastic consumption indicator can be calculated. Equation 5 is first used to calculate the apparent consumption of plastic for the Plastic Key groups of P101 – P809. Equation 6 then calculates the total apparent consumption of plastic across all groupings by summing these together. The output of equation 6 may be used to report on Indicator 1. It is recommended that this analysis and reporting be done on an annual basis.

### RECOMMENDATIONS FOR HARMONIZED ASSESSMENT

It is evident that the current restraints regarding data availability, format and resolution will restrict AMS in applying Methodology 1 immediately. Instead, adjustments are likely required in collaboration with national statistical authorities to begin collecting the necessary data before this indicator can be measured in a harmonized manner. This is particularly the case for domestic production data, which at present is lacking in most AMS, and for which no other data sources are available. This Guidebook still recommends the eventual use of this methodology and the monitoring of Indicator 1 despite these restraints, as alternative methodologies for measuring upstream indicators (such as plastic consumption) pose similar constraints. With renewed global emphasis on monitoring plastic production and trade following the Plastic Treaty negotiations, it is expected that data availability and reliability will improve in this area, making implementation of this methodology easier going forward.

The use of proxy data to estimate the apparent consumption of plastics has recently been proposed as part of the SEA-Map Report: 'Recommendations for a Plastic Pollution Indicator Framework for ASEAN' (ASEAN & SEA-MaP, 2024). To overcome the lack of data for domestic plastic production, a revised approach is suggested that narrows the scope of the assessment compared to the recommended methodology to include only ISIC code 2220 (Manufacture of plastics products) for manufacturing data, and HS code 39 (Plastics and articles thereof) for trade data. Likewise, to fill data gaps around lack of production data, available data from Thailand is used as a basis on which to scale other AMS production data using relative levels of Gross Domestic Product (GDP), adjusted for purchasing power parity (PPP). Whilst this method enables 'baseline' values of apparent consumption of plastics to be produced, such values would not be suitable for long-term monitoring of this Indicator and are therefore not recommended here.

### ACCESS TO TRAINING AND SUPPORT

The methodology behind applying the Apparent Consumption of Plastics Methodology is discussed in the UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle (UNEP & UNITAR, 2026). Further details on the general approach is also available in the UNEP document on 'Practical guidance on the development of inventories of plastic waste' (UNEP, 2022). An excel toolkit for support in the calculation of apparent consumption of plastic is also available through the Basel Convention (Wagner & Baldé, 2022); however, it is currently unclear how aligned this is with the updated UNEP / UNITAR Statistical Guidelines.

**The instructions provided in this Guidebook are for information purposes only. They do not replace the user manuals or negate the need for completing any necessary training via the methodology developers.**



# How to Co-Apply Methodology 2 & 3:

## Waste Wise Cities Tool (WaCT) & Waste Flow Diagram (WFD)





# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

The 20-30 survey helpers who are dedicated full-time for 8-10 days are required to ensure the smooth operation of household waste characterization studies: this requires the sampling of 90 households (150 for mega cities) for 8 continuous days. The number of households to sample is standardized by the methodology to balance accuracy with effort in low resource settings. Other elements of the methodologies such as planning, interviews, visiting facilities and observation studies can be performed by smaller teams of 1-2 experts. Relatively basic equipment is required to implement WaCT (Table 4), with this mainly being used for the household waste characterization studies. It is essential that suitable personal protective equipment be used for these tasks due to the hazards associated with handling waste. No specialist equipment is required for the WFD, but PPE is again strongly advised when visiting waste facilities. Some basic secondary data is required, such as population sizes / demographic data (e.g., from census), and data on businesses operating in the city.

**Table 4: Summary of equipment requirements for WaCT. No specialized equipment is required for WFD. Personal protective equipment is also essential (UN-Habitat,2021)**

| Things to Prepare                                                                   | Quantity                   |                                  |                                |
|-------------------------------------------------------------------------------------|----------------------------|----------------------------------|--------------------------------|
|                                                                                     | 1 Survey area              | 9 survey areas<br>(average city) | 15 survey areas<br>(mega-city) |
| Survey team                                                                         | 2-3 people                 | 18-27 people                     | 30-45 people                   |
| Transportation for waste collection                                                 | 1 collection vehicle trips | 9 collection vehicle trips       | 15 collection vehicle trips    |
| Liner bags (vol: 60L)                                                               | 80                         | 720                              | 1200                           |
| Identification tape (tag bags)                                                      | 1                          | 9                                | 15                             |
| Pens                                                                                | 3                          | 27                               | 45                             |
| Markers                                                                             | 1                          | 9                                | 15                             |
| Hanging Weighing scale (up to 60 kg)                                                | 1                          | 9                                | 15                             |
| Thick plastic sheet (at least 4 x 4 metres)                                         | 1                          | 9                                | 15                             |
| Waste containers or bags (60 L)                                                     | 12                         | 89                               | 180                            |
| Scissors                                                                            | 1                          | 9                                | 15                             |
| Spades                                                                              | 1                          | 9                                | 15                             |
| Brooms                                                                              | 1                          | 9                                | 15                             |
| Camera/ Smart Phone                                                                 | 1                          | 9                                | 15                             |
| Reporting sheets                                                                    | 1                          | 9                                | 15                             |
| Informed consent letters (with space for signing and dating) for each sample member | 10                         | 90                               | 150                            |





# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

### GUIDE TO IMPLEMENTING THESE METHODOLOGIES

#### APPLYING THE WASTE WISE CITIES TOOL

There are seven steps to follow in applying WaCT (Figure 20):

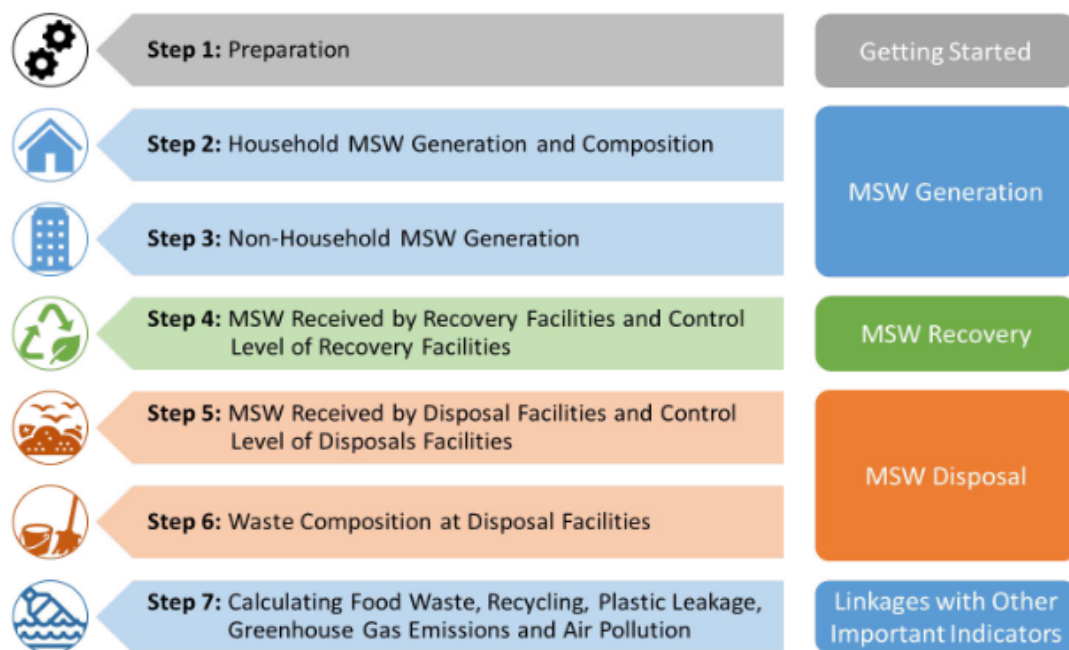


Figure 20: Seven steps of the Waste Wise Cities Tool

**Step 1: Preparation** - This step involves getting political support for implementing WaCT, establishing a working team, preparing tools and equipment, and collecting necessary secondary data such as population estimates and business licensing data. We recommend that the boundaries of the study area be clearly established and documented to allow harmonization with the WFD and data sharing. The choice of the study is at the discretion of the AMS. Possible considerations for suitable municipalities are those with existing poor SWM data, municipalities with high concern over SWM practices or plastic pollution, or those looking to implement SWM reforms such as developing an Integrated Solid Waste Management Plan (ISWM) or improving SWM infrastructure and practices.

**Step 2: Household MSW generation and composition** - Step 2 is the most resource intensive step of WaCT, as it involves the sampling of waste from households over an 8-day period. The amount of waste generation and composition varies based on income levels of households; therefore, stratified sampling is required to ensure this variation is captured. The total sample size recommended is a minimum of 90 households with three separate areas surveyed for each of low-, middle- and high-income neighbourhoods, each with 10 households sampled (i.e., 3 income categories X 3 survey areas X 10 households per area = 90 households). This increases to 150 households in mega cities (populations >10 million) with 5 survey areas per income group. Households should be selected randomly for each income category to avoid bias. Once the households are selected and agreements are in place, the waste characterization involves collecting the households' waste each day in individual bin bags (ensuring they are labelled to accurately identify them), with subsequent weighing and sorting of each bag to record waste generation and composition. Waste characterization can be a time consuming and complex task (with the trade off being the invaluable data it provides); therefore, we strongly advise users of WaCT to read the details of the user manual in full (UN-Habitat, 2021) and conduct necessary training. Details such as ensuring households are handing over all waste and not selling recyclables to the informal sector are particularly important for the ASEAN context.



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# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

**Step 3: Non-household MSW generation** – Municipal solid waste includes more than just household waste; commercial, institutional and public waste also require sampling. Unfortunately, due to the large variety in types and sizes of these establishments, getting an accurate sample using waste characterization can be resource intensive and challenging. Ideally, waste characterization will be performed in a similar way to that for households, whereby non-household sources are randomly selected for sampling. If this is not feasible, alternative methods can be used such as interviewing the establishment on their waste generation or using a proxy that non-household waste generation is approximately 30% of total MSW generation (UN-Habitat, 2021). Therefore, assuming this proxy is accurate, household waste generation can be divided by 0.7 to arrive at the total MSW generation.

**Step 4: MSW received by recovery facilities and control level of recovery facilities** – WaCT requires data to be collected on the amount of material that is sent to recovery facilities. Recovery facilities include any facilities with recovery activities, including recycling, composting, incineration with energy recovery, materials recovery facilities (MRF), mechanical biological treatment (MBT) facilities, etc. This can be achieved by making a list of major recovery facilities that deal with waste generated in the case study city. These facilities are then categorized by their type (e.g., intermediate trader, end of chain recycler) and prioritized by importance. Interview and site visits to the facility are performed following a preset questionnaire to ascertain information such as the types and quantity of waste entering the recovery facility, as well as how much of the material is processed versus rejected. Informal sector contributions to recovered material are estimated by asking facilities how they obtained the material. Some AMS already collect information on informal sector activities; therefore, this information can be optionally used to improve estimates when available.

As the main aim of WaCT is to calculate SDG 11.6.1 – the proportion of a city's municipal waste generation that is collected and managed in controlled facilities - information is also collected on the level of control of each facility. This is achieved using defined 'ladders of control', whereby practices at the facility can be matched against prescribed levels of control. An example of this is provided for disposal sites in Table 5.

**Step 5: MSW received by disposal facilities and control level of disposal facilities** – WaCT requires data on the amount of waste generated in the city that goes to disposal sites. Disposal in this context means any operation whose main purpose is not the recovery of materials or energy, even if the operation has as a secondary consequence the reclamation of substances or energy. Typically, this includes formal land disposal sites, which may be either run in a controlled or uncontrolled manner. It excludes unrecognized sites where waste is occasionally deposited in small amounts (e.g. informal dumpsites), even if authorities clean this waste up occasionally. Data is collected in the same way as for recovery facilities, whereby site visits and interviews occur. In addition, disposal sites may already be recording data on the amount received, for example, by logging vehicles or using weighbridges.

**Table 5: Extract of the WaCT Ladder of control for disposal sites (UN-Habitat, 2021)**

| CONTROL LEVEL    | Category                             | Landfill Site                                                                                                                                                                                                             |
|------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Full Control     | Security                             | » Physical boundary surrounding the site and supervised access control 24/7                                                                                                                                               |
|                  | Water and leachate control           | » Site engineering preventing surface and groundwater ingress into the landfill<br>» Functioning leachate containment and management                                                                                      |
|                  | Slope stabilization                  | » Slopes stabilized, including erosion control, to mitigate risk of landslide                                                                                                                                             |
|                  | Waste handling, compaction and cover | » Waste deposited in clearly defined operational areas with strict management control<br>» Waste layered and compacted promptly<br>» Daily and intermediate cover applied                                                 |
|                  | Fire control                         | » Zero evidence of burning of waste on the surface of the landfill                                                                                                                                                        |
|                  | Landfill gas management              | » Landfill gas controlled with utilization where practicable                                                                                                                                                              |
|                  | Staffing                             | » Site staffed full-time with professionally qualified personnel                                                                                                                                                          |
|                  | Recording                            | » Functional weighbridge in use with recording waste quantities by waste types                                                                                                                                            |
|                  | Environment Health and Safety (EHS)  | » EHS measures implemented in accordance with professional risk assessment and operating plan<br>» Showering and sanitary facilities<br>» Environmental monitoring system in place with annual reporting capability       |
|                  | Site planning                        | » Site development and operational filling plan in place<br>» Post closure plan in place                                                                                                                                  |
| Improved Control | Security                             | » Physical boundary surrounding the site and supervised access control                                                                                                                                                    |
|                  | Water and leachate control           | » Site engineering preventing surface water ingress into the landfill<br>» Measures taken to prevent seepage of untreated leachate into surface and groundwater                                                           |
|                  | Slope stabilization                  | » Slopes stabilized, mitigating risk of landslide                                                                                                                                                                         |
|                  | Waste handling, compaction and cover | » Waste deposited in supervised operational area<br>» Waste layered and compacted promptly<br>» Waste periodically covered                                                                                                |
|                  | Fire control                         | » Zero evidence of burning of waste on the surface of the landfill                                                                                                                                                        |
|                  | Landfill gas management              | » Landfill gas controlled, including venting or flaring                                                                                                                                                                   |
|                  | Staffing                             | » Site staffed with trained personnel                                                                                                                                                                                     |
|                  | Recording                            | » Functional weighbridge in use with data for each delivered waste load recorded in a register                                                                                                                            |
|                  | EHS                                  | » Procedures in place to ensure health and safety of workers<br>» Toilets and hand washing stations<br>» Environmental monitoring system in place with annual reporting capability                                        |
|                  | Site planning                        | » Operational filling plan in place                                                                                                                                                                                       |
| Basic Control    | Security                             | » Boundary and access control allowing single point of supervised access                                                                                                                                                  |
|                  | Water control                        | » Perimeter drainage maintained around the site                                                                                                                                                                           |
|                  | Slope stabilization                  | » Slopes stabilized, mitigating risk of landslides                                                                                                                                                                        |
|                  | Waste handling, compaction and cover | » Waste trucks directed to specific operational area of disposal<br>» Heavy mechanical equipment reliably available<br>» Waste layered and compacted within the specific operational area<br>» Some use of cover material |
|                  | Fire control                         | » Zero evidence of burning of waste on the surface of the landfill                                                                                                                                                        |
|                  | Staffing                             | » Site staffed during operational hours                                                                                                                                                                                   |
|                  | Recording                            | » Functional weighbridge in use                                                                                                                                                                                           |
|                  | EHS                                  | » Basic personal protective equipment in use<br>» Toilets and hand washing stations                                                                                                                                       |
|                  | Site planning                        | » Site drawing showing landfill boundary and filling area in place                                                                                                                                                        |



# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

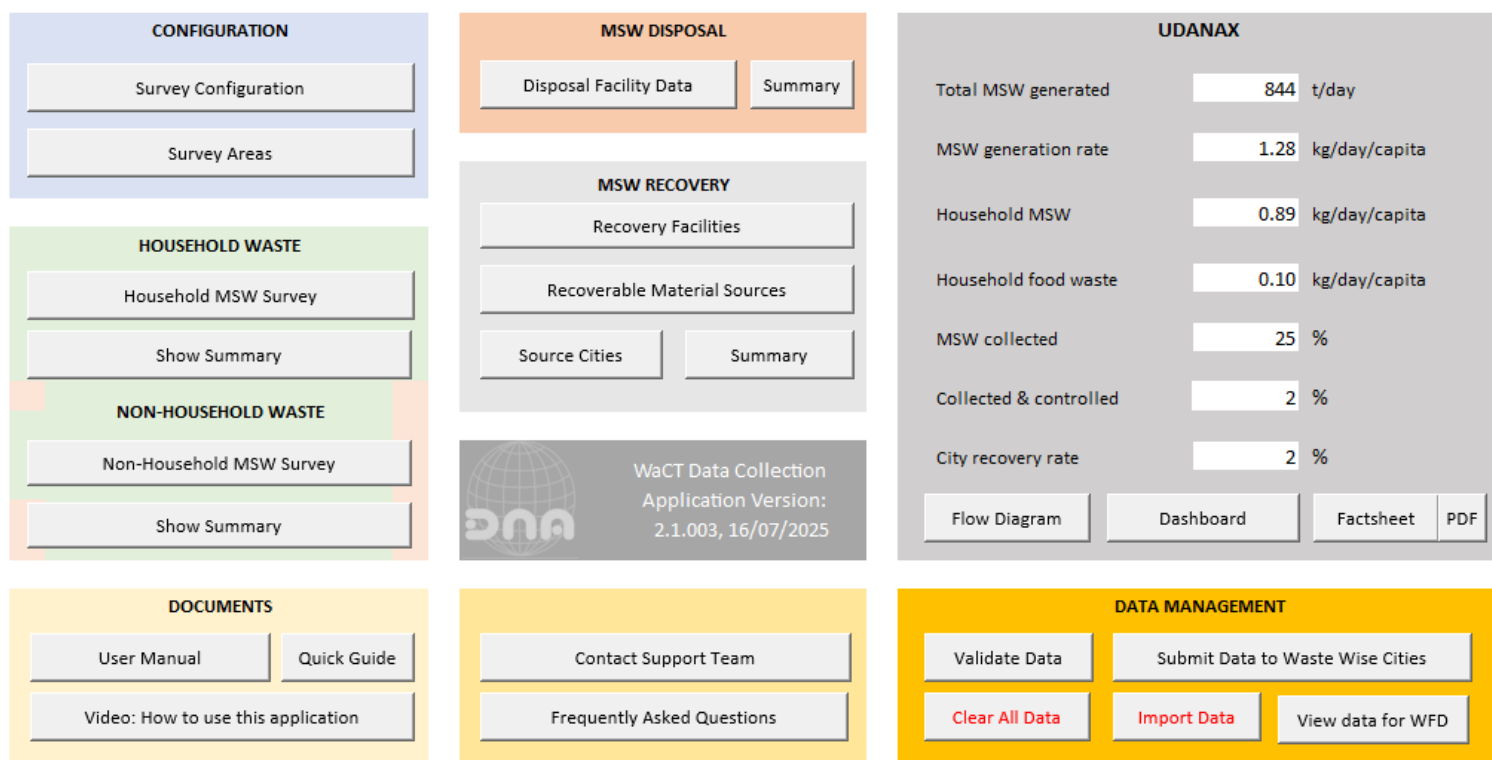
If logging vehicles or using weighbridges are not available as options, the assessor may manually count vehicles over a period of 5-7 days, recording each truck's maximum capacity and load (% full). Interview with site managers and waste pickers (if present) should also be conducted, with the goal to quantify the amount and types of material recovered. Finally, the level of control of the disposal facility can be estimated by matching the infrastructure and practices to the WaCT ladder of control for disposal sites (Table 5, page 61).

**Step 6: Waste composition at disposal sites** – In addition to the amounts entering disposal sites, data on the composition of the waste is also required. This can be collected in 1-2 days by sub-sampling waste from three trucks (one for each area: low-, middle- and high- income). Sub-sampling involves quartering the waste into smaller piles until around 50-70 kg is remaining, from which sorting and weighing occurs.

**Step 7: Calculating food waste, recycling, plastic leakage, greenhouse gas emissions and air pollution** – This is an optional additional step to quantify other important information. This Guidebook only covers the plastic leakage element whereby the Waste Flow Diagram is the recommended approach.

### WaCT Data Collection Application (DCA)

A dedicated data collection application is available for WaCT through UN-Habitat via the Waste Wise Cities Data Portal (<https://unh.rwm.global/>). The DCA provides an interactive means for users to record data and summarize results, as shown in Figure 21 and Figure 22.



| UDANAX                 |                    |
|------------------------|--------------------|
| Total MSW generated    | 844 t/day          |
| MSW generation rate    | 1.28 kg/day/capita |
| Household MSW          | 0.89 kg/day/capita |
| Household food waste   | 0.10 kg/day/capita |
| MSW collected          | 25 %               |
| Collected & controlled | 2 %                |
| City recovery rate     | 2 %                |

Figure 21: Main page of the Waste Wise Cities Tool Data Collection Application (WaCT DNA). (Requires Microsoft Excel)



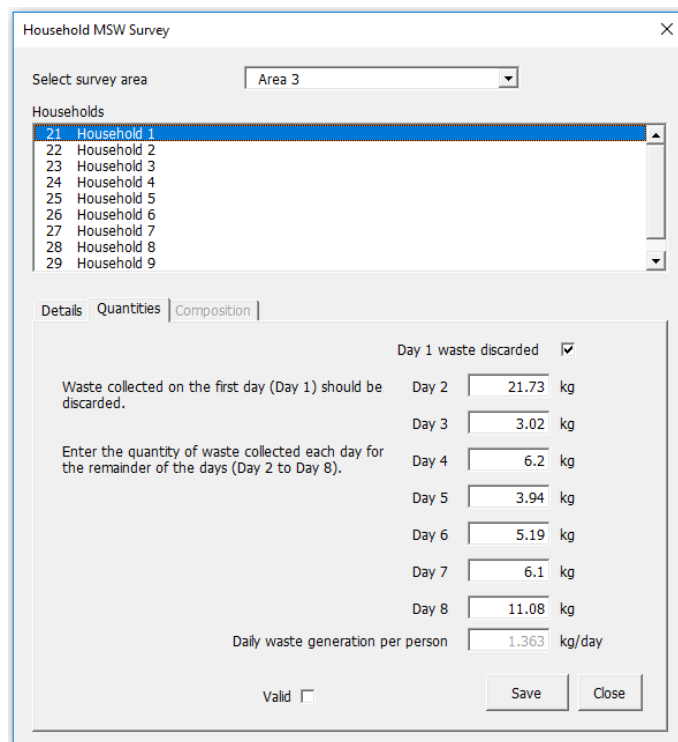
# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

Although the WaCT DCA is optional for implementing WaCT, it is highly recommended as it aids in the organization and storage of large amounts of data. For example, when collecting data on household waste characterization, data needs to be recorded on waste quantities and fractions for each of the eight sampling days and for all individual 90 - 150 households sampled (Figure 22). Without the use of the WaCT DCA, it is easy to lose data or not record all the required details. The WaCT DCA, therefore, supports an accurate implementation of WaCT, and retains the granularity and accessibility of data to support harmonization.

Another benefit of using the WaCT DCA is that the data is automatically processed to produce summary results and KPI. For example, results can be easily viewed through the dashboard, summary tables and via automatic creation of a standardized 'factsheet' report.

The WaCT DCA also has built in data validation to help in the identification of errors. Data can also be shared with the Waste Wise Cities Network for inclusion on the WaCT Data portal to ensure longevity and facilitate harmonization and comparison.



**Figure 22: Household surveys data collection page for the Waste Wise Cities Tool Data Collection Application (WaCT DCA)**

### APPLYING THE WASTE FLOW DIAGRAM

The Waste Flow Diagram is applied at a city / municipal level, and therefore the data that populates it should be from the same level. Data requirements can be broadly split into three types:

1. Data on municipal solid waste management (MSWM)
2. Data on municipal solid waste practices and infrastructure
3. Observation data on where plastic is observed in the environment

**Collecting MSWM data** - Data on MSWM can come from WaCT, assuming this has been implemented as recommended in this Guidebook. If the municipality already has data on MSWM, it may be possible to apply WFD without WaCT; however, care should be taken that all data points are available, and that the quality of the data is high. We recommend recording the source of the data used in WFD as metadata when reporting the indicator to ensure transparency and encourage harmonization. The WFD additionally has input fields to allow the user to select the reliability of the data (high to low), with uncertainties propagated through the material flow analysis model.

Data is required on the amounts and composition of MSW generation, waste reaching disposal and recovery facilities, material extracted from disposal facilities by waste pickers (referred to as the informal value chain) and rejects from sorting and facilities. Each of these is obtainable from WaCT; however, the WaCT uses a more detailed list of compositions formed of 12 categories, compared to the six used in WFD. Converting data from the WaCT study to that required by the WFD has been simplified using the WaCT data collection application. This application provides a button to click that semi-automatically aggregates data from WaCT to the format required for the WFD (Figure 23).





# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

WFD Inputs

| Number | Question                                 | Input value |  |
|--------|------------------------------------------|-------------|--|
| 1.     | Population                               | 661901      |  |
| 2.     | Average MSW generation rate              | 1.2751      |  |
| 3.1    | Paper                                    | 2.89        |  |
| 3.2    | Plastics                                 | 10.308      |  |
| 3.3    | Glass                                    | 1.248       |  |
| 3.4    | Metals                                   | 0.625       |  |
| 3.5    | Other                                    | 8.086       |  |
| 3.6    | Organics                                 | 76.843      |  |
| 4.1    | Paper                                    | 9.356       |  |
| 4.2    | Plastics                                 | 22.033      |  |
| 4.3    | Glass                                    | 1.083       |  |
| 4.4    | Metals                                   | 1.751       |  |
| 4.5    | Other                                    | 28.499      |  |
| 4.6    | Organics                                 | 132.058     |  |
| 5.1    | Paper                                    | 0           |  |
| 5.2    | Plastics                                 | 0           |  |
| 5.3    | Glass                                    | 0           |  |
| 5.4    | Metals                                   | 0           |  |
| 5.5    | Other                                    | 0           |  |
| 5.6    | Organics                                 | 0           |  |
| 6.1    | Paper                                    | 4.5         |  |
| 6.2    | Plastics                                 | 15.3        |  |
| 6.3    | Glass                                    | 0           |  |
| 6.4    | Metals                                   | 0           |  |
| 6.5    | Other                                    | 0           |  |
| 6.6    | Organics                                 | 0           |  |
| 7.1    | Paper                                    | 0           |  |
| 7.2    | Plastics                                 | 0           |  |
| 7.3    | Glass                                    | 0           |  |
| 7.4    | Metals                                   | 0           |  |
| 7.5    | Other                                    | 0           |  |
| 7.6    | Organics                                 | 0           |  |
| 8.1    | Informal collection (Yes/No)             | ND          |  |
| 8.2    | Informal collection (%)                  | ND          |  |
| 9.1    | Controlled recovery                      | 100         |  |
| 9.2    | Controlled EfW                           | 0           |  |
| 9.3    | Controlled disposal (%)                  | 0           |  |
| 12.1   | Formal recovery residues / rejects       | 10          |  |
| 13.1   | Informal recovery residues / rejects (%) | 0           |  |

Close

**Figure 23: WaCT DCA integrates with the WFD by creating a list of the WFD inputs that can be copied to the clipboard and into an WFD excel file or the online data portal. WaCT data can be converted to the required format for the WFD by clicking the 'View data for WFD' button in the WaCT DCA**

### Collecting data on municipal solid waste practices and infrastructure –

The novel concept of the WFD is that it estimates plastic emissions (leakages) into the environment by assessing the quality of infrastructure and practices used to handle the MSW in the city. If the practices and infrastructure used provide little containment to the waste, the amount of plastic emitted into the environment will be calculated as higher than when practices and infrastructure provide high levels of containment. Assessors are required to match the conditions that they observe to 'leakage potential' tables in the WFD. An example of such a table is shown in Table 6 for waste during transportation, where assessors are asked about the level of coverage the collection vehicles have. The 'leakage potential' chosen automatically feeds through to a decision tree that combines the various infrastructure and practices to estimate the total leakage from the process, in this case transportation (Figure 24).

**Table 6: Leakage potential levels for influencer 'Coverage of collection vehicle' (GIZ, 2020)**

| Leakage potential | Description                                                                             | Leakage factor |
|-------------------|-----------------------------------------------------------------------------------------|----------------|
| Very high         | Most of the collection vehicles in the city are uncovered                               | 1.0            |
| High              | The number of collection vehicles are fairly split between uncovered and fully enclosed | 0.5            |
| Medium            | Most of the collection containers in the city are fully enclosed                        | 0.1            |
| None              | All the collection containers in the city are fully enclosed (e.g. compactor trucks).   | 0              |



# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

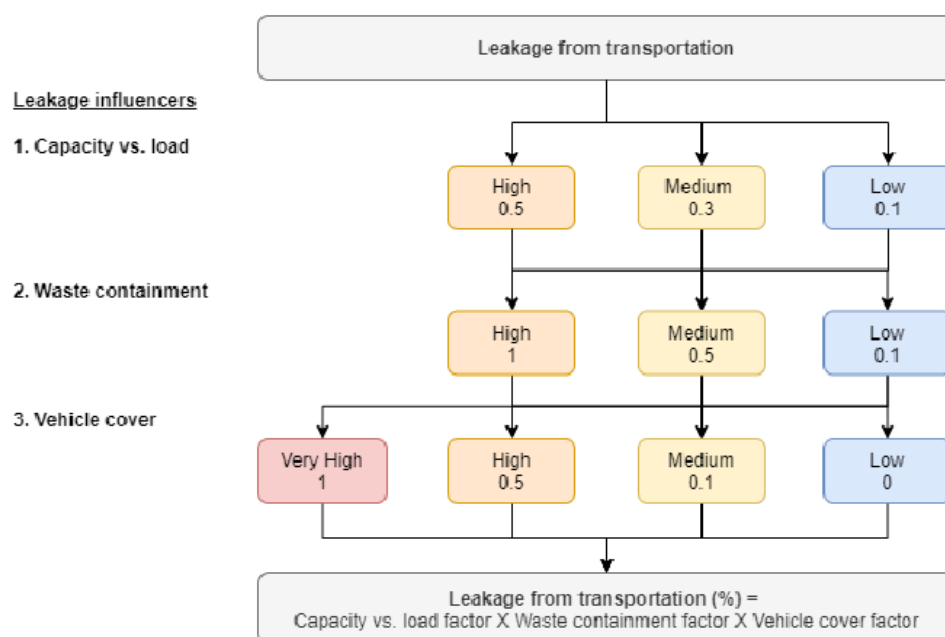


Figure 24: Decision tree and calculation of leakages from Transportation (GIZ, 2020)

**Collecting data on where plastic is observed in the environment** – The observational approach is also used to decide the fate of plastic material in the environment (i.e., where it will end up). Each emission source is split into a distinct category depending on whether the plastic emission occurs at a single location, such as a dumpsite (point source), across large areas like emissions during transportation (diffuse source), and whether the emission occurred voluntarily (such as dumping of uncollected waste), or involuntarily (such as waste blowing off a collection container). Assessors are required to observe and record the locations they visually see plastic in the environment for each emission source, with the WFD automatically assigning fates based on the relative selections made (Figure 25). For example, for leakage from dumpsites, users would observe the types of locations (e.g., land, water, drains) they found plastic in the vicinity of the dumpsite, with the WFD then normalizing these to 100%. To avoid biasing results, it is recommended that multiple locations be observed across the city for the diffuse emission sources, with the user selecting the leakage potential or plastic fate that matches their most common observation.

| 5. Plastic pollution levels per fate |                                                                   |                                          |      | Baseline  |                       |
|--------------------------------------|-------------------------------------------------------------------|------------------------------------------|------|-----------|-----------------------|
| No.                                  | Item                                                              | Description                              | Unit | Value     | Normalised Fate (%) ⓘ |
| 17.1                                 | Fate of uncollected plastic waste                                 | Level of plastic openly burnt            | NA   | Medium    | 23.8%                 |
| 17.2                                 |                                                                   | Level of direct dumping on land          | NA   | High      | 61.9%                 |
| 17.3                                 |                                                                   | Level of direct dumping in drains        | NA   | Low       | 9.5%                  |
| 17.4                                 |                                                                   | Level of direct dumping in water systems | NA   | Very low  | 4.8%                  |
| 18.1                                 | Fate of plastic waste leaked during collection and transportation | Level of plastic to land                 | NA   | Very high | 69.0%                 |
| 18.2                                 |                                                                   | Level of plastic to drains               | NA   | High      | 27.6%                 |
| 18.3                                 |                                                                   | Level of plastic to water systems        | NA   | Very low  | 3.4%                  |
| 19.1                                 |                                                                   | Level of plastic openly burnt            | NA   | None      | 0.0%                  |
| 19.2                                 | Fate of plastic waste leaked from formal sorting                  | Level of direct dumping on land          | NA   | Medium    | 57.1%                 |
| 19.3                                 |                                                                   | Level of direct dumping in drains        | NA   | Medium    | 28.6%                 |
| 19.4                                 |                                                                   | Level of direct dumping to water systems | NA   | Low       | 14.3%                 |
| 20.1                                 |                                                                   | Level of plastic openly burnt            | NA   | Very high | 46.2%                 |
| 20.2                                 | Fate of plastic waste leaked from informal sorting                | Level of direct dumping on land          | NA   | Low       | 15.4%                 |
| 20.3                                 |                                                                   | Level of direct dumping in drains        | NA   | Low       | 7.7%                  |
| 20.4                                 |                                                                   | Level of direct dumping to water systems | NA   | High      | 30.8%                 |
| 21.1                                 |                                                                   | Level of plastic to land                 | NA   | Very high | 69.0%                 |
| 21.2                                 | Fate of plastic waste leaked from disposal facilities             | Level of plastic to drains               | NA   | High      | 27.6%                 |
| 21.3                                 |                                                                   | Level of plastic to water systems        | NA   | Very low  | 3.4%                  |

Figure 25: Screenshot of the WFD Excel model for the entering of observations around plastic fate in the environment. The grey column shows how these selections are normalized to a percentage for allocation





# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

**Using the WFD toolkit** – There are two options to run the WFD. A Microsoft Excel version is available to download from <https://wfd-data.rwm.global/resources> or an online interface is available to registered users through the ‘user dashboard’ option at the [WFD Data Portal](#). Both options include two versions of the WFD. Version 1.0 is the original model as discussed in the User Manual. Alternatively, Version 2.0 is an updated version of the model that includes improvements, for instance by calculating aspects such as open burning from land disposal sites and estimating greenhouse gas emissions. It is recommended that Version 2.0 always be used given it incorporates improvements. The WFD Data Portal allows results to be automatically updated based on the versions selected.

The Microsoft Excel version contains a sheet called ‘Baseline data entry’. This is the sheet where data should be added. There is also a sheet called ‘Scenarios data entry’, which optionally allows for the impact of future scenarios to be assessed (for example, the impact of improving infrastructure or practices or the impact of reducing plastic consumption). Each data input includes a column to add metadata to detail the source of the data input or method by which it was measured, and a column to qualitatively score the reliability of the data from low to high.

Results are shown for the baseline and any modelled scenarios across two sheets. The material flow analysis results are shown on the ‘Flow diagrams’ sheet. These can be visualized either in the form of a material flow analysis diagram or in a more simplified Sankey diagram format. Key performance indicator results are shown on the ‘Results summary’ sheet. This displays core results on solid waste management and plastic emission (leakage), as shown in Figure 26. Here, ‘unmanaged’ plastic waste is the equivalent of plastic emissions and is provided in units of tonnes per year and as a percentage of plastic waste generation. To convert this result into the units required for Indicator 6 (kg/capita/year), users should multiply the tonnes per year value by 1,000 and divide by the population of the city.

|                                                   | Plastic waste |            |            |            | Unit                                 |
|---------------------------------------------------|---------------|------------|------------|------------|--------------------------------------|
|                                                   | Baseline      | Scenario 1 | Scenario 2 | Scenario 3 |                                      |
| Unmanaged plastic waste                           | 7,931         | 4,937      | 2,875      | 812        | Tonnes/year                          |
| Unmanaged plastic waste                           | 38%           | 24%        | 14%        | 4%         | % of plastic waste generation        |
| Contribution from uncollected waste               | 97.43%        | 99.06%     | 98.13%     | 92.49%     | % of mismanaged plastic waste        |
| Contribution from collection service              | 1.81%         | 0.25%      | 0.50%      | 2.04%      | % of mismanaged plastic waste        |
| Contribution from informal value-chain collection | 0.38%         | 0.07%      | 0.12%      | 0.42%      | % of mismanaged plastic waste        |
| Contribution from formal sorting                  | 0.09%         | 0.18%      | 0.36%      | 1.47%      | % of mismanaged plastic waste        |
| Contribution from informal sorting                | 0.15%         | 0.16%      | 0.32%      | 1.30%      | % of mismanaged plastic waste        |
| Contribution from transportation                  | 0.00%         | 0.00%      | 0.00%      | 0.00%      | % of mismanaged plastic waste        |
| Contribution from disposal facilities             | 0.13%         | 0.28%      | 0.56%      | 2.28%      | % of mismanaged plastic waste        |
| Plastic waste retained on land                    | 3,394         | 2,084      | 1,216      | 351        | Tonnes/year                          |
| Plastic waste retained on land                    | 43%           | 42%        | 42%        | 43%        | % of mismanaged plastic waste        |
| Plastic waste openly burnt                        | 2,042         | 1,296      | 753        | 210        | Tonnes/year                          |
| Plastic waste openly burnt                        | 26%           | 26%        | 26%        | 26%        | % of mismanaged plastic waste        |
| Plastic waste cleaned from drains                 | 334           | 207        | 120        | 34         | Tonnes/year                          |
| Plastic waste cleaned from drains                 | 4%            | 4%         | 4%         | 4%         | % of mismanaged plastic waste        |
| Plastic waste to water systems                    | 2,160         | 1,350      | 785        | 218        | Tonnes/year                          |
| Plastic waste to water systems                    | 27%           | 27%        | 27%        | 27%        | % of mismanaged plastic waste        |
| Plastic waste to water systems                    | 10%           | 7%         | 4%         | 1%         | % of plastic waste generation        |
| Contribution directly entering water systems      | 38%           | 39%        | 39%        | 39%        | % of plastic in water systems        |
| Contribution entering via storm drains            | 62%           | 61%        | 61%        | 61%        | % of plastic in water systems        |
| Plastic to water systems per person               | 2.2           | 1.3        | 0.8        | 0.2        | kg per person/year                   |
| Plastic to water systems per person               | 72            | 45         | 26         | 7          | no. PET bottles per person/year*     |
| Plastic to water systems                          | 25            | 16         | 9          | 3          | no. of olympic swimming pools/year** |
| Plastic to water systems                          | 3,177         | 1,985      | 1,155      | 321        | no. of waste trucks/year***          |

**Figure 26:** Screenshot of the WFD Excel model ‘Results summary’ sheet. The top row can be converted to units of kg/capita/year to inform on Indicator 6



# HOW TO CO-APPLY METHODOLOGY 2 & 3



## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

As an alternative to the Microsoft Excel version of the WFD, users can choose to use the online user interface at the [WFD Data Portal](#). The user interface guides users through each question and retains the ability to enter metadata, comments and score the reliability of data points (Figure 27). Files can also be attached to the data entry, for example linking to the origins of the data in study reports.

Waste generation information

Data

Metadata

Comments

Save

What is Municipal Solid Waste composition?

3.1. Paper

0.00

% by weight

?

3.2. Plastics

0.00

% by weight

3.3. Glass

0.00

% by weight

3.4. Metals

0.00

% by weight

3.5. Other

0.00

% by weight

3.6. Organics

0.00

% by weight

Total

0%

Total should be 100%

Reliability

Figure 27: Screenshot of the WFD online user interface data entry

The online interface displays the main results in a similar manner to the Excel version of the WFD with Flow diagrams, Sankey diagrams, and KPI, all shown as tabs that can be navigated between. Additional features are also provided in the online version. For instance, automated reports can be generated that visualize all the key results (such as major plastic leakage sources) and provide background information to the study. Raw and processed data can also be downloaded to .csv files to allow for further analysis by users.

### RECOMMENDATIONS FOR HARMONIZED ASSESSMENT

The Waste Wise Cities Tool and the Waste Flow Diagram are already interoperable, with data from WaCT able to feed into the WFD. As such, much of the terminology and data inputs are harmonized. Despite this, it is important that details of the implementation be recorded and reported alongside Indicators 2 – 6. Suggestions of the types of metadata to include when reporting the indicators are discussed in [Step 5: Monitoring and Reporting](#) and the accompanying Supporting Toolkit.

One particularly important part to harmonize on is ensuring that the same geographical area and demographics are used across both methods. Often, the administrative boundary differs from the ‘urban’ boundary and therefore variations can be easily overlooked; this can significantly impact the results. Although it is possible to use WaCT data from a nearby city as a proxy to estimate the input data to the WFD, such assumptions should be clearly acknowledged and the automatic data entry tools within the WaCT DCA should be avoided in this case. Likewise, variations exist in the composition categories used between both tools; therefore, extra care should be taken to ensure that the WaCT compositions are aggregated to a format that aligns with those of the WFD. Material recorded as received by reprocessing facilities is a prominent example of where harmonization is more challenging due to different composition categories used. If possible, it is recommended that the WaCT category of ‘mixed waste’ be avoided, as converting this to the six categories of the WFD can be challenging without additional information.

Lastly, it should be noted that the emission factors used in WFD are not currently harmonized with the emission factors used in the SPOT model. Work is on-going to standardize these; however, to facilitate harmonization, it is essential that the methods used for calculating plastic leakage be clearly recorded alongside Indicator 6.

# HOW TO CO-APPLY METHODOLOGY 2 & 3

## WASTE WISE CITIES TOOL & WASTE FLOW DIAGRAM

### ACCESS TO TRAINING AND SUPPORT

WaCT is supported by UN-Habitat and has an extensive user manual (UN-Habitat, 2021), [training videos](#), and a dedicated '[data collection application](#)' (DCA). Users are also encouraged to join the [Waste Wise Academy](#) for knowledge sharing and support.<sup>1</sup>

Training material for WFD is readily available, for example: a [user manual](#) available in English, Spanish and Portuguese (GIZ et al., 2020), [online training videos](#), a dedicated [data portal and online application](#) of the WFD (requires registration), [case studies](#) and a [user forum](#).

**The instructions provided in this Guidebook are for information purposes only. They do not replace the user manuals or negate the need for completing any necessary training via the methodology developers.**

- <sup>1</sup> The ASEAN region already has strong experience in applying WaCT; however, members unfamiliar with the methodology can be trained via a 1–2-day workshop led by UN-Habitat via their Waste Wise Cities Network ([wastewisecities@un.org](mailto:wastewisecities@un.org)). We recommend that members of the expert team have a good understanding of municipal solid waste management (MSWM) systems.
- <sup>2</sup> Dedicated training workshops can also be arranged through [GIZ](#). It is highly recommended that any implementation of the WFD be done in unison with GIZ; doing so provides additional benefits, such as validation of the study by experts and addition of results to the data portal.



# How to Co-Apply Methodology 2, 4 & 5A: Waste Wise Cities Tool (WaCT), BRS Material Flow Analysis (MFA) Toolkit & SPOT Model (existing estimates)



# HOW TO CO-APPLY METHODOLOGY 2, 4 & 5A

## WASTE WISE CITIES TOOL, BRS MATERIAL FLOW ANALYSIS TOOLKIT & SPOT MODEL (EXISTING ESTIMATES)

### REQUIREMENTS FOR APPLYING THESE METHODOLOGIES

This approach uses the archetypal aggregation method of the BRS Material Flow Analysis (MFA) Toolkit to measure the solid waste management indicators at a national level. Three archetypes are used in the BRS MFA toolkit, each of which requires data on solid waste management:

1. Mega – Large metropolitan urban area
2. Medium – Smaller urban areas
3. Small – Small towns and rural areas

The data required to be collected in each of these archetypes is similar to that of the Waste Flow Diagram on which it is based. This includes data on:

- Population
- Waste generation rates
- Proportion of plastic in MSW
- Quantities of plastic waste arriving at land disposal sites (including split between controlled and uncontrolled disposal sites)
- Quantities of plastic waste collected for recycling by the formal and informal sector
- Quantities of plastic waste sent to incineration (waste to energy) facilities
- Plastic reject rates from formal and informal sorting facilities
- Mass of plastic imports per day
- Mass of plastic exports per day

There are, however, notable differences between the BRS MFA and WFD data inputs: the former relate only to the plastic proportion of municipal solid waste, and additional data is required on plastic imports and exports.

The preferred approach for collecting data in each of the archetypes is to implement the Waste Wise Cities Tool (WaCT) in three ‘typical’ case study municipalities, one for each of the archetypes. This is preferential as WaCT provides a clearly defined methodology to follow to measure the inputs and it produces harmonized results. However, the effort to achieve this is high; for a single study, WaCT requires “a working team of 20-30 survey helpers who are dedicated full-time for 8-10 days, led by 2-3 well trained experts dedicated for a combined total of about 6 working weeks per city” (UN-Habitat, 2021). (Full details of the requirements for implementing the WaCT is available under [‘How to co-apply Methodology 2 & 3’](#) section.)

The second preferential approach is to use a combination of existing data for archetypes (when the data is considered reliable) and supplementing this with WaCT studies for archetypes that have unreliable data or no data. For example, it is likely that data is more readily available and higher quality for Mega archetypes than for Medium or Small archetypes where populations and resources are more limited. One possible approach to address this could be to use existing data for the Mega and Medium archetypes and apply WaCT in a typical Small archetype municipality. Likewise, if data is only reliable for a Mega archetype, WaCT could be applied in both a Medium and Small archetype municipality. Depending on the frequency that existing data is collected, WaCT could also be periodically applied on a rolling basis across each of the archetypes to update and validate the reliability of existing data.

The final approach to data collection is to use existing data for all three archetypes. This is only recommended when there is reliable data for each of the archetypes. Even in this case, it is advisable (if resources allow) to periodically implement WaCT in one or more of the archetypes to validate the reliability of existing data.



# HOW TO CO-APPLY METHODOLOGY 2, 4 & 5A

## WASTE WISE CITIES TOOL, BRS MATERIAL FLOW ANALYSIS TOOLKIT & SPOT MODEL (EXISTING ESTIMATES)

The BRS MFA methodology mirrors the approach of the Waste Flow Diagram in using observational assessments of infrastructure and practices to estimate plastic emissions. However, we do not recommend it be used for this purpose. This is due to challenges with harmonization and extrapolation of visual observations to the national level. Harmonization issues arise as the BRS MFA methodology is based on version 1.0 of the WFD and is not compatible with the updated Version 2.0 (recommended as an alternative approach in this Guidebook). Likewise, the infrastructure and practices used in each archetype at a local level often vary considerably, making it challenging to accurately generalize and extrapolate results. For example, one municipality in the Mega archetype may have a controlled engineered sanitary landfill leading to low plastic emissions, whereas another municipality also within the Mega archetype may use an uncontrolled dumpsite and have high emissions. Therefore, achieving an average plastic emission rate for the archetypes is not feasible using the visual observation approach, and as such is not recommended as part of the BRS MFA methodology. As an alternative, it is recommended to use the existing estimates from the SPOT model to measure Indicator 6 – Plastic emissions into the environment.

### GUIDE TO IMPLEMENTING THE METHODOLOGIES

#### Choosing archetype municipalities

The BRS MFA methodology uses three archetypes of municipalities: Mega, Medium and Small. Definitions are provided for each of these in the accompanying user manual (Pisharody & Lerpiniere, 2021):

1. Mega - All Metropolitan Assemblies comprising urban centres with populations over 250,000
2. Medium - All Municipal Assemblies comprising single-town councils with populations of 95,000 or more
3. Small - All District Assemblies comprising smaller towns and rural areas with low population density

This Guidebook recommends that the population numbers referenced in these definitions be treated as guidance only. Instead, users should ensure that archetypes reflect three distinct types of municipality, such as urban centres (Mega), towns (Medium) and rural locations (Small) regardless of the exact population size. It is also likely that a single municipality has elements of all three archetypes in its borders, for example rural areas in the administrative jurisdiction of a city. It is important that measurements of solid waste management be collected according to the full administrative boundary rather than just the sections of a municipality that reflect the archetype best. This is to avoid potentially biasing results (e.g., by focusing only on the more urban and serviced areas of a city) and to help align any primary data collection with secondary demographic data (e.g., populations recorded via a census are likely to relate to the full administrative jurisdiction rather than just the urban areas of a municipality).

The municipalities chosen to represent each archetype should relate to a typical municipality within that archetype to avoid biasing results. For instance, results could be biased by choosing a capital city or large mega city for sampling of the Mega archetype if it has much greater resources and solid waste management performance compared to most other cities in the country. Other factors may also influence the choice of archetype municipalities, for example, the availability of reliable data or preferences around which municipalities would benefit the most from primary data collection using WaCT. To encourage harmonization, the municipalities used to represent an archetype should be clearly recorded alongside the indicators, as well as the justifications for why these municipalities were chosen.







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# HOW TO CO-APPLY METHODOLOGY 2, 4 & 5A

## WASTE WISE CITIES TOOL, BRS MATERIAL FLOW ANALYSIS TOOLKIT & SPOT MODEL (EXISTING ESTIMATES)

| B          | C        | D                                                                                                              | E                                                                                                              | F                                                                                                                                                                                                                                                                                                                            | G             | H         | I                                                                                                                                                                                                | J                                                                                                                                                                                                                                                                      | K                 |
|------------|----------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Data point | MFA ref. | Data point                                                                                                     | Description                                                                                                    | Guidance                                                                                                                                                                                                                                                                                                                     | Unit          | Value     | Data Source                                                                                                                                                                                      | Comment                                                                                                                                                                                                                                                                | Data reliability  |
| 1          | -        | Population                                                                                                     | Total population of archetype                                                                                  | Consider the most recent census or national statistical sources which provide the estimated breakdown by demographic and geographical regions of the country to enable better defining of archetypes                                                                                                                         | Persons       | 2,589,213 | GSS, 2019 (Metropolitan - urban areas with populations over 250,000 Municipal - single-town councils with populations of 95,000 or more District - wider areas that cover rural areas and towns) | Ghana has 6 Metropolitan Assemblies which constitute the Mega archetype in this inventory (Medium cities (107 Municipal Assemblies) and Small cities (147 District Assemblies). In all, areas by archetype making 260 Districts)                                       | Reliable          |
| 2          | -        | Rate of MSW generation                                                                                         | Rate of generation of municipal solid waste                                                                    | Preferably obtained through waste characterisation studies. In the absence of the above, triangulation of values from representative regions using literature sources may be used.                                                                                                                                           | kg/person/day | 0.72      | Waste generation within four of the five metropolitan areas studied; Accra, Kumasi, Takoradi, and Cape Coast 0.72 kg/person/day in the major urban areas (Miezah et al., 2015)                   | Metropolitan - urban areas with populations over 250,000 Municipal - single-town councils with populations of 95,000 or more District - wider areas that cover rural areas and towns                                                                                   | Somewhat reliable |
| 3          | -        | Proportion of plastic in municipal solid waste                                                                 | Proportion of plastic waste found in MSW                                                                       | Preferably obtained through waste characterisation studies. In the absence of the above, triangulation of values from representative regions using literature sources may be used.                                                                                                                                           | %             | 17        | National Association of Sachet & Packaged Water Producers, 2018                                                                                                                                  | Data collection by local project team                                                                                                                                                                                                                                  | Somewhat reliable |
| 4          | TD1      | Tonnes of plastics waste disposed in landfills                                                                 | Amount of plastic waste in the waste that is disposed in designated disposal sites                             | Preferably obtain through waste characterisation studies and surveys of disposal sites. In the absence of real time data, use triangulated values from representative regions using literature sources or proxies.<br><br><i>Refer guidance from SDG11.6.1 for disposal site surveys and characterisation methodologies.</i> | tonnes/day    | 215.49    | Ackah, R., Carboo, D., & Gyamfi, E. (2012). Challenges of plastic waste disposal in Ghana: a case study of solid waste disposal sites in Accra. & Landfill data from stakeholders                | Landfill data for two landfills were obtained for 2017 to 2019 from MMDAs. For the Mega archetype, average waste input to the Engineered landfill in the Accra region were used. Plastic composition of 17% obtained from literature was applied to the landfill data. | Less reliable     |
| 5          | -        | Plastic waste disposed in controlled landfills                                                                 | Proportion of disposed plastic ending up in controlled landfills                                               | Preferably obtained from official records where available or surveys of designated disposal sites                                                                                                                                                                                                                            | %             | 54        | Expert judgment & Odure-Appiah et al. 2020.                                                                                                                                                      | Percentage proportion estimated using quantity of waste in controlled and uncontrolled landfills (Fig 2, Pg 7)                                                                                                                                                         | Less reliable     |
| 6          | -        | Plastic waste disposed in uncontrolled landfills                                                               | Proportion of disposed plastic ending up in uncontrolled landfills                                             |                                                                                                                                                                                                                                                                                                                              | %             | 46        | Expert judgment & Odure-Appiah et al. 2020.                                                                                                                                                      | Percentage proportion estimated using quantity of waste in controlled and uncontrolled landfills (Fig 2, Pg 7)                                                                                                                                                         | Less reliable     |
| 7          | -        | Proportion of total plastic waste received at landfills that comes from formal mixed waste collection services | Proportion of plastic waste in mixed waste received at landfills which comes from formal collection services   | Preferably obtained from landfill site records of incoming vehicles and waste quantities. In the absence of records, conduct interviews of waste collection service actors and landfill operators to obtain estimation proportions.                                                                                          | %             | 90        | Estimate                                                                                                                                                                                         | Although some landfill records were provided, the data was incomplete and collected in different years. Hence, the proportional split had to be estimated from partial data using expert judgement.                                                                    | Less reliable     |
| 8          | -        | Proportion of total plastic waste received at landfills that comes from informal mixed collection services     | Proportion of plastic waste in mixed waste received at landfills which comes from informal collection services |                                                                                                                                                                                                                                                                                                                              | %             | 10        | Estimate                                                                                                                                                                                         | Although some landfill records were provided, the data was incomplete and collected in different years. Hence, the proportional split had to be estimated from partial data using expert judgement.                                                                    | Less reliable     |
| 9          | IC1      | Quantity of plastic waste                                                                                      | Quantity of plastic waste received at energy                                                                   | Obtained through interviews and waste                                                                                                                                                                                                                                                                                        | tonnes/day    | 0         | Assumed to be zero due to lack of evidence                                                                                                                                                       |                                                                                                                                                                                                                                                                        | Less reliable     |

**Figure 29: Example of a data collection sheet for the BRS MFA toolkit (Pisharody and Lerpiniere, 2021).** The quantitative data inputs are added to the yellow shaded 'Value' column, whereas meta data and data reliability scores are added to the 'Data Source', 'Comment' and 'Data reliability' columns

Additional information can also be added to the 'Data source', 'Comment' and 'Data reliability' columns. Whilst the toolkit will run without data in these three columns, it is highly recommended to include this data for purposes of tracing data inputs and achieving harmonization between studies.

No data is required to be input into the 'Leakage estimation' sheets of each archetype given that this Guidebook recommends the SPOT model estimates for Indicator 6 instead. As such, once data has been entered into the data collection sheets for all three archetypes, the results are ready to be viewed on the 'All flows' and 'Summary' sheets.



# HOW TO CO-APPLY METHODOLOGY 2, 4 & 5A

## WASTE WISE CITIES TOOL, BRS MATERIAL FLOW ANALYSIS TOOLKIT & SPOT MODEL (EXISTING ESTIMATES)

### Converting BRS MFA results to format required for reporting Indicators 2-5

Results are occasionally provided in the BRS in a format that requires converting to the required units for reporting of the indicators. The details and calculations for achieving this are outlined below. All variables in equations relate to the national level results shown on the result sheets.

$$\text{Indicator 2: Plastic waste generation rate (kg/capita/year)} = \frac{\text{Plastic waste generation (tonnes/year)}}{\text{National population}} \quad (\text{Eq. 7})$$

$$\text{Indicator 3: MSW collection coverage (\%)} \cong \text{MSW collection coverage (\%)} = \frac{\text{Plastic waste generation (tonnes/year)} - \text{Uncollected plastic waste (tonnes/year)}}{\text{Plastic waste generation (tonnes/year)}} \times 100 \quad (\text{Eq. 8})$$

Note: The top line of equation 8 demonstrates that the collection coverage measured by the BRS MFA toolkit is only approximately equal to Indicator 3: MSW collection coverage. This is due to the BRS MFA toolkit only measuring plastic flows; therefore, the collection coverage it calculates is plastic collection coverage. The plastic collection coverage may be slightly higher than the MSW collection coverage due to plastic typically being recovered more for recycling than other components of MSW. However, for the reporting of Indicator 3 they can be considered approximately equal. Any reporting of this indicator calculated using the BRS MFA approach should include metadata to explain that the collection coverage reported refers to the plastic collection coverage.

**Indicator 4:** Municipal solid waste collected and managed in controlled facilities is not measured by the BRS MFA toolkit. However, if WaCT has been used to collect data for one of the archetypes, this indicator will be available through the WaCT tool for that respective municipality only.

**Indicator 5:** Municipal plastic recycling rate (%), is calculated in the correct format on the BRS MFA Toolkit 'Summary' sheet in row 15: column F (Proportion recycled – National).

### Obtaining existing estimates of plastic emissions from SPOT

As previously discussed, this Guidebook does not recommend the use of the BRS MFA Toolkit to measure

**Indicator 6:** Municipal plastic emissions into the environment. Instead, estimates of Indicator 6 can be obtained from the existing estimates of the SPOT model. For details on how to retrieve the data for this, see section [How to Apply Methodology 5A: SPOT Model \(existing estimates\)](#).

## RECOMMENDATIONS FOR HARMONIZED ASSESSMENT

The co-application of methodologies 2, 4 and 5A offer a flexible approach to measure Indicators 2-6 at a national level. However, this flexibility also means extra care must be taken to ensure harmonized assessment. Key points to consider are that the BRS MFA methodology measures only plastic flows, whereas Indicator 3 is related to municipal solid waste. As such, any reporting of Indicator 3 using this approach should clearly include metadata to indicate the method used and actual measurement that is recorded.

The data requirements for the BRS MFA methodology can be obtained from a combination of WaCT studies and existing reliable data. To facilitate harmonization, the methodology behind the indicators must therefore also be put in context. For example, care should be taken to record the source of the data inputs that feed into the BRS methodology, as this can range from using WaCT data to existing data following varying methodologies. It is recommended that WaCT studies be applied when resources allow, even if data from other methodologies is available, as this can act as further validation of the data inputs.

## ACCESS TO TRAINING AND SUPPORT

A user manual and the Microsoft Excel toolkit are available to download from [Basel Convention](#).

The instructions provided in this Guidebook are for information purposes only. They do not replace the user manuals or negate the need for completing any necessary training via the methodology developers.



# How to Apply Methodology 5A: SPOT Model (existing estimates)



# HOW TO APPLY METHODOLOGY 5A

## SPOT MODEL (EXISTING ESTIMATES)

### REQUIREMENTS FOR APPLYING THIS METHODOLOGY

There are no requirements as it uses existing published estimates of the SPOT model to estimate Indicators 2 – 6. This should only be used when primary data collection is not possible.

### GUIDE TO METHODOLOGY

#### Summary of methodology

The SPOT model publishes an estimate of flows of MSW in the SWM system and plastic emissions for every municipality and country in the world. These flows directly quantify Indicators 2 – 6 and can therefore be used as estimates by countries when no other data is available or when collecting primary data is not possible.

SPOT is a material flow analysis (MFA) methodology that works at a local (municipal) scale but can aggregate results to any higher level (e.g., national level). The model works by following 5 broad steps as shown in Figure 30:

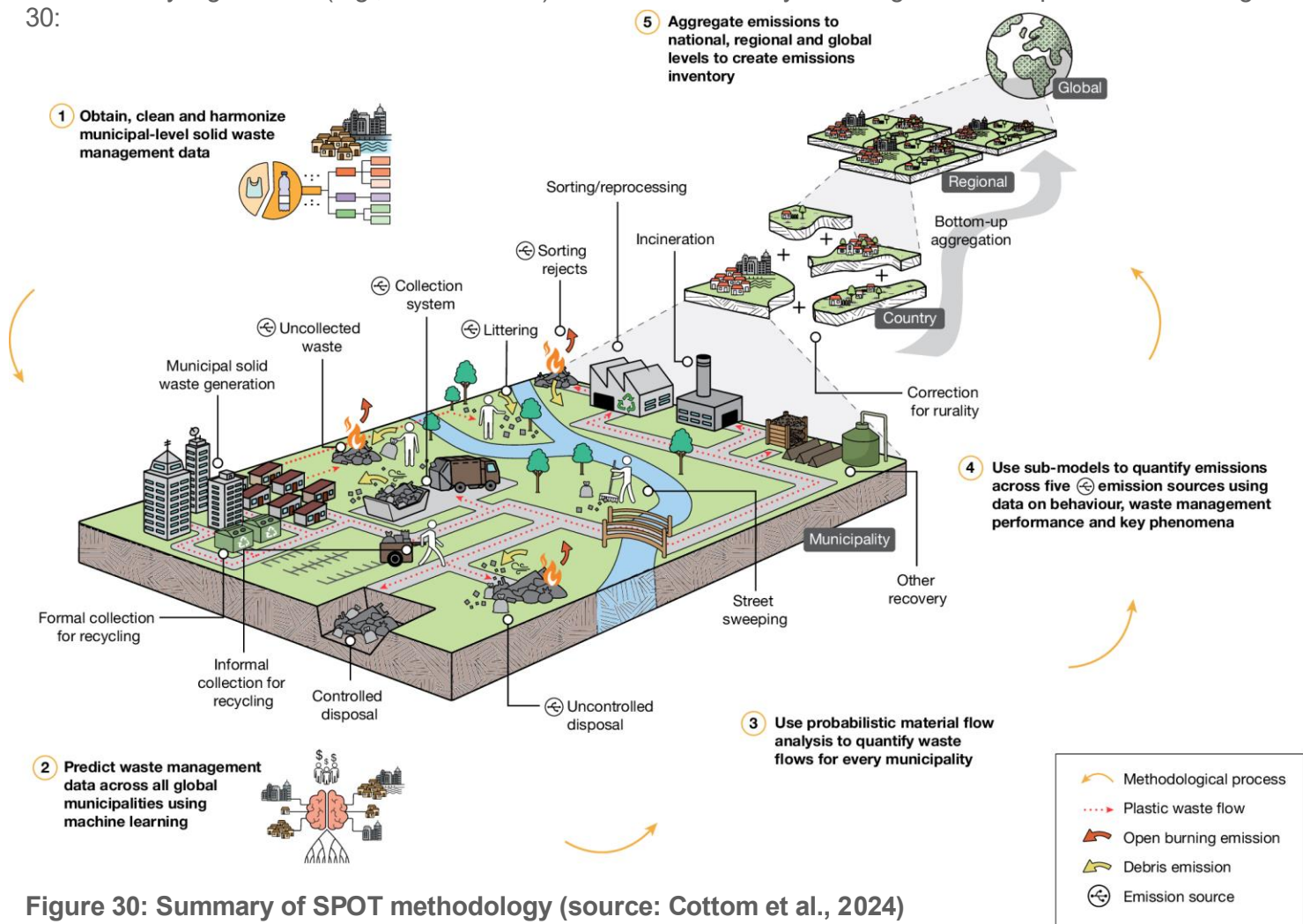


Figure 30: Summary of SPOT methodology (source: Cottom et al., 2024)

The authors collected data from across the world on how cities manage their waste, for example using data from the Waste Wise Cities Tool (UN-Habitat, 2021) and the World Bank publication, What a Waste 2.0 (Kaza et al., 2018). This data was cleaned and corrected to remove erroneous data points and to harmonize it to a consistent basis, including accounting for MSW flows that are not typically measured by municipalities such as uncollected waste. The cleaned data was used to train a machine learning model, which in turn allows the prediction of SWM data for municipalities where no data exists. The data predicted by the machine learning model was used to



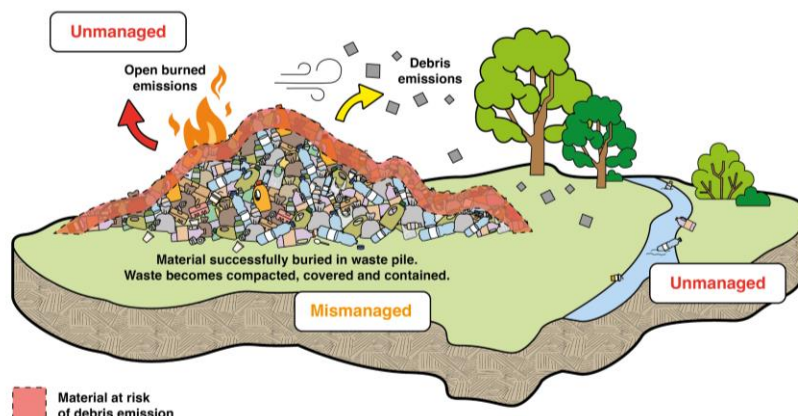
# HOW TO APPLY METHODOLOGY 5A

## SPOT MODEL (EXISTING ESTIMATES)

perform material flow analyses for every municipality in the world (>50,000). These MSW flows form the basis for quantification of the SWM Indicators 2 – 5. Step 4 of the methodology allows the estimation of Indicator 6 (plastic emissions into the environment) by multiplying relevant material flows from step 3 by emission factors. Emission factors are quantified by sub-models which relate available emission factor data to conditions on the ground. An example of a sub-model for plastic emissions from uncontrolled disposal sites is shown in Figure 31:

**Figure 31: Illustration of a sub-model for quantifying plastic emissions from an uncontrolled disposal site.** Emissions are dependent on the amount of open burning occurring at the dumpsite (open burning plastic emissions) and the quantity of material at the surface of the dumpsite, which is at risk from environmental factors such as wind (plastic debris emissions).

Source: Cottom et al., 2024



Five emission sources are quantified in SPOT (Figure 30), namely: (1) Uncollected litter, (2) Uncollected waste, (3) Collection system emissions, (4) Emissions from uncontrolled disposal sites, and (5) Emissions from mismanaged sorting rejects. Further distinction is provided on whether the emissions are plastic debris (physical plastic items) or due to open burning of the plastic, and the proportion of the emissions that is from rigid and flexible plastic items. The final step of the SPOT Model is to aggregate the results from the municipal level up to the national or regional level.

### Accessing existing estimates of Indicators 2 – 6

At present (July 2025), results are only available for the year 2020; however, periodic updates are planned to allow continual updating of results for monitoring purposes. Indicators 2 – 6 are available to extract from the SPOT model at both municipal and national level, with results for 2020 available for download from : [Dryad - https://doi.org/10.5061/dryad.8cz8w9gxb](https://doi.org/10.5061/dryad.8cz8w9gxb)



**View existing estimates of Indicators 2 - 6**  
(mean result only)



**Download the full SPOT results**  
(for further analysis or quantification of sub-indicators)

## RECOMMENDATIONS FOR HARMONIZED ASSESSMENT

SPOT was developed to be harmonized with the Waste Wise Cities Tool. Estimates of plastic emissions are not fully aligned with those of the Waste Flow Diagram at present, although there are plans to harmonize these in the future. Any reporting of indicators using existing SPOT estimates should clearly state the source (model version and baseline year) to allow transparency and harmonization. Further discussion on achieving this is provided in [Step 5: Monitoring and Reporting](#) section.

## SUB-INDICATORS

The SPOT model allows the assessment of additional optional sub-indicators. Ones of particular significance to the ASEAN region include: MSW generation rate; proportion of plastic in MSW; openly burned plastic; plastic debris emissions; rigid vs flexible plastic emissions; controlled vs uncontrolled disposal; MSW openly burnt; and emissions quantified by five major sources: (1) Uncollected litter, (2) Uncollected waste, (3) Collection system emissions, (4) Emissions from uncontrolled disposal, and (5) Emissions from mismanagement of reject from plastics sorting.





# HOW TO APPLY METHODOLOGY 5A

## SPOT MODEL (EXISTING ESTIMATES)

Table 7: Estimates of Indicators 2-6 at the national level for the year 2020 from the SPOT model. Values shown relate to the mean estimate. *Source: Cottom et al., 2024*

| Country     | Indicator 2 –<br>Plastic waste<br>generation rate                                                                                                                                                                                                     | Indicator 3 –<br>MSW collection<br>coverage                                                                                                                                                                                                                                                                                                                                                                                                                                             | Indicator 4 –<br>SDG11.6.1: MSW<br>collected and<br>managed in<br>controlled facilities                                                                                                                                                                | Indicator 5 –<br>Plastic recycling rate                                                                                                                                                                                                                                                                                                                                                                                                                                            | Indicator 6 –<br>Plastic emissions to<br>the environment                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unit:       | kg/capita/year                                                                                                                                                                                                                                        | % of MSW generated                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | % of MSW generated                                                                                                                                                                                                                                     | % of MSW plastic<br>generation                                                                                                                                                                                                                                                                                                                                                                                                                                                     | kg/capita/year                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Brunei D.   | 98                                                                                                                                                                                                                                                    | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 100                                                                                                                                                                                                                                                    | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.2                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Cambodia    | 52                                                                                                                                                                                                                                                    | 62                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 5                                                                                                                                                                                                                                                      | 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 25.2                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Indonesia   | 30                                                                                                                                                                                                                                                    | 72                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 11                                                                                                                                                                                                                                                     | 21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 12.4                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Laos        | 24                                                                                                                                                                                                                                                    | 37                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 4                                                                                                                                                                                                                                                      | 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 17.3                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Malaysia    | 46                                                                                                                                                                                                                                                    | 87                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 87                                                                                                                                                                                                                                                     | 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 6.0                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Myanmar     | 27                                                                                                                                                                                                                                                    | 62                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 9                                                                                                                                                                                                                                                      | 19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 13.6                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Philippines | 32                                                                                                                                                                                                                                                    | 82                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 57                                                                                                                                                                                                                                                     | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 7.4                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Singapore   | 63                                                                                                                                                                                                                                                    | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 100                                                                                                                                                                                                                                                    | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.03                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Thailand    | 48                                                                                                                                                                                                                                                    | 82                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 24                                                                                                                                                                                                                                                     | 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 13.9                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Viet Nam    | 38                                                                                                                                                                                                                                                    | 87                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 50                                                                                                                                                                                                                                                     | 17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 7.8                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Notes       | Data on plastic waste generation per capita is provided under output ID 'pwg_per_cap' in the '03_Outputs' sheet'. The value provided is in units of kg/capita/day, so these are multiplied by 365 to convert to the required units of kg/capita/year. | Data on MSW collection coverage is provided under output ID 'col_del_pct_gen' in the '03_Outputs' sheet'. Collection coverage in the SPOT model is calculated as the mass of MSW received by formal facilities or collected by informal recyclers, divided by the total mass of MSW generated. The total mass of MSW generated includes waste that is typically not measured by municipalities such as uncollected waste, uncollected litter, and emissions from the collection system. | Data on SDG11.6.1 is provided under output ID 'man_cont_pct_gen' in the '03_Outputs' sheet. The 'Ladder of control' for disposal sites in the UN-Habitat Waste Wise Cities Tool is used as a basis to estimate what is considered controlled disposal. | Plastic recycling rate is calculated using SPOT data by summing the mass of plastic waste sorted for recovery by the formal and informal sectors (processes IDs P23aa, P23ab, P25aa and P25ab in the '01_Processes' sheet) and dividing this mass by the mass of plastic waste generated (output ID 'pwg' in the '03_Outputs' sheet') and multiplied by 100 to convert to a percentage. This mass sorted for recovery excludes rejects during the sorting and reprocessing stages. | Data on plastic emission to the environment is provided under output ID 'plas_em_per_cap' in the '03_Outputs' sheet. Plastic emissions include (1) plastic debris emissions (physical particles >5 mm) and (2) open burning (mass combusted in open uncontrolled fires). Open burning emissions relate to the mass of material that is subjected to the practice, rather than the gaseous, liquid or solid matter emitted by the process. |

### ACCESS TO TRAINING AND SUPPORT

Full details of the methodology are freely accessible in the [academic publication](#) and associated [Supplementary information](#). An introductory tutorial video is also available on the [GPML Global Plastics Hub](#).

The instructions provided in this Guidebook are for information purposes only. They do not replace the user manuals or negate the need for completing any necessary training via the methodology developers.



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Step 5

# How to Apply Methodology 5B: SPOT Model (modeling new estimates)



# HOW TO APPLY METHODOLOGY 5B

## SPOT MODEL (MODELING NEW ESTIMATES)

### REQUIREMENTS FOR APPLYING THIS METHODOLOGY

The SPOT model can be applied to estimate Indicators 2 – 6 when a country has access data on SWM that is reported at a local (municipal level) with no / minimal data gaps. Specific data points required include data on MSW waste generation, composition (proportion of MSW that is plastic), collection coverage, other recovery (e.g., composting and anaerobic digestion), incineration, recycling and controlled disposal. These data points allow the SPOT model to perform material flow analysis of all major MSW flows and estimate plastic emissions into the environment. The accuracy of the results inherently depends on the accuracy of the input data. As such, we recommend countries only apply this method if they are reasonably confident that the data inputs are reliable. For example, data inputs should be based on measurements (such as via the Waste Wise Cities Tool, using data from weighbridges etc.) rather than assumptions. To be useful for monitoring, it is preferable that the data be up-to-date. In addition to the above data requirements, users will require basic skills in Microsoft Excel, data analytics and be able to run R code (brief instructions on achieving this are provided later in this section). If you are unable to meet these requirements, we recommend you revisit [Step 3](#) for selecting a suitable methodology.

Assuming that the above data requirements are met, the time to implement the methodology is ~2 – 3 person days, of which half a day may be the actual running of SPOT, and the remaining time being allocated to the data inputs. This can increase significantly if major analysis or corrections are required to get the input data in the correct format and be reliable. The time required to do so will depend on the level of analysis required.

### GUIDE TO METHODOLOGY

#### Summary of methodology

SPOT is a material flow analysis (MFA) methodology that aims to map the flows of municipal solid waste from the point of generation until their final fate, whether that be recycling, disposal or emission into the environment. Plastic emissions into the environment are estimated by multiplying relevant material flows from the MFA by emission factors. Emission factors are automatically quantified by sub-models of SPOT, which relate available emission factor data to conditions on the ground. SPOT is a bottom-up methodology where MFA is conducted for every municipality in a country, allowing the results to be aggregated to the national level for reporting.

Previously, SPOT was applied to every municipality and country in the world using the year 2020 as a baseline (see the [academic publication](#) for details). However, more recent estimates are currently not available (although forthcoming), and the global scale of the model means machine learning was used to estimate SWM in a country, rather than accounting for any SWM data that a country may routinely collect.

#### How to implement SPOT for modeling new estimates of Indicators 2-6

Here we describe how the SPOT model can be applied for a county with the intention of updating the results to more recent years and accounting for any municipal level SWM data that a country has available. As discussed in the 'Requirements for applying this methodology' section above, countries must have available reliable data on SWM at a municipal level, including information on MSW waste generation, composition (proportion of MSW that is plastic), collection coverage, other recovery (e.g., composting and anaerobic digestion), incineration, recycling and controlled disposal. Typically, this data is reported by municipalities to a specific department responsible for waste management (e.g., Ministry of Environment, Ministry of Housing), or to a department responsible for statistics (e.g., Department of Statistics) and forms part of a SWM database. Ideally data should be available for most municipalities in a country, although advice is provided here on how to fill data gaps when required.

The SPOT model has been adapted for implementation at a national level and can be downloaded below:



**Download SPOT model V1.3.1-C-0126<sup>1</sup>**  
(for implementation at a national level)



1. Additional software is also required to run SPOT. This includes Microsoft Excel, [R](#) and preferably [RStudio](#). Both R and RStudio are free to use, and instructions for installing are available [here](#).



# HOW TO APPLY METHODOLOGY 5B

## SPOT MODEL (MODELING NEW ESTIMATES)

### Data collection

As the SPOT model works at a municipal level, the first step of applying the methodology involves creating a list of municipalities in the country. This list of municipalities should match the level at which waste is typically managed (e.g., collected, treated and disposed) to align with measurements of waste data. A data input template that includes all the ASEAN countries has been created for this Guidebook and is available to download alongside the Supporting Toolkits. The template is a Microsoft Excel workbook and contains seven sheets, although only 1 of these ('MFA\_Inputs') is required to be edited by AMS. The remaining 6 sheets relate to assumptions and background workings of the model; these should not be edited. The 'MFA\_Inputs' should be initially modified to only include rows relating to the country being modelled. To do this, AMS simply need to open the Microsoft Excel workbook, navigate to the sheet called 'MFA\_Inputs' and delete rows relating to other AMS. Columns A – H relate to the naming information of the municipality and country. Columns I – V relate to other explanatory data that describes the country (e.g., income level, levels of rurality for each municipality). Columns W – AX relate to data inputs of municipal solid waste management that are typically measured by municipalities (e.g., waste generation rate, collection coverage). Columns AY – DR relate to required data inputs that are not typically measured by municipalities (e.g., plastic leakage, informal sector collection) and are therefore pre-estimated here based on the Global SPOT model. For the model to run, it is essential that this structure remain as is, and additional columns not be added or removed.

Firstly, the data in columns I – V need updating to the year being modelled. This includes four types of data:

1. Population of the municipality (Column I) – obtainable via census or, alternatively, from data source of point 2.
2. Data on the degree of urbanization of the municipality (Columns J – T), for example, the proportion of the population classified as rural. This follows the harmonized definition provided by the European Commission, Global Human Settlement Layer Degree of Urbanization (GHS-DUC) (European Commission, 2021). Data is available in 5-year increments up to 2030 and is available for download from the [Global Human Settlement Layer Data Portal](#). The download provides multiple Excel workbooks, each one relating to a specified year and administrative level (e.g. level 0 is the national level). Users should extract the data from the year they are interested in modeling, and at the level that matches the municipalities from the SPOT data template. This dataset also includes estimates of municipal population to fulfil the population data point (Column I).
3. The income level of the country (Column U), where 4 = high-income, 3 = upper-middle income, 2 = lower-middle income, and 1 = low income. As this is a national level data point, the same value should be assigned for each municipality (row).
4. The Corruption Perception Index (CPI) of the country (Column V) is obtainable from [Transparency International](#). As this is a national level data point, the same value should be assigned for each municipality.

Once the above data points have been updated to the modeling year, the municipal solid waste management data needs to be entered for each municipality in Columns W – AX. The data input required are shown in Table 8. The file should then be saved with the name 'Monte Carlo MFA Inputs V1.3.1-C-0126.xlsx'. (Users can optionally save as a different name but the R code on the 0\_MasterScript.R file will need updating to reflect this).

**Table 8: Solid waste management inputs required by the SPOT model at a municipal level**

| Input ID | Input name                                                                        | Required unit        |
|----------|-----------------------------------------------------------------------------------|----------------------|
| tP1pc    | Waste generation rate (tributary model)                                           | kg/cap/day           |
| tC1      | Collection coverage (tributary model)                                             | % of MSW generated   |
| tC2i     | Formal sector collection of MSW for dry recycling (tributary model)               | % of MSW collected   |
| tC2ii    | Collected MSW for recovery (composting, AD and other similar recovery operations) | % of MSW collected   |
| tC2iii   | Collected MSW for incineration (with or without energy recovery)                  | % of MSW collected   |
| tC3      | Controlled disposal of MSW                                                        | % of disposed MSW    |
| C0       | Plastic in MSW                                                                    | % of waste generated |



## SPOT MODEL (MODELING NEW ESTIMATES)

A model is only as reliable as the data that feeds it; therefore, care should be taken that the data input is deemed reliable. Common issues often found with solid waste management data that should be cross-checked include:

- Ensuring waste generation amounts relate to all municipal waste generated. For example, if waste generation is measured based on the amount arriving at disposal sites (as is common), this excludes waste generated but never collected (uncollected waste), or waste diverted to other treatment facilities.
- Likewise, when measuring waste at treatment or disposal facilities, care must be taken that the data measured relates only to the municipality in question and does not include contributions from other neighboring municipalities due to them sharing a disposal site.
- Data on the plastic fraction of MSW should relate the point of generation, for example as measured through waste characterization studies. When measured at disposal sites, the estimated plastic fraction is often artificially low, as the informal sector frequently recovers high-value plastics from households, diverting a substantial portion away from disposal sites.
- Controlled disposal of MSW should ideally follow a set definition. In SPOT, the Waste Wise Cities Tool (Methodology 2) Ladder of control for disposal sites is used as the basis for what counts as 'controlled'. Categories of 'basic' and 'above' are treated as controlled.

The SPOT model is a probabilistic model which means that uncertainties in input data are propagated throughout the model and reflected in the output data. As such, any uncertainty in the input of SWM data will be input into the model. Depending on the method used to measure the data in the first instance, this uncertainty may already be quantified (typically represented as either a confidence interval or standard) alongside a central (e.g., average) result. Alternatively, where no uncertainty is reported, it may be estimated using a data pedigree approach – such as that proposed by Lau et al. (2020) – in which data are scored based on perceived reliability, uncertainty and age, and these scores are then used to derive an estimated standard deviation.

To input the SWM data and associated uncertainty into the Excel template, each of the data inputs of Table 8 has four associated columns, represented by underscores 1 through to 4. These four columns represent parameters of a given distribution type, as selected by the user on the PDF sheet. For example, if a normal distribution was selected for a given data input (X), the column labelled 'X\_1' should have assigned the 'mean' data value, 'X\_2' has the standard deviation, 'X\_3' has the lowest allowed value (typically zero), and 'X\_4' has the maximum allowed value (typically 100). The mean and standard deviations are used to produce normal distributions of each input data point that are sampled by the SPOT model. The minimum and maximum allowed values restrict this sampling to a defined range, for example 0-100 for percentage-based inputs.

If data is not available for some municipalities, these must be approximated. It is recommended that this be done by using the average value from similar municipalities in the surrounding region (for example, using a provincial average). The uncertainty can only be estimated using the data pedigree approach described above. It is recommended that data gaps make up less than 20% of required data. If this is not the case, alternative methods may be more suitable, such as using the published SPOT model results ([Methodology 5A](#)).

The data in Columns AY – DR relate to required data inputs that are not typically measured by municipalities (e.g., plastic leakage rates, informal sector collection). Therefore, these columns have been pre-filled based on global reviews and assumptions as part of the SPOT model and should remain unchanged unless AMS have such data. For example, some AMS collect data on the informal sector; therefore, this data can be used to replace the modelled estimates when available. Further details of these inputs are provided in the *Nature* publication of SPOT (Cottom et al., 2024) and a forthcoming publication on the topic of applying the SPOT model for Indonesia.



# HOW TO APPLY METHODOLOGY 5B

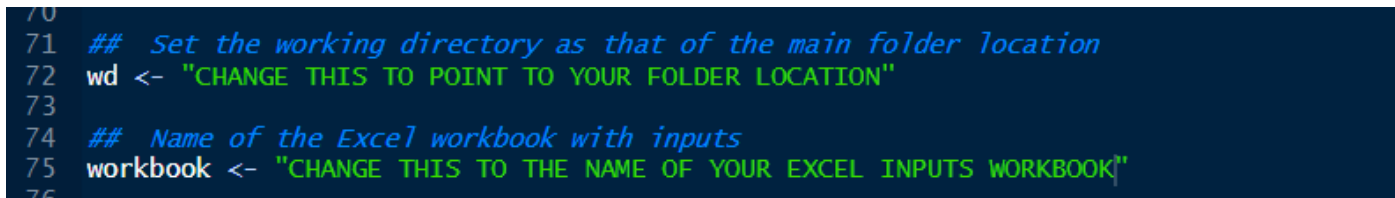
## SPOT MODEL (MODELING NEW ESTIMATES)

### Running the SPOT model

Once all the data inputs have been entered into the Excel template, the SPOT model can be run. SPOT is developed using the coding language R and therefore requires users to have R installed on their computer. It is also advised that the program R Studio also be installed to allow ease of running the model and editing necessary parts of the code (discussed below). Guidance on installing R and R Studio can be found at: <https://rstudio-education.github.io/hopr/starting.html>.

Following installation, the R script called '0-MasterScript.R' can be opened from the previously downloaded files. Necessary packages required to run the script are listed at the top and should be installed by users. Two lines of codes need editing for the code to run (Figure 32). Firstly, the working directory (wd) needs to link to a folder on your computer. This folder should contain three sub-folders, (1) 'inputs', which contains the Excel workbook of data inputs, (2) 'outputs', which can be left empty, and (3) called 'script', which contains the R script files downloaded. These folders must be named in lowercase. Also note, R uses forward slashes '/' in naming directories instead of the backslash '\' used by Windows. Secondly, the workbook variable needs updating to match the name of the MFA inputs Excel file in which data was added. This filename should include the file extensions (e.g. '.xlsx'). Once these lines have been edited, the model can be run by selecting all the code (control + A) and clicking the 'Run' button in the top right of the R Studio screen.

The time required to run the code will depend on the computer power being used and the number of municipalities in the country and the number of iterations selected. For a typical computer, this can take 1-2 hours. If the computer does not have the resources to run the code or the script is taking too long, the 'iterations' variable can be reduced in the 'MasterScript.R' file. It is not recommended to reduce this below 1,000 iterations. A progress bar will show in R Studio to help signify to users how complete the analysis is.



```
70
71 ## Set the working directory as that of the main folder location
72 wd <- "CHANGE THIS TO POINT TO YOUR FOLDER LOCATION"
73
74 ## Name of the Excel workbook with inputs
75 workbook <- "CHANGE THIS TO THE NAME OF YOUR EXCEL INPUTS WORKBOOK"
76
```

Figure 32: Screenshot of the 2 lines of R code that require modification for the SPOT model to run

### Interpreting and analysing outputs

Once the SPOT model has completed the analysis, three Excel files will be saved into the 'outputs' folder:

1. "SPOT\_MFA\_National\_results\_XXX.xlsx"
2. "SPOT\_MFA\_Provincial\_results\_XXX.xlsx"
3. "SPOT\_MFA\_Municipal\_results\_XXX.xlsx"

'XXX' in the file names above specifies details of the run such as the version number of the model used and the number of iterations. Both aspects should be recorded alongside the Indicators for reference as discussed in [Step 5: Monitoring and Reporting](#).

This Guidebook focuses mainly on the calculation of national level Indicators; therefore, further discussion in this Guidebook will relate to the national level results. However, most of what is discussed is also relevant to the municipal and provincial level results and whilst not required for reporting, these may still support the development of local action plans or hotspotting of plastic pollution.

After downloading and opening the results in Microsoft Excel, you will see three sheets called 'Processes', 'Coefficients' and 'Outputs' (Figure 33). Here, processes represent the results of the material flow analysis, coefficients refer to the transfer coefficients that dictate how the flows are split between processes, and outputs refer to any other additional calculations and summaries (such as summing together all the leakages to get a total or converting results to a per capita basis).





# HOW TO APPLY METHODOLOGY 5B

## SPOT MODEL (MODELING NEW ESTIMATES)

| A             | B         | C    | D          | E          | F          | G          | H          | I          | J          | K          |
|---------------|-----------|------|------------|------------|------------|------------|------------|------------|------------|------------|
| Statistic     | Country   | ISO3 | Population | Rural_sha  | wg         | wg_per_c   | pwg        | rigid_pwg  | flex_pwg   | col_cov_p  |
| Mean          | Indonesia | IDN  | 270203898  | 0.14750078 | 61929276.2 | 0.62793043 | 9858989.1  | 4122533.99 | 5736455.11 | 46.6447513 |
| 5th percentil | Indonesia | IDN  | 270203898  | 0.14750078 | 48788278.9 | 0.4946876  | 7684207.22 | 3204996.47 | 4447941.64 | 45.546335  |
| Lower quarti  | Indonesia | IDN  | 270203898  | 0.14750078 | 55735319.1 | 0.56512695 | 8839894.47 | 3696568.13 | 5137319.64 | 46.1796275 |
| Median        | Indonesia | IDN  | 270203898  | 0.14750078 | 61397819.2 | 0.62254173 | 9801425.55 | 4097761.09 | 5688004.28 | 46.6384834 |
| Upper quarti  | Indonesia | IDN  | 270203898  | 0.14750078 | 67779626.3 | 0.68724992 | 10799690.7 | 4516992.66 | 6299232.97 | 47.1118866 |
| 95th percent  | Indonesia | IDN  | 270203898  | 0.14750078 | 76592407.7 | 0.7766069  | 12252123   | 5142604.74 | 7150745.38 | 47.7393349 |

Figure 33: Example screenshot of the SPOT results for a country

To extract the results for Indicators 2 – 6, first navigate to the sheet called '03\_Outputs'. The first column shows the statistic that relates to the uncertainty of the result. For example, the 'Mean' statistic row shows average national results from across all the iterations that SPOT ran. The other statistic rows can be interpreted as the prediction intervals (i.e., 5<sup>th</sup> percentile means only 5% of iterations were below this value). Only the mean value is recommended for reporting, although the associated uncertainty can also be useful to report as metadata and to assess the reliability of the results. The Indicators can then be extracted from the columns as follows:

**Indicator 2** - Data on plastic waste generation is provided under output ID 'pwg' in units of tonnes/year. Therefore, this must be multiplied by 1,000 and divided by the national population to convert to units of kg/capita/year.

**Indicator 2** - Data on MSW collection coverage is provided under output ID 'col\_del\_pct\_gen'.

**Indicator 4** - Data on SDG11.6.1 is provided under output ID 'man\_cont\_pct\_gen'.

**Indicator 5** - The plastic recycling rate is calculated using data from SPOT by summing the mass of plastic waste sorted for recovery by both the formal and informal sectors (processes IDs P23aa, P23ab, P25aa and P25ab in the 'Processes' sheet) and dividing this mass by the mass of plastic waste generated (provided under output ID 'pwg' in the '03\_Outputs' sheet) and multiplied by 100 to convert to a percentage. This mass of plastic waste sorted for recovery excludes rejects during the sorting and reprocessing stages.

**Indicator 6** - Data on plastic emissions to the environment is provided under output ID 'plas\_em\_per\_cap' in the 'Outputs' sheet. Plastic emissions include: (1) plastic debris emissions (physical particles >5 mm) and (2) open burning (mass combusted in open, uncontrolled fires). Open burning emissions relate to the mass of material that is subjected to the practice, rather than the gaseous, liquid or solid matter emitted by the process.

### RECOMMENDATIONS FOR HARMONIZED ASSESSMENT

SPOT was developed to be harmonized with the Waste Wise Cities Tool. At present, estimates of plastic emissions are not fully aligned with those of the Waste Flow Diagram; this said, there are plans to harmonize these in the future. Any reporting of indicators using existing SPOT estimates should clearly state the source (model version and baseline year) to allow transparency and harmonization. Further discussion on achieving this is provided in [Step 5: Monitoring and Reporting](#) section.

### SUB-INDICATORS

The SPOT model allows for the assessment of additional optional sub-indicators. Those of particular significance to the ASEAN region include: MSW generation rate, proportion of plastic in MSW, openly burned plastic, plastic debris emissions, rigid vs flexible plastic emissions, controlled vs uncontrolled disposal, MSW openly burnt, and emissions quantified by five major sources: (1) Uncollected litter, (2) Uncollected waste, (3) Collection system emissions, (4) Emissions from uncontrolled disposal, and (5) Emissions from mismanagement of reject from plastics sorting.

### ACCESS TO TRAINING AND SUPPORT

Full details of the methodology are freely accessible in the [academic publication](#) and associated [Supplementary information](#). An introductory tutorial video is also available on the [GPML Global Plastics Hub](#).

The instructions provided in this Guidebook are for information purposes only. They do not replace the user manuals or negate the need for completing any necessary training via the methodology developers.



# How to Apply Methodology 6: Riverine Macroplastic Flux Methodology



## RIVERINE MACROPLASTIC FLUX METHODOLOGY

### REQUIREMENTS FOR APPLYING THIS METHODOLOGY

There are many ways in which the amount of plastic in rivers can be measured, including visual observation (González-Fernández and Hanke, 2017; van Emmerik et al., 2018), non-human detection (van Lieshout et al., 2020; Maharjan et al., 2022), and physical sampling (Morritt et al., 2014; Haberstroh et al., 2021). The methodology recommended in this Guidebook relies on visual observation and is based on the European Joint Research Centre (JRC) method of González-Fernández and Hanke (2017) due to its simplicity, flexibility and low resource requirements. No specialized equipment is required, although the method can be optionally expanded to include physical sampling using nets, and for extrapolation to a year's timeframe following the method of van Emmerik et al. (2018). An android compatible [application](#) is available to assist users in collecting and recording data. The most basic implementation of the methodology requires at least 2 persons for a day, although more people and time may be required depending on the specifics of the river being sampled.

### GUIDE TO METHODOLOGY

#### Summary of methodology

Sampling of plastic transport in rivers is challenging given the diversity in rivers, location of infrastructure, available equipment and item properties (e.g., size and whether they sink or float). The quantities of plastic in rivers has also been shown to vary substantially with time due to changes in weather conditions, hydrology, extreme events (e.g., flooding or the 'first-flush' event of increased river discharge after dry periods), and variations in source emissions. As such, a one-size fits all solution for monitoring plastic over long periods and across many rivers does not exist. Instead, the simplest methodology is recommended here, that of visual observation, whilst a discussion is also provided in the 'sampling plan' section on how the method can be expanded for more detailed sampling and analysis if required.

The recommended visual observation methods (termed here the 'riverine macroplastic flux methodology') relies on counting the number of plastic items observed to flow down a river over a given time (Figure 34). Typically, the visual observation is conducted from bridges; however, this can be adapted based on the river to use either observation from riverbanks (if the river width is suitably narrow), or boats. If the river width is large, the sampling is typically repeated across multiple segments ('tracks') of the river. Optional adaptations to the methodology include assessing the composition of plastic items (recommended but not necessary for reporting Indicator 7) and assessing the mass of plastic flux which can in certain cases be used as a proxy for the quantity of plastic entering the marine environment.



**Figure 34: Illustration of a visual observation assessment of floating macroplastic debris.**  
Source: Adapted from Hurley et al. (2023)



## RIVERINE MACROPLASTIC FLUX METHODOLOGY

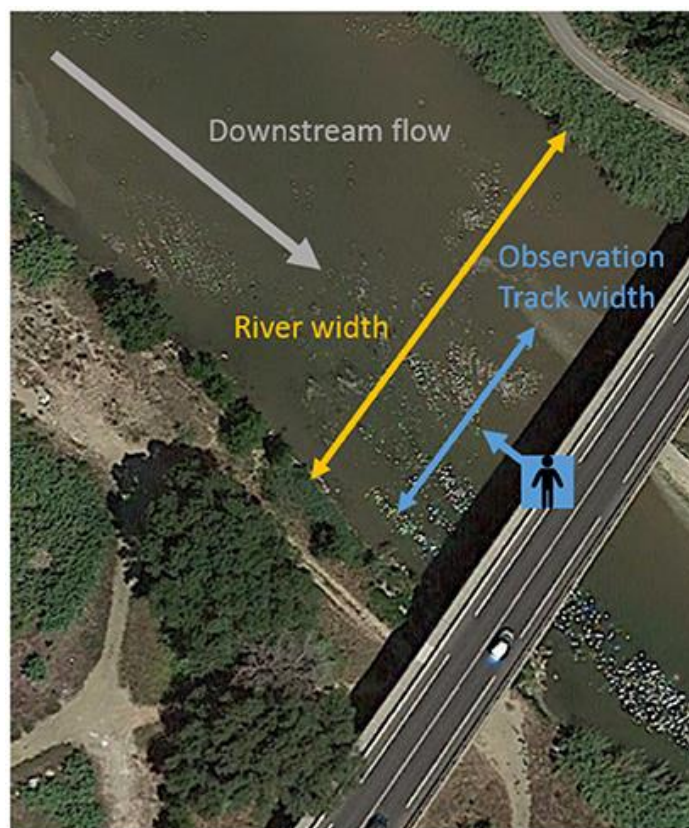
### Choosing a river to monitor

Indicator 7 – Plastic riverine flux, is unable to be measured at the national level using the recommended methodology. Instead, the indicator is measured for a specified river. To choose a monitoring location, two aspects need to be considered: (1) the value provided from monitoring the proposed river, and (2) the practicality of monitoring the proposed river.

An assessment of how much value monitoring a specific river provides is at the discretion of the country. It is recommended that the rivers chosen are those believed to contain high amounts of plastic pollution and which flow through or near population centres. Priority may also be given to rivers that have sensitive ecology, important uses (e.g., recreation, agriculture, fishing) or where intervention measures to stop plastic pollution are planned to enable monitoring of their potential effectiveness. If the monitoring is required to estimate the amounts of plastic entering oceans, the mainstream of a river that drains into the ocean should be chosen, rather than any upstream tributaries.

Practical considerations are likely to restrict the suitability of some rivers and, therefore, should also be considered when choosing a river to monitor. The Riverine Macroplastic Flux Methodology relies on assessors being able to visually observe the plastic, typically from a bridge. The chosen bridge should be accessible to foot traffic to allow the assessors to safely stand on the bridge during the sampling. The bridge should also be a suitable height above the river so that assessors can visually observe plastic items floating on the river down to a size of at least 2.5 cm. Practically, this is likely to mean a bridge of less than 20m in height, although it is recommended that tests be performed to verify this by releasing a buoyant, 2.5cm sized dummy item upstream (e.g., a stick). The capacity of assessors to observe such sizes is also likely to vary and should be considered.

In addition to the availability and height of a suitable bridge, the river characteristics also impact the practicality of establishing a suitable monitoring program. For instance, sampling near a river estuary is likely to cause problems due to tidal variations in the flow. Tidal influence may result in plastic flows transferring upstream during rising tide, before returning during ebb tide, thereby leading to accumulation of plastic and potentially distorting measurements. As such, it is recommended that a sampling location be chosen upstream of any tidal influence, which for some rivers can be a considerable distance. Likewise, river widths often widen towards the estuary. The method allows rivers wider than a single observational width to be assessed by repeating the observation across river segments (Figure 35). However, it should be noted that doing so can increase the time required and lead to observer fatigue. It is recommended that it take no more than one hour to complete all segments (details on sampling times for each segment are discussed in the 'visual observation' sub-section). Other practical considerations include choosing a location where turbulence is low to aid in observing items and avoiding sites which have close upstream obstacles that might distort measurements (e.g., river booms, dams or high levels of aquatic vegetation such as water-hyacinths).



**Figure 35: Illustration of the setup for a visual observation assessment of floating macroplastic debris. Observer track width (observation segment) is less than the width of the river. Source: adapted from González-Fernández and Hanke (2017)**



# HOW TO APPLY METHODOLOGY 6

## RIVERINE MACROPLASTIC FLUX METHODOLOGY

### Sampling plan

A sampling plan should be devised following the selection of a suitable river and location for monitoring. The sampling plan depends on the aim of the assessment and should establish what data is to be collected and the methods for doing so. Table 9 summarizes how the recommended visual observation assessment can be modified depending on the monitoring aims.

**Table 9: Summary of the recommended sampling approach to use for varying aims of riverine macroplastic flux monitoring. The green highlighted row is the recommended approach if AMS are unsure of which approach to use.**

| Aims of monitoring                                                                                                                     | Sampling approach                                                                     | Requirements                                                                        | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measurement of Indicator 7 – Macroplastic riverine flux                                                                                | Visual observation assessment (recording number of items only)                        | Suitable sampling location ( <i>see choosing a river to monitor sub-section</i> )   | Simplest approach, but in most cases can be expanded to measure composition with ease                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Measurement of Indicator 7 – Macroplastic riverine flux + composition of items                                                         | Visual observation assessment (including recording item types observed)               | As above + use of JRC Floating Litter Monitoring App ( <i>android compatible</i> ). | Recommended approach unless aims require extra information to be monitored                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Measurement of Indicator 7 – Macroplastic riverine flux + mass of riverine flux (including optional extrapolation to annual timeframe) | As above + supplemented with physical collection of items using nets for sub-sampling | As above + use of static nets                                                       | Guidance on suitability of nets for sampling depends on local conditions and is not discussed here. Further guidance can be found in UNEP (2022). It is important to record all details of the net sampling (e.g., dimensions, mesh size, deployment method, duration, depth) to facilitate harmonization.<br><br>As above, but physical sampling is used to measure mass of items and average mass is used to estimate mass of riverine flux. Optional extrapolation to an annual basis can be estimated using the river discharge - for full details see van Emmerik et al. (2018). If performed close to a river mouth, this can act as a proxy for plastic inputs to oceans; however, there is significant uncertainty regarding the behaviour of plastic in estuaries (Schemewski et al., 2021). |





## RIVERINE MACROPLASTIC FLUX METHODOLOGY

The guidance provided here covers the first two rows of Table 9 and assumes that a bridge is being used for the visual assessment; however, the principles are largely similar if using a boat. Guidance is not provided on the use of nets for physical sampling, as the suitability of nets depends on complex and highly diverse local conditions. Detailed guidance on the use of nets can be found in UNEP (2022). Likewise, guidance is not provided for alternate forms of measuring plastic in rivers such as use of river booms, drones, tracking methods or modeling approaches, as these are not recommended as part of this Guidebook for harmonized assessment of Indicator 7.

The sampling plan should include details on the number of observation segments / tracks to sample to cover the width of the river, the time allocated for observation of plastic in each segment, and the number and frequency of any repeat measurements. Start by identifying a suitable width of the segment. The segment width should be narrow enough so that the observer can identify items down to 2.5cm across the full width of the segment, and so that the rate at which plastic items moving in the segment is not so great that counting and recording the item types is infeasible. Selection of a suitable segment width is therefore dependent on the sampling height (as this dictates the observable segment width), the amount of plastic in the segment and the flow velocity of the river. Typical segments widths used in other studies range from 5 – 65 metres, although widths around 15 – 20m are most common (Hurley et al., 2023). To make the visual observation and recording of plastic items easier, a minimum of two assessors are required, with one observing the items and the other recording the data.

Once a segment width has been agreed, the observation time for sampling each segment can be determined. The time should be long enough to capture the movement of any plastic in that segment, but not so great that sampling fatigue occurs. The sampling time chosen should be consistent for each segment and recorded as metadata along with the results. This Guidebook recommends the following for selecting a suitable sampling time based on the items per minute (n) observed:

|                 |                                                |
|-----------------|------------------------------------------------|
| $n \leq 2$      | = 15-minute sampling duration for each segment |
| $2 < n \leq 20$ | = 5-minute sampling duration for each segment  |
| $n > 20$        | = 2-minute sampling duration for each segment  |

It is recommended that the sampling of all segments take no more than one hour to avoid assessor fatigue. If the number of segments multiplied by the sampling duration per segment is greater than one hour, there are two potential options to reduce this. Firstly, more than one assessor team (observer and data recorder) can work simultaneously on different segments, or the full width of the river is not surveyed. The former is preferable but requires more resources (tests should be done to ensure each assessor team is quantifying at a similar accuracy). Alternatively, the second option can be used if resources do not allow multiple assessor teams. If the full width of the river is not sampled, the results from the sampled sections should be extrapolated for the missing segments. This can be done by calculating the average number of items recorded across sampled segments and multiplying this value by the number of unsampled segments. It is essential that information such as the width of the river sampled, number of sampled / unsampled segments, and whether extrapolation was used be recorded as meta data (see 'Recommendation for harmonized assessment' sub-section).

Other information to collect before the visual observation sampling begins is:

- River velocity – can be measured using a flow meter or by timing how long an object takes to float a known distance.
- Estimates of river cross-sectional area (width and depth) to allow a discharge to be estimated. Alternatively, see if there is a nearby gauge station already monitoring the rivers hydrology.
- Estimate the minimum item size you can reliably observe (this should be at no bigger than 2.5cm).
- Estimate the visibility depth.
- Report presence of vegetation (especially aquatic vegetation) and whether any river clean-up events occurred recently.





## RIVERINE MACROPLASTIC FLUX METHODOLOGY

### Visual observation

This section discusses the methodology for undertaking a visual observation sampling exercise of plastic items for a given river segment. A two-person team of assessors should allocate one person as the observer and the other person as the data recorder. More people may be required depending on the item flux and river velocity. The team should install the JRC Floating Litter Monitoring App (Figure 36) on a compatible Android device and familiarize themselves with its operation and item categories prior to the sampling. This app is useful as it allows information on item types, sizes, and other metadata to be recorded. A manual is provided within the app. Alternatively, manual recording of items can also be done and may be useful when item flux is high.

A stopwatch should be used to time the sampling session as per the sampling plan. It is recommended the observer face upstream, but this can be changed to downstream if it provides better visibility (e.g., lack of sun glare or visual barriers). The observer then counts the items they can see floating down the river within the specified segment width and relays the information on item type and estimated size to the recorder who logs it in the app. Binoculars can be used to help identify an item; however, they should not be used to observe new items that cannot be seen without binoculars. Natural objects such as vegetation should not be counted – consult the item categories in the app to see what should be recorded. When the sampling is complete, click the STOP button in the top right of the app.

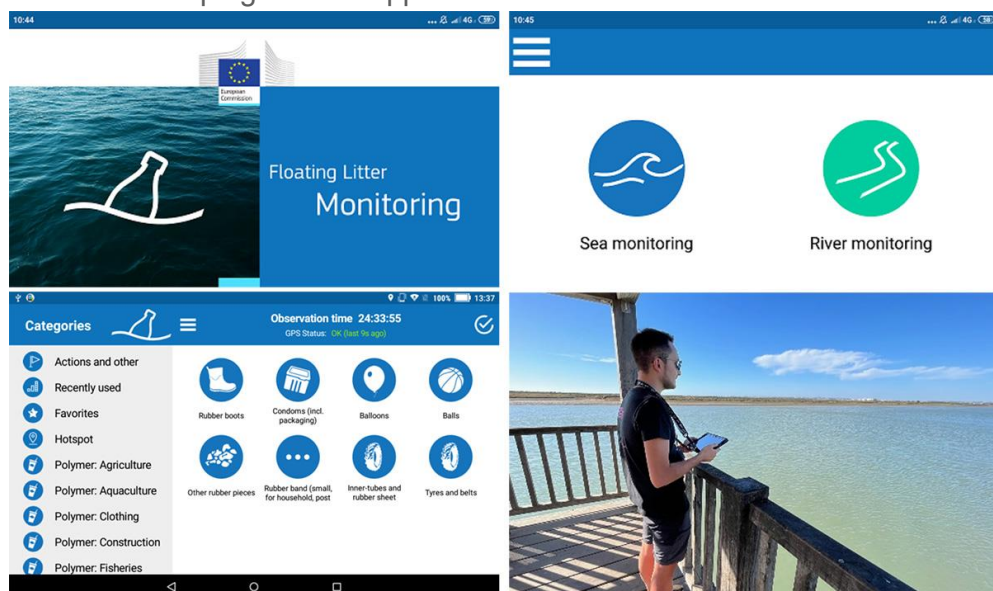


Figure 36: JRC Floating Litter Monitoring App (European Commission Joint Research Centre, 2025)

### Data analysis

The raw data collected needs to be converted into a format suitable for reporting Indicator 7 – Plastic riverine flux, measured with units of items per hour. Firstly, as the indicator measures only macroplastic material, the non-plastic items recorded should be excluded from the analysis, as well as any items <2.5 cm in size. (Note: we recommend these items still be recorded as part of the methodology, just not reported for Indicator 7.) Secondly, the data from each segment should be extrapolated to a period of one hour and across the full river width. If the entirety of the river width was sampled, the following formula can be used:

$$\text{Indicator 7, Macroplastic riverine flux} \left( \frac{\text{items}}{\text{hour}} \right) = \sum_{i=1}^n F_i \times \frac{60}{t_i} \quad (\text{Eq. 9})$$

Where:

i is the segment index, representing a portion of the river width sampled (segment widths should be constant)

- $t_i$  is the duration of observation for that segment
- $F_i$  is the count of plastic items observed in segment i over  $t_i$
- N is the total number of river segments observed



# HOW TO APPLY METHODOLOGY 6

## RIVERINE MACROPLASTIC FLUX METHODOLOGY

If the full river width is not sampled by all segments, the previous formula changes to:

$$\text{Indicator 7, Macroplastic riverine flux } \left( \frac{\text{items}}{\text{hour}} \right) = \left( \sum_{i=1}^n F_i \times \frac{60}{t_i} \right) \times \frac{W}{\sum w_i} \quad (\text{Eq. 10})$$

Where:

- W is the total width of the river
- $w_i$  is the river segment width (therefore  $\sum w_i$  is the width of the river sampled)

The segment width should remain constant for the above formulas to work, as per the sampling plan. The observation time should also ideally remain constant between segments; however, the above formula does allow for varying times to be used between segments (for example, if a segment has a particularly low flux, a longer observation time may be more suitable).

### RECOMMENDATIONS FOR HARMONIZED ASSESSMENT

No two rivers are the same, and therefore direct comparison of macroplastic riverine flux between rivers should be treated with caution. For example, the plastic flux recorded in a fast-moving large river is not directly comparable with that in a slow-moving small river. Instead, the primary goal in reporting Indicator 7 is to allow harmonization rather than standardization. Harmonization aims to achieve interoperability, compatibility and comparability, whilst accounting for the contextual and methodological variations.

To support harmonization, it is recommended that additional metadata be collected alongside the main indicator to clearly explain the settings in which the indicator was measured. Additional metadata recommended to measure as part of the visual observation technique include:

- Location & time of sampling
- Meteorological conditions during sampling
- River characteristics (width, depth, velocity, discharge, visible depth)
- Duration of sampling
- Number and width of river segments sampled
- Minimum observation size
- Sampling height
- Any relevant issues with visibility or counting of items
- Time elapsed since any significant events (e.g., clean-ups, heavy rainfall, flooding, festivals / ceremonies)
- Net dimensions, mesh size, suspension method (if used as additional measure)

Other mechanisms by which harmonization can be encouraged include:

- Avoid sampling flooding or high turbulence as the visibility is likely to be poor leading to low accuracy.
- Monitor frequently (e.g., multiple times a year) at a few locations rather than infrequent monitoring at many locations. The exact frequency of sampling is left to the discretion of the AMS; however, we recommend trying to keep this consistent.
- Aim to report items >2.5 cm. We do not recommend items below this size be reported in Indicator 8, although they can still be recorded.

### ACCESS TO TRAINING AND SUPPORT

Details and support for using the data recording application are available from the [Inspire website](#) and within the application user manual.<sup>1</sup>

**The instructions provided in this Guidebook are for information purposes only. They do not replace the user manuals or negate the need for completing any necessary training via the methodology developers.**

<sup>1</sup> Specific recommendations have been proposed by the authors of this Guidebook to help facilitate harmonized assessment across the ASEAN region. These recommendations are based on the guidance published by González-Fernández and Hanke (2017), van Emmerik et al. (2018), United Nations Environment Programme (2020), and Hurley et al. (2023).



# How to Apply Methodology 7: CSIRO Survey Methodology



# HOW TO APPLY METHODOLOGY 7

## CSIRO SURVEY METHODOLOGY

### REQUIREMENTS FOR APPLYING THIS METHODOLOGY

The CSIRO Survey Methodology requires fieldwork in the form of environmental sampling on land. A study area would typically sample between 30 – 40 sites, each with between 3 – 6 transects. Surveying this number of sites can be resource intensive for both time and manpower; however, only basic equipment is required (see 'Equipment and preparation' sub-section below). The methodology was developed to consider resource requirements and attempts to strike a balance between effort and accuracy.

Experience within the AMS for applying this methodology is high; however, users are highly recommended to perform the sampling in partnership with the developers at CSIRO. This is so that the developers can support the design of the randomized and stratified sampling approach and so that training can be provided to new users of the methodology. Details of how to contact the developers can be found at:

<https://research.csiro.au/marinedebris/>

### GUIDE TO METHODOLOGY

**This brief guide is for information purposes only – it does not replace the official user manual or negate the need for completing training via the methodology developers.**

CSIRO's methodology is comprised of four different survey methods: coastal surveys, ocean trawls, river surveys and inland surveys. As Indicator 8 relates to plastic debris density on land, the following only discusses the inland survey method.

#### Equipment and preparation

Equipment for land-based surveys includes:

- 1x 50m tape measure (or 2x 25m tape measures)
- 1x 1m long piece of string or rope
- Gloves and other required PPE
- Print-outs of 'size class' and 'items list'
- Smart phone with compass app and ODK Collect app

Other preparation includes establishing a team to undertake the necessary training and fieldwork and choosing a location for the methodology to be applied (see 'Recommendations for harmonized assessment' for suggestions on how this should be chosen). The methodology is commonly used for assessing areas up to 200 – 400 km in size (diameter).

#### Site selection

Once a location for application of the methodology has been decided (e.g., a city, province, national park, area of special scientific interest), sites are chosen across the location where transects will be applied. This site selection is an integral part of the methodology and must be randomly stratified to ensure avoidance of bias. At present, users are recommended to work closely with the staff at CSIRO to undertake this activity. Guidance is forthcoming that will allow users to also undertake this site selection themselves in the future. If one of the sites cannot be accessed, users should instead sample as close to it as reasonably possible – do not ignore the site. It is crucial to keep this activity randomized – do not bias the results by basing the site location on the amount of litter visible.

#### Site information

Details on each of the sites surveyed need to be recorded. The ODK app can assist with this. Details collected include: the environment, weather, land use, descriptions of site cleanliness or presence of informal dumping, infrastructure and GPS coordinates.



# HOW TO APPLY METHODOLOGY 7

## CSIRO SURVEY METHODOLOGY

### Transect location

Between 3 and 6 transects are conducted at each site. If litter is detected on the first three transects, you stop sampling at the site. If no debris (i.e., litter) is detected in the first three transects, you add an additional transect until debris is found, up to a maximum of 6 transects. Do not conduct more than 6 transects at a site.

Transects should be either 12.5m x 2m in size (default) or, if necessary, 25m x 1m in size, and typically require 2 surveyors. Transects should be conducted across the dominant designated land use types, with any additional transects done on unsurveyed land uses if available. If sampling the same land use, transects should be at least 30m apart.

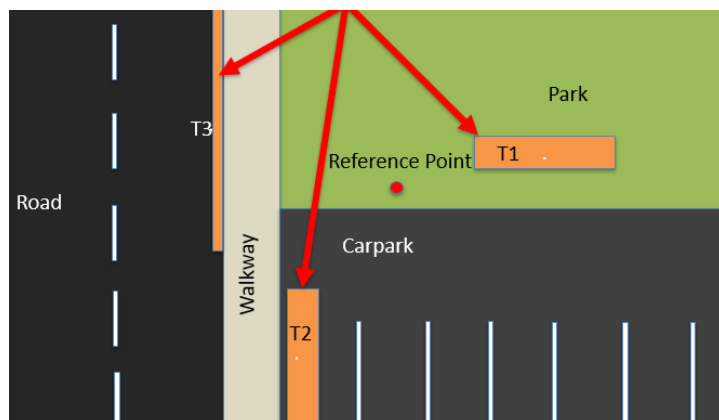


Figure 37: Example of transects across different land use / habitats (Source: COBSEA & CSIRO, 2022b)

### Sampling litter items

In general, transects are 2m wide. A tape measure will be laid down the middle of the transect and one surveyor will count items that fall within 1m on one side of the tape measure, whilst the other surveyor counts items on the other side. Counting should be done from a standing height as shown in the illustration opposite.

There is no requirement in the methodology to clean-up the litter, although this can be done if resources allow. Any clean-up should take place after the transect has been surveyed.



Figure 38: Correct way to transect is to look down from standing height (Source: COBSEA & CSIRO, 2022b)

### Recording sizes and items

A transect is divided into 10 even intervals, and the size of the first encountered item in each interval is recorded according to the 'size class' classification. The longest dimension of the item is used to assign this class. The type of items found in each interval are to be recorded. This can be done using the 'item list' print out, or via the ODK app. The item list establishes a comprehensive list of items (including non-plastic items) to select from. This categorization is broadly comparable to other widely used lists (e.g., GESAMP categories).

### Sub-sampling and estimating

If there is a large amount of debris at a site and sampling would take longer than 30 minutes, it is necessary to subsample. The transect interval lengths should be divided by a factor (X) into smaller lengths, with the value of this factor recorded. Surveyors then count the items in the reduced interval length and multiply by the factor X before recording this calculated value. This allows an estimate of the total number of items in the interval if it were to be surveyed in full.

### Data analysis

Once all sites have been surveyed and all data recorded, the data needs to be analyzed to measure the metric. A mathematic model is used for this analysis and should currently be performed with the assistance of the staff at CSIRO. (Note: there are plans to release the details of the analysis, so it is likely that AMS may be able to perform the analysis themselves in the future.)



# HOW TO APPLY METHODOLOGY 7

## CSIRO SURVEY METHODOLOGY

### RECOMMENDATIONS FOR HARMONIZED ASSESSMENT

There are four key aspects that need to be considered to allow for a harmonized assessment of the metric, both between AMS and across time.

**When?** The date that the survey is conducted may have a large impact on the indicator monitored. This is due to events such as heavy rainfall (e.g., monsoon season), festivals / religious celebrations and clean-ups, all affecting the amount of litter than may be present on land. For example, waste is often reported to accumulate during the dry season and then moves to rivers and oceans during the first period of heavy rain (known as the 'first flush'). Sampling on land after this first flush is therefore likely to give very different results than sampling before it.

The frequency of the surveys depends on the resources available to the AMS. We recommend that at least one assessment per year be performed, with this taking place toward the end of the dry season, before the first flush. Additional surveys can be conducted at different times (e.g., after the first flush, monthly, seasonally, for specific events) at the discretion of the user; however, these should not replace the continual monitoring and reporting taking place toward the end of the dry season before the first flush. Details of the dates over which the survey was conducted should be recorded, including extra information on presence of clean-ups, events, rainfall etc. (see Step 5 – [Monitoring and Reporting](#), for details).

**Where?** Selection of the study location is left to the discretion of the user (in consultation with the CSIRO staff for practicality issues). We recommend a site chosen be one that the user feels is important to monitor plastic pollution, for example, an ecologically sensitive site, a popular tourist location, or a major city. For continual monitoring, this site should be revisited repeatedly. If the user requires other locations to be surveyed, this can be done either as standalone assessments, or by establishing it as an additional monitoring location. The details of the location should always be reported along with the indicator.

**How?** The CSIRO Survey Methodology is the recommended approach for measuring this indicator and should be used by all AMS to ensure a harmonized assessment. Deviations from the method are discouraged; however, the scope can be expanded depending on the requirements of the user, for example to cover additional locations, or environmental compartments. However, it is essential that the indicator reported relate only to the inland survey to ensure comparability with assessments by other AMS. Additional results and information (i.e., metadata) can be recorded alongside this, details of which are provided in Step 5 – Monitoring and Reporting.

**What?** The CSIRO Survey Methodology has a categorization of items and size classes (see the user manual for details) that should be used to record item types and sizes. We do not recommended deviating from this list. Flexibility is provided via the 'other' categories to allow recording of items that may be unique to a specific AMS or study location.

### ACCESS TO TRAINING AND SUPPORT

Resources available at: <https://research.csiro.au/marinedebris/resources/> and via the COBSEA Report on [Regional Guidance on Harmonized National Marine Litter Monitoring Programmes](#) (COBSEA, 2022). Full methodological details are planned for release by the end of 2025 that will enable users to undertake site selection and analysis.

**The instructions provided in this Guidebook are for information purposes only. They do not replace the user manuals or negate the need for completing any necessary training via the methodology developers**





# STEP 5: MONITORING AND REPORTING



# STEP 5: MONITORING & REPORTING

## MONITORING

This Guidebook aims to provide guidance on how monitoring can be performed for plastic pollution across its full life cycle. Monitoring refers to measuring the indicators over a period of time (e.g., several years); therefore, a single application of the recommended methodologies would not constitute monitoring. Monitoring is important as it allows trends in plastic pollution to be assessed, track progress towards meeting targets and can be used to assess the effectiveness of any interventions that are introduced.

The frequency of monitoring is an important consideration that should be agreed upon at the start of any monitoring and evaluation plan. The frequency chosen will likely depend on a number of factors, such as:

- Any national reporting obligations
- The resources required to implement a methodology
- The impact seasonal / weather variations may have on the indicator (particularly relevant for Indicators 7 & 8)
- The availability of staff, equipment, or involvement of other stakeholders
- The frequency that data inputs are collected (e.g., plastic manufacturing and trade data required for Indicator 1 is typically released on an annual basis).

It is recommended that a monitoring plan be developed for all indicators intended to be monitored. Ideally, this plan should align with the timeframes of any relevant national targets, or span before and after the introduction of any interventions (such as policy / regulation changes, behavioral change programs, or alterations to solid waste management services and infrastructure). The monitoring frequency does not have to be the same for each indicator and can also be intermittent if required (although regular monitoring is always preferred).

Designing an indicator- and methodology-specific monitoring plan that accounts for the factors outlined above is preferable, as it supports a more sustainable approach to monitoring. Budgets and resources for repeat monitoring should ideally be agreed in advance. Guidance on the resources required is provided in the budgeting Supporting Toolkit. For sub-national indicators, it may be tempting to try to monitor as many different sites as possible. However, as the purpose of monitoring is repeat measurement, this Guidebook recommends monitoring fewer sites at high quality and frequency, than to attempt to monitor more sites at low quality and for which repeat measurement is not feasible.

Although this Guidebook has recommended methodologies that are suitable for the ASEAN region and require relatively low resources to implement, the effort involved to monitor all the recommended Indicators is large. As such, it is recommended that indicators selected for monitoring be carefully prioritized to those that provide the most value and for which repeat monitoring can be achieved. Further details on how to prioritize indicators is provided in [Step 2 – Prioritizing indicators](#). Regular review of monitoring plans is also advised to ensure they are working as intended, consistently providing value, account for developments in reporting requirements, and that the latest scientific or methodological advancements are incorporated.



# STEP 5: MONITORING & REPORTING

## REPORTING

The goal of the Guidebook is to facilitate harmonization between AMS on plastic pollution monitoring. Harmonization differs from standardization (measuring things in the same way), by allowing flexibility in the approaches used and data collection methods harnessed. Harmonization can be achieved by ensuring the context and methodology behind calculation of the indicators can be understood, allowing reasoned comparison. Clear and precise reporting of indicators and the methodologies used in their calculation is therefore imperative for harmonization. Key information that should be reported includes:

- A precise and clear definition of the indicator and what it includes or excludes
- Detailed description of the indicator units (e.g., instead of saying percentage, it is preferable to describe what the percentage relates to, such as % of MSW generation)
- The timeframe (e.g., year) that the indicator is measured for
- The spatial scale the indicator is measured for
- The methodology used to calculate the indicator
- Core metadata to explain key data inputs, assumptions and methodological decisions or challenges to aid in interpreting the context of the indicators
- Associated case study reports and data

In addition to reporting the indicators alongside the necessary metadata above, it is also important that systems be available to facilitate the long-term management of the data. This management ideally includes providing secure places to store the data and allowing sharing of data with relevant stakeholders or between AMS. Whilst this data sharing is an optional endeavour to be agreed upon by AMS, the merits of harmonized approaches are often to facilitate such data sharing and comparison. Visualization of results is also commonly enabled by data platforms to facilitate comparison and observation of trends. Although these long-term data management decisions go beyond the scope of this Guidebook, an Excel-based Supporting Toolkit has been created to support AMS in the collection and reporting of key metadata for the recommended indicators.



## ASEAN ROLE IN SUPPORTING THE GUIDEBOOK AND THE HARMONIZATION OF METHODOLOGIES

### 1. Encouraging a plan for uptake of the Guidebook by AMS as it supports the ASEAN RAP.

ASEAN can help ensure that the Guidebook is not just a reference document but also integrated into national and regional planning. By aligning the Guidebook with the ASEAN RAP, ASEAN can encourage each AMS to adopt the methodologies into their monitoring frameworks. This would provide a structured roadmap for implementation and consistency across the region.

### 2. Enhancing and sharing the communication and dissemination of the Guidebook with ASEAN resources and networks.

ASEAN can leverage any established networks, such as communication channels, working groups, and platforms to distribute the Guidebook and raise its visibility. This would promote common understanding and encourage its use by national authorities and research institutions across the region.

### 3. Updating recommendations in the Guidebook as new methodologies, science or reporting requirements are established.

Plastic pollution monitoring is a rapidly evolving field. ASEAN can coordinate regular updates of the Guidebook to ensure it reflects international best practices, advances in science, and evolving global reporting frameworks (e.g., as may be produced by the on-going plastic treaty negotiations). A periodic review mechanism would keep the document relevant and authoritative.

### 4. Facilitating data sharing between the AMS on indicators and methodology implementations.

ASEAN can provide an online platform for AMS to exchange data and experiences with implementation of the Guidebook. Facilitating this sharing helps build transparency, comparability, and mutual learning across countries. This can also strengthen regional reporting on progress toward ASEAN RAP objectives, while respecting national data governance.

### 5. Providing long-term storage solutions for the measured indicators and metadata.

A major challenge for regional monitoring is ensuring continuity and accessibility of data. ASEAN could support the establishment of regional repositories or databases where measured indicators and metadata are stored securely. This would safeguard long-term data integrity, prevent data loss, and allow for cross-country trend analysis over time. The monitoring and reporting supporting toolkit that sits alongside this Guidebook offers an initial pathway to achieving this.

### 6. Creating online visualization and analysis platforms that enable comparison of indicators over time and between AMS.

ASEAN can promote the development of regional dashboards or visualization tools that make the results more accessible and comparable. By enabling easy, cross-country comparisons, time-series analysis, and reporting, such platforms would enhance policy relevance and provide evidence to guide decision-making at both national and regional levels.

### 7. Coordinating multilateral training, support, and access to resource and guidance.

Capacity varies across AMS in terms of technical expertise, resources, and infrastructure for monitoring plastic pollution. ASEAN can coordinate joint training programs, workshops, and peer-to-peer exchanges to ensure that all member states have the knowledge and tools needed to apply the Guidebook methodologies. This not only strengthens national capacity but also promotes harmonization and consistency across the region.



## ANNEX 1

[Click to visit](#)



Terminology & key principles

## ANNEX 2

[Click to visit](#)



Approach behind development of the Guidebook

## ANNEX 3

[Click to visit](#)



Global review and characterization of plastic pollution assessment methodologies

## ANNEX 4

[Click to visit](#)



ASEAN country profiles – Regulations, policies, targets and monitoring programs

## ANNEX 5

[Click to visit](#)



References



# ANNEX 1:

# TERMINOLOGY & CORE PRINCIPLES





# TERMINOLOGY

## LIFE CYCLE STAGES TERMINOLOGY

### PRODUCTION, MANUFACTURING AND TRADE STAGE

At the production, manufacturing, and trade stage, activities focus on raw material extraction, polymer production, plastic product manufacturing, and plastic trade. Methodologies typically quantify polymer and product amounts across economic sectors using national/international data sources like UN Comtrade, statistical databases, and customs records. All AMS monitor plastic imports, exports, and manufacturing through official reports or statistical divisions, though data is usually recorded in monetary terms rather than mass/volume, making quantification challenging. Data releases are often sporadic or outdated, and granularity varies between countries, with most recording only broad HS codes (see [Guidebook approach – Annex 2](#) for further details). Example indicators used at this stage include:

- Mass of polymer production
- Import / export mass of polymers
- Proportion of recycled content in item

### DISTRIBUTION, SALE AND CONSUMPTION STAGE

Activities that occur after the production of plastic products, but prior to those products becoming waste are included in the distribution, sale and consumption stage. Methodologies operating in this stage usually quantify the types of products sold. Example indicators used at this stage include:

- Single-use plastic consumption
- Apparent consumption of plastics
- Reusability

### WASTE MANAGEMENT, RESOURCE RECOVERY AND DISPOSAL STAGE

This life cycle stage is defined by activities that occur after use, and at the end-of-life stages, but this excludes plastic that is unmanaged in the environment. Methodologies operating in this stage usually quantify the effectiveness of the solid waste management system, including amounts emitted into the environment. Most of the AMS report data on solid waste management, commonly shared via annual reports or statistical departments, although some countries have dedicated data portals (e.g., SIPSN for Indonesia). Example indicators include:

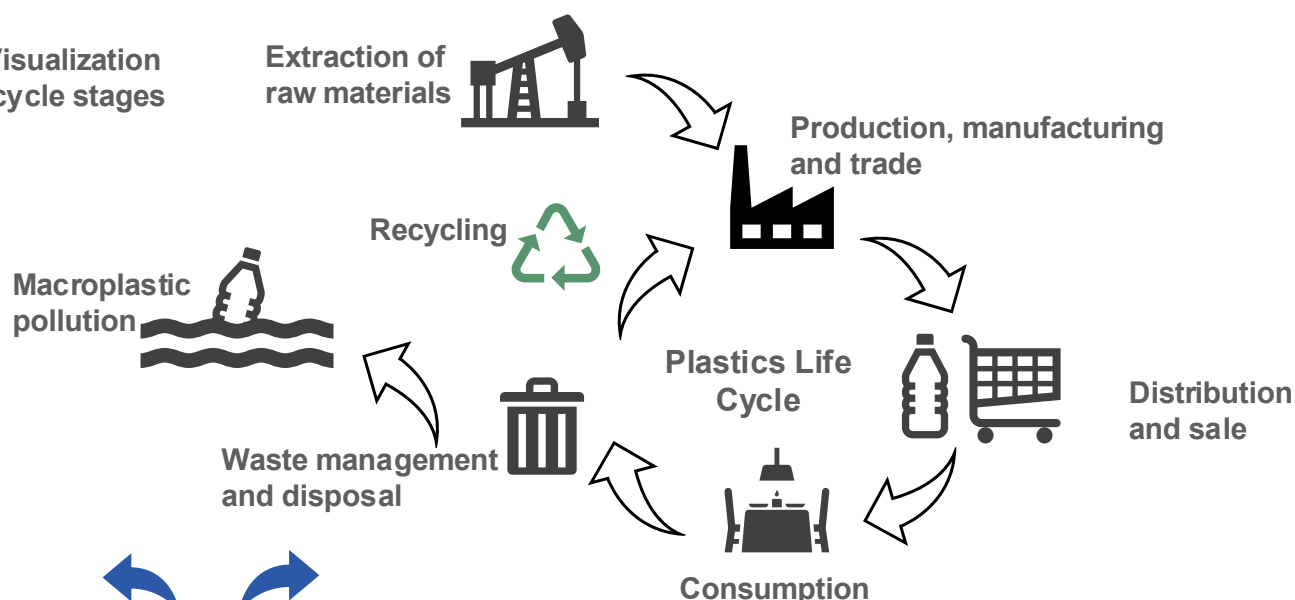
- Plastic waste generation
- Collection coverage
- Recycling rate
- Mismanaged waste
- Collection and controlled disposal (SDG11.6.1)

### POLLUTION STAGE

Plastic pollution occurs when plastic enters the environment without any management or control. Methodologies at this stage quantify plastic concentrations in the environment and flows to rivers and oceans. Despite AMS countries having plastic pollution targets, systematic monitoring is lacking. While some action plans propose pollution databases, their scope and methods remain unclear. Most countries have conducted one-off studies or baselines but lack ongoing systematic monitoring. Exceptions include Thailand, (which uses equations to monitor ocean emissions and tracks plastic in rivers and oceans), and Indonesia (which monitors beach and ocean plastic, though methods need clarification). Example indicators include:

- Marine debris on coastlines
- Mass of open-burned plastic
- Plastic flux from rivers to oceans

**Figure A1.1: Visualization of plastic life cycle stages**



# TERMINOLOGY

## PLASTIC POLLUTION TERMINOLOGY

### PLASTIC POLLUTION ASSESSMENT METHODOLOGIES

Plastic pollution assessment methodologies are defined as:

*“An implementable methodology that quantifies macroplastic pollution, providing knowledge and understanding in order to effectively act.” – PLAST, 2023*

### MACROPLASTICS VS MICROPLASTICS

- Macroplastics are pieces of plastic larger than 5mm in size
- Macroplastics are the main concern in the ASEAN region
- We cannot stop the generation of microplastics without solving the macroplastics problem first
- The scope of this Guidebook is limited to macroplastics

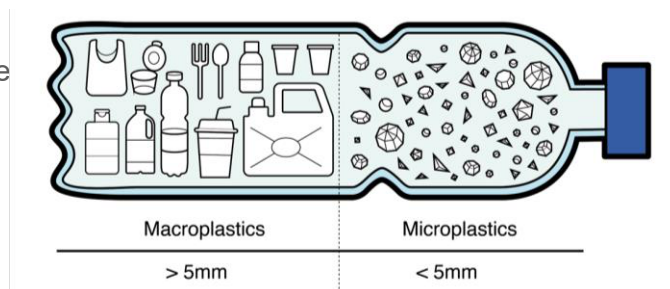


Figure A1.2: Macroplastics vs microplastics (Source: Cottom et. al., 2024)

### PLASTIC EMISSIONS

Plastic emissions are defined as:

*“Plastic material that has moved from the managed or mismanaged system (controlled or contained state) to the unmanaged system (unmanaged or uncontained).” (Cottom et. al, 2024).*

The graphic on the right illustrates plastic emissions, highlighting the distinctions between managed waste (which results in no emissions), mismanaged waste, and unmanaged waste, as well as the different types of emissions that occur when plastics are uncollected or not managed in controlled facilities.

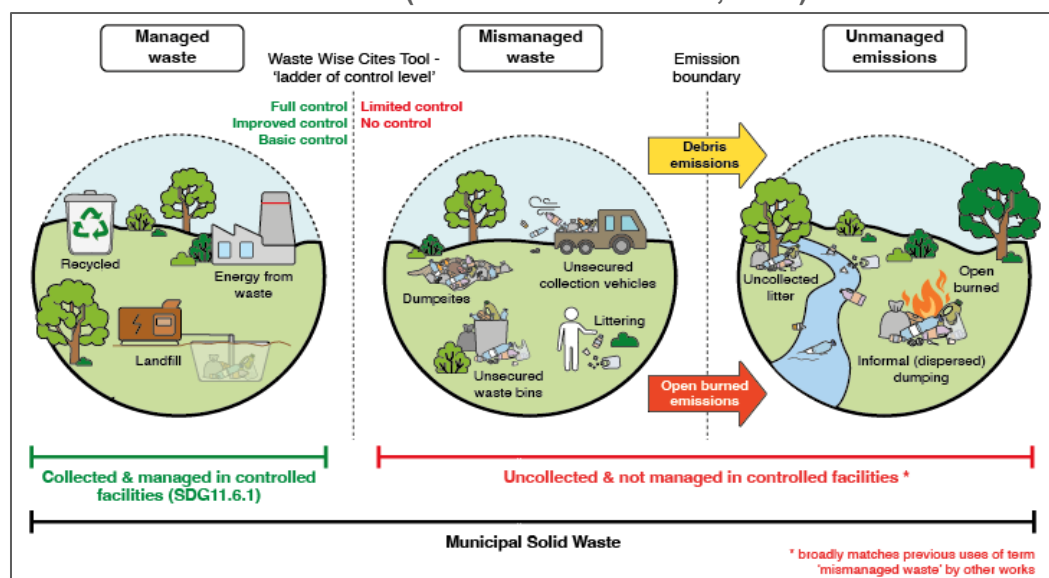


Figure A1.3: Illustration of plastic emission concept and relation to mismanaged waste (Source: Cottom et. al., 2024)

### UNCOLLECTED WASTE

Concentrated or containerized waste is waste that is not collected by the formal or informal sector and therefore is 'self-managed' by the generator (e.g., via informal dumping, backyard burying or open burning). It excludes litter, which is generated on-the-go in small quantities, and therefore is not concentrated or containerized.

### OPEN BURNING

Open burning is defined as: *“Material combusted in open uncontrolled fires. Open burning emissions refer to the mass of material openly burned rather than any gaseous emissions” (Cottom et. al, 2024).*

Open burning is an important source of plastic pollution that should not be overlooked. This is because, globally, more plastic is openly burned than released as debris (Cottom et. al, 2024), presenting challenges for all environmental compartments. Open burning releases a wide range of potentially hazardous substances, negatively affecting local air quality, contributing to climate change, and harming human health through smoke and associated toxins.



## MONITORING TERMINOLOGY

For users of the Guidebook, it is important to understand a few key terms related to monitoring of plastic pollution. These include:

**TARGET** – A target is a time bound goal (e.g., “By 2030, the country aims to reduce plastic inputs to the ocean by 80%”).

**DATA** – Data is defined as a piece of information (e.g., river discharge, amount of plastic imported, amount of waste collected, etc).

**METHODOLOGIES** – A methodology is a structured and systematic way to collect and process data to gain information (e.g., a river sampling methodology).

**METRIC** – A quantitative measure that provides information on a process or activity (e.g., plastic items/m<sup>2</sup> or number of items collected).

**INDICATOR** – A metric or series of metrics that are useful for monitoring important information and targets (e.g., plastic debris density or plastic flux).

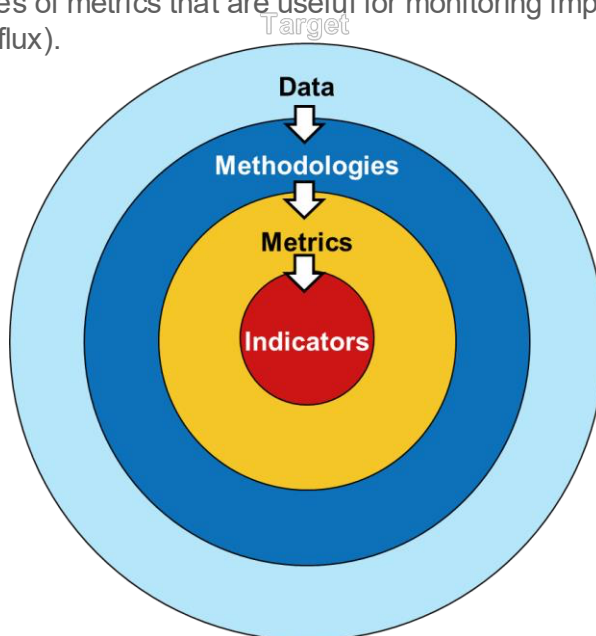


Figure A1.4: Relationship between data, methodologies, metrics and indicators

## MODELING TERMINOLOGY

When users of the Guidebook consider modeling approaches, a few key terms should be understood:

**SCALE** – The maximum geographical area on which the model informs.

**SPATIAL RESOLUTION** – The minimum geographical area on which the model informs.

**TEMPORAL RESOLUTION** – The minimum time-period on which the model informs.

**ENVIRONMENTAL COMPARTMENT** – The part of the natural or built environment that the model focuses on (e.g., Built-environment, Terrestrial, Marine, Riverine, or Atmosphere).

**SCOPE** – The aspects and metrics that the model deals with (e.g., environmental concentrations of plastics, performance of the SWM system).

**MODEL INPUTS** – This is the data that is fed into the model.

**MODEL OUTPUTS** – Data produced by a model after it has performed one or more operations on the raw data.



## CORE PRINCIPLES

There are two basic ways you can measure an indicator at a national level: Top-down, or Bottom-up as shown in the figure below.

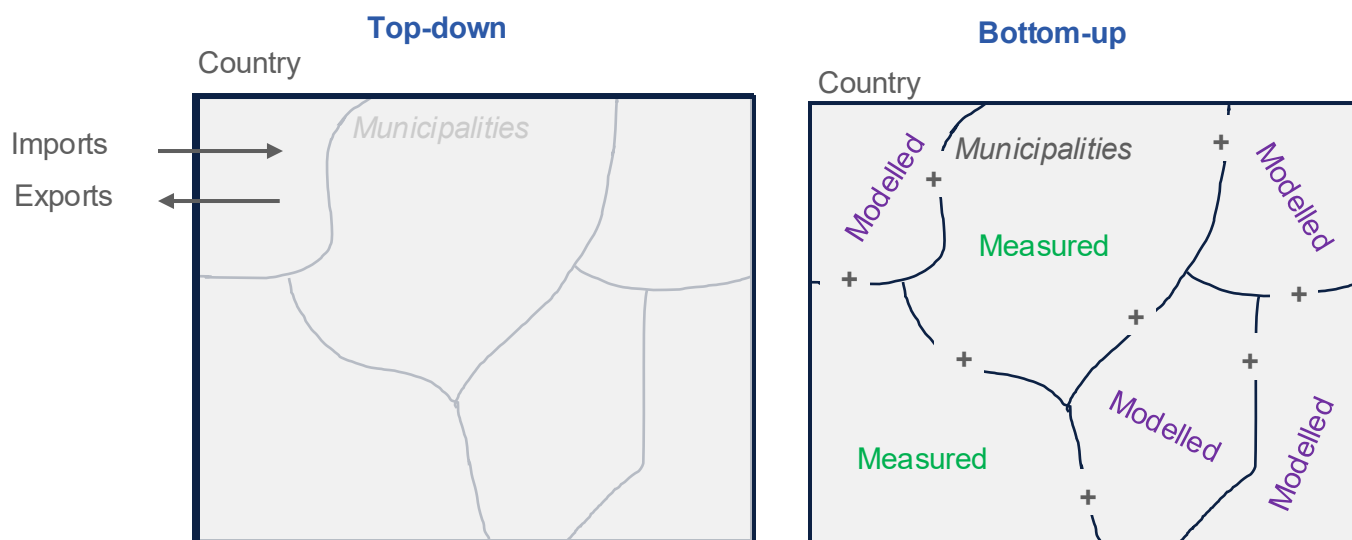


Figure A1.5: Visualization of top-down versus bottom-up modeling approaches

**IMPORTANT:** Many of the suggested indicators cannot be measured directly at a national level using a top-down approach whilst still maintaining the key criteria for monitoring (e.g., based on new data collection and ensuring harmonization).

Bottom-up approaches with extrapolation to the national level are therefore required, or alternatively the reporting scale is reduced to sub-national scales. This principle formed a key part of the decision-making process for the selection of methodologies in this Guidebook.

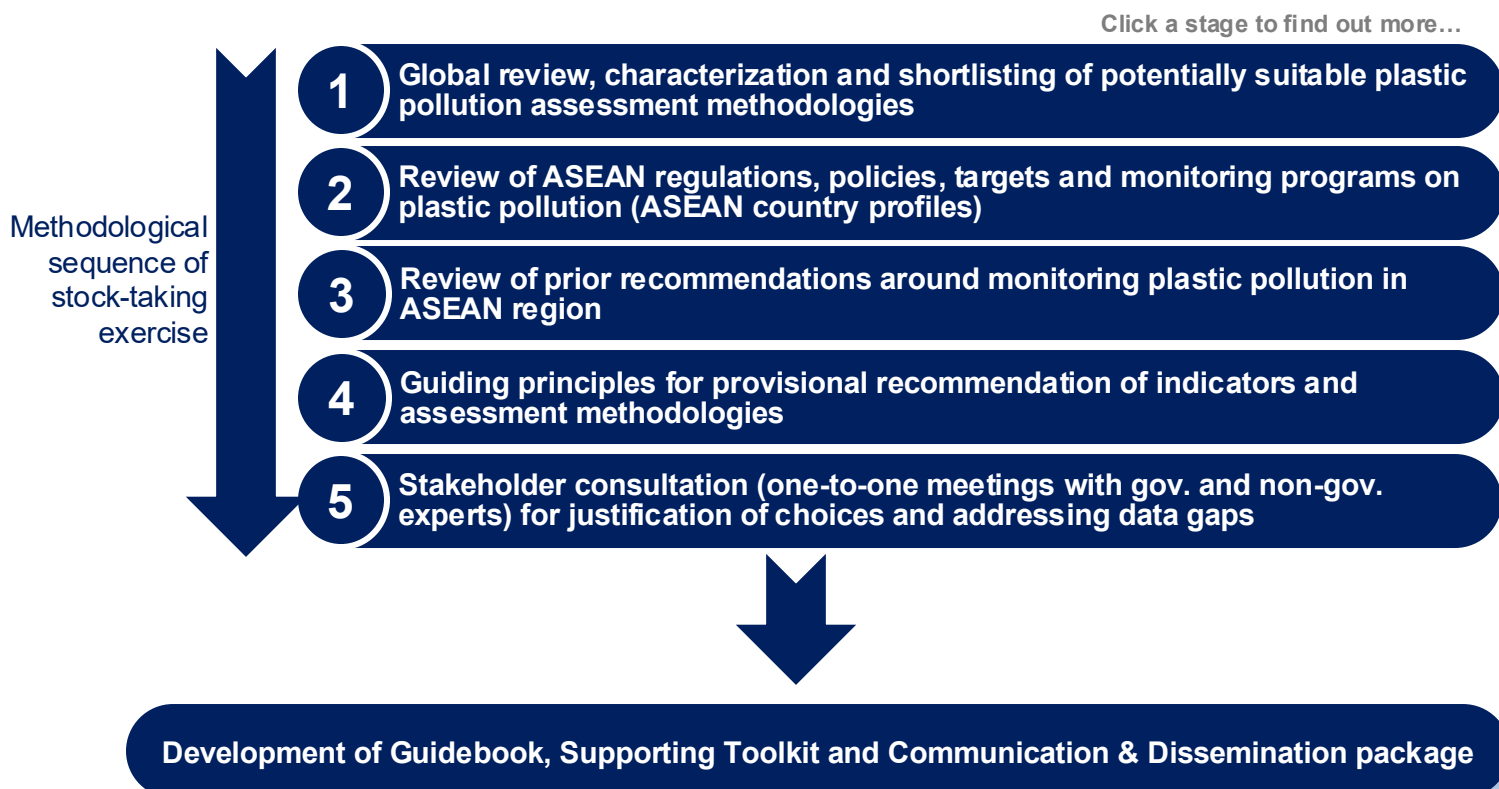
# ANNEX 2:

# GUIDEBOOK APPROACH



## HOW INDICATORS AND METHODOLOGIES WERE RECOMMENDED

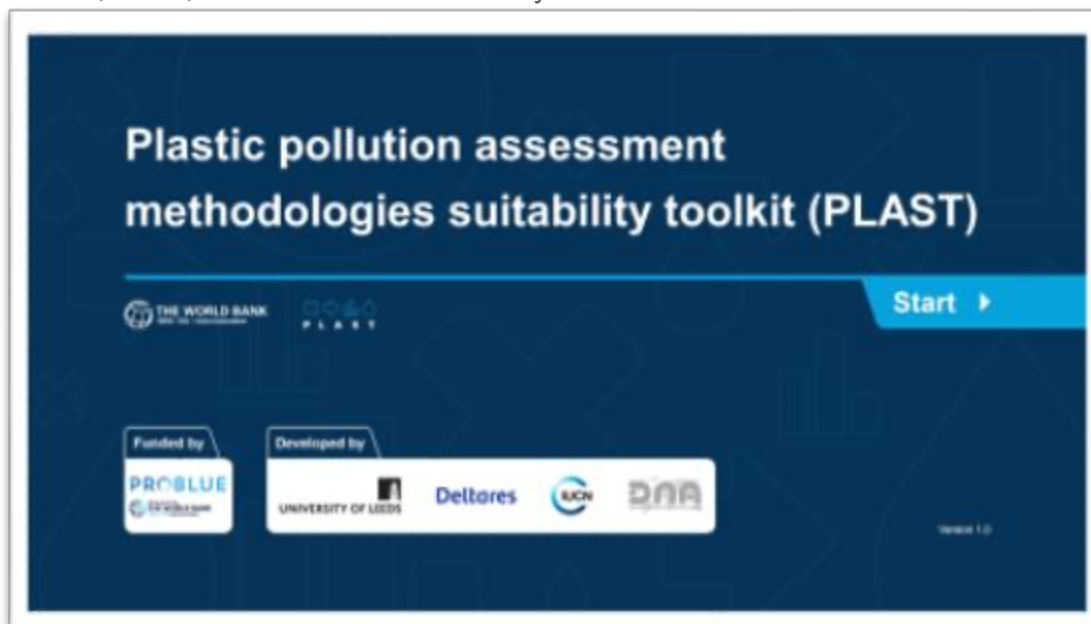
This section presents the approach behind the development of the Guidebook and Supporting Toolkits. The core component in the development of the Guidebook was building an evidence base that can be used as a basis to recommend indicators for monitoring, as well as the most suitable methodologies for measuring these indicators. The evidence base was developed as part of a stock-taking exercise that had five stages, as shown in the figure below:





## GLOBAL REVIEW OF PLASTIC POLLUTION ASSESSMENT METHODOLOGIES

A clearly defined scope is integral for the successful undertaking of a literature review. We define a plastic pollution assessment methodology as “*an implementable methodology that quantifies macroplastic pollution, providing knowledge and understanding in order to effectively act*”. This definition originates from the Plastic Pollution Assessment Methodologies Suitability Toolkit (PLAST – Figure A2.1) (World Bank, 2023), developed in 2023 by the University of Leeds, IUCN, Deltares and David Newby Associates on behalf of the Work Bank Group.



**Figure A2.1: Title page of the Plastic pollution assessment methodologies suitability toolkit (PLAST) which includes 31 assessment methodologies in its framework. PLAST was used as a starting point for the wider literature review (World Bank, 2023)**

PLAST was developed as an interactive toolkit to aid in the selection of plastic pollution assessment methodologies based on a user's needs and resources, with particular focus on the ASEAN region. As such, it is highly relevant to the current work. However, PLAST does not consider methodologies that quantify upstream plastic lifecycle metrics (e.g., plastic production). In addition, although PLAST was developed in 2023 and includes 31 methodologies, the rapidly evolving nature of the field means that new methodologies may have been established since its publication. To address these limitations, a new literature review was conducted that builds upon the methodologies identified in PLAST to include new methodologies and methodologies that consider the upstream plastic lifecycle stage. Outdated and superseded methodologies in PLAST were also removed.

The literature review was conducted for both academic, peer-reviewed literature and grey literature (e.g., reports and methods from non-governmental organisations (NGOs), consultancies, international organizations, governmental departments, etc.). Academic literature was searched for in the repository, Scopus, using the search term: “TITLE-ABS-KEY (“plastic pollution” OR (“plastic waste” AND pollution)) AND NOT TITLE (micro\* OR nano\*)”. Grey literature was searched for using a combination of Google and Google Scholar, snowball searching, and searching within the websites of organizations active in plastic pollution.

In line with the PLAST definition, only methodologies, which quantify macroplastic pollution were considered; methodologies focused solely on microplastics or those which primarily quantify other forms of pollution (e.g., Greenhouse gas emissions) were deemed out of scope. In addition, to be considered an assessment methodology, the method must be implementable to new case studies (e.g., in the ASEAN region), be systematic and repeatable, and provide knowledge or understanding that enables AMS to monitor or act (e.g., by measuring a relevant metric or suggesting specific actions).

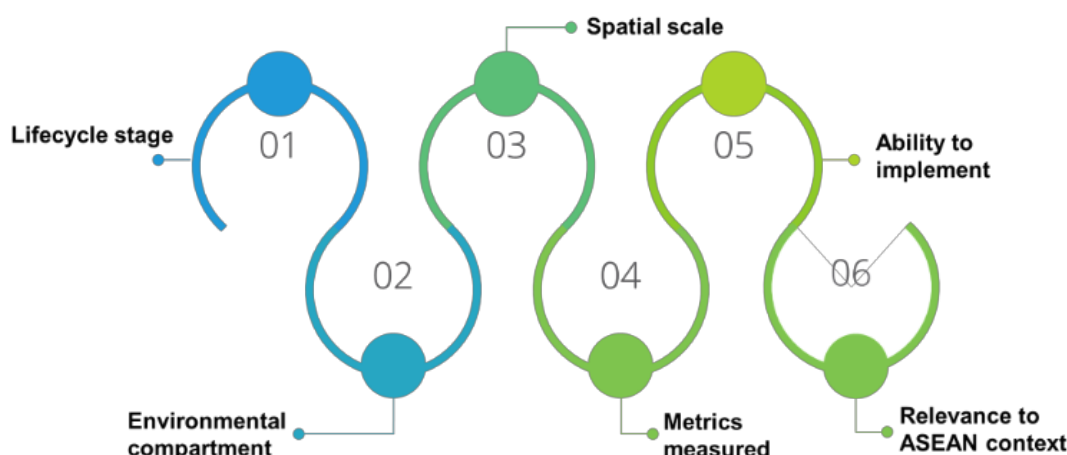


## GLOBAL REVIEW OF PLASTIC POLLUTION ASSESSMENT METHODOLOGIES

Each plastic pollution assessment methodology was characterized by a newly developed framework (outlined in [Annex 3](#)). Features specified in the framework are listed below, with the core element summarized in Figure A2.2, below.

- Methodology name
- Authors
- Year of release
- Lifecycle stages in which it operates
- Environmental compartments it studies
- Spatial scope
- Metrics / indicators that it quantifies
- Methodology and objectives
- Whether the method was developed for repeat implementation or was instead used in a one-off study
- Applicability to the ASEAN region, for example in terms of its context, applicability for repeat monitoring and resource requirements.

As the characterization of some of these framework components are subjective, justification was provided when necessary to explain the reasoning behind any classification.



**Figure A2.2: Summary of the framework used to characterize plastic pollution assessment methodologies.**

The completed framework enabled a shortlisting process, under which reviewed methodologies were retained as potential candidates for inclusion in the Guidebook only if they met defined criteria. These criteria required that methodologies be suitable for the ASEAN context, including consideration of regional conditions such as the presence of the informal recycling sector, constraints on resources and technical capacity, and the inclusion of locally relevant sources of plastic pollution (e.g., open burning and uncollected waste). A second consideration used in the shortlisting stage was that the assessment methodology must be suitable for harmonized monitoring. This implies that the methodology must be implementable to new case studies, be systematic and transparent to allow harmonized measurement, and that it not rely solely on historic, secondary data to allow for the metrics to be continually updated.

The results of the global review of plastic pollution assessment methodologies, characterized by the developed framework, are shown in [Annex 3](#). The review found 53 plastic pollution assessment methodologies of which 20 were shortlisted as being potentially suitable for inclusion in the Guidebook. (These shortlisted methodologies are colored green in [Annex 3](#)). Further refinement of these methodologies is discussed in the '[Provisional recommendation of indicators and assessment methodologies](#)' section.

## REVIEW OF ASEAN REGULATION, POLICIES, TARGETS AND MONITORING PROGRAMS ON PLASTIC POLLUTION

A country-by-country scoping review was conducted across the ASEAN region to assess existing initiatives related to plastic pollution. The findings informed the selection of indicators and methodologies included in the Guidebook, for example by aligning indicators with existing targets, and accounting for prior monitoring experience when selecting methodologies.

Three categories of information were reviewed. First, laws, regulations and policies were included where they were directly relevant to plastic pollution or contained provisions relevant to monitoring programs. More general legislation – such as that addressing solid waste management responsibilities, hazardous waste treatment, or environmental protection – was excluded for conciseness. (A detailed review of these regulations and policies is available from the Economic Research Institute for ASEAN and East Asia (ERIA, 2025) Regional Knowledge Centre for Marine Plastic Debris, via the Global Plastics Policy Centre (2024), and as part of the SEA-MaP Report Recommendations for a Plastic Pollution Indicator Framework for ASEAN (ASEAN & SEA-MaP, 2024)).

Secondly, the review documented any national targets relating to plastic pollution across its life cycles (e.g., plastic production, waste management or as pollution in the environment). Many of these targets are established within the aforementioned national policies and strategies; however, we extracted them here for clarity and ease of comparison. The recommendation of indicators for inclusion in the Guidebook align with these targets where possible to streamline efforts and to provide countries with a mechanism by which they can achieve harmonized evaluation and monitoring of their targets. To enable this cross-linking, only quantitative targets that can be repeatedly measured as part of a monitoring programme have been included. Strategic directions (e.g., strengthen waste management and circular economy) without quantitative goals, were omitted. Likewise, qualitative targets (for example, the state of extended producer responsibility laws in a county) were also excluded as they do not require a systematic methodology or monitoring program, as the Guidebook aims to address. Despite this, such qualitative targets are important to consider as part of wider monitoring programs.

Thirdly, the presence of any existing monitoring programs in each of the ASEAN countries was reviewed. This assesses practical information such as availability of any relevant data, which is collected on a regular basis and therefore potentially suitable for repeat monitoring. The review was centered around three areas to align with life cycle stages: 1) plastic production and trade (upstream), 2) solid waste management, and 3) plastic in the environment.

Results from this scoping review are displayed on a country-by-country basis in [Annex 4](#). The results were validated for accuracy and completeness during the stakeholder consultations with governmental and non-governmental experts, details of which are provided in the '[Stakeholder consultation](#)' section. Due to the complex and continually changing landscape of plastic pollution regulations, policies, targets and monitoring programs, it is possible that some information is omitted or misrepresented. It is recommended that the country profiles be regularly updated (e.g., annually or biennially) to account for any developments, for example, via designated national focal points.



## REVIEW OF ASEAN REGULATION, POLICIES, TARGETS AND MONITORING PROGRAMS ON PLASTIC POLLUTION

### RESULTS OF REVIEW ON REGULATIONS / POLICIES

Analyzing the results from the country profiles in [Annex 4](#) shows that the ASEAN region has been highly active in the development of regulations and policies around plastic pollution. These regulations and policies also tend to span the full life cycle of plastics. For example, evidence was found that seven of the ten AMS have dedicated action plans related to circular economy or sustainable consumption. Likewise, half of the AMS have a dedicated action plan on solid waste management, whilst six AMS have a dedicated action plan on either single-use plastics or relating to plastic pollution in general (Figure A2.3). (Note that the categories discussed are not mutually exclusive; instead, considerable overlap occurs between all three.) Figure A2.3 aims to provide a visual summary of the AMS with dedicated action plans. It should be noted that a higher number of action plans does not necessarily suggest greater action as the scope and ambition of each varies considerably.

#### Dedicated action plans on circular economy / sustainable consumption



#### Dedicated action plans on waste management



#### Dedicated action plans on (single-use) plastics / plastic pollution



**Figure A2.3: Summary illustration of AMS with dedicated action plan on circular economy, sustainable consumption, waste management, single-use plastics and plastic pollution**

The results from the review of ASEAN regulation and policies around plastic pollution were used as a basis on which justification of recommended indicators were informed. For example, given the breadth of the action plans, it was decided that indicators must cover the full plastics life cycle, and, where possible, at least inform on the following aspects:

- Circular economy (e.g., recycling)
- Plastic consumption (e.g., apparent consumption of plastic, waste generation)
- Waste management
- Single-use plastics
- Plastic in the environment

### RESULTS OF REVIEW ON TARGETS

To further support the justification for recommended on indicators, the quantitative targets relating to plastic pollution of each AMS were also reviewed, as shown in [Annex 4](#). Given that the details of these targets varied considerably between countries – and to assist in the identification of trends – targets were categorized into broad groups, as show in Table A2.1.



## REVIEW OF ASEAN REGULATION, POLICIES, TARGETS AND MONITORING PROGRAMS ON PLASTIC POLLUTION

**Table A2.1: Summary of the focus of quantitative targets (as shown in green) relevant to plastic pollution by each AMS using data from the country profiles of [Annex 4](#).**

This summary aims to simply visualize common areas where targets have been set; it does not demonstrate the ambition, achievability, value or monitoring capability of each target. Qualitative targets, regulations and policies are also excluded. As such, the inclusion or absence of targets does not reflect the ambition of the respective country in mitigating plastic pollution.

| Country has target related to:                         | Brunei Darussalam | Cambodia    | Indonesia | Lao PDR     | Malaysia | Myanmar | Philippines | Singapore | Thailand | Viet Nam |
|--------------------------------------------------------|-------------------|-------------|-----------|-------------|----------|---------|-------------|-----------|----------|----------|
| Reduction in plastic imports                           |                   |             |           |             |          |         |             |           |          |          |
| Reduction / banning specific plastic item              |                   |             |           |             |          |         |             |           |          |          |
| Reduction in single-use plastics                       |                   |             |           |             |          |         |             |           |          |          |
| Reduction in overall plastics use                      |                   |             |           |             |          |         |             |           |          |          |
| Biodegradable plastics                                 |                   |             |           |             |          |         |             |           |          |          |
| Recyclability of plastics                              |                   |             |           |             |          |         |             |           |          |          |
| Recycled content                                       |                   |             |           |             |          |         |             |           |          |          |
| Waste generation                                       |                   | Local level |           |             |          |         |             |           |          |          |
| Waste segregation at source                            |                   |             |           |             |          |         |             |           |          |          |
| Waste collection                                       |                   |             |           | Local level |          |         |             |           |          |          |
| Controlled disposal                                    |                   |             |           |             |          |         |             |           |          |          |
| Reduction in informal dumping                          |                   |             |           |             |          |         |             |           |          |          |
| Open burning                                           |                   |             |           |             |          |         |             |           |          |          |
| Recycling                                              |                   |             |           |             |          |         |             |           |          |          |
| Reduced waste to land disposal                         |                   |             |           |             |          |         |             |           |          |          |
| Street sweeping / clean-ups                            |                   |             |           | Local level |          |         |             |           |          |          |
| Reduction in plastic entering the ocean                |                   |             |           |             |          |         |             |           |          |          |
| Reduction in plastic pollution in the ocean            |                   |             |           |             |          |         |             |           |          |          |
| Reduction in abandoned, lost or discarded fishing gear |                   |             |           |             |          |         |             |           |          |          |

Key findings were that most AMS have a target relating to recycling in some form. As such, there is a strong justification for recommending an indicator that assesses recycling. Likewise, upstream targets primarily focus on reducing consumption of plastic, either plastic as a material overall, and/or in relation to problematic items such as single-use plastics. This suggests that an indicator relating to plastic consumption would be useful for AMS, particularly if it could measure plastic consumption at a finer resolution, such as single-use plastics. In addition, many targets focus on the waste management life cycle stage. These range from reduction in (plastic) waste generation, improving waste collection, or improved aspects of controlled disposal. Therefore, an indicator that covers the performance of the municipal solid waste management system would likely be useful to AMS. Lastly, several targets focus on reduction of plastic pollution in the environment, with these mainly focused on the reduction of marine litter. Therefore, an indicator that can be measured in a harmonized manner and reflect the status of marine litter would be valuable.



## REVIEW OF ASEAN REGULATION, POLICIES, TARGETS AND MONITORING PROGRAMS ON PLASTIC POLLUTION

### RESULTS OF REVIEW OF MONITORING PROGRAMS

The ASEAN country profiles of [Annex 4](#) were also analyzed to assess common trends around monitoring programs that the AMS have already established on plastic pollution. These are elaborated on below based on three life cycle stages to match the format of the Country Profiles.

#### Plastic manufacture and trade stage:

It was found that all AMS monitor plastic imports, exports and domestic manufacturing to some degree. This data is typically collected via the national statistic department using methods such as customs reports and economic census surveys. The release of this data is not always made publicly available, although when it is, reporting mechanisms include statical yearbooks, or online data platforms and websites. The frequency of reported data varies between AMS; in general, however, it is often sporadic in its release, and relatively old data is reported. Likewise, data on plastic trade is predominantly recorded on a monetary basis (e.g. value of goods). Domestic production data is also often reported as a monetary value, or via alternative units such as number of employees, number of establishments etc. This is likely due to the structure of the economic census used to collect manufacturing data. These reporting units may be a barrier to implementing some of the upstream methodologies identified in the review of [Annex 3](#), as methodologies usually require data on a mass basis. The reporting granularity of trade and production data also varies considerably between AMS, with most AMS only recording the broadest of Harmonized System (HS) codes that are used for trade (for example, HS 39 – Plastics and articles thereof). This broad category may be useful for understanding plastic consumption but does not allow for more detailed analysis of specific plastic products, or plastic-containing products. A minority of AMS do report by more detailed categories, for example Thailand. Trade data is also often reported at slightly higher levels of detail within the [UN Comtrade database](#). This suggests that more data may be collected than publicly released via the statistical departments.

#### Solid waste management:

All AMS report data on municipal solid waste management, except for Brunei Darussalam, Laos and Myanmar. Viet Nam is believed to report solid waste management data; however, this was not publicly available to verify. Data is most commonly released via annual reports from the departments responsible for waste management, or alternatively via national statistical departments. Data platforms to access SWM data are also used in some countries, such as the [Sistem Informasi Pengelolaan Sampah Nasional](#) (SIPSN) database in Indonesia.

Despite the relatively wide availability of municipal solid waste management data, the methods by which this data was collected are unknown. There is also wide variation in the scales used to report the data, with national or provincial scales being the most common. As municipal solid waste management data is typically measured at the municipal level, it is assumed this data has been aggregated; however, the methodologies for achieving this are also unknown.

#### Plastic in the environment:

Despite several countries having targets relating to plastic pollution, systematic monitoring was found to be lacking. Although there are calls within action plans to create a database on plastic pollution, it is unclear what the scope of methods for populating this database are. To date, and to the authors' knowledge, none of these databases have been developed. Conversely, one-off studies to establish plastic pollution baselines have been widely implemented, resulting in the development of regional capacity to measure plastic pollution. However, this capacity has not yet translated into ongoing, systematic monitoring efforts. Exceptions include Thailand, which has a simple equation for monitoring plastic emission to oceans, and monitors plastic in rivers and the ocean. In addition, Indonesia monitors plastic on beaches and in the ocean, but methods for performing this are unclear. In conclusion, there is limited systematic and repeat (i.e., time-series data) monitoring of plastic pollution in the ASEAN region.

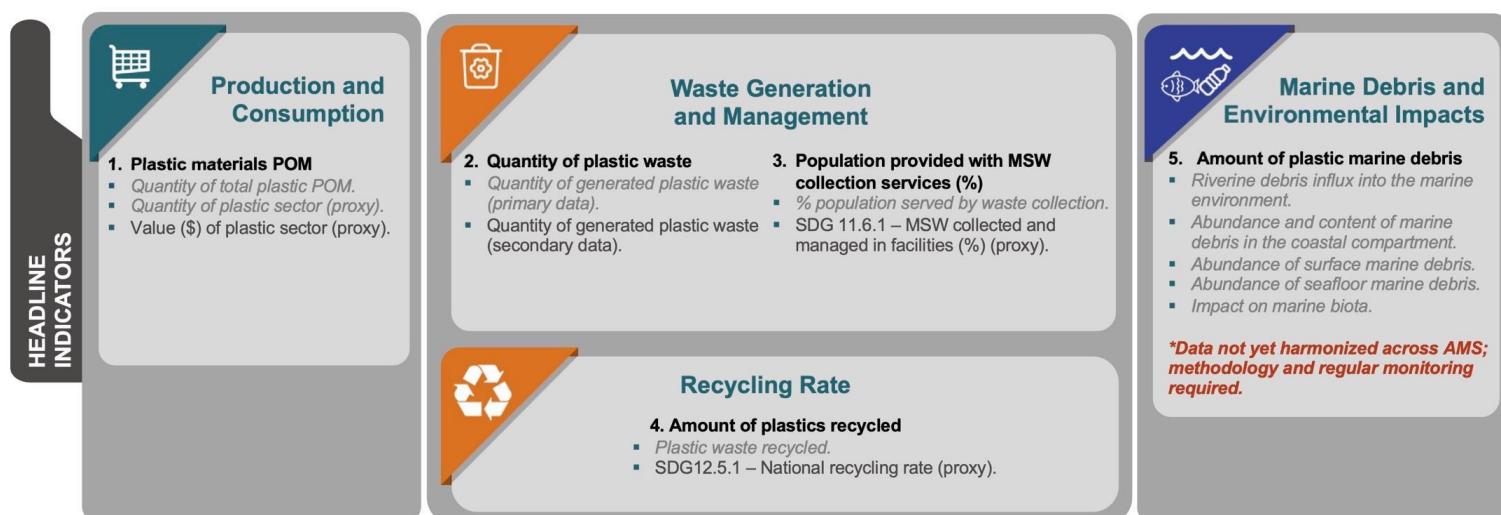




## REVIEW OF PRIOR RECOMMENDATIONS AROUND MONITORING PLASTIC POLLUTION IN ASEAN REGION

### RESULTS OF REVIEW ON RECOMMENDED INDICATORS FOR ASEAN REGION

A review was also performed that focused on prior recommendations around monitoring of plastic pollution in the ASEAN region. One main document that guided this was the *SEA-MaP Synthesis Report: Recommendations for a Plastic Pollution Indicator Framework* (ASEAN & SEA-MaP, 2024) that preceded the development of this Guidebook. The *Synthesis Report* identified five ‘headline indicators’ that it estimated as part of the baseline assessment. These five indicators had several sub-metrics (referred to in the Report and ‘variables’) (Figure A2.4). The five ‘headline indicators’ recommended were used as a starting point when assessing the recommendation of indicators for this Guidebook. However, additional considerations were added such as the availability of existing plastic pollution assessment methodologies for measuring these, the ability to measure them in a harmonized manner, alignment with AMS policies and targets on plastic pollution, and the scientific merit and value that monitoring of each indicator would provide. Further details on how indicators were recommended in this Guidebook is discussed in the [‘Guiding principles for recommendation of Indicators’](#) section.



**Note:** **Bold** = headline indicators – essential to track progress on the main objectives of the ASEAN RAP; dark gray text = data could be available across all AMS for indicator monitoring in the short term with the use of proxy indicators to serve as temporary substitutes for the headline indicators as necessary; *light gray italics text* = data is not currently available across all AMS for indicator monitoring; **red text** = important prerequisite.

POM = placed on the market; SDG = Sustainable Development Goal; MSW = municipal solid waste

**Figure A2.4: Indicators recommended as part of the ‘Recommendations for a Plastic Pollution Indicator Framework for ASEAN’ Report and on which an initial baseline was calculated. (ASEAN & SEA-MaP, 2024)**



In addition to the SEA-MaP *Synthesis Report: 'Recommendations for a Plastic Pollution Indicator Framework for ASEAN'*, COBSEA and UNEP have developed concrete recommendations and tools to support a harmonized assessment of plastic pollution in the ASEAN region. This includes the report, *'Regional Guidance on Harmonized National Marine Litter Monitoring Programmes'* (COBSEA, 2022), which reviews approaches for monitoring plastic pollution in the environment and aims to build capacity while promoting data comparability and aligning efforts at a regional and global level. The subsequent *'Marine Litter Monitoring Methods Handbook (Part I)'* expands on this by creating a handbook of methodologies for monitoring marine litter at national and regional scales, including guidance on best practices (COBSEA & CSIRO, 2022a). Part two of this Handbook addresses the implementation of a methodology for monitoring plastic pollution on land, rivers and at sea, the CSIRO Survey Methodology (COBSEA & CSIRO, 2022b).

Other relevant works include the SEA-Circular report entitled *'Identifying plastic waste leakage hotspots and flows in South-East Asia'* (UN-Habitat, 2022). This Report recommends the use of two methodologies for assessment of city level waste flows and plastic leakage, namely the Waste Wise Cities Tool (UN-Habitat, 2021) and Waste Flow Diagram (GIZ et. al., 2020). Lastly, UNEP also released a report called *'Monitoring plastics in rivers and lakes – Guidelines for the harmonization of methodologies that provided recommendations for harmonizing measurement of plastic in rivers and lakes across the ASEAN region'* (UNEP, 2020). These guidelines were incorporated into this Guidebook.

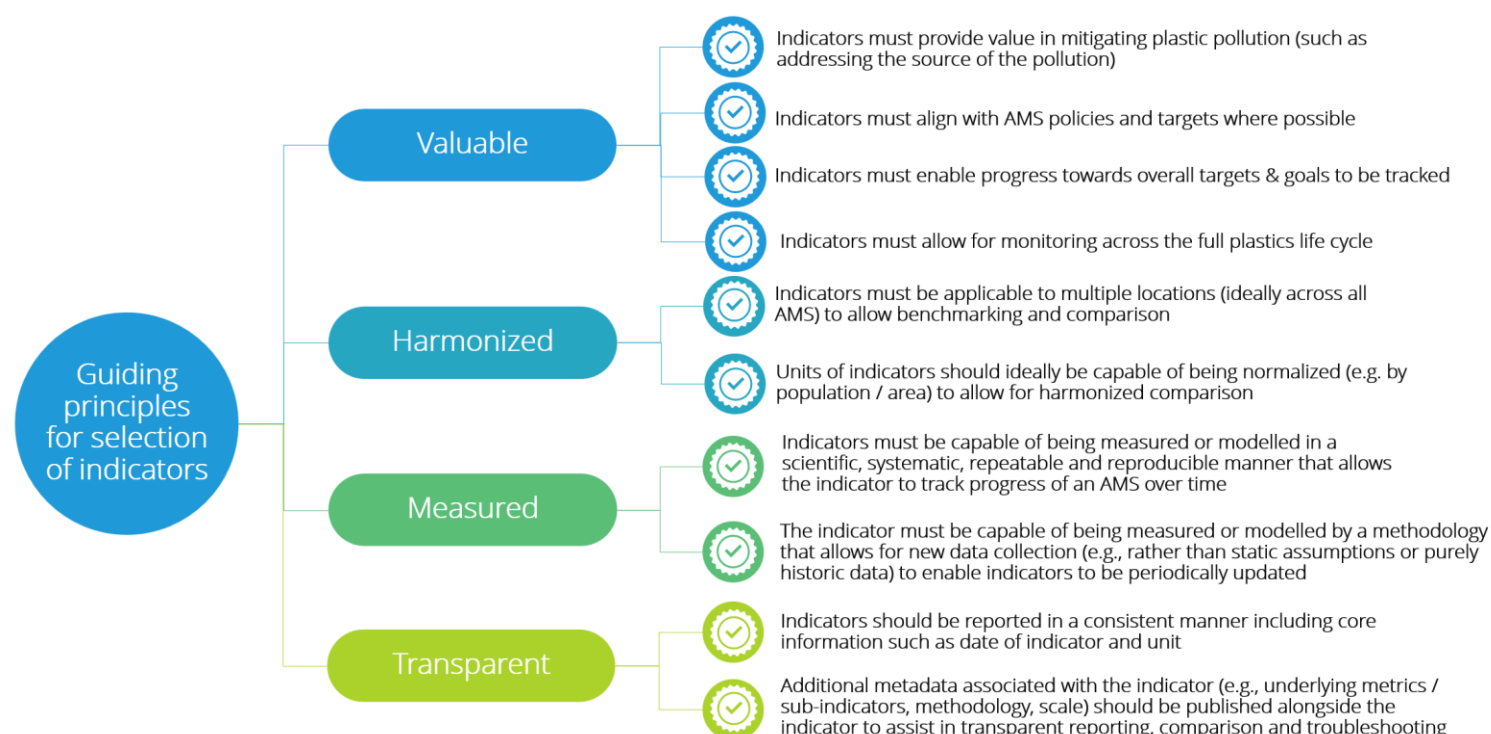
## GUIDING PRINCIPLES FOR RECOMMENDATION OF INDICATORS AND ASSESSMENT METHODOLOGIES

A systematic and transparent approach was used for the recommendation of indicators to be included in this Guidebook. This approach involved the creation of 'guiding principles' that form the basis on which indicators were chosen. These guiding principles were designed to account for four core requirements:

1. Monitoring of indicator should provide value to AMS
2. Indicator must be capable of reporting in a harmonized manner (i.e., across multiple contexts and locations)
3. Indicator must be capable of being measured or modelled by existing methodologies
4. Indicator must allow for transparency in reporting

Additional guiding principles were developed based on these four overarching requirements, as shown in Figure A2.5.





**Figure A2.5: Guiding principles created for recommendation of indicators for inclusion in the Guidebook**

These guiding principles, combined with information from the previous three review steps, led to the recommendation of eight indicators that span the full plastic life cycle:

1. Plastic consumption (kg/capita/yr)
2. Municipal plastic waste generation rate (kg/capita/year)
3. Municipal solid waste collection coverage (% of municipal solid waste generation)
4. Municipal solid waste collected and managed in controlled facilities (% of municipal solid waste generation)
5. Municipal plastic recycling rate (% of municipal solid waste generation)
6. Municipal plastic emissions to the environment (kg/capita/year)
7. Plastic riverine flux (items/hour)
8. Plastic debris density on land (items/m<sup>2</sup>)

## GUIDING PRINCIPLES FOR RECOMMENDATION OF PLASTIC POLLUTION ASSESSMENT METHODOLOGIES

In addition to creating guiding principles for the recommendation of indicators to monitor, similar guiding principles were also produced for the selection of the most appropriate plastic pollution assessment methodologies, as listed below:

1. Methodology must be relevant to ASEAN context
2. Methodology must be implementable by AMS (although capacity building may be required)
3. Methodology must inform on one or more of the selected indicators
4. Methodology must report on indicators in a harmonized manner, and ideally at a national level to enable comparison between countries
5. Methodology preferably has been applied in ASEAN region before; therefore, AMS have some experience
6. Methodology must allow for new data collection rather than solely relying on historic data

The shortlisted methodologies were subject to the above guiding principles to make a structured decision on the most appropriate methods. This justification is shown in the tables below for each of the recommended indicators. Note, the indicators relating to municipal solid waste management have been grouped, as many methodologies are able to measure these simultaneously.

## PROVISIONAL RECOMMENDATION OF METHODOLOGIES

### METHODOLOGIES FOR UPSTREAM INDICATORS

**Table A2.2: Methodologies that measure upstream indicators, and justifications for inclusion or exclusion based on developed guiding principles. (Included methodologies are colour coded green, whilst excluded methodologies are colour-coded red.)**

| Methodology / Publication name                                                  | Justification                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Statistical Guidelines for Measuring Flows of Plastic Throughout the Life Cycle | Measures required plastic consumption indicator. This method is an updated version of the 'BRS Placed on Market' methodology and can be optionally expanded to include other indicators across the full plastics life cycle. Same limitations as BRS Placed on Market methodology (see below). |
| Basel, Rotterdam, Stockholm (BRS) Placed on Market Methodology (POM)            | Measures plastic consumption indicator at a national level, although data availability in correct form could be challenging for some AMS. Could be useful if data collection mechanisms are adapted to suit.                                                                                   |
| National Guidance for Plastic Pollution Hotspotting and Shaping Action          | Has elements related to plastic import and export, but this is not the primary focus of the methodology. Largely reliant on existing secondary data rather than primary data collection making use for monitoring challenging.                                                                 |
| Circularity Assessment Protocol                                                 | Mixed methods approach where some elements may be useful for the apparent consumption of plastic indicator, but only at a city spatial scale.                                                                                                                                                  |



## METHODOLOGIES FOR SOLID WASTE MANAGEMENT INDICATORS

**Table A2.3: Methodologies that measure municipal solid waste management indicators, and justifications for inclusion or exclusion based on developed guiding principles. (Included methodologies are colour coded green, whilst excluded methodologies are colour-coded red.)**

| Methodology / Publication name                                         | Justification                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Waste Wise Cities Tool (WaCT)                                          | Official UN methodology for measuring SWM systems. Developed for ease of use and ability to be applied in ASEAN context (e.g. informal recycling sector). However, works only at a local city level. Measures most of the required indicators, with the exception of plastic emissions to the environment.          |
| Waste Flow Diagram                                                     | Links with WaCT for data collection and measures the SWM indicators, including plastic emissions to the environment. However, works at local level (although has been trailed at national level with adaptations).                                                                                                  |
| BRS Material Flow Analysis (MFA) Methodology                           | Based on the Waste Flow Diagram, but adapted to allow estimation of SWM indicators at national scale. Methodology for data collection can be combined with data collected through WaCT. As with WFD, it measures the recommended SWM indicators. We do not recommend measuring plastic emission with this approach. |
| SPOT model                                                             | Measures all SWM indicators, including plastic emissions. Can use WaCT data or existing SWM data from a country, if collected. Able to aggregate local SWM data to national level in a harmonized manner. Alternate option to BRS MFA methodology based on technical capacity / data needs.                         |
| Plastic Drawdown                                                       | Uses material flow analysis to measure recommended indicators, however emissions are estimated from local stakeholders, making wider harmonization across AMS challenging.                                                                                                                                          |
| ISWA Plastic Pollution Calculator                                      | Works at city / regional level. Measures SWM indicators, but requires large resources for data collection and analysis. Includes GIS elements that may be challenging for some AMS to implement.                                                                                                                    |
| National Guidance for Plastic Pollution Hotspotting and Shaping Action | Models SWM system and related plastic pollution, but relies primarily on existing secondary data, much of which is likely lacking in some AMS. This tool is more suitable for baseline and action planning than for continual monitoring.                                                                           |
| Marine Plastic Footprint                                               | Largely superseded by the National Guidance for Plastic Pollution Hotspotting and Shaping Action methodology. Relies on secondary data, so limited suitability for on-going monitoring efforts.                                                                                                                     |
| Pathways Tool                                                          | Adaption of the P2O model to make suitable for national context. More of a tool than a method; therefore, would be difficult to harmonize across AMS. Large data requirements and lacks data collection procedures.                                                                                                 |
| Circularity Assessment Protocol                                        | Measures SWM aspects, but not the required indicators. Difficult to harmonize across AMS.                                                                                                                                                                                                                           |



## METHODOLOGIES FOR MEASURING PLASTIC IN THE ENVIRONMENT (POLLUTION STAGE) INDICATORS

**Table A2.4: Methodologies that measure plastic in environment indicators, and justifications for inclusion or exclusion based on developed guiding principles. (Included methodologies are colour coded green, whilst excluded methodologies are colour-coded red.)**

| Methodology / Publication name                                                                                                       | Justification                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Visual observation method (González-Fernández and Hanke, 2017) (hereafter referred to as the Riverine Macroplastic Flux Methodology) | Simple method that relies on visual observation from bridges for counting plastic. Measures riverine macroplastic flux indicator and has already been tested by several AMS. Recommended in previous COBSEA work (with flexibility to adapt to local situations).                                                                                                                          |
| CSIRO Survey Methodology                                                                                                             | Widely used throughout ASEAN region. Measures required indicator of plastic debris density on land at regional scale. Recommended as part of prior COBSEA work for harmonized assessment.                                                                                                                                                                                                  |
| A methodology to characterize riverine macroplastic emission into the ocean (Van Emmerik et al, 2018)                                | Incorporates visual observation method of González-Fernández and Hanke (2017). Measures riverine macroplastic flux indicator, including by mass, and expands to annual timeframes, albeit with high uncertainty and requiring extra data collection.                                                                                                                                       |
| A field-based assessment of anthropogenic macrolitter loads and emission rates of three German tributaries                           | Measures riverine macroplastic flux indicator. Similar to alternate methods in scope but requires extensive sampling across water surface, water column, riverbed and riverbanks, which may be challenging, particularly if heavily polluted. Tested only in Germany.                                                                                                                      |
| APLASTIC-Q: Machine learning for aquatic plastic litter detection, classification and quantification                                 | Requires specialist drones which may be challenging to use across all AMS. Accuracy of method uncertain, particularly over large rivers.                                                                                                                                                                                                                                                   |
| High-Resolution mapping of Japanese microplastic and macroplastic emissions from the land into the sea                               | Uses water balance as basis for estimating plastic movement in rivers. Requires high GIS skills and data availability combined with lots of field sampling, so unlikely to be suitable for many AMS.                                                                                                                                                                                       |
| Major sources and monthly variations in the release of land-derived marine debris from the Greater Jakarta area, Indonesia           | Developed and tested in Indonesia. Similar to other methods in scope but relies on net sampling; therefore, not as easy or as flexible in its approach as the visual observation method and may not be suitable for all locations.                                                                                                                                                         |
| Rapid assessment of floating macroplastic transport in the Rhine                                                                     | Adaption of other methods to also include litter traps. Tested in Netherlands only. Perhaps not suitable for all locations.                                                                                                                                                                                                                                                                |
| Methodology to quantify mismanaged plastic waste entering the ocean in coastal countries                                             | Applicable to ASEAN region but only tested in Peru. Modeling based approach with limited primary data collection. No validation of results. May be difficult to implement and harmonize across AMS.                                                                                                                                                                                        |
| Other transect / sampling / clean-up methodologies                                                                                   | Many other sampling / clean-up / transect based methods are available; however, these are focused mainly on beaches / coastal / marine environments, which limits their suitability for broader harmonization and systematic monitoring, as well as their overall effectiveness in supporting plastic pollution mitigation. (These methodologies were removed at the short-listing stage.) |





## SUMMARY OF RECOMMENDED METHODOLOGIES

A summary of the recommended methodologies and the indicators that they can measure is shown in Table A2.5.

**Table A2.5: Recommended methodologies and indicators on which they inform, including a brief description and data requirements**

| Methodology                                                                                                                                       | Description                                                                                                                                                                                                                     | Data requirements                                                                                                                          | Indicators measured                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Apparent Consumption of Plastics Methodology (as included in UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle) | Used to estimate the amount of plastic goods (e.g. single-use plastics) consumed                                                                                                                                                | Requires data on mass of international trade and domestic production of plastic                                                            | 1. Plastic consumption                                                                           |
| Waste Wise Cities Tool (WaCT)                                                                                                                     | Methodology for understanding the amount/type of waste generated in a city and how it is managed (e.g., collected, recycled, disposed)                                                                                          | Data collected from performing waste characterization studies in cities and surveying waste facilities                                     | 2. MSW plastic generation                                                                        |
| Waste Flow Diagram (WFD)                                                                                                                          | Local-level methodology using material flow analysis and visual observation assessment of infrastructure to estimate plastic leakage                                                                                            | Uses WaCT data and visual observation assessments                                                                                          | 3. MSW collection coverage<br>4. SDG 11.6.1 - MSW collected and managed in controlled facilities |
| Basel, Rotterdam, Stockholm (BRS) Material Flow Analysis (MFA) Methodology                                                                        | Performs material flow analysis (MFA) to map how waste is managed at a national level. Can be combined with the Waste Wise Cities Tool, which acts as local data collection                                                     | Requires data on waste generation, composition, collection and plastic waste management across three 'archetypes' (e.g. City, Town, Rural) | 5. Plastic recycling rate                                                                        |
| SPOT Model                                                                                                                                        | Similar in scope to the BRS MFA methodology, but provides more detailed outputs, including plastic emissions into the environment. Can be combined with the Waste Wise Cities Tool or a countries existing solid waste database | Requires data on waste generation, composition, collection and management at a local (municipal) level                                     | 6. Plastic emissions to environment                                                              |
| Riverine Macroplastic Flux Methodology                                                                                                            | Estimates the amount of plastic in rivers by visual counting of items from bridges.                                                                                                                                             | Data collected by visual observation                                                                                                       | 7. Plastic riverine flux                                                                         |
| CSIRO Survey Methodology                                                                                                                          | Uses transect surveys on land, beaches, and riverbanks to estimate the amount of plastic debris in the environment                                                                                                              | Data collected from transect surveys                                                                                                       | 8. Plastic debris density on land                                                                |



## AMS EXPERIENCE IN RECOMMENDED METHODOLOGIES

The recommended methodologies (or very similar adaptations) were reviewed to assess which of the AMS they had already been applied in. It was found that many of the methodologies have already been applied, therefore demonstrating that there is existing capacity and an understanding of them (Table A2.6). This was confirmed in the one-to-one meetings with AMS.

The methodologies that have not been widely applied include: the apparent consumption method (as included in UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle) and the BRS Material Flow Analysis method. The UNEP Statistical Guidelines is a new methodology, and as previously explained, there are a lack of suitable alternative methodologies for measuring the recommended upstream indicator. The BRS Material Flow Analysis method is largely an adaption of the Waste Flow Diagram that allows extrapolation to the national level; therefore, whilst no AMS have applied this directly, it is highly likely that they have much of the expertise and skills necessary to do so, based on their previous experience with WFD applications. Although the SPOT Model has been applied across all AMS, this was part of a global application by the methodology developers (Cottom et al., 2024). A more focused study has also been performed in Indonesia using the SIPSN data (publication pending).

**Table A2.6: Summary of experience of AMS in applying the recommended methodologies.**

| Methodology                            | Brunei | Cambodia | Indonesia | Lao PDR | Malaysia | Myanmar | Philippines | Singapore | Thailand | Viet Nam |
|----------------------------------------|--------|----------|-----------|---------|----------|---------|-------------|-----------|----------|----------|
| Apparent Consumption Method *          |        |          |           |         |          |         |             |           |          |          |
| Waste Wise Cities Tool                 |        |          |           |         |          |         |             |           |          |          |
| Waste Flow Diagram                     |        |          |           |         |          |         |             |           |          |          |
| BRS Material Flow Analysis             |        |          |           |         |          |         |             |           |          |          |
| SPOT Model **                          |        |          |           |         |          |         |             |           |          |          |
| Riverine Macroplastic Flux Methodology |        |          |           |         |          |         |             |           |          |          |
| CSIRO Survey Methodology               |        |          |           |         |          |         |             |           |          |          |

\* as included in UNEP Statistical Guideline for Measuring Flows of Plastic Throughout the Life Cycle

\*\* SPOT model has been applied for every country in the world as per Cottom, et al. (2024). It has also been applied using national solid waste management databases for Indonesia. Despite this, experience of AMS in applying the methodology themselves is low due to the SPOT Model only having been recently released.



## STAKEHOLDER CONSULTATION (ONE-TO-ONE MEETINGS WITH AMS AND NATIONAL EXPERTS)

The Guidebook has benefited from inputs from one-one-one online meetings, which were conducted with both AMS government representatives and non-government experts during March – May 2025. These aimed to:

- 1 Fill any data gaps or misunderstandings in the ASEAN country profiles (i.e., policies, regulations, targets and monitoring programs)
- 2 Introduce the recommended indicators and methodologies and understand their experience with them
- 3 Obtain feedback on how useful the recommended indicators and methodologies would be for the country
- 4 Get suggestions for where additional technical support may be required (to feed into the decision making on how to develop the supporting toolkits)

All countries were invited to participate, with reminders sent to non-responses. ASEAN country profiles and pre-meeting surveys were shared with experts along with the invitation. The responses received are shown in Table A2.7:

**Table A2.7: Summary of one-one meetings conducted with AMS and non-governmental experts.**

■ Interviewed      ■ Not interviewed

| Country           | Interviewed representative from government | Interviewed non-government expert |
|-------------------|--------------------------------------------|-----------------------------------|
| Brunei Darussalam | No                                         | No                                |
| Cambodia          | No                                         | Yes                               |
| Indonesia         | No                                         | No                                |
| Lao PDR           | No                                         | Yes                               |
| Malaysia          | Yes                                        | No                                |
| Myanmar           | Yes                                        | No                                |
| Philippines       | Yes                                        | Yes                               |
| Thailand          | Yes                                        | Yes                               |
| Singapore         | No                                         | No                                |
| Viet Nam          | No                                         | Yes                               |
| ASEAN             | Not applicable                             | Yes                               |



## STAKEHOLDER CONSULTATION (ONE-TO-ONE MEETINGS WITH AMS AND NATIONAL EXPERTS)

### KEY FINDINGS ON INDICATORS

- Familiarity with indicators varies based on existing monitoring in place in each country.
- There is strong consensus that solid waste management system indicators are useful, but significant uncertainty exists about environmental monitoring indicators.
- There are targets in each country to measure solid waste management, and the indicators should directly link to these, where possible.
- Data availability and data quality are issues throughout the ASEAN region.
- For solid waste management indicators (2 – 5), all the AMS countries should aim to streamline their solid waste management data collection to improve monitoring and address plastic pollution.
- For all indicators, a means to check the quality of data being collected would be useful.
- The Guidebook should help AMS prioritize which indicators to monitor initially.

### KEY FINDINGS ON METHODOLOGIES

- AMS need substantial technical capacity building, training programs, and external assistance to implement harmonized plastic pollution monitoring methodologies.
- AMS face regional challenges in data collection infrastructure and standardization, with significant capacity gaps in collection, coherence, sharing, and long-term monitoring.
- Most AMS already have familiarity with the Waste Flow Diagram, WaCT, and CSIRO Survey Methodologies, meaning using these would require less capacity building compared to other methodologies.
- Limited inter-stakeholder communication creates implementation barriers, requiring standardized monitoring coordination between data owners, ministries, and local authorities to minimize gaps and inconsistencies.
- Most AMS have only "Limited" to "Moderate" technical capacity across key skill areas, with no country reporting "Extensive" capacity, indicating significant skills gaps across the region.



## STAKEHOLDER CONSULTATION (ONE-TO-ONE MEETINGS WITH AMS AND NATIONAL EXPERTS): SURVEY QUESTIONS

The Guidebook was created with inputs from surveys and one-to-one calls with AMS governmental and non-governmental experts. In the next three pages, users will be able to understand how the AMS experts contributed with their technical knowledge and contextual experiences to share their needs, barriers, and approaches currently in use. This page shows the survey questions. Between February and May 2025, the survey, along with the country profiles, were sent to 114 experts in the AMS. National teams from the PSC and other groups, NGOs, consultants, and academics either arranged for calls with the project team or sent in survey responses by email.

The questions below demonstrated a semi-structured approach to research, and follow-up questions for each country were defined in the detailed country profiles, which were emailed to the experts. An initial stage in the development of the Guidebook required a review of the following information: national policies on plastic pollution; national targets addressing plastics across their life cycle (including production, import, use, waste management and pollution); existing methodologies or monitoring programs for data gathering, reporting, and monitoring plastic across its life cycle; and national capacity and support needs related to data collection, reporting, and implementation of monitoring programs on plastic pollution across the AMS. This information assisted in selecting indicators and methodologies suitable for the harmonized monitoring of plastic pollution across the ASEAN region. This research also enabled alignment of the Guidebook content with ongoing initiatives and identified areas where greater support/capacity building of AMS is required.

**Question 1:** Does X have any national policies or regulations related to plastic pollution across its full life-cycle that are not included in the country profile?

**Question 2:** Are there any national targets related to plastic pollution across its full life-cycle that are not included in Table 1?

**Question 3:** Are there any other official (or widely applied) methodologies / monitoring procedures for measuring international trade of plastic or domestic production of plastic that have not been mentioned in the country profile?

**Question 4:** Are there any other official (or widely applied) methodologies / monitoring procedures for measuring the solid waste management system that have not been mentioned in the country profile?

**Question 5:** Are there any other official (or widely applied) methodologies / monitoring procedures for measuring plastics in the environment not been mentioned in the country profile?

**Question 6:** How useful are each of the eight proposed indicators for supporting X in monitoring its strategic objectives on plastic pollution?

**Question 7:** Please give an indication on the availability of these data types in X: (plastic trade data, domestic plastic production, solid waste generation, solid waste management, plastic recycling)

**Question 8:** The following technical skills may be beneficial for implementing the proposed methodologies. Please rate their current capacity of the governmental department / institution that is most likely to be tasked with monitoring the plastic pollution indicators: (analyze trade data, waste characterization, monitor riverine plastic, environmental transects, run models, assess data quality)

**Question 9:** What technical support is most useful for X for implementing the proposed methodologies?

*Occasional country-specific follow-up questions used to clarify aspects originating from the stocktaking review (e.g., presence of databases, how targets will be monitored etc.)*

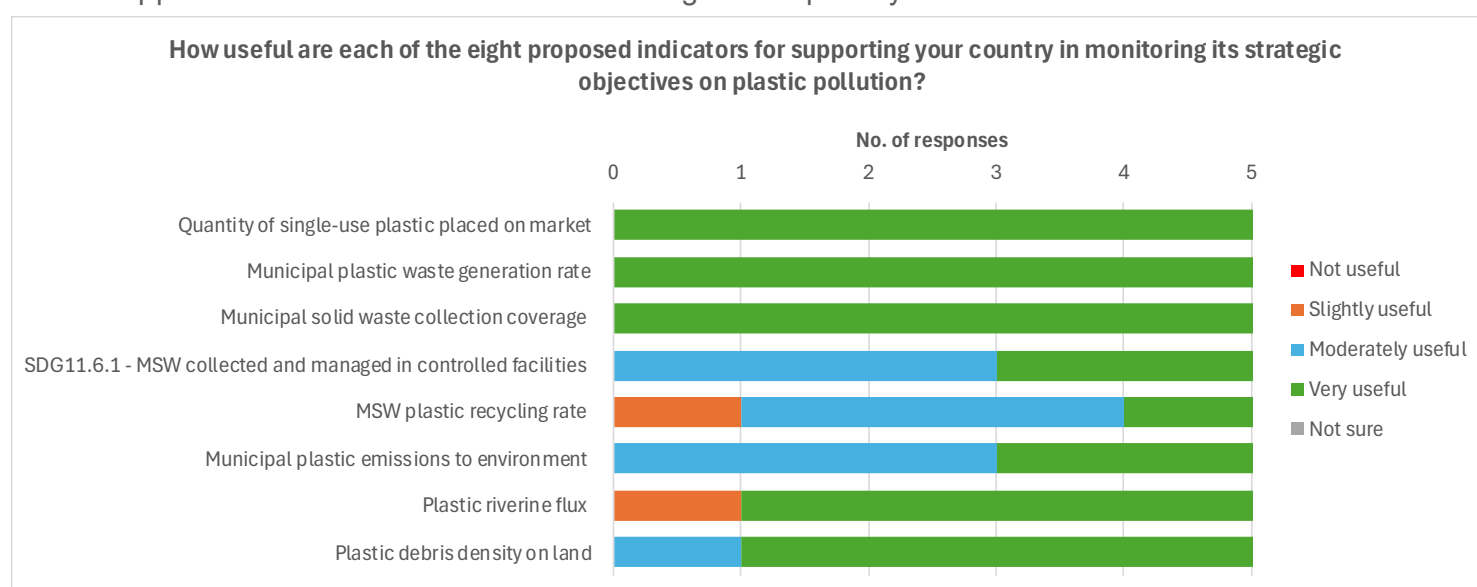
*Semi-structured interview approach used to allow flexibility and to obtain extra information when relevant*



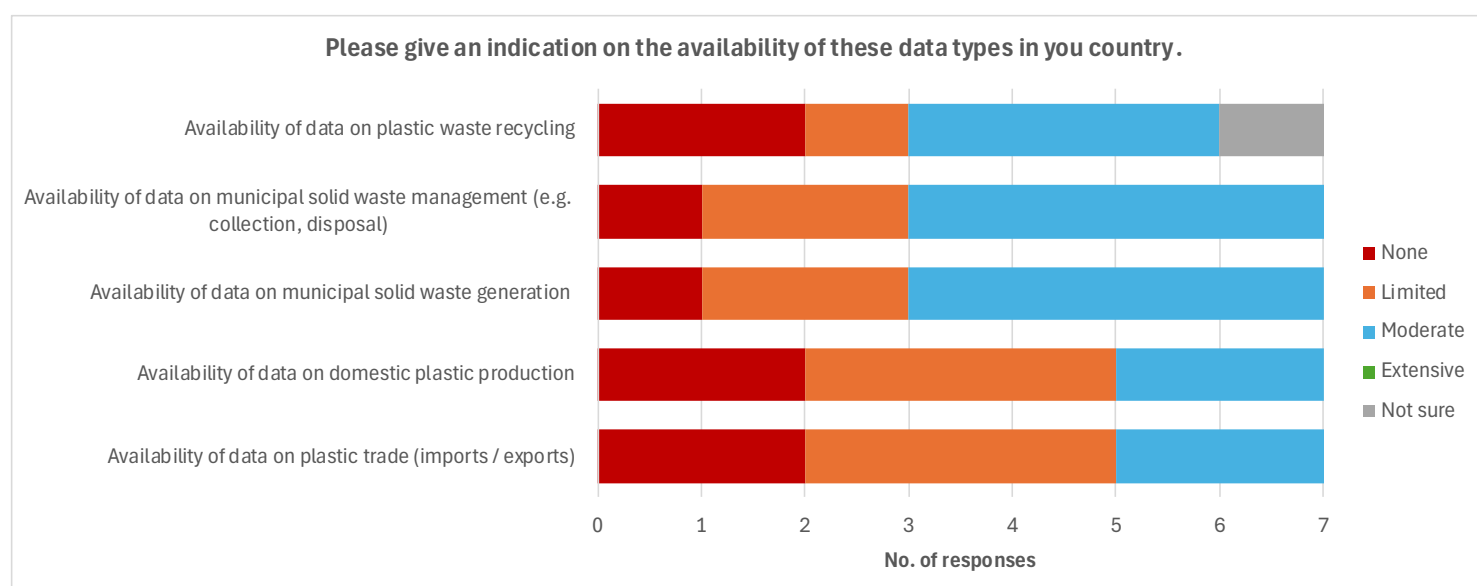
## STAKEHOLDER CONSULTATION (ONE-TO-ONE MEETINGS WITH AMS AND NATIONAL EXPERTS) SURVEY RESULTS

Additional survey findings that supplement the summary on the previous page are presented below and illustrated in the accompanying graphs.

- The country profiles were praised for being comprehensive; any omissions were noted, and country profiles were updated accordingly.
- Almost all countries expressed that the indicators were 'very useful' for their strategic objectives on plastic pollution.
- Some countries suggested that waste management indicators were the most useful to monitor, but highlighted capacity concerns for any primary data collection.
- Many experts highlighted data availability and reliability as a concern across the full plastics lifecycle.
- This supports the decision to focus on methodologies with primary data collection.



**Figure A2.6: Response distributions for question asking about value of the proposed indicators**



**Figure A2.7: Response distributions for question asking about availability of different data types**





## STAKEHOLDER CONSULTATION (ONE-TO-ONE MEETINGS WITH AMS AND NATIONAL EXPERTS)

As noted on the previous page, the survey results provided a strong basis of information for the Guidebook. Most experts rated the current capacity of the various technical skills as being either 'Limited' or 'Moderate'. Given this, the Guidebook needed to explain any technical steps in an easy-to-follow manner; further capacity building and training is also likely required. Relevant comments received from the AMS are summarized as follows:

### On Methodologies, Indicators, Data:

- WaCT and CSIRO Methodologies are most familiar to countries, requiring less capacity building than other approaches.
- Strong consensus exists on waste management system indicators, but uncertainty remains about environmental monitoring indicators.
- Data quality checking mechanisms and indicator prioritization guidance would be valuable.

### On Technical Capacity, Training:

- AMS require substantial capacity building, training programs, and external technical assistance to implement harmonized plastic pollution monitoring systems.
- Most countries have only "Limited" to "Moderate" technical capacity across key skill areas, with no country reporting "Extensive" capacity in most categories.

### On Data Infrastructure, Data Standardisation

- Significant data gaps exist across all critical plastic waste monitoring areas, with weak data collection infrastructure, standardization, sharing, and communication systems.
- Inter-stakeholder communication barriers between data owners, ministries, and local authorities create data inconsistencies.

### On Implementation Priorities

- Waste management indicators should link to existing country targets.
- Streamlining waste collection data across all AMS would improve monitoring and address plastic pollution

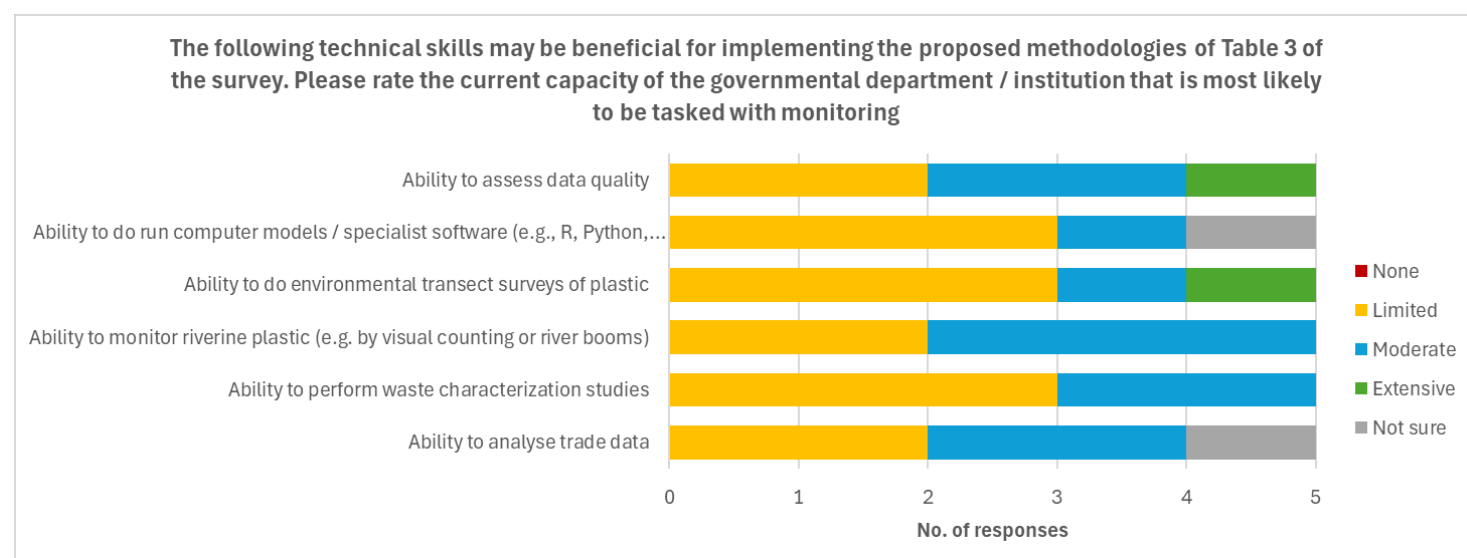


Figure A2.8: Response distributions for question asking about current capacity of technical skills



# ANNEX 3:

## GLOBAL REVIEW & CHARACTERIZATION OF PLASTIC POLLUTION ASSESSMENT METHODOLOGIES



# GLOBAL REVIEW OF METHODOLOGIES

## GLOBAL REVIEW & CHARACTERIZATION OF PLASTIC POLLUTION ASSESSMENT METHODOLOGIES

| Methodology                                                                                                | Author(s)                                             | Lifecycle stage | Env. Compartment          | Spatial scope    | Metric(s)                                                   | Methodology & objectives                                                                                                                                                                                                                                                                                                                                                            | Transferable to new ASEAN studies                                                                 | Shortlisted                                                       |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-----------------|---------------------------|------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| A European threshold value and assessment method for macro litter on coastlines                            | Technical Group Marine Litter (van Loon et al., 2020) | Pollution stage | Beaches / Coastline       | Regional         | Threshold (target) value for number of items/100m coastline | Establishes a European threshold value for number of items on beaches per 100m to act as a target for which progress can be compared. The threshold value is taken as the 15th percentile (20 items/100m), calculated using data from European beaches.                                                                                                                             | European value unlikely to be suitable for ASEAN context                                          | No - Not applicable to ASEAN context in current form              |
| A field-based assessment of anthropogenic macrolitter loads and emission rates of three German tributaries | Schöneich-Argent et al., 2020                         | Pollution stage | Riverine                  | Local - riverine | Mass of anthropogenic litter emitted to oceans from a river | Estimates anthropogenic macro litter outputs from a river to ocean by extrapolating from sampling measurements on water surface, water column, riverbed and riverbank. The method introduces means to harmonize measurements and extrapolate to annual flux to oceans.                                                                                                              | Although implemented in Germany, method applicable to other locations, including the ASEAN region | Yes                                                               |
| A methodology to characterize riverine macroplastic emission into the ocean                                | Van Emmerik et al., 2018                              | Pollution stage | Riverine                  | Local - riverine | Mass of macroplastic emitted to oceans                      | Methodology for estimating plastic flux to oceans from a river using a 4-step approach: (1) Surface observations are used to determine cross-sectional plastic flux across river, (2) Average mass of plastic items are calculated from trawled mass, (3) Relate mass to river discharge, (4) Extrapolate to longer timescales. Method has been applied to Saigon River in Vietnam. | Applicable to ASEAN rivers, and has been applied in Vietnam within Van Emmerik et al., 2018       | Yes                                                               |
| APLASTIC-Q: Machine learning for aquatic plastic litter detection, classification and quantification       | World Bank, Wolf et al., 2020                         | Pollution stage | Riverine, Beach / Coastal | Local - riverine | Count of plastic items in rivers                            | Methodology (software) for a machine learning model that counts and characterizes floating or washed-ashore plastic litter from high-resolution drone imagery. Applied to areas in Cambodia and extended to other ASEAN countries.                                                                                                                                                  | Applicable to ASEAN rivers and applied in Cambodia already                                        | Yes - although drones may not be suitable throughout ASEAN region |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                             | Author(s)                                       | Lifecycle stage | Env. Compartment | Spatial scope    | Metric(s)                                                                     | Methodology & objectives                                                                                                                                                                                                                                                                                                     | Transferable to new ASEAN studies                                                                                                                      | Shortlisted                                                                                                                |
|---------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------|------------------|------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Assessment of the plastic inputs from the Seine Basin to the sea using statistical and field approaches | Tramoy et al., 2019                             | Pollution stage | Riverine         | Local – riverine | Mass of macroplastic emitted to oceans                                        | Methodology to compare amount of plastic flux to oceans. Uses a combination of Jambeck et al., (2015) approach and field sampling (using booms). Results extrapolated by cross-section of river and with time. Methodology applied to Seine River.                                                                           | Limited applicability to ASEAN region – would require booms in rivers, which may not always be accessible for all AMS                                  | No – Limited applicability to ASEAN context in current form                                                                |
| Baseline and power analysis for the assessment of beach litter reductions in the European OSPAR region  | Schulz et al., 2019                             | Pollution stage | Beach / Coastal  | Regional         | Number and timespan of beach surveys required                                 | Methodology for establishing a baseline of beach litter abundance in the European OSPAR region and estimating the minimum number of required beach litter surveys to detect a certain reduction in abundance.                                                                                                                | Method could be applied to ASEAN region in theory – but results on paper only relevant to European OSPAR region. Therefore, applicability uncertain    | No – Uncertain applicability to ASEAN context in current form                                                              |
| Beach-litter baselines                                                                                  | EU Joint Research Centre (Hanke et al., 2019)   | Pollution stage | Beach            | Regional         | Items/100m beach at spatially aggregated level (e.g. National)                | Methodology for producing baseline of beach litter abundance using historical survey data. This methodology was established for the EU using beach litter data from EMODnet.                                                                                                                                                 | Developed for Europe but could be applicable to ASEAN region – would require significant data of beach surveys conducted in a semi-harmonized approach | No – Limited applicability to ASEAN context in current form, as would require significant beach survey data to be analyzed |
| Closing the Mediterranean marine floating plastic mass budget: Inverse modelling of sources and sinks   | Kaandorp et al., 2020                           | Pollution stage | Marine           | Regional - Ocean | Mass of plastic in ocean, Inputs into ocean (mass), fate of plastics in ocean | Methodology uses inverse modeling to understand possible sources and sinks of plastics to match observations in the ocean. Applied to the Mediterranean.                                                                                                                                                                     | Theoretically, could be applied to ASEAN region, but practically hard for countries to implement                                                       | No – limited applicability to ASEAN context in current form                                                                |
| Counter MEASURE                                                                                         | UNEP, Asian Institute of Technology (AIC), 2021 | Pollution stage | Land             | Regional         | Hotspots of plastic pollution (very low to very high)                         | CounterMEASURE is a project that has developed a GIS toolkit with the aim of providing a regional-based model for monitoring and assessment of plastic leakage and pollution reduction. Methodology described in academic publication: <a href="https://doi.org/10.3390/su14137879">https://doi.org/10.3390/su14137879</a> . | Applicable to ASEAN region                                                                                                                             | No – qualitative indicators                                                                                                |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                 | Author(s)                                                           | Lifecycle stage                                  | Env. Compartment | Spatial scope        | Metric(s)                                                  | Methodology & objectives                                                                                                                                                                                                      | Transferable to new ASEAN studies                                                                                                                                           | Shortlisted                                                                                                                             |
|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------|------------------|----------------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Baseline estimation of plastic discharges from land-based sources via rivers and coastlines | World Bank, Deltares, Haskoning PT (2021) and Viegas et al., (2023) | Pollution stage                                  | Riverine, Land   | National             | Mass of macroplastic emitted to oceans                     | Methodology for estimating a national baseline of plastic waste discharges from land-based sources, via rivers and coastlines, integrating hydrology.                                                                         | Applicable to ASEAN region but would require significant expertise to apply to countries other than Indonesia and to run hydrology elements of model, which are proprietary | No – not practically implementable by AMS                                                                                               |
| Export of plastic debris by rivers into the sea                                             | Schmidt et al., 2017                                                | Pollution stage                                  | Riverine         | Global               | Mass of macroplastic emitted to oceans                     | Methodology for producing global estimates of plastic waste discharge by rivers into oceans by relating riverine field measurements to upstream mismanaged plastic waste.                                                     | Applicable to ASEAN region but may not be suitable for regular monitoring                                                                                                   | No – not suitable for monitoring, as it solely relies on secondary data of varying dates                                                |
| Plastics in the Environment                                                                 | Consultic / BKV, 2021                                               | Pollution stage                                  | Land, Riverine   | National             | Mass of plastic entering oceans, inland waterways and soil | Developed by Consultic and BKV, the plastic pollution assessment model entitled 'From the land to the sea – land-based model to capture plastic waste' aims to identify the land-based sources and pathways of marine litter. | Limited applicability to ASEAN region as it has been developed primarily for European countries                                                                             | No – not suitable for ASEAN context in current form                                                                                     |
| Full Circle - PET collection, landfill and environmental leakage rates in Southeast Asia    | GA Circular, 2019                                                   | Waste man., resource recovery and disposal stage | Land             | National to Regional | Recycling rate of PET                                      | Methodology for mapping PET plastic bottles flows within a country, including emission into the environment and recycling (formal & informal). Applied to six ASEAN countries.                                                | Applicable to ASEAN region, but method relies on industry data which may limit its suitability or ability to be used for monitoring                                         | No – relies on industry data so may be challenging for continual monitoring. Does not directly inform on one of the proposed indicators |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                            | Author(s)                                                | Lifecycle stage                                                   | Env. Compartment                        | Spatial scope     | Metric(s)                                                                                         | Methodology & objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Transferable to new ASEAN studies                                                                                                                                   | Shortlisted                                                                                     |
|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------|-------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| CSIRO Global Plastic Leakage Baseline Project                                                          | Schuyler, Willis, Mann, Wilcox and Hardesty (CSIRO) 2017 | Pollution stage                                                   | Land, Riverine, Beach / coastal, Marine | Local to National | Plastic density (items/m <sup>2</sup> ) on land, rivers and oceans                                | Developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia, this plastic pollution assessment methodology estimates the sources, distribution and movement of plastic waste in the environment. The methodology uses random stratified sampling to select sites for surveying. Transects are used to measure the abundance of plastic, with mathematical models then applied by CSIRO to estimate total abundance, distribution and movement. | Applicable to ASEAN region – successfully implemented in several ASEAN countries. Method relies on working in partnership with CSIRO to perform stratified sampling | Yes                                                                                             |
| High-resolution mapping of Japanese microplastic and macroplastic emissions from the land into the sea | Nihei et al., 2020                                       | Pollution stage                                                   | Riverine                                | National          | Mass of plastic (macro and micro) entering oceans, concentration (abundance) of plastic in rivers | Methodology to derive high-resolution, spatial maps of plastic in rivers and mass entering oceans. Uses a combination of field sampling and water balance analysis to estimate concentration of plastics in rivers.                                                                                                                                                                                                                                                                   | Methodology applicable to ASEAN region but may have issue with data availability for water balance analysis                                                         | Yes                                                                                             |
| Identification of sources of marine litter using a Likelihood Matrix Scoring Technique                 | Tudor & Williams, 2004                                   | Pollution stage                                                   | Beach / coastal                         | Local - beach     | Source of beached litter                                                                          | Methodology to identify sources of beach litter using a matrix to score the likelihood scoring technique.                                                                                                                                                                                                                                                                                                                                                                             | Applied to Bristol Channel beach in UK. Sources not applicable to ASEAN context                                                                                     | No – sources not applicable to ASEAN region and does not measure any of the proposed indicators |
| ISWA Plastic Pollution Calculator                                                                      | ISWA, University of Leeds, 2018                          | Waste man., resource recovery and disposal stage, Pollution stage | Land, Riverine                          | Local - municipal | Various SWM metrics, emission of plastic into environment, mass of plastic entering oceans        | The Plastic Pollution Calculator aims to map the complex flows of plastic waste in the solid waste management system and the environment by performing material flow analysis. Emissions of plastic into the environment are calculated using conceptual models that link important parameters to plastic release.                                                                                                                                                                    | Applicable to ASEAN region – applied in Indonesia, Vietnam, Thailand, and Malaysia                                                                                  | Yes                                                                                             |





# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                                                | Author(s)                                                               | Lifecycle stage                                                                                      | Env. Compartment | Spatial scope    | Metric(s)                                                                  | Methodology & objectives                                                                                                                                                                                                                                                                                                                                                                                                         | Transferable to new ASEAN studies                                                               | Shortlisted                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------|------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Major sources and monthly variations in the release of land-derived marine debris from the Greater Jakarta area, Indonesia | Cordova & Nurhati, 2019                                                 | Pollution stage                                                                                      | Riverine         | Local - riverine | Mass of plastic entering oceans                                            | Methodology aims to quantify spatio-temporal variability and type of plastic emissions to ocean from rivers. It does this by sampling rivers using nets and extrapolating by time.                                                                                                                                                                                                                                               | Applicable to ASEAN region                                                                      | Yes                                                                                                                                                                                                  |
| Marine Debris Action Planner (MDAP)                                                                                        | GRID-Arendal, SALT, n.d.                                                | Pollution stage                                                                                      | Coastal          | National         | Plastic hotspots on coastlines                                             | Methodology developed to produce a geographical model capable of predicting litter accumulation hotspots. Applied to the Norwegian coastline.                                                                                                                                                                                                                                                                                    | Theoretically could be applied to ASEAN region, but hard for countries to implement in practice | No – does not inform on any of the proposed indicators and difficult for ASEAN countries to implement                                                                                                |
| Marine Plastic Footprint                                                                                                   | IUCN (Boucher et al., 2020a)                                            | Pollution stage                                                                                      | Land             | National         | Mass of plastic entering oceans                                            | A life cycle assessment approach aimed at inventorying plastic emissions to the marine environment. Methodology uses a basic assessment of solid waste management system to determine release of plastic to marine.                                                                                                                                                                                                              | Applicable to ASEAN region                                                                      | Yes – although largely superseded by National Guidance for Plastic Pollution Hotspotting and Shaping Action. Also, elements rely on secondary data, limiting its suitability for on-going monitoring |
| National Guidance for Plastic Pollution Hotspotting and Shaping Action                                                     | UNEP, IUCN, EA, Quantis, Life Cycle Initiative, (Boucher et al., 2020b) | Production, manu. and trade stage, Waste man., resource recovery and disposal stage, Pollution stage | Land             | National         | Plastic placed on market, various SWM metrics, plastic emissions to oceans | The National Guidance for Plastic Pollution Hotspotting and Shaping Action methodology developed by UNEP and IUCN aims to both identify plastic pollution hotspots and shape corresponding actions. This methodology uses existing data at a national level on plastic imports / production and solid waste management, along with leakage rates determined from the Plastic Leak Project (PLP) to estimate emissions to oceans. | Applicable to ASEAN region, although primarily for baselining rather than monitoring            | Yes – although elements rely on secondary data, therefore limiting suitability for on-going monitoring                                                                                               |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                                           | Author(s)                                                                                          | Lifecycle stage                                                         | Env. Compartment | Spatial scope             | Metric(s)                                                                                                      | Methodology & objectives                                                                                                                                                                                   | Transferable to new ASEAN studies                                                                                                                                                         | Shortlisted                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------|---------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| OSPAR Litter Analyst - standard method and software for statistical analysis of beach litter data in the OSPAR region | OSPAR Schulz et al., 2017                                                                          | Pollution stage                                                         | Beach            | Local to regional - beach | Abundance of specific items on beaches, spatial and temporal trends of specific items on beaches               | A statistical software package, OSPAR Litter Analyst, was produced for analyzing OSPAR beach litter data to quantify litter abundance by item type and spatial / temporal trends.                          | Applicable to ASEAN region but requires litter collection to use OSPAR categories                                                                                                         | No – potentially suitable for ASEAN context but does not inform on one of the proposed indicators                                                 |
| P2O                                                                                                                   | The PEW Charitable Trusts, SYSTEMIQ, University of Leeds, University of Oxford, (Lau et al., 2020) | Waste management, resource recovery and disposal stage, Pollution stage | Land             | Global                    | Various SWM metrics, emission of plastic into environment, mass of plastic entering oceans, mass openly burned | A methodology to examine scenarios for reducing plastic emissions to the ocean. Methodology was applied at the global scale by archetypes.                                                                 | Applicable to ASEAN region but runs at archetype level – therefore, not suitable for national level analysis without major reconfigurations                                               | No – runs at archetype level; therefore, not suitable for national monitoring                                                                     |
| Plastic Drawdown                                                                                                      | Common Seas (Royale et al., 2022)                                                                  | Waste man., resource recovery and disposal stage, Pollution stage       | Land             | National                  | Various SWM metrics, mass of plastic entering oceans                                                           | Developed by Quantis and EA, the Plastic Leak Project aims to enable companies to inventory plastic waste flows, including those related to plastic production, packaging, products amongst other sources. | Not applicable to ASEAN countries as developed for companies. Can be implemented as part of the UNEP methodology 'National Guidance for Plastic Pollution Hotspotting and Shaping Action' | No – developed for companies, but data can be incorporated in the 'National Guidance for Plastic Pollution Hotspotting and Shaping Action' method |
| Plastic Leak Project                                                                                                  | Quantis / EA, (Peano et al., 2020)                                                                 | Waste man., resource recovery and disposal stage, Pollution stage       | Land             | Companies                 | Mass of plastic emission into environment, mass of plastic emission to oceans                                  | Developed by Quantis and EA, the Plastic Leak Project aims to enable companies to inventory plastic waste flows, including those related to plastic production, packaging, products amongst other sources. | Not applicable to ASEAN countries as developed for companies. Can be implemented as part of the UNEP methodology 'National Guidance for Plastic Pollution Hotspotting and Shaping Action' | No – developed for companies but data can be incorporated in the 'National Guidance for Plastic Pollution Hotspotting and Shaping Action' method  |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                                      | Author(s)                                  | Lifecycle stage                                                   | Env. Compartment | Spatial scope       | Metric(s)                                           | Methodology & objectives                                                                                                                                                                                                                                                                                                     | Transferable to new ASEAN studies                                                                                                  | Shortlisted                                                                          |
|------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------|------------------|---------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Plastic waste inputs from land into the ocean (and subsequent adaptations)                                       | Jambeck et al., 2015, and Law et al., 2020 | Waste man., resource recovery and disposal stage, Pollution stage | Land             | National            | Mass of plastic entering oceans                     | The landmark publication by Jambeck et al. (2015) aimed to provide the first global quantification of marine litter from land-based sources. The methodology calculates mismanaged waste at a national level and estimates the amount of this entering oceans by applying a transfer coefficient for the coastal proportion. | Applicable to ASEAN region but not suitable for monitoring as uses existing data                                                   | No – uses secondary data so challenging for monitoring                               |
| Polymer-specific modeling of the environmental emissions of seven commodity plastics as macro- and microplastics | Kawecki and Nowack, 2019                   | Waste man., resource recovery and disposal stage, Pollution stage | Land             | National            | Mass of plastic emission to water and soil          | Methodology that maps the flows of seven polymers within a country including their loss to the environment using probabilistic material flow analysis.                                                                                                                                                                       | Not applicable to ASEAN region – developed for Switzerland and does not include important ASEAN sources, such as uncollected waste | No – not suitable for ASEAN context in current form                                  |
| Rapid assessment of floating macroplastic transport in the Rhine                                                 | Vriend et al., 2020                        | Pollution stage                                                   | Riverine         | Local - riverine    | Mass of plastic entering oceans                     | Combines two methodologies for plastic monitoring in rivers to estimate plastic input to ocean in Rhine river.                                                                                                                                                                                                               | Applicable to ASEAN region                                                                                                         | Yes                                                                                  |
| River plastic emissions to the world's oceans                                                                    | Lebreton et al., 2017                      | Pollution Stage                                                   | Riverine         | Global - riverine   | Mass of macroplastic emitted to oceans              | Methodology for producing global estimates of plastic waste discharge by rivers into oceans by relating riverine field measurements to upstream mismanaged plastic waste.                                                                                                                                                    | Applicable to ASEAN region but not suitable for monitoring                                                                         | No – not suitable for monitoring as solely relies on secondary data of varying dates |
| Visual observation of floating macro litter                                                                      | González-Fernández and Georg Hanke, 2017   | Pollution Stage                                                   | Riverine         | Regional - riverine | Count and types of items entering ocean from rivers | Uses visual observation from bridges, banks or boats to measure macro-litter observations.                                                                                                                                                                                                                                   | Applicable to ASEAN region                                                                                                         | Yes                                                                                  |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                                    | Author(s)                                                             | Lifecycle stage                                                   | Env. Compartment | Spatial scope            | Metric(s)                                                    | Methodology & objectives                                                                                                                                                                                                                                                                                                                                                                                                                     | Transferable to new ASEAN studies                                                | Shortlisted                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------|------------------|--------------------------|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Regional budget of marine plastic litter                                                                       | Turrell, 2020                                                         | Pollution Stage                                                   | Riverine         | National - riverine      | Mass of plastic entering oceans                              | Methodology estimates annual inputs of macro- and microplastics to the ocean. Developed for Scotland.                                                                                                                                                                                                                                                                                                                                        | Developed for Scotland – not applicable to ASEAN region as major sources omitted | No – not suitable for ASEAN context in current form                                                                             |
| Simulation of dispersion and accumulation of marine debris using numerical models, including particle-tracking | Several (e.g., Soto-Navarro et al., 2020; van der Mheen et al., 2020) | Pollution Stage                                                   | Marine           | Local to global - marine | Abundance of plastic in oceans                               | Various methodologies using similar particle tracking methods to understand the fate of marine debris.                                                                                                                                                                                                                                                                                                                                       | Applicable to ASEAN region                                                       | No – does not inform on the proposed indicators and technique may be challenging for ASEAN countries to implement independently |
| Spatio-temporal quantification of plastic pollution origins and transportation (SPOT) model                    | University of Leeds (Cottom et al., 2024)                             | Waste man., resource recovery and disposal stage, Pollution stage | Land             | Local to global          | Various SWM metrics, Mass of plastic emission to environment | SPOT is a GIS-based model for predicting the origins, transportation pathways, and sink hotspots of plastic pollution. The methodology combines data on solid waste management with machine learning to predict data gaps. Conceptual models and probabilistic material flow analysis are then used to quantify emissions into the environment. Local (municipal) level results can be aggregated to the national, regional or global level. | Applicable to ASEAN region                                                       | Yes                                                                                                                             |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                                                              | Author(s)                                                          | Lifecycle stage                                                   | Env. Compartment | Spatial scope     | Metric(s)                                                    | Methodology & objectives                                                                                                                                                                                                                                                            | Transferable to new ASEAN studies | Shortlisted                                     |
|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------------|------------------|-------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------------------------------------|
| The effect of tidal fluctuation on the accumulation of plastic debris in the Wonorejo River Estuary, Surabaya, Indonesia | Kurniawan and Imron, 2019                                          | Pollution stage                                                   | Coastal          | Local - coastal   | Plastic abundance with tidal fluctuations                    | The study sought to understand the effect of tide levels on debris distribution along the coastline within the Wonorejo River Estuary in Surabaya, Indonesia. The methodology involved sampling sites along an estuary at high and low tide.                                        | Applicable to ASEAN region        | No – does not inform on the proposed indicators |
| Waste Flow Diagram                                                                                                       | GIZ, University of Leeds, Eawag-Sandec, Wasteaware, 2020           | Waste man., resource recovery and disposal stage, Pollution stage | Land             | Local / municipal | Various SWM metrics, Mass of plastic emission to environment | This methodology allows rapid quantification of a city's plastic pollution.                                                                                                                                                                                                         | Applicable to ASEAN region        | Yes                                             |
| Basel Convention toolkit for consumption-lifespan                                                                        | Basel Convention, UNITAR (Wagner and Balde, 2021)                  | Production stage, Distribution, sale and consumption stage        | Land             | National          | Plastic placed on market, Plastic waste generation           | Methodology uses the apparent consumption method, which estimates plastic placed on market as the amount imported + domestic production - exports. Comtrade data is used for import and export data, whereas domestic production uses CPC codes to link.                            | Applicable to ASEAN region        | Yes                                             |
| Basel Convention toolkit for material flow analysis                                                                      | Basel Convention, Resource Futures (Pisharody and Lepiniere, 2021) | Waste man., resource recovery and disposal stage, Pollution stage | Land             | National          | Various SWM metrics, Mass of plastic emission to environment | Methodology is a simplified version of the Waste Flow Diagram that uses material flow analysis to map flows of waste. Unlike the WFD, it is made for the national level and uses archetypes to distinguish diversity of settlement types. Emissions are estimated using WFD values. | Applicable to ASEAN region        | Yes                                             |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                  | Author(s)                       | Lifecycle stage                                                                                                | Env. Compartment | Spatial scope                 | Metric(s)                                                                                                 | Methodology & objectives                                                                                                                                                                                                                                                                                                       | Transferable to new ASEAN studies                                                                                                             | Shortlisted                                                                                                                     |
|----------------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------|------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| GPAP National Analysis & Modeling (NAM) tool | GPAP, 2022                      | Waste man., resource recovery and disposal stage, Pollution stage                                              | Land             | National                      | Various SWM metrics, Mass of plastic emission to environment                                              | Methodology is an adaption of the P2O model and UNEP National Guidance for Plastic Pollution Hotspotting and Shaping Action model.                                                                                                                                                                                             | Applicable to ASEAN region                                                                                                                    | No – more for baselines than continual monitoring                                                                               |
| Plastic Waste Makers Index                   | Minderoo, 2021                  | Production stage, Distribution, sale and consumption stage                                                     | Land             | Companies                     | Mass of single use plastic in MSW                                                                         | Methodology for estimating single use plastics (SUP) production by companies, which follows 6 steps: (1) polymer production, (2) polymer trade, (3) polymer conversion to SUP items, (4) trade of SUPs in bulk and (5) trade of SUPs in finished goods, and finally, (6) SUPs in MSW. Industry data is used for the estimates. | Not directly applicable to ASEAN region as developed for companies; however, some data could be useful for estimating national SUP generation | No – not suitable to ASEAN context in current form, and does not inform on one of the proposed indicators                       |
| Pathways Tool                                | PEW, University of Oxford, 2024 | Production stage, Waste man., resource recovery and disposal stage, Pollution stage                            | Land             | Local (municipal) to National | Various SWM metrics, Mass of plastic emission to environment                                              | The Pathways tool is an evolution of P2O (Breaking the Plastic Wave) model. Pathways is not a methodology as such, but instead a toolkit (software) allowing flows of plastic waste to be quantified and scenarios to be run into the future.                                                                                  | Applicable to ASEAN region                                                                                                                    | Yes – although would require a default system map and data collection (sampling) strategy to harmonize and allow for monitoring |
| Circularity Assessment Protocol (CAP)        | Jambeck et al., 2024            | Production stage, Use and consumption stage, Waste man., resource recovery and disposal stage, Pollution stage | Land             | Local (municipal)             | Plastic debris density (items/m <sup>2</sup> ), Fast moving consumer goods on marker. Various SWM metrics | CAP is a mixed methods approach for understanding circularity in a city. It includes assessments of plastic in the environment, community, surveys of fast-moving consumer goods, product design and use, and assessments of the waste management systems.                                                                     | Applicable to ASEAN region; has already been applied in several cities                                                                        | Yes – elements such as plastic debris density in particular                                                                     |





# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                   | Author(s)                                | Lifecycle stage                                        | Env. Compartment | Spatial scope     | Metric(s)                                   | Methodology & objectives                                                                                                                                                                                                                                                                                                                                                              | Transferable to new ASEAN studies | Shortlisted                                                                                                |
|-------------------------------------------------------------------------------|------------------------------------------|--------------------------------------------------------|------------------|-------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------------------------------------------------------------------------|
| Risk and Warning System for Macroplastic Litter                               | DHI, 2022                                | Pollution stage                                        | Riverine         | Global, Riverine  | Mass of plastic emission in rivers          | Developed using DHI global hydrological model and incorporating data from the University of Leeds SPOT model, this model predicts the load of plastic in rivers in real time and projects into the future.                                                                                                                                                                            | Applicable to ASEAN region        | No – Not suitable for monitoring countries' progress                                                       |
| More than 1000 rivers account for 80% of riverine plastic emissions to oceans | Meijer et al., (The Ocean Cleanup), 2021 | Pollution stage                                        | Riverine         | Global, Riverine  | Mass of plastic riverine emission to oceans | This study used spatial maps of mismanaged waste along with precipitation and hydrology data to predict the amount of plastic waste emitted to oceans.                                                                                                                                                                                                                                | Applicable to ASEAN region        | No – Global baseline rather than a methodology for continual monitoring                                    |
| The Plastic Pathfinder                                                        | Mellink et al., 2022                     | Pollution stage                                        | Riverine         | River basin       | Mass of plastic entering rivers             | The Plastic Pathfinder is a numerical model for simulating the flow of plastic overland. The model starts from spatial maps of mismanaged plastic waste and incorporates the wind speed and surface runoff to simulate plastic mobilisation into rivers.                                                                                                                              | Applicable to ASEAN region        | No – does not measure any of proposed indicators and would be challenging for ASEAN countries to implement |
| Waste Wise Cities Tool (WaCT)                                                 | UN-Habitat, 2021                         | Waste management, resource recovery and disposal stage | Land             | Local (municipal) | Various SWM metrics. SDG 11.6.1             | WaCT is a methodology for measuring the performance of a municipality's solid waste management system. It involves primary data collection in the form of household waste characterization to calculate the waste generation rate, collection coverage and levels of controlled disposal. These are used to calculate SDG11.6.1 - MSW collected and managed in controlled facilities. | Applicable to ASEAN region        | Yes                                                                                                        |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                           | Author(s)                        | Lifecycle stage | Env. Compartment  | Spatial scope   | Metric(s)                                              | Methodology & objectives                                                                                                                                                                                                                                                                                                                      | Transferable to new ASEAN studies | Shortlisted                                                                                             |
|---------------------------------------------------------------------------------------|----------------------------------|-----------------|-------------------|-----------------|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------|
| International Coastal Cleanup                                                         | Ocean Conservancy                | Pollution       | Coastal / beaches | Local           | Items littered on beaches                              | The Ocean Conservancy International Coastal Cleanup is an initiative that encourages citizens to clean up beaches. Although not a defined methodology as such, data is collected in these clean ups, such as the mass collected and the item prevalence.                                                                                      | Applicable to ASEAN region        | No – does not inform on one of the proposed indicators                                                  |
| Project AWARE                                                                         | Padi / Dive against debris, 2011 | Pollution       | Marine            | Local           | Mass and items collected from marine environment       | Whilst not a standalone methodology, the surveys encouraged by PADI and Dive against Debris project collected information on marine litter such as the mass collected and item types.                                                                                                                                                         | Applicable to ASEAN region        | No – does not inform on one of the proposed indicators                                                  |
| Guidelines for the monitoring and assessment of plastic debris in marine environments | GESAMP (Kershaw et al., 2019)    | Pollution       | Marine            | Local           | Various relating to plastic in oceans and on shoreline | Provides guidelines on monitoring of plastic in oceans and shorelines.                                                                                                                                                                                                                                                                        | Applicable to ASEAN region        | No – Guidelines more than a set methodology, meaning harmonization would be difficult between countries |
| Transfer dynamics of macroplastics in estuaries                                       | Tramoy et al., 2020              | Pollution       | Riverine          | Local (Estuary) | Distance traveled by items in estuaries                | Used date prints on stranded debris and GPS trackers to understand the transfer dynamics of plastics in estuaries.                                                                                                                                                                                                                            | Applicable to ASEAN region        | No – does not inform on one of the proposed indicators                                                  |
| MARINA model                                                                          | Stokal et al., 2023              | Pollution       | Riverine          | Global          | Mass of plastic riverine emission to oceans            | Quantifies amount of macro and micro plastics entering oceans by a river sub-basin. Macroplastic emissions are determined by assigning a fraction of the mismanaged waste in a sub-basin as emission to ocean. This fraction is based on the amount of water that transfers to ocean compared to that removed for aspects such as irrigation. | Applicable to ASEAN region        | No – macroplastic emissions overly simplistic and method unlikely to be used for monitoring             |



# GLOBAL REVIEW OF METHODOLOGIES

| Methodology                                                                              | Author(s)                             | Lifecycle stage | Env. Compartment | Spatial scope             | Metric(s)                                         | Methodology & objectives                                                                                                                                                                                                                                                                                                                                                                                                                          | Transferable to new ASEAN studies | Shortlisted                                                                                                        |
|------------------------------------------------------------------------------------------|---------------------------------------|-----------------|------------------|---------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Riverine plastic litter monitoring using UAVs                                            | Geraeds et al., 2019                  | Pollution       | Riverine         | Local                     | Plastic density (items/m <sup>2</sup> ) in rivers | Method to use drones (unmanned aerial vehicles) for monitoring of plastic in rivers.                                                                                                                                                                                                                                                                                                                                                              | Applicable to ASEAN region        | No – does not inform on one of the proposed indicators, and unlikely to be widely implementable by ASEAN countries |
| OSPAR guidelines for monitoring marine litter on beaches                                 | OSPAR (Wenneker and Oosterbaan, 2010) | Pollution       | Beaches          | Local                     | Plastic item characterization                     | Guidelines rather than a set methodology on how to perform sampling on beaches. Includes useful information such as standardized categories of plastic items.                                                                                                                                                                                                                                                                                     | Applicable to ASEAN region        | No – does not inform on one of the proposed indicators                                                             |
| Methodology to quantify mismanaged plastic waste entering the ocean in coastal countries | Ita-Nagy et al., 2022                 | Pollution       | Riverine         | Local, Regional, Riverine | Mass of plastic riverine emission to oceans       | Methodology to model the mass of plastic waste entering oceans from rivers. Calculates the proportion of mismanaged waste that enters the ocean based on assessing factors such as natural and anthropogenic barriers, wind speed and direction, natural disasters, formal and informal recycling and river basin characteristics. The methodological framework attempts to combine observations through field studies with data on river basins. | Applicable to ASEAN region        | Yes                                                                                                                |



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# **ANNEX 4:**

# **COUNTRY PROFILES OF ASEAN POLICIES, REGULATIONS, TARGETS AND MONITORING PROGRAMMES ON PLASTIC POLLUTION**



## BRUNEI DARUSSALAM

Brunei Darussalam has shown strong commitments to reduce its waste generation and improve recycling, as demonstrated by its national targets <sup>[1]</sup>. The table outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Brunei Darussalam. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Brunei Darussalam, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Brunei Darussalam

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Notes                                                                                                                                                                                                                                                                 |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy     | No Plastic Bag Everyday Initiative <sup>[2]</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Aims to encourage the use of reusable plastic bags in participating stores. Over 60 stores currently participate, with this trying to be expanded.                                                                                                                    |
| Policy     | Plastic Bottle Free Initiative <sup>[3]</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Aims to raise awareness of plastic bottle use and promote refill and sustainable alternatives.                                                                                                                                                                        |
| Policy     | Sungai Brunei Cleanup Initiative <sup>[4]</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Project to collect waste daily from households, collect waste accumulated underneath houses and in their immediate vicinity, and collect floating waste in rivers via debris booms.                                                                                   |
| Regulation | Prevention of Pollution of the Sea Order <sup>[5]</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Regulates the prevention of waste from ships, with specific mention of plastics. Any discharge must be recorded, and the owner of the vessel charged recovery costs.                                                                                                  |
| Regulation | 5% excise duty of the declared trade value on import of plastic primary forms and other related plastic products <sup>[6]</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Aims to reduce plastic waste generation.                                                                                                                                                                                                                              |
| Target     | Waste generation limited to 1 kg per person per day by 2035 <sup>[1]</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Brunei Darussalam currently estimates a waste generation rate of 1.4 kg·cap <sup>-1</sup> ·day <sup>-1</sup> . <sup>[2]</sup> Method for monitoring target not apparent.                                                                                              |
| Target     | Recycling rate of 30% by 2035 <sup>[1]</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | The 2023 Voluntary National Review of progress towards the Sustainable Development Goals (SDGs) records <sup>[7]</sup> the national recycling rate, noting a drop from 25.2% in 2015, to 8.72% in 2021. The methodology for calculating these values is not apparent. |
| Monitoring | <b>Manufacture and trade:</b> For plastic trade, Brunei monitors the import and export of plastic using HS codes, as per the international and ASEAN standard and available through Comtrade. For domestic manufacture, Business Reporting User Guidelines <sup>[8]</sup> state that businesses are required to report economic revenue according to the codes of the Brunei Darussalam Standard on Industrial Classification (BDSIC) <sup>[9]</sup> . The BDSIC codes match those of the International Standard Industrial Classification of All Economic Activities Rev. 4 (ISIC), whereby ISIC Code 2220 relates to the manufacture of plastic products. However, this code does not cover all sectors or provide granularity on the types of plastic produced. |                                                                                                                                                                                                                                                                       |

# COUNTRY PROFILES

| Type       | Name / Description                                                                  | Notes                                                                                                                                                                                                                                       |
|------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring | <b>Solid waste management:</b> No established monitoring for solid waste management | Brunei Darussalam currently estimates a waste generation rate of $1.4 \text{ kg} \cdot \text{cap}^{-1} \cdot \text{day}^{-1}$ [2]; however, there is no apparent method for monitoring waste generation, collection, treatment or disposal. |
| Monitoring | <b>Plastic pollution:</b> No established monitoring for plastic in the environment  | Although one-off studies have measured plastic pollution in Brunei, e.g. the abundances of plastic on beaches and in rivers [10, 11], no regular monitoring program is known to occur.                                                      |

## CAMBODIA

The rapid growth of Cambodia has led to the country establishing several policies and targets aimed at sustainability, particularly in relation to resource use. The table on the next two pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Cambodia. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Cambodia, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Cambodia

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Notes                                                                                                                                                                                                                                                                                                                     |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy     | <p>Cambodia's Circular Economy Strategy and Action Plan <sup>[1]</sup> aims to increase circularity and reduce single-use plastics. It highlights eight goals:</p> <ol style="list-style-type: none"> <li>1. Increase sustainable production and energy use</li> <li>2. Increase sustainable consumption</li> <li>3. Reduce waste generation at source</li> <li>4. Improve effectiveness of waste collection management, segregation, and transport</li> <li>5. Promote product reuse and repair</li> <li>6. Increase recycling, composting and energy recovery</li> <li>7. Ensure environmental controls at all waste management sites</li> <li>8. Promote widespread environmental education and awareness raising</li> </ol> | Each of these eight goals led to a series of priority areas and actions. A proposed monitoring and evaluation framework was put forward for the priority areas and actions; however, it is unclear if this was fully accepted or regulated. Relevant quantitative targets are shown in the targets section of this table. |
| Policy     | Cambodia's Roadmap for sustainable consumption and production 2022-2035 <sup>[2]</sup> covers five elements: sustainable production, sustainable distribution, sustainable consumption, sustainable investment, and values for sustainability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Specific priority actions mentioned include: development of extended producer responsibility (EPR) standards, promotion of single-use plastic (SUP) alternatives, reduction of SUP by levies or subsidies, waste separation and collection, and public awareness campaigns on waste reduction.                            |
| Regulation | Restrictions on import and production of plastic bags.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Plastic bag imports or local productions are restricted to bags that have a thickness of more than 0.03mm and a base width over 25cm <sup>[3]</sup> .                                                                                                                                                                     |
| Regulation | Supermarkets are required to charge 400 Riel for a plastic bag <sup>[3]</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | There appears to be limited success of this policy so far, with not all supermarkets enforcing the charge and customers unaware of the policy <sup>[4]</sup> .                                                                                                                                                            |
| Target     | 50% decrease in single-use plastic use in target sector compared to 2021 baseline by 2023.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Targets proposed as part of Cambodia's Circular Economy Strategy and Action Plan <sup>[1]</sup> . It is unclear if these are officially endorsed.                                                                                                                                                                         |
| Target     | 100% collection coverage in subnational municipalities by 2025.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                           |
| Target     | 100% of state-owned landfill following updated residual waste legislation by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                           |
| Target     | All municipalities introduce waste separation and effective collection to support recycling by 2035 <sup>[2]</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | This target is outlined in Cambodia's Roadmap for sustainable consumption and production 2022-2035 <sup>[2]</sup> . Several other targets exist, for instance around single-use plastic alternatives, although these predominantly focus on establishing regulations and incentives.                                      |

# COUNTRY PROFILES

| Type   | Name / Description                                                                                                                                                                                                                                                                                                                                                                                             | Notes                                                                                                                                                                                                                                                                                |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Target | All municipalities introduce waste separation and effective collection to support recycling by 2035 <sup>[2]</sup> .                                                                                                                                                                                                                                                                                           | This target is outlined in Cambodia's Roadmap for sustainable consumption and production 2022-2035 <sup>[2]</sup> . Several other targets exist, for instance around single-use plastic alternatives, although these predominantly focus on establishing regulations and incentives. |
| Target | The Urban Solid Waste Management 2020-2030 Policy <sup>[5]</sup> has several strategic goals around the improvement of solid waste management, elimination of pollution, and increase in circularity. These are non-quantitative in nature.                                                                                                                                                                    | The goals are arranged according to short, medium and long-term goals, but are non-quantitative.                                                                                                                                                                                     |
| Target | Local-level targets exist for Phnom Penh for the year 2035, including: <ul style="list-style-type: none"> <li>• Limiting waste generation to 1.0 kg/cap/day.</li> <li>• 100% waste collection rate</li> <li>• 95% non-organic recycling rate</li> <li>• 20% organic recycling rate</li> <li>• Development of sanitary landfill</li> <li>• 20% of survey respondents practicing daily 3R principles.</li> </ul> | Targets are outlined in the Phnom Penh Waste Management Strategy and Action Plan 2018-2035 <sup>[7]</sup> .                                                                                                                                                                          |
| Target | 'SDG 11.6.1: Amount of urban solid waste regularly collected and with adequate final discharge'. Targets 1.35 million tonnes (Mt) by 2020, 1.43 Mt by 2025 and 1.50 Mt by 2029. Baseline for 2015 is 1.2 Mt. It is unclear what is classed as adequate final discharge.                                                                                                                                        | Targets are established as part of 'Schedule 2' of the Cambodian Sustainable Development Goals (CSDGs) Framework (2016-2030) <sup>[6]</sup> .                                                                                                                                        |
| Target | 'Percentage of the deduction plastic bag used'. Target interpreted as the percentage reduction in plastic bag usage. Targets 20% by 2020, 30% by 2025, with this remaining constant until 2029. Baseline for 2015 is 10%. Note: this is referred to in the framework as SDG 11.6.2; however, this does not match the official UN SDG 11.6.2, which is in relation to particulate matter.                       |                                                                                                                                                                                                                                                                                      |
| Target | 'Percentage of the solid wasted will be segregated by technical guidance' target interpreted as the percentage of solid waste separated at source. Targets 55% by 2020, rising to 70% by 2025 and 75% by 2029. Baseline for 2015 is 50%. Note: this is referred to in the framework as SDG 11.6.3; however, there is no official UN SDG 11.6.3.                                                                |                                                                                                                                                                                                                                                                                      |
| Target | 'SDG12.5.1: National recycling of materials used'. Targets 180 kilotonnes (kt) by 2020, rising to 210 kt by 2025 and 240 kt by 2029. Baseline for 2015 is 163 kt.                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                      |
| Target | 'SDG14.1.1: Percentage of the reduction of the sea pollution by the conservation activities. Unclear what is meant by 'conservation activities'. Targets a 50% reduction by 2020, rising to 60% by 2025 and 70% by 2029. Baseline for 2015 is 40% reduction, although it is unclear what this 40% reduction is based on.                                                                                       |                                                                                                                                                                                                                                                                                      |



# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring | <p><b>Manufacture and trade:</b> For plastic trade, Cambodia monitors the import and export of plastic using HS codes, as per the international and ASEAN standard and for which data are typically available through Comtrade.</p> <p>Domestic manufacture of plastic products is recorded under the Cambodia Standard Industrial Classification (CSIC) code 222<sup>[8]</sup>. This category includes: the manufacture of builder's wares or construction plastics (22210), the manufacture of plastic articles for the packaging of goods (22220), the manufacture of finished plastics products (22230), and the manufacture of other plastics products (22290). Data is collected through the Economic Census Surveys, the last of which was in 2022<sup>[9]</sup>. It is unclear whether data is available on plastic production at the CSIC resolution listed above.</p> | <p>Data on the domestic production of plastic in Cambodia is believed to be collected as part of the Economic Census<sup>[9]</sup>. However, the final census report only shows detailed data on the CSIC sub codes (required for plastic production) for the number of establishments and number of persons engaged. It is unclear whether data is available at this resolution on a mass or monetary basis. The 'information collected' section suggests that sales data may be recorded, but this is not provided at sufficient resolution in the report.</p>                                                                                                                                                                                                                                                                    |
| Monitoring | <p><b>Solid waste management:</b> The agencies / departments responsible for monitoring the SDG targets are outlined in Schedule 1 of the Cambodian Sustainable Development Goals (CSDGs) Framework (2016-2030)<sup>[6]</sup>. Details such as the reporting frequency (annual for all except national recycling rate, which is every three years), definitions, and basic calculation of the indicators (nominators and denominators) are also provided. However, the full methodological details on how to calculate the numerators and denominators is not provided.</p>                                                                                                                                                                                                                                                                                                     | <p>Monitoring of solid waste management is proposed through annual progress reports released as part of the Urban Solid Waste Management 2020-2030 Policy<sup>[5]</sup>. However, there does not appear to be a systematic method for measuring this.</p> <p>For the SDG goal monitoring, responsible agencies for the waste management related targets include the: Ministry of Environment (MOE), Ministry of Industry and handicraft (MIH), Ministry of Interior (Mol), and Phnom Penh Municipality. Data sources are listed as above, plus Environment Protection Agency (EPA).</p> <p>Responsible agencies for the recycling target are the: EPA, MOE, Ministry of Commerce (MoC), Ministry of Agriculture, Fisheries and Forestry (MAFF), with these also recorded as the data sources. MoE is responsible for SDG14.1.1.</p> |
| Monitoring | <p><b>Plastic pollution:</b> No established monitoring methods for plastic in the environment were found.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <p>Note from interview: "I think it'd be really helpful to clarify the term "plastic pollution" (i.e., whether and/or to what extent it encompasses coastal and/or marine). There are at least multiple guidelines or plans developed in Cambodia that claim to tackle marine plastic pollution, but the methodology really focuses on municipality only and hardly in the marine/coastal environment itself. I think doing so will further help determine the right methodology for monitoring the pollution."</p>                                                                                                                                                                                                                                                                                                                 |

## INDONESIA

Indonesia is at the forefront of efforts to address plastic pollution and has been one of the first countries in the world to adopt national targets on its prevention, with a 70% reduction of marine plastic debris targeted by 2025 <sup>[1]</sup>. The table on the next two pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Indonesia. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Indonesia, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programmes of plastic pollution in Indonesia

| Type       | Name / Description                                                                                                                                                                                                                                                                                    | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy     | Indonesia's Plan of Action on Marine Plastic Debris 2017 – 2025 <sup>[1]</sup> .                                                                                                                                                                                                                      | The plan is centred around five pathways for achieving the goal of 70% reduction of marine plastic debris by 2025: (1) improving behavioral change, (2) reducing land-based leakage, (3) reducing sea-based leakage, (4) reducing plastics production and use, and (5) enhancing funding mechanisms, policy reform and law enforcement.                                                                                                        |
| Policy     | Presidential Regulation No. 97 of 2018 on the National Policy and Strategy on Household and Household-like Waste Management (Jakstranas) <sup>[2]</sup> .                                                                                                                                             | This national policy and strategy on waste management establishes guidelines for the reduction of household and household-like waste (i.e., municipal solid waste), with several national targets established on amounts for waste reduction and handling (see targets section).                                                                                                                                                               |
| Policy     | Indonesia National Plastic Action Partnership (NPAP) <sup>[3]</sup> .                                                                                                                                                                                                                                 | The Indonesia National Plastic Action Partnership (NPAP) <sup>[3]</sup> is part of the Global Plastic Action Partnership <sup>[4]</sup> , which aims to develop partnerships and action plans in countries across the world to prevent plastic pollution. The Indonesian NPAP specifically aims to support Indonesia's Plan of Action on Marine Plastic Debris 2017 – 2025 <sup>[1]</sup> and Jakstranas <sup>[2]</sup> .                      |
| Regulation | Limit the generation of plastic bags and avoid using single-use goods and/or packaging.                                                                                                                                                                                                               | Law 18 of 2008 <sup>[5]</sup> concerning waste management divides waste management into two activities, (1) waste reduction, and (2) waste handling. Waste reduction includes limiting waste generation, recycling and reuse, whereas waste handling includes sorting, collection, transportation, processing and disposal of waste. Article 11 provides examples that 'limiting waste generation' includes plastic bags and single-use items. |
| Regulation | Regulates measures for producers to increase reduction, reuse and recycling of plastic products. Measures are specifically targeted at a broad range of single-use plastic items and contain a mixture of bans, specifying minimum recycled content of products, and regulating items are recyclable. | These regulations are established in the Ministry of Environment and Forestry Regulation Roadmap of Waste Reduction by Producer <sup>[6]</sup> . The regulations contribute to the target for 30% reduction in waste generation by 2025 as established in the Presidential Regulation No. 97 of 2018 on the National Policy and Strategy on Household and Household-like Waste Management (Jakstranas) <sup>[2]</sup> .                        |
| Regulation | Final processing of waste (i.e. land disposal) should be by 'controlled landfill' or 'sanitary landfill'.                                                                                                                                                                                             | Law 18 of 2008 <sup>[5]</sup> concerning waste management regulates that controlled landfill or sanitary landfill should be used for disposal of waste. Controlled landfill is described as having compaction and coverage of waste with top-soil at least once a week, whereas sanitary landfill has compaction and coverage every day.                                                                                                       |

# COUNTRY PROFILES

| Type              | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Regulation</b> | Local bans on plastic bags and other single-use plastic items.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>In addition to national level regulations <sup>[5-6]</sup>, local regulations have also banned single-use plastics. These include:</p> <ul style="list-style-type: none"> <li>• Regulation No. 142 of 2019 for Jakarta on shopping bags</li> <li>• Regulation No. 97 of 2018 for Bali on 'disposable plastics' (plastic bags, polystyrene straws etc.)</li> <li>• Regulation No. 61 of 2018 for Bogor on plastic bags</li> <li>• Regulation No.1 of 2019 for Balikpapan on single-use plastics</li> </ul> |
| <b>Regulation</b> | Presidential Regulation No. 83 of 2018 regarding marine debris management <sup>[7]</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | This regulation was established to support the target of 70% reduction in plastic marine debris by 2025. It aims to increase awareness, encourage research and support legal mechanisms, monitoring and financing.                                                                                                                                                                                                                                                                                           |
| <b>Monitoring</b> | <p><b>Manufacture and trade:</b> For plastic trade, Indonesia monitors the import and export of plastic using HS codes as per the international and ASEAN standard and available through Comtrade and the Statistics Indonesia website <sup>[8]</sup>.</p> <p>Domestic manufacture of plastic is recorded in both monetary and mass terms in the annual 'Statistik Industri Manufaktur Produksi' (Statistics of Manufacturing Industry and Production), with 2022 being the latest release <sup>[9]</sup>. Manufacture is characterized according to Indonesia's Standard Industrial Classification codes (KLBI) <sup>[10]</sup>, which are based on the International Standard Industrial Classification codes, covering plastics under code 222.</p> | Data on domestic manufacture according to Indonesia's Standard Industrial Classification codes (KLBI) is also further broken down by commodity codes (KBKO) <sup>[11]</sup> , providing insight on specific product types manufactured.                                                                                                                                                                                                                                                                      |

| Type                | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |                     |                              |                   |                   |     |          |                                |     |             |                             |     |            |                            |     |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|------------------------------|-------------------|-------------------|-----|----------|--------------------------------|-----|-------------|-----------------------------|-----|------------|----------------------------|-----|
| Monitoring          | <p><b>Monitoring of solid waste management performance and related targets:</b></p> <p>Waste management performance at a district level (waste reduction, handling and recycling) is monitored using the SIPSN database [12]. This is aggregated to national annual reporting by the Ministry of Environment and Forestry (KLHK). Aggregation appears to only include data from available cities and regions, with data gaps not filled.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>The Regulation number 6 of 2022 establishes the requirements for the National Waste Management Information System (SIPSN) [13]. SIPSN includes data on waste sources, generation, composition, characteristics, and waste management facilities. Data is to be submitted to SIPSN by each district/city. Generation of waste is calculated by one of three tiers. Tier 1 uses waste generation rate estimates based on the city size:</p> <div> <p>Table 1 : Waste Generation Estimation Factor/Capita, based on City Classification.</p> <table> <tr> <th>City Classification</th><th>Population (People)</th><th>Factor Value (kg/person/day)</th></tr> <tr> <td>Metropolitan City</td><td>&gt; 1,000,000 souls</td><td>0.7</td></tr> <tr> <td>Big city</td><td>500,001 &lt; p &lt; 1,000,000 people</td><td>0.6</td></tr> <tr> <td>Medium City</td><td>100,001 &lt; p &lt; 500,000 souls</td><td>0.5</td></tr> <tr> <td>Small town</td><td>20,000 &lt; p &lt; 100,000 souls</td><td>0.4</td></tr> </table> </div> <p>Tier 2 uses data from cities within the same classification as a proxy, or by using the Indonesia National Standards. Tier 3 uses waste characterization. It is unclear how the three tiers of disposal (sanitary, controlled, dumpsite) are attributed.</p> | City Classification | Population (People) | Factor Value (kg/person/day) | Metropolitan City | > 1,000,000 souls | 0.7 | Big city | 500,001 < p < 1,000,000 people | 0.6 | Medium City | 100,001 < p < 500,000 souls | 0.5 | Small town | 20,000 < p < 100,000 souls | 0.4 |
| City Classification | Population (People)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Factor Value (kg/person/day)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |                     |                              |                   |                   |     |          |                                |     |             |                             |     |            |                            |     |
| Metropolitan City   | > 1,000,000 souls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |                     |                              |                   |                   |     |          |                                |     |             |                             |     |            |                            |     |
| Big city            | 500,001 < p < 1,000,000 people                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0.6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |                     |                              |                   |                   |     |          |                                |     |             |                             |     |            |                            |     |
| Medium City         | 100,001 < p < 500,000 souls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |                     |                              |                   |                   |     |          |                                |     |             |                             |     |            |                            |     |
| Small town          | 20,000 < p < 100,000 souls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |                     |                              |                   |                   |     |          |                                |     |             |                             |     |            |                            |     |
| Monitoring          | <p><b>Monitoring of plastic pollution and plastic marine debris target:</b> Indonesia's metadata for SDG 14.1.1 – percentage reduction in marine litter outlines four types of marine debris [14]:</p> <ol style="list-style-type: none"> <li>1) Marine debris on beaches</li> <li>2) Plastic waste in the ocean water column</li> <li>3) Plastic waste on the seabed</li> <li>4) Plastic waste eaten by marine animals</li> </ol> <p>Monitoring is reported to occur annually and is the responsibility of the National Coordination Team for Marine Debris Reduction, the Ministry of Maritime Affairs and Fisheries, and the Ministry of Environment and Forestry. The methodology for measuring each of these types of marine debris is not known.</p> <p>No evidence was found for systematic nationwide monitoring of other forms of plastic pollution (e.g., that on land, or entering oceans via rivers), although Bali has applied the CSIRO survey methodology [15].</p> | <p>0.52 ± 0.36 million tonnes per year of plastic entering oceans from Indonesia in 2020 is believed to be the baseline value on which progress is tracked [16]. It is not apparent how the 70% reduction in marine litter target is monitored, but the responsibility is believed to be that of the National Coordination Team for Marine Debris Reduction. However, the website for this coordination team does not function.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                     |                     |                              |                   |                   |     |          |                                |     |             |                             |     |            |                            |     |

## LAO PDR

Lao PDR has been proactive in its efforts to address plastic pollution, with several initiatives and targets enacted. The table on the next two pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Laos. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Laos, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Lao PDR.

| Type   | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Notes                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy | Guidelines for reducing single-use plastic items in meetings and offices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | The guidelines were developed by the Ministry of Natural Resources and Environment (MoNRE) and United Nations Development Programme (UNDP) <sup>[1]</sup> .                                                                                                                                                                                                                                              |
| Policy | The Environmental Pillar of the National Green Growth Strategy <sup>[2]</sup> aims to decrease pollution, waste and greenhouse gases, with specific focus on waste management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Waste management objectives proposed are: <ul style="list-style-type: none"> <li>• Promoting the use of biodegradable bags</li> <li>• Avoiding dumping of waste by the public</li> <li>• Encourage source separation to enable recycling and reuse</li> <li>• Improve financial mechanisms of waste management</li> <li>• Build and improve waste management infrastructure such as landfills</li> </ul> |
| Policy | <p>The National Plastics Action Plan (NPAP) for the Lao PDR 2024 – 2030 <sup>[5]</sup> was endorsed in August 2024 by the Ministry of Natural Resources and Environment (MoNRE). Its high-level objectives are:</p> <ol style="list-style-type: none"> <li>1. To develop and improve legislation, regulations, policies, and manuals to manage and reduce plastic waste, and enhance an extended producer responsibility mechanism</li> <li>2. To raise awareness for everyone in society and business about plastic reduction, reuse, and segregation of plastic waste at source</li> <li>3. To encourage the reduction of single-use plastics, promote the use of sustainable alternative products, and increase recycling rates</li> <li>4. To create a management, monitoring and evaluation system for the implementation of the operational plan</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                          |

# COUNTRY PROFILES

## LAO PDR

| Type          | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Notes                                                                                                                                                                                                                                                                                                                                                |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Policy</b> | <p>The Get CLEAN and GREEN - Solid and Plastic Waste Management in Lao PDR report by the World Bank <sup>[3]</sup> outlines a roadmap for creation of The National Plastics Action Plan (NPAP) <sup>[5]</sup>. Relevant additional recommended actions include:</p> <ul style="list-style-type: none"> <li>• Creation of legal and institutional frameworks for solid waste management</li> <li>• Investment in solid waste management, such as by extending collection, upgrade disposal sites, and creation of a data collection system for more accurate data on solid and plastic waste</li> <li>• Move towards a circular economy</li> </ul> | The report <sup>[3]</sup> also establishes a baseline of plastic pollution in Lao PDR that could be used as a basis for any future monitoring. A 10-year Roadmap for Solid Waste Management Vision and Strategy 2030 is also discussed as under-development.                                                                                         |
| <b>Target</b> | Reduce the waste generation in the municipal areas across the country by 30%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | The Ministry of Natural Resources and Environment (MoNRE) in Lao PDR established in 2015 the MoNRE Vision toward 2030 – Natural Resources and Environment Strategy (2016-2015) <sup>[4]</sup> . This strategy outlined several targets related to the environment, climate and resource use, with those relevant to plastic pollution outlined here. |
| <b>Target</b> | 50% of households in the municipalities in the six priority provinces and households along the national road 13 implement proper waste separation practices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                      |
| <b>Target</b> | Main roads and public areas in municipalities and the important tourist areas have effective and efficient clean up and waste collection systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                      |
| <b>Target</b> | Reduce waste generation per person from 237 kg/person/year to 210 kg/person/year by 2025, and 180 kg/person/year by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Targets established in the National Green Growth Strategy <sup>[2]</sup> .                                                                                                                                                                                                                                                                           |
| <b>Target</b> | 65% of waste to be 'reused' (assumed to mean recycling) or disposed of through proper methods and sites by 2025, with this rising to 80% by 2030. 2015 baseline stands at 50%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                      |



# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Notes                                                                                                                                                                                                                                                                                                                                 |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Target     | Voluntary EPR with 50 businesses participating by the end of 2024.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Targets shown are a selection of the most relevant short, medium and long-term indicators and activities, as outlined in the NPAP [5].                                                                                                                                                                                                |
| Target     | Integrated plastic waste database and reporting system by the end of 2024.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                       |
| Target     | Banning of plastic bags in supermarkets by 23 <sup>rd</sup> March 2025.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                       |
| Target     | Reduce plastic waste imports by 10% by 2024.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                       |
| Target     | Tax on single-use plastics by 2026.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                       |
| Target     | Restrictions on the use of certain single-use plastic items by between 2024 – 2026.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                       |
| Target     | Roll-out of source segregation, plastic sorting facilities to all municipalities leading to 40% reduction in waste to landfills by 2040.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                       |
| Target     | At a local level, Vientiane targeted 100% waste collection coverage by 2020.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | This target was established by the Vientiane City Office for Management and Service (VCOMS) in the Solid Waste Management in Vientiane, Lao P.D.R report [6]. It is unclear how much progress was achieved on meeting the target.                                                                                                     |
| Monitoring | <b>Manufacture and trade:</b> For plastic trade, Laos monitors the import and export of plastic using HS codes as available through Comtrade and the Lao Statistics Bureau [7] (albeit with plastics and rubber combined and in monetary terms). Domestic production of plastics is also recorded annually by the Lao Statistics Bureau [7], however, this is in monetary values and is combined with rubber.                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                       |
| Monitoring | <b>Solid waste management:</b> The Handbook of Indicators for Economic and Environmental Monitoring and Evaluation 2021-2025 [8] outlines indicators for waste management such as waste generation, composition, management and trade (Indicators predominantly in section 2.3.1 – ‘Pollution and waste’). Information is provided on the department responsible for monitoring, the reporting frequency and administrative level of reporting. However, details on specific methodologies are vague, for example, often simply suggesting data comes from ‘waste management reports’. It is not known if there is an official methodology for measuring this data.                                                                                                                   | Some of these indicators are aligned with the Sustainable Development Goals (SDGs), for example SDG 11.6.1 (proportion of a city’s waste generated that is collected and managed in controlled facilities) and SDG 12.5.1 (national recycling rate).                                                                                  |
| Monitoring | <b>Plastic pollution:</b> Baseline estimates of plastic leakage (emission) and riverine transport were conducted by the World Bank [9]. This baseline appears to be a one-off study without repeat monitoring.<br><br>The NPAP for Lao PDR states that monitoring and evaluation will be conducted by the Ministry of Natural Resources and Environment (MONRE), the Ministry of Public Works and Transportation (MPWT), the Ministry of Industry and Commerce (MOIC) and representatives from local government. However, it is unclear at present how this steering committee will measure progress for all indicators. As such, monitoring of plastic pollution in Lao PDR is not occurring and there is a lack of scientific studies quantifying plastic pollution in the country. | The World Bank baseline [9] was conducted in six major cities across Lao and close to the Mekong River. Analysis included material flow analysis (MFA) modeling, riverine surveys using net traps, boats and visual observation from bridges. The baseline additionally includes a list of all plastic production facilities in Laos. |

## MALAYSIA

Malaysia has been active in its policies relating to plastic pollution and solid waste management, with a particular emphasis on recycling and reduction in single-use plastics. Key policies include the development of its flagship Roadmap Towards Zero Single-Use Plastics <sup>[1]</sup> and its National Marine Litter Policy and Action Plan <sup>[2]</sup>. The table on the next two pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Malaysia. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Malaysia, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Malaysia

| Type   | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Notes                                                                                                                                                |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy | The Roadmap Towards Zero Single-use Plastics (2018-2030) <sup>[1]</sup> launched in 2018 aims to eliminate single-use plastics by 2030. Actions include the introduction of pollution charges on single-use plastic bags, making straws only available on request and uptake of biodegradable and compostable products.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | No quantifiable targets are established as part of the Roadmap.                                                                                      |
| Policy | The Malaysia Plastics Sustainability Roadmap (2021-2030) <sup>[3]</sup> released in 2021 outlines an action plan for increased circularity of plastics in Malaysia. This includes the phasing out of problematic, single-use plastics and the introduction of a mandatory, extended producer responsibility (EPR) scheme by 2026.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | The Roadmap further outlines several national level targets, as discussed within the 'targets' section of this table.                                |
| Policy | Malaysia is committed to the 2030 Agenda for Sustainable Development, with three 5-year phases spanning from 2016-2030 established in alignment with Malaysia's National Development Plans. Specific Sustainable Development Goals (SDGs) relating to plastic pollution include SDG14.1 – "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" <sup>[4]</sup> . The Roadmap Towards Zero Single-use Plastics (2018-2030) <sup>[1]</sup> and Malaysia's Plastics Sustainability Roadmap (2021-2030) <sup>[3]</sup> are mentioned as the means of addressing this.                                                                                                                                      | Time-bound quantifiable targets are discussed within the 'targets' section of this table. Notably, there is no quantifiable target set for SDG 14.1. |
| Policy | The National Marine Litter Policy and Action Plan 2021 – 2030 <sup>[2]</sup> (NMLPAP) aims to address marine litter in Malaysia and sits alongside the Roadmap Towards Zero Single-use Plastics (2018-2030) <sup>[1]</sup> . NMLPAP contains six desired national outcomes, to be implemented through 17 identified actions and 103 key activities, under five priority pillars as follows:<br><ol style="list-style-type: none"> <li>1. Policy adoption and implementation</li> <li>2. Deployment of technologies, innovation and capacity building</li> <li>3. Improve monitoring and data collection on marine litter</li> <li>4. Communication, education, public awareness, and outreach</li> <li>5. Adopt whole-of-nation and multi-stakeholders' approach in harmonizing cross-cutting objectives.</li> </ol> | Actions are split between short (2021 – 2023), medium (2024 – 2027) and long-term (2028 – 2030).                                                     |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                    | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy     | The National Cleanliness Policy <sup>[5]</sup> of Malaysia aims to create a clean and sustainable society for the well-being of people and the environment. It is built around five clusters: (1) awareness of cleanliness, (2) environmental sustainability, (3) circular economy, (4) governance and enforcement, and (5) quality and skilled human capital. These five clusters encompass 14 strategies and 91 actions for the 2020 – 2030 period. | <p>Actions relevant to plastic pollution focus on the themes of:</p> <ul style="list-style-type: none"> <li>• Reduction in littering (either by education or enforcement)</li> <li>• Reduced consumption of plastic bags</li> <li>• Avoidance in the blocking of drains</li> <li>• Education of 3R practices</li> <li>• Provision of facilities and research for the management of solid waste</li> <li>• Promotion of source segregation</li> <li>• Improvement of management, monitoring and enforcement of imported plastic waste</li> <li>• Development of recycling collection points and recycling facilities</li> <li>• Encouragement in practices for generating income from waste (e.g., use recycled content)</li> <li>• Encourage Extended Producer Responsibility (EPR)</li> <li>• Development of solid waste management database</li> <li>• Expansion in solid waste management and cleaning services</li> </ul> |
| Policy     | Several local governments of Malaysia (e.g. Penang, Selangor and Kedah) have implemented 'No Plastic Bag Day' initiatives, whereby charges are implemented on plastic bags on certain days of the week.                                                                                                                                                                                                                                               | Gradually the number of days that the 'No Plastic Bag Day' covers has been increased.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Regulation | The Environmental Quality Act 1974 regulates prohibition and control of pollution. This includes prohibiting or regulating the open burning of waste and dumping of waste on land, inland waters or Malaysian waters.                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Target     | Phasing out problematic SUPs.                                                                                                                                                                                                                                                                                                                                                                                                                         | These national targets were established as part of the Malaysia Plastics Sustainability Roadmap (2021-2030) <sup>[3]</sup> . Additional policy related targets around creating post-consumer halal rPET standards by 2022 were also specified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Target     | 25% post-consumer plastic packaging to be recycled by 2025.                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Target     | 100% recyclability of plastic packaging by 2030.                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Target     | 15% average recycled content by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Target     | 76% average collected-for-recycling rate by 2025.                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Target     | 40% recycling rate of household waste by 2025.                                                                                                                                                                                                                                                                                                                                                                                                        | This target was established as part of Malaysia's commitment to the Sustainable Development Goals. The recycling rate target for SDG12.5 is also repeated for SDG11.6, despite SDG11.6 having different sub-indicators <sup>[4]</sup> . For example, SDG 11.6.1 measures the collection and controlled management of waste; however, this is not currently reflected in any targets of Malaysia, with recycling rates instead preferred or used as a proxy.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Notes                                                                                                                                                                                                                                                |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring | <p><b>Manufacture and trade:</b> Data on the import and export of plastics is made available by Malaysia's Department of Statistics as part of monthly, quarterly and annual publications [6]. Imports and export data are provided for plastics in primary forms, plastics in non-primary forms, manufacture of plastics, and articles of plastics. Values are predominantly reported in monetary values without an indication of the mass traded. However, data is also available through Comtrade according to international standards and reported on a mass basis.</p> <p>Domestic manufacture of plastics is published annually as part of the Statistik Ekonomi Tahunan Pembuatan report [7]. Values are reported by the number of establishments and monetary output. Monthly domestic manufacture is also reported in the Perangkaan Pembuatan Bulanan [8], with values reported in monetary terms and percentage change. Select products are also reported on a mass basis; however, plastic production is not included in this list at present.</p> |                                                                                                                                                                                                                                                      |
| Monitoring | <p><b>Solid waste management:</b> The Department of Statistics Malaysia publishes an annual Compendium of Environmental Statistics [9], which reports data on waste management activities, including:</p> <ul style="list-style-type: none"> <li>• Emissions of pollutants to the atmosphere (with the other category claiming to include emissions due to open burning activities – although it is unclear if this includes open burning of waste)</li> <li>• Solid waste collected (by households, institutional, commercial and industrial (ICI) waste, bulk waste, public cleansing waste, construction and demolition and others)</li> <li>• Solid waste composition (as measured at a landfill site)</li> <li>• Recycling rate (%)</li> <li>• Capacity and amount of waste sent to municipal waste treatment and disposal facilities by state</li> <li>• Scheduled waste (hazardous waste) by state and category</li> <li>• Operational landfills by state</li> </ul>                                                                                    |                                                                                                                                                                                                                                                      |
| Monitoring | <p><b>Plastic pollution:</b> No established monitoring methods for plastic in the environment was found.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <p>The National Marine Litter Policy and Action Plan 2021 – 2030 [2] outlines an action to establish a centralized, integrated, national database to monitor marine litter pollution by 2025. It is unclear what progress has been made on this.</p> |

## MYANMAR

Myanmar has shown its dedication to tackling plastic pollution through many initiatives. The table on the next two pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Myanmar. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Myanmar, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Myanmar

| Type              | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Policy</b>     | Myanmar's Sustainable Development Strategy (2009) <sup>[1]</sup> aims to promote sustainability resource management. Goal 3.1.4 on Environmental Quality Management and Enhancement is particularly relevant for plastic pollution as it aims to improve solid waste management and promote environmental sound management of toxic chemical and hazardous wastes. Furthermore, Goal 3.1.6 on Sustainable Management of Coastal, Marine and Island Ecosystems includes mention of reducing waste entering oceans.                                                                                                                                                                                                                   | Activities proposed relevant to plastic pollution include: <ul style="list-style-type: none"> <li>• Applying polluter pays principles</li> <li>• Increasing public awareness and community involvement in monitoring disposal of domestic waste</li> <li>• Education of the public on environmentally sound waste management including 3R principles</li> <li>• Encourage private investment in solid waste management services.</li> <li>• Formulate a solid waste management master plan and guidelines with priority given to big cities</li> <li>• Cooperate with ASEAN countries in the development and implementation of a regional Action Plan for the Protection of the Marine Environment from Land-based and Sea-based Activities</li> </ul> |
| <b>Regulation</b> | Chapter IX of the Environmental Conservation Rules (2014) <sup>[2]</sup> addresses waste management. The regulation mandates that the Ministry of Environmental Conservation and Forestry, along with the support from other government departments, shall be responsible for determining categories and classes of hazardous waste, and establishing facilities for the treatment of such waste or determining which industries should establish their own waste treatment facilities. The Environmental Conservation Department is responsible for supervising the confiscation, storing, keeping safety materials, transport, import, export, management, treatment and disposal of hazardous waste using advanced technologies. | Article 69a specifies prohibitions, with persons mandated to not emit, cause to emit, dispose, cause to dispose, pile and cause to pile, by any means, the pollutants to environment. A separate prohibition restricts persons from carrying out actions, which cause damage to the natural environment.                                                                                                                                                                                                                                                                                                                                                                                                                                               |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Regulation | Myanmar's Environmental Impact Assessment Procedure (2015) <sup>[3]</sup> regulates that any project that may cause impact on environmental quality is required to complete an environmental impact assessment (EIA) or Initial Environmental Examination (IEE) and obtain permission for the project to proceed. Details need to be provided on both waste generation expected (types, categories and amounts) and waste management methods around the collection, storage, handling, transport, treatment, disposal and recycling / reuse of wastes. Further details on emissions are also required, with this including emissions of waste into the environment.                                                                                                                                                                                                                        | Emissions are defined as “the direct or indirect release of any emission from individual or diffuse sources into the air, water, land or any subterranean area. Emissions include emission of solid waste, effluent, gas, noise, odor, light, radiation, vibration or heat” <sup>[3]</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Policy     | <p>The National Waste Management Strategy and Master Plan (2018-2030) <sup>[4]</sup> aims to build capacity for sustainable, integrated waste management and promote moving to a circular economy following 3R principles. Both solid waste and wastewater are included in the plan, with particular emphasis on municipal solid waste. Six overarching goals are outlined in the plan:</p> <ul style="list-style-type: none"> <li>A. Extending sound waste collection and eliminate uncontrolled disposal and open burning</li> <li>B. Extending sustainable and environmentally sound management of industrial and other hazardous wastes</li> <li>C. Reduce waste through 3Rs (reduce, reuse and recycle)</li> <li>D. Ensure sustainable finance mechanisms</li> <li>E. Awareness raising, advocacy and capacity building</li> <li>F. Compliance, monitoring and enforcement</li> </ul> | <p>The following actions are particularly relevant for plastic pollution assessment, mitigation and monitoring:</p> <p>A.1: Expand access to municipal waste management service to ensure a minimum level of services for all citizens, irrespective of income levels</p> <p>A.2: Safe treatment and disposal of waste in permitted/ officially approved landfill sites to protect uncontrolled dumping and open burning</p> <p>C.1: Promote waste reduction upstream through introduction of sustainable production and consumption (including mandatory Extended Producer responsibility (EPR))</p> <p>C.2: Promote waste reuse, recycling and recovery of waste materials before final disposal</p> <p>F.1: Institutionalize mechanisms for monitoring, enforcement and recognition (including the development and regular updating of an interactive database on waste management – F1.1)</p> <p>Each goal of the strategic plan includes targets, with the most relevant to plastic pollution assessment and monitoring documented in the targets section of this table.</p> |
| Policy     | Mandalay City has also implemented a local level Waste Management Strategy and Action Plan to 2030 <sup>[5]</sup> . The goals mirror those of the National Waste Management Strategy and Master Plan, but the actions and targets are modified to be more specific for the local context, including: introducing waste separation at source, integrating private and informal sectors, improving waste management infrastructure, prevent illegal dumping, introduce waste to energy technologies, and establish a new sanitary landfill.                                                                                                                                                                                                                                                                                                                                                  | Each goal of the strategic plan includes short-term targets (2017-2020), mid-term targets (2021-2025) and long-term targets (2026-2030). The long-term targets most relevant for plastic pollution assessment and monitoring are documented in the targets section of this table.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Policy     | A National Plastic Action Plan for Myanmar is currently under development and will likely include additional targets for monitoring plastic pollution across its life-cycle.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |



# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Notes                                                                                                                                                                                                                                                                                  |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Target     | Achieve sound waste collection services for 100% of citizens by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Targets are established as part of the National Waste Management Strategy and Master Plan (2018-2030) [4]. Although monitoring and evaluation of these targets is mentioned as a core component, no details are provided on how these targets will be measured.                        |
| Target     | Eliminate the uncontrolled dumping and burning in the cities and mandate the operation of environmentally sound disposal facilities in 100% of all townships by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                        |
| Target     | Mandate the development of city waste management strategies and action plans with actual waste reduction targets by all City Development Committees (CDCs) and Township Development Committees (TDCs) by 80% by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                        |
| Target     | Mandate the separate collection and set waste recycling targets for industrial, medical and other waste by 60% by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                        |
| Target     | All City and Township development Committees establish benchmark performance indicators with 100% coverage by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                        |
| Target     | 100% waste collection coverage by 2030                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Targets are applicable for Mandalay City, as outlined in the Mandalay City Waste Management Strategy and Action Plan to 2030 [5]. Although monitoring and evaluation of these targets is mentioned as a core component, no details are provided on how these targets will be measured. |
| Target     | All townships of the city to have waste separation at source and collection system by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                        |
| Target     | 80% material recovery and recycling rate, made up from 20% recyclables and 60% food waste by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                        |
| Target     | 100% reduction of illegal dumping and open burning by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                        |
| Target     | Full operation of a sanitary landfill by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                        |
| Target     | Introduction of refuse derived fuel (RDF) and waste to energy (WtE) technologies by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                        |
| Target     | Full establishment and monitoring of data collection and benchmark performance indicators by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                        |
| Monitoring | <p><b>Manufacture and trade:</b> The Central Statistical Organization of Myanmar publishes the import and export of products as part of monthly reports [7]. Raw plastic materials are recorded as one of the categories in terms of million USD; however, plastic containing products fall under multiple other categories. Import and export data is also published annually through the Statistical Yearbook [8] by main HS codes (e.g., Plastics and articles thereof).</p> <p>Domestic production of plastic is partly reported as part of the annual Statistics Yearbook [8]. Plastic is grouped under the category, 'Manufacture of rubber and plastics products', with values reported in terms of the number of state-owned economic enterprises and the number of small, medium and large-scale manufacturing industries. In addition, data is also provided in the Statistical Yearbook for the volume of production (by item count) of 'Plastic Ware' by state-owned and joint venture enterprises.</p> | The Central Statistical Organization last published a monthly report for trade for October 2020 – January 2021. More recent annual data is available through the Statistical Yearbook [8] and Comtrade, but only in monetary terms.                                                    |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring | <b>Solid waste management:</b> No national monitoring of solid waste management is occurring. Myanmar lacks a centralized database on solid waste management; however, the National Waste Management Strategy and Master Plan (2018–2030) <sup>[4]</sup> outlines an action (F1.1) related to the development of such a database. | Any efforts to monitor solid waste management performance are currently fragmented and undertaken primarily by City Development Committees of major municipalities. For example, ASEANstats reports SDG 11.6.1 – The proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated (%) for Yangon. This indicator requires data on waste generation rates, collection coverage and amounts entering controlled facilities; therefore, it is assumed that Yangon collects this data, although the methodology behind this is unclear. Likewise, the recycling rate (SDG 12.5.1) is also reported through ASEANstats for Yangon. |
| Monitoring | <b>Monitoring of plastic pollution:</b> Although one-off studies have tried to quantify the amount of plastic in the environment (land, sea, rivers), there is no established monitoring program or methodology in Myanmar to monitor this.                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## PHILIPPINES

The Philippines has been active in its policies relating to plastic pollution and solid waste management, including a goal of zero waste to Philippine waters by 2040, as set out in The Philippines National Plan of Action for the Prevention, Reduction and Management of Marine Litter (NPOA-ML) <sup>[1]</sup>. The table on the next two pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in the Philippines. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in the Philippines, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in the Philippines

| Type   | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy | <p>The Philippines National Plan of Action for the Prevention, Reduction and Management of Marine Litter (NPOA-ML) <sup>[1]</sup> aims for there to be “zero waste to Philippine waters by 2040”. The plan sets out ten extensive strategies to achieve this:</p> <ol style="list-style-type: none"> <li>1. Establish science- and evidence-based baseline information on marine litter, including developing monitoring, reporting and verification systems</li> <li>2. Mainstream circular economy (CE) and sustainable consumption and production (SCP) initiatives</li> <li>3. Enhance recovery and recycling coverage and markets</li> <li>4. Prevent leakage from collected or disposed waste</li> <li>5. Reduce maritime sources of marine litter</li> <li>6. Cleanup of riverine and marine environments</li> <li>7. Enhance policy support and enforcement for marine litter prevention and management</li> <li>8. Develop and implement strategic and targeted social marketing and communications campaigns using various media</li> <li>9. Enable sufficient and cost-effective financing for the implementation of the NPOA-M</li> <li>10. Strengthen local government units (LGU) capacities and local level implementation of NPOA-ML</li> </ol> | <p>Baseline information for Strategy 1 appears to be primarily based off solid waste management (SWM) reporting by local government units (LGUs) – see SWM monitoring section of this table. The NPOA-ML references leakage estimates from various global and national works (for example, those of the National Strategy to Reduce Short-Lived Climate Pollutants from Municipal Solid Waste Sector <sup>[2]</sup>), although these are for all municipal waste, not just plastic.) Baseline monitoring for marine litter is currently being established through the DENR-EMB Marine Litter Monitoring Program (2023-2025), which serves as an initial reference for data consolidation under the NPOA-ML.</p> <p>The NPOA-ML also calls for the development of a monitoring, evaluation, reporting and verification (MERV) system, although it is unclear what progress has been achieved on this.</p> |
| Policy | <p>The Philippine Development Plan (2023 – 2028) <sup>[3]</sup> discusses several strategies for improving SWM and reducing plastic pollution. For example, strategies include broadening waste minimization initiatives, increasing access to proper waste disposal facilities, implementation of Extended Producer Responsibility (EPR) mechanisms, and creating legislative measures for single-use plastic regulations.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

# COUNTRY PROFILES

| Type              | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Regulation</b> | The Ecological Solid Waste Management Act of 2000 (Republic Act - RA9003) <sup>[4]</sup> aims to regulate solid waste management in the Philippines. This is coordinated through the National Solid Waste Management Commission, a body composed of 14 government sector members and 3 members from the private sector, including representatives from the recycling industry and manufacturing / packaging industry. The regulation establishes the solid waste management practices, such as mandatory waste segregation at source (Section 21), 100% collection and transport of solid waste (Article 3), recycling (Article 4), and waste disposal facilities (Article 6). | In relation to plastic pollution, open burning of waste, littering, open dumps, and the import / manufacture of packaging in non-environmentally acceptable materials (or those misrepresented as recyclable) are all prohibited under Section 48.<br><br>Reporting for solid waste management is also regulated, as discussed more in the 'monitoring' section of this table.                                                                                                                                                                |
| <b>Policy</b>     | The Philippine Action Plan for Sustainable Consumption and Production (PAP4SCP) <sup>[5]</sup> is a strategic framework that aims to promote sustainable production, consumption and circularity in the Philippines. Actions are broken down into short-term (2022-2023), medium-term (2024-2030) and long-term (2031-2040). Relevant actions include the implementation of EPR for plastic packaging, regulating and finding alternatives for single-use plastics, and waste minimization and recycling.                                                                                                                                                                      | The Philippine Action Plan for Sustainable Consumption and Production (PAP4SCP) <sup>[5]</sup> includes on-going work on developing measurable indicators for circular economy and plastics management, led by the Department of Economy, Planning, and Development (DEPDev), with support from partner agencies.                                                                                                                                                                                                                             |
| <b>Policy</b>     | The Department for Environment and Natural Resources (DENR) website on Solid Waste Management <sup>[6]</sup> includes details of the United Nations Industrial Development Organization (UNIDO) Open Burn Project. This project aims to reduce unintentional persistent organic pollutants (U-POPs) by educating around the issue of open burning of waste and providing tools / guidance on best available techniques (BAT) and best environmental practices (BEP) around open burning activities.                                                                                                                                                                            | This was a regional project covering the Philippines, Cambodia, Laos, Mongolia and Viet Nam.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Regulation</b> | The Extended Producer Responsibility Act of 2022 (RA11898) <sup>[7]</sup> primarily targets plastic items. Key provisions include requiring large organizations to create, implement and audit EPR programs that align with set rules and regulations. Mechanisms for this include reduction of products, inclusion of recycled content, product refilling, waste recovery schemes, and clean-up programs amongst others.                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Roadmap</b>    | Although not an official policy of the Philippines, the 'Roadmap for the Management of Plastic Waste and Reduction of Non-Recyclable Single-use Plastics in The Philippines' <sup>[8]</sup> , developed by the World Bank Group in 2024, is worthy of mention. The roadmap outlines 3 outcomes across varying timescales:<br><br><ol style="list-style-type: none"> <li>1. Closing plastic leakage pathways (2023 – 2028)</li> <li>2. Enabling plastic recycling (2023 – 2034)</li> <li>3. Managing plastic demand (2023 – 2040)</li> </ol>                                                                                                                                    | Actions are proposed for each outcome, including: replacing single-use plastics with alternatives, increasing recovery of plastics, establishing a national database on recycling and SWM, improving collection, integrating informal sector, improving capacity of LGUs to manage plastics, creating new centralized material recovery facilities (MRFs) and assisting enterprises in participating in EPR programs. These actions are distributed according to the short, medium or long term, and are not considered quantitative targets. |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Notes                                                                                                                                                                                                                                                                                  |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Target     | Zero plastic waste to Philippine waters by 2040.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Target established in the National Plan of Action for the Prevention, Reduction and Management of Marine Litter (NPOA-ML) <sup>[1]</sup> .                                                                                                                                             |
| Target     | 53% of barangays served by MRF by 2028 (baseline of 41% in 2021).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Targets established in The Philippine Development Plan 2023 - 2028 <sup>[3]</sup> and are monitored by Annual Solid Waste Management Reports.                                                                                                                                          |
| Target     | 50% of cities and/or municipalities served by sanitary landfill by 2028 (baseline of 32% in 2021).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                        |
| Target     | 80% recovery of plastic product footprint by 2028.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Target established in The Extended Producer Responsibility Act of 2022 (RA11898). Plastic product footprint refers to plastic good produced, imported, distributed or supplied by a product producer and deemed to cause damage to the environment.                                    |
| Monitoring | <b>Manufacture and trade:</b> For plastic trade, the Philippines monitors the import and export of plastic using HS codes, as per the international and ASEAN standard and available through Comtrade and the 'OpenSTAT' database <sup>[9]</sup> . Data on domestic production of plastic is available through the 'OpenSTAT' database <sup>[9]</sup> ; however, this is available only for 2015 – 2017, and values are not reported on a volume or mass basis but in terms of number of establishments, employment or monetary terms.                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Data on the domestic production is collected via questionnaires as part of the Monthly Integrated Survey of Selected Industries <sup>[10]</sup> .                                                                                                                                      |
| Monitoring | <b>Solid waste management:</b> Section 16 of the Ecological Solid Waste Management Act of 2000 (Republic Act - RA9003) <sup>[4]</sup> states that local government units (LGUs) are required to prepare 10-year Solid Waste Management Plans in line with the National Solid Waste Management Framework. This is to include details of waste generation and composition, collection and transfer, processing, source reduction, recycling, composting and final disposal. The status of SWM plans are shown on the Department for Environment and Natural Resources (DENR) database <sup>[6]</sup> .<br><br>Furthermore, National Solid Waste Management Status Reports are to be produced every two years, or as the need arises. These are to include details of waste generation and composition (including waste generation projections), existing waste facilities, markets for recyclable materials, and details of costs of SWM. Reports are available on the DENR website <sup>[6]</sup> . | It is believed that the National Solid Waste Management Status Reports are composed from the data submitted LGUs under Section 16. A standardized methodology <sup>[11]</sup> for the measurement of waste generation and composition is provided on the DENR website <sup>[6]</sup> . |
| Monitoring | <b>Plastic pollution:</b> Systematic national monitoring of marine litter is currently under development through DENR—EMB and CSIRO collaborative projects (2023-2025), covering pilot sites in Manila Bay, Visayas and Mindanao <sup>[12]</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                        |

## SINGAPORE

Singapore has shown its dedication to tackling plastic pollution through initiatives such as the Zero Waste Masterplan <sup>[1]</sup> and The National Action Strategy Addressing Marine Litter in Singapore <sup>[2]</sup>. The table on the next two pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Singapore. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Singapore, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Singapore

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Regulation | Litter and dumping are regulated in Singapore under the <b>Environmental Protection and Management Act</b> <sup>[3]</sup> and <b>Environmental Public Health Act</b> <sup>[4]</sup> . The latter act contains detailed information on street cleansing, provision and maintenance of dustbins and refuse bins, collection and disposal of waste and prohibits littering (including to land, drains, rivers and the sea).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | The Environmental Public Health Act was amended in April 2014 to mandate the reporting of waste data by premises used for “industrial, trade, commercial or manufacturing purposes and includes all construction sites, work sites and farms” <sup>[5]</sup> . Commercial establishments cover hotels and malls. Data these establishments must report includes the mass of waste disposal and mass recycled (by waste fraction), alongside waste reduction plans following 3R principles with progress updates. |
| Regulation | The <b>Resource Sustainability Act</b> of 2019 <sup>[6]</sup> regulates the collection and treatment of electrical and electronic waste, food waste and packaging for extended producer responsibility (EPR) schemes and resource sustainability. The act mandates the submission of annual reports on the amount and type of packaging introduced into Singapore in a year. In addition, a report must also be submitted detailing a plan to reduce, re-use or recycle packaging in Singapore, with this plan to be implemented within 3 years of submission.<br><br>Related regulations include: <ul style="list-style-type: none"> <li>• Resource Sustainability (Packaging Reporting) Regulations 2020 <sup>[7]</sup></li> <li>• Resource Sustainability (Producer Responsibility Schemes) Regulations 2021 <sup>[8]</sup></li> <li>• Resource Sustainability (Disposable Carrier Bag Charge) Regulations 2023 <sup>[9]</sup></li> <li>• Resource Sustainability (Beverage Container Return Scheme) Regulations 2024 <sup>[10]</sup></li> </ul> | Under the Mandatory Packaging Reporting (MPR) Scheme: Companies with an annual turnover of more than SGD 10 million are required to submit annual reports of their packaging data and 3R plans to NEA. This aims to raise companies’ awareness of the benefits of packaging reduction and to spur companies to reduce the amount of packaging used <sup>[11]</sup> .                                                                                                                                             |
| Policy     | Singapore’s <b>Zero Waste Masterplan</b> <sup>[1]</sup> outlines a strategy for building climate, resource and economic resilience. This is embedded in transitioning to a circular economy. Aligning with the Resource Sustainability Act <sup>[6]</sup> , the Masterplan focuses on three priority waste streams of electrical / electronic waste, food waste and packaging, including plastics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | A core aim of the Masterplan is to extend the life of the Semakau Landfill beyond 2035 by reducing waste sent to landfill and increasing recycling. Details of these targets are provided in the targets section of this table.                                                                                                                                                                                                                                                                                  |



# COUNTRY PROFILES

| Type   | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy | The <b>Singapore Green Plan 2030</b> <sup>[12]</sup> was launched in 2021 and aims to advance Singapore's national agenda on sustainable development across five key pillars (City in Nature, Energy Reset, Green Economy, Resilient Future and Sustainable Living). The plan supports Singapore's Sustainable Development Goals and reaffirms the targets outlined in the Zero Waste Masterplan around reducing the amount of waste sent to landfill by 20% by 2026, and 30% by 2030.                                                           | The Singapore Green Plan 2030 <sup>[12]</sup> is a whole of government approach that is led by five ministries - the Ministries of Sustainability and the Environment (MSE), Trade and Industry (MTI), Transport (MOT), National Development (MND), and Education (MOE).                                                                                                                                                                                             |
| Policy | The <b>National Action Strategy Addressing Marine Litter in Singapore</b> (NASML) <sup>[2]</sup> is a strategy for reduction of marine litter based around 6 priority areas: <ol style="list-style-type: none"> <li>1. Reduction of land-based sources of litter</li> <li>2. Reduction of sea-based sources of litter</li> <li>3. Circular economy approach</li> <li>4. Research and development</li> <li>5. Maintaining and strengthening outreach and stakeholder engagement</li> <li>6. International engagement and collaboration</li> </ol> | Measures proposed include: improvement to control of waste collection and disposal within an integrated solid waste management system, waterway and coastal clean-ups (both manually and using litter traps / removal craft), inspections for prohibiting release of litter and waste at sea, reducing single-use disposable plastics, promoting recycling, and raising awareness amongst all stakeholders. No quantifiable targets are established in the strategy. |
| Policy | The <b>Packaging Partnership Programme (PPP)</b> <sup>[13]</sup> is an industry led initiative launched in March 2021 that aims to reduce packaging waste in Singapore by supporting companies in adopting sustainable packaging practices and fulfilling their obligations under the Mandatory Packaging Reporting framework.                                                                                                                                                                                                                   | The PPP builds industry capability on packaging sustainability through a variety of training and outreach activities including workshops, webinars, conferences, and newsletters. The PPP has also developed online resources on packaging sustainability, including a 3R Guidebook <sup>[14]</sup> for Packaging and a set of Guidelines on Sustainable E-commerce Packaging <sup>[15]</sup> .                                                                      |
| Policy | The <b>Beverage Container Return Scheme</b> <sup>[17]</sup> is currently under development in Singapore and is intended to commence in 2026. The scheme will apply a 10-cent refundable deposit on pre-packaged beverages in plastic and metal containers between the sizes of 150ml to 3 litres.                                                                                                                                                                                                                                                | Designated return points in large supermarkets and via reverse vending machines will refund the deposit when a beverage container is returned.                                                                                                                                                                                                                                                                                                                       |
| Target | Reduce the amount of waste (per capita) sent to landfill by 30% by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Target established in the Zero Waste Masterplan <sup>[1]</sup> . Achieving the target requires a reduction from 800g of waste generation per person per day down to 640g by 2030. As much of this waste is recycled or treated, this equates to a reduction from 360g per capita of waste sent to landfill in 2018 down to 250 g per capita in 2030. The targets were designed to extend the lifespan of Singapore's only landfill beyond 2035.                      |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Notes                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring | <p><b>Manufacture and trade:</b> Data on plastic imports and exports is published by the Department of Statistics Singapore <sup>[18]</sup> according to Commodity Divisions and Commodity Groups and reported in monetary terms. A more detailed breakdown is provided by Comtrade according to HS codes, with this data typically available by mass.</p> <p>Data on domestic manufacturing of plastic collected via the annual Census of Manufacturing Activities by the Research and Statistics Unit of the Economic Development Board <sup>[19]</sup>. Industries are classified according to Singapore Standard Industrial Classification <sup>[20]</sup>; however, data is reported through the Department of Statistics Singapore <sup>[18]</sup> according to a more course category of 'Rubber and plastic products'. This data is only provided in monetary terms.</p> <p>The <b>Resource Sustainability Act</b> of 2019 <sup>[6]</sup> mandates companies that are over a specified threshold to report the amounts and types of packaging introduced into Singapore. Whilst only applicable to packaging, and not other forms of plastic, it is envisaged that data is available via this mechanism.</p> | <p>The data available through Comtrade suggests trade data is collected at a more granular level than that publicly released through the Department of Statistics Singapore <sup>[18]</sup>. Likewise, the methodology behind the Census of Manufacturing Activities <sup>[19]</sup> suggests manufacturing data is also collected in more detail than that publicly reported.</p> |
| Monitoring | <p><b>Solid waste management:</b> Singapore releases annual updates of statistics on solid waste management through the National Environment Agency <sup>[21]</sup> website and the Department of Statistics Singapore data portal <sup>[18]</sup>. The latest data year available is 2023. Data points reported are:</p> <ul style="list-style-type: none"> <li>• Waste generation by composition</li> <li>• Waste disposed by composition</li> <li>• Waste disposed by domestic and non-domestic</li> <li>• Recycling rate by composition</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>The methodology for measuring this data is not apparent, however, given the small size of Singapore and that it has 100% waste collection coverage, it is assumed this data is measured on arrival at treatment and disposal facilities. It is unclear whether more granular data exists, for example municipal solid waste (MSW) generation and plastic recycling rates.</p>   |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring | <p><b>Monitoring of plastic pollution:</b></p> <p>In 2021, the National Environment Agency (NEA) commissioned a Marine Litter and Microplastics Consultancy Study to determine the levels and pathways of plastic waste in Singapore <sup>[22]</sup>.</p> <p>In terms of plastic litter monitoring, in 2024, NEA conducted about 130 enforcement blitzes at littering and smoking hotspots compared to 21 blitzes in 2023. NEA also strengthened its camera surveillance capabilities and scaled capacity to conduct up to 1,000 CCTV deployments a year, compared to 250 in 2023. At hotspots, NEA strengthened enforcement presence to increase deterrence with visible patrols, standees and CCTVs. NEA also partnered with community stakeholders to seek their assistance in identifying egregious offenders captured by the CCTV footage <sup>[23]</sup>.</p> <p>The International Coastal Cleanup Singapore <sup>[24]</sup> regularly hosted cleanups across Singapore; however, the last available data is for 2019, and it is unclear if these events are still on-going.</p> | <p>The Marine Litter and Microplastics Consultancy Study concluded at the end of 2023. The survey had three major findings:</p> <ul style="list-style-type: none"> <li>• First, the majority of plastic litter (including microplastics) found on Singapore's recreational beaches originated from sea-based sources (e.g. ships, transboundary waste), rather than inland sources</li> <li>• Second, weather factors, particularly monsoon seasons, influenced the transport of plastic debris washing up on the shoreline</li> <li>• Third, the microplastics polymers identified in the environment indicate that they mainly originate from larger post-consumer plastic products</li> <li>• The Study used the Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) National Oceanic and Atmospheric Administration (NOAA)-based definitions, classifying macroplastics as larger-sized plastic particles of diameter &gt; 5mm, and microplastics as smaller fragments of diameter &lt; 5mm. Sampling was conducted monthly for a year to capture seasonal variations at inland and coastal water bodies, as well as beaches, using standardized methods recommended by GESAMP and NOAA with a rigorous level of QA/QC. Microplastics collected under the Study were analysed using FTIR, a plastic polymer identification technology, which has been used extensively in environmental microplastic research</li> </ul> |

## THAILAND

Thailand has shown its dedication to tackling plastic pollution with the enactment of ambitious policies such as the Plastic Waste Management Roadmap 2018-2030 <sup>[1]</sup>. The table on the next three pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Thailand. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Thailand, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Thailand

| Type   | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy | <p>Thailand approved a National Solid Waste Management Master Plan (2016-2021) <sup>[2]</sup> in 2016. The plan aims to reduce municipal and hazardous waste generation at source following the 3R principles, and to establish proper disposal methods by improving collection efficiency and ensuring efficient disposal practices. The plan was supported by the Thailand Zero Waste Action Plan <sup>[2]</sup> and the Municipal Solid Waste Management Action Plan for 2018, both of which had additional short-term targets <sup>[3]</sup>.</p> <p>Having expired in 2021, the Master Plan was replaced with the Second National Waste Management Action Plan (2022-2027) <sup>[4]</sup>. This plan places emphasis on improved waste management and management of plastic waste across the full life-cycle, including source separation to enable recycling and energy recovery.</p> | <p>Several targets were proposed in the initial National Solid Waste Management Master Plan (2016-2021). These were superseded by improved targets of the Second National Waste Management Action Plan (2022-2027) <sup>[4]</sup>, as outlined in the 'targets' section of this table.</p>                                                                                                                                                                                  |
| Policy | <p>Thailand's National Bio-plastics Roadmap was launched in 2008 and aimed at making Thailand a leader in bio-plastics. The roadmap included goals such as accelerating technological development, supporting infrastructure and investment in bio-plastic industries <sup>[5]</sup>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <p>The roadmap ran from 2008 to 2015 across two phases; Phase 1 (2008 – 2012) and Phase 2 (2011 – 2015).</p>                                                                                                                                                                                                                                                                                                                                                                |
| Policy | <p>Thailand's Plastic Waste Management Roadmap 2018-2030 <sup>[1]</sup> is a national strategy to reduce plastic waste, enhance plastic recycling and increase public awareness. The roadmap was built around three phases:</p> <p>Phase 1 (2018 - 2019): Aims to reduce specific single-use plastic items and raise awareness around plastic consumption.</p> <p>Phase 2 (2020 – 2022): Aims to target additional single-use plastic items and improve waste management infrastructure to support plastic recycling.</p> <p>Phase 3 (2023 – 2030): Aims to achieve widespread recycling and sustainable management of plastic with recycling of all targeted plastic waste and significant reduction of plastic waste leakage into the environment.</p>                                                                                                                                    | <p>Key actions include launching campaigns to reduce plastic bag usage, removing seals around plastic bottle caps and banning microplastics in personal care products.</p> <p>Key actions include banning plastic bags (&lt; 36 microns thick), cups (&lt;100 microns), straws and polystyrene food containers, as well as implementing recycling systems.</p> <p>Key actions include implementing advanced recycling technologies and promoting alternative materials.</p> |

# COUNTRY PROFILES

| Type              | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Policy</b>     | <p>The Action Plan on Plastic Waste Management <sup>[4]</sup> supports the implementation of the strategies within the Plastic Waste Management Roadmap. Phase 1 of the action plan ran from 2020 to 2022 and aligned with the objectives and targets of Phase 2 of the roadmap. The ambitious targets were not met in Phase 1; however, substantial progress was achieved. For example, by 2021 there was a 42% reduction in single-use plastics (targeted 75% by 2021 and 100% by 2022), and 25% of targeted plastics were recycled (targeted 40% by 2021 and 50% by 2022).</p> <p>Phase 2 of the action plan (2023 – 2027) builds upon Phase 1 with actions outlines four measures: Measure 1 – production of eco-friendly plastic products, Measure 2 – reduction of plastic waste at consumption stage, Measure 3 – management of plastic waste post-consumption, and Measure 4 – management of plastic marine debris. Monitoring of the action plan is to be carried out annually by a sub-committee on Plastic and Electronic Waste Management under the National Environment Board.</p> | <p>Each measure outlined in Phase 2 of the Action Plan has several activities associated with it, as well as details of leading / supporting agencies and timelines. Particularly relevant activities for the monitoring of plastic pollution include:</p> <ul style="list-style-type: none"> <li>• Determine characteristics of plastic packaging production</li> <li>• Develop and update a database on plastics</li> <li>• Set / evaluate indicators on plastic waste reduction and segregation for government agencies; and expand MSW reduction and segregation measures to local administrative organizations</li> <li>• Generate tools linking data on amount of plastic waste between local government organizations and recycling plants</li> <li>• Develop digital platforms for the public, Salang, junk shop, garbage collector, recycling business operator, and local administrative organizations</li> <li>• Monitor protection and collection of plastic marine debris and send to proper management</li> <li>• Develop data collection system and Marking Gear inspection and recall system for fishing gear</li> </ul> |
| <b>Regulation</b> | The Enhancement and Conservation of National Environmental Quality Act of 1992 is the central regulation governing solid waste management in Thailand.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Measures of particular relevance to plastic pollution and monitoring include the restriction of dumping waste from sea-going vessels, banning illegal dumping of waste on public land and the requirement for waste disposal facilities to collect data on the daily functioning of the facility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Regulation</b> | The Local Administrative Organizations Act of 1992 outlines the requirements of local government regarding the management of solid waste and wastewater.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Measures of particular relevance to plastic pollution and monitoring include preventing the dumping or discarding of waste in a public place and adherence of environmental quality standards for waste disposal pertaining to water and air quality.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Regulation</b> | The 1992 Act on the Maintenance of the Cleanliness and Orderliness of the Country addresses littering in detail, including duties and fines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | The act restricts dropping waste in public places, areas with grass or trees and waterways. Restricting waste from blowing off vehicles is also mentioned, as well as calling for litter to be collected from a person's land if it can be seen from a public place.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Regulation</b> | A draft Sustainable Packaging Management Act was proposed in 2024 and aims to promote sustainable packaging management by addressing gaps in previous legislation. Primarily, this is focused on outlining extended producer responsibility (EPR) to reduce unnecessary single-use plastics and ensure unavoidable plastics are collected and recycled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | A revised draft was put forward in February 2025, with the approval process on-going <sup>[7]</sup> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Regulation</b> | The 'Ministry of Commerce Regulations on Permission to Import Waste into the Kingdom B.E 2024' is an act that came into force on the 1 <sup>st</sup> January 2025. The act bans the import of plastic waste under HS code 3915 (waste, parings, and scrap of plastics).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

# COUNTRY PROFILES

| Type   | Name / Description                                                                                                                                                     | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Target | Properly manage 80% of municipal solid waste by 2027.                                                                                                                  | Targets established in the 2 <sup>nd</sup> National Solid Waste Management Plan (2022-2027) [4]. These targets superseded the targets from the National Solid Waste Management Master Plan (2016-2021) [2] and the more immediate single-year targets to reduce MSW by 5% by 2017, as proposed in the Thailand Zero Waste Action Plan [2]. Likewise, the Municipal Solid Waste Action Plan for 2018 also included additional short-term targets for 2018 of 40% proper MSW disposal, upgrading 20% of improper disposal, and recycling or utilising 30% of MSW [3]. |
| Target | 100% of plastic waste is 'reused' by 2027 (plastic waste refers to the targeted plastic items, as outlined in Phase 2 of The Action Plan on Plastic Waste Management). |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Target | Ban plastic cap seals (shrink wrap sleeves placed around bottle caps) by 2019.                                                                                         | Targets established as part of the Plastic Waste Management Roadmap 2018-2030 [1]. Most of the targets are incremental but only the final target is listed here. For example, the reuse and recycling rate target was set to increase by 10% each year, starting from 30% in 2020 until the final target of 100% in 2027.                                                                                                                                                                                                                                           |
| Target | Ban plastic bags <36 microns thick by 2022.                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Target | Ban polystyrene food containers by 2022.                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Target | Ban single-use plastic cups < 100 microns thick by 2022.                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Target | Ban plastic straws by 2022.                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Target | Achieve a 100% reuse and recycling rate (including energy recovery) of targeted plastic items by 2027.                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Target | 100% reduction of targeted plastic waste to landfills by 2027.                                                                                                         | Targets established as part of Phase 2 of the Action Plan on Plastic Waste Management [4]. 'Targeted plastic' items are plastic bottles (all types), bottle caps, mono-layer plastic film packaging (HDPE, LL, LDPE), plastic bags, and plastic cups.<br><br>The baseline value quoted for plastic waste with potential leakage into the seas was 0.02 million tonnes of plastic waste. (See monitoring of plastic pollution section for more details.)                                                                                                             |
| Target | 100% recovery of targeted plastic products to recycling systems by 2027.                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Target | 50% reduction of plastic waste with potential leakage into the sea by 2027.                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |



# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Notes                                                                                                                                                                                                                |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring | <p><b>Manufacture and trade:</b> Data on plastic manufacture is publicly available through the Office of Industrial Statistics E-Statistics data portal [7]. Plastic manufacturing data is distributed by 5-digit codes relating to Thailand's Standard Industrial Classification, thereby providing a high level of granularity on plastic types manufactured (e.g. 22220 010 = plastic sacks, 22220 020 = plastic bag etc.). Data is provided on a mass basis, as well as by sales, value and production capacity.</p> <p>Data on plastic trade (imports and exports) is provided by the Customs Department data portal [8] according to 2, 4, 8 and 11-digit codes. Data is provided on a monthly basis but is reported in value only.</p>                                                                                                                                                                                                                                                                    | Comtrade also publishes data on imports and exports for Thailand, including (but not always) on a mass basis. This is restricted to 4-digit HS codes.                                                                |
| Monitoring | <p><b>Solid waste management:</b> Data on solid waste generation and management is reported on the Pollution Control Department database [9]. Information is provided on the amount of waste generated, recycled, 'properly disposed', 'improperly disposed' and residual waste. The number of different waste facility types (e.g., composting, sanitary landfill, waste to energy, transfer stations, etc.) are also provided.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Data is reported at a provincial level. It is not clear if there is a standardized methodology for measuring this data at a local level, or if any quality assurance / data gap filling is performed.                |
| Monitoring | <p><b>Monitoring of plastic pollution:</b> 50% reduction of plastic waste with potential leakage into the seas is a target of Phase 2 of the Action Plan on Plastic Waste Management [4]. The baseline value of 0.02 million tonnes was calculated as:</p> $A = B \times C \times D \times E / 100$ <p>Where:</p> <p>A is the amount of plastic waste from disposal sites with potential leakage into the seas (tonnes/year)</p> <p>B is amount of waste entering waste mismanaged disposal sites with a distance of 50 km from the coast in 23 coastal provinces (tonnes/year)</p> <p>C = Composition of plastic waste in landfills in each province, and average number of plastic waste (28.13% or 0.2813)</p> <p>D = Average moisture of municipal solid waste (40% or 0.40)</p> <p>E = Probability of plastic waste leakage (5% or 0.05) — from a World Bank study (reference not provided)</p> <p>It is unclear if Thailand plans on using this approach to monitor plastic pollution in future years.</p> | It is unclear if this method is the officially adopted approach for measuring plastic waste with potential leakage into the seas, or if any other methods are officially recognized for measuring plastic pollution. |

## VIET NAM

Viet Nam is proactively addressing plastic pollution, for example through the aspirational National Action Plan for Management of Marine Plastic Litter by 2030 <sup>[1]</sup> and the National Action Plan on Sustainable Production and Consumption (2021 – 2030) <sup>[2]</sup>. The table on the next four pages outlines the core information we know so far on regulations, policies, targets and monitoring programs for plastic pollution in Viet Nam. The table is not intended to be a comprehensive review of all policies on solid waste management, for which there are typically many. Instead, it aims to summarize on-going initiatives that are potentially relevant to plastic pollution in Viet Nam, and to advance the development of a harmonized quantitative assessment of plastic pollution.

### Summary of policies, regulations, national targets and monitoring programs of plastic pollution in Viet Nam

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                              | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Regulation | The National Strategy for Integrated Solid Waste Management to 2025 with a Vision to 2050 (decision No.491/QD-TTg) <sup>[3]</sup> amends previous version of the law on management of solid waste. Its objectives for 2050 are to prevent, control and limit the discharge of solid waste, increase the management of solid waste, and apply advanced environmentally friendly technologies to treat the waste. | Targets are provided for 2025 on hazardous waste management, urban solid waste, rural solid waste, industrial solid waste and other solid waste (e.g., construction and demolition waste, agricultural waste and sludge). The municipal solid waste (urban and rural) targets are discussed further in the targets section of this table.                                                                                                            |
| Regulation | The Promulgation of National Technical Regulations on Environment (Circular No. 08/2018/TT-BTNMT) regulates the types of plastic scrap that can be imported in Viet Nam <sup>[4]</sup> .                                                                                                                                                                                                                        | Restrictions include e-waste which contains PBDE (polybrominated diphenyl ether) compounds, PBB (polybrominated biphenyl) compounds, phthalate compounds, lead, cadmium, mercury or chromium (VI), and partially burned plastics. The quantity of impurities in imports is also restricted.                                                                                                                                                          |
| Regulation | Resolution No. 36-NQ/TW, dated October 22, 2018, of the Party Central Committee (12th tenure) on the Strategy for sustainable development of Viet Nam's marine economy to 2030, with a vision to 2045.                                                                                                                                                                                                          | It sets the goal that by 2030, Vietnam will prevent, control, and significantly reduce marine environmental pollution, and become a regional pioneer in reducing ocean plastic waste.                                                                                                                                                                                                                                                                |
| Regulation | Resolution No. 26/NQ-CP dated March 5, 2020, promulgating the Government's Master Plan and Five-Year Plan for the implementation of Resolution No. 36-NQ/TW.                                                                                                                                                                                                                                                    | It sets the following targets: by 2025, to implement the National Action Plan on Ocean Plastic Waste Management; by 2030, to promote the establishment of a regional and international cooperation framework on the prevention, control, and reduction of ocean plastic waste; and to establish and put into operation an International Center for Ocean Plastic Waste in Vietnam.                                                                   |
| Regulation | Decree No. 45/2022/ND-CP Issued: July 7, 2022, Effective: August 25, 2022. Regulates penalties for administrative violations related to environmental protection.                                                                                                                                                                                                                                               | Penalties (as per Decree No. 45/2022/ND-CP)<br>Fines are imposed on individuals and organizations that fail to sort household solid waste at the source (from VND 500,000 to over 1,000,000 depending on severity).<br>Penalties for improper waste disposal, open burning of waste, and other environmental violations.<br>Enterprises violating EPR regulations may face administrative penalties and be required to undertake corrective actions. |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                              | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Regulation | Decision No. 1746/QD-TTg dated December 4, 2019, on the National Action Plan on marine plastic debris management through 2030, as approved by the Prime Minister.                                                                               | Aimed at: effectively implementing Vietnam's international initiatives and commitments to address plastic waste issues, with a focus on marine plastic waste; ensuring the prevention of plastic waste discharge from land-based sources and marine activities; and striving to make Vietnam a pioneering country in the region in reducing marine plastic waste.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Regulation | Decision No. 1316/QD-TTg dated July 22, 2021, on the Proposal for strengthened management of plastic waste in Viet Nam, as approved by the Prime Minister.                                                                                      | With the goal of strengthening plastic waste management from the central to local levels, contributing to the successful implementation of the National Strategy on Integrated Solid Waste Management to 2025, with a vision to 2050, as approved by the Prime Minister in Decision No. 491/QD-TTg dated May 7, 2018.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Regulation | Directive No. 33/CT-TTg dated August 20, 2020, on strengthening of management, reuse, recycling, disposal and reduction of plastic waste, as approved by the Prime Minister.                                                                    | Aimed at further enhancing the effectiveness of activities related to the management, treatment, reuse, and recycling of used plastics, and reducing plastic waste emissions into the environment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Regulation | Circular No. 02/2022/TT-BTNMT dated January 10, 2022, on detailing several articles of Law on Environmental Protection, as approved by the Minister of Natural Resources and Environment (MONRE).                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Policy     | Viet Nam government Decision No. 450/QD-TTg dated April 13, 2022, on the National Environmental Protection Strategy to 2030, with a vision to 2050, as approved by the Prime Minister.                                                          | The Strategy sets out the task of strengthening the reduction, reuse, recycling, collection, and treatment of plastic waste. After 2025, the circulation and use of single-use plastic products and non-biodegradable plastic packaging will no longer be allowed in commercial centers, supermarkets, hotels, and tourist areas. After 2030, the production and importation of single-use plastic products, non-biodegradable plastic packaging, and products or goods containing microplastics will be discontinued. The Strategy also promotes the development of environmentally friendly products and materials as alternatives. It calls for the effective implementation of the Scheme on strengthening plastic waste management in Vietnam, as approved by the Prime Minister in Decision No. 1316/QD-TTg, dated July 22, 2021. |
| Policy     | Decision No 687/QD-BNN-TCTS 05 Feb 2021 on the Approval of the Action Plan for Ocean Plastic Waste Management in the Fisheries Sector, 2020-2030, as approved by the Minister of MARD (Ministry of Agriculture and Rural Development) Decision. | Reducing plastic waste in the fisheries production sector, gradually managing ocean plastic waste through a source-to-sea approach, circular economy, and green economy development; raising awareness and social responsibility among farming and fishing communities, as well as businesses, regarding plastic waste—thereby contributing to the successful achievement of the goals set out in the National Strategy on Integrated Solid Waste Management.                                                                                                                                                                                                                                                                                                                                                                           |
| Regulation | Law No. 57/2010/QH12 on Environmental Protection Tax <sup>[5]</sup> regulates a fee for producers and importers of plastic bags when made from single polyethylene plastic film.                                                                | The tax rate is 30,000 – 50,000 Vietnamese Dong per kg of plastic bags.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Notes                                                                                                                                                                                                                                                                                                                                                                             |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy     | <p>The National Action Plan for Management of Marine Plastic Litter by 2030 <sup>[1]</sup> was introduced in 2019 and aims to eliminate plastic litter from marine and land-based sources, becoming a pioneering country for plastic pollution mitigation. The objectives to achieve this are: improving waste management in line with the National Strategy for integrated solid waste management, adopting circular economy approaches, and improving public awareness and behaviors. Specific tasks outlined include:</p> <ul style="list-style-type: none"> <li>• Education and behavior change, such as on single-use plastics</li> <li>• Beach clean-up campaigns</li> <li>• Quantification and control of plastic litter at source (both from land and sea-based sources)</li> <li>• International cooperation, scientific research and processing of marine litter</li> </ul>                                                                                                                                                                               | <p>Targets on marine plastic pollution reduction, single-use plastic reduction and monitoring were set for the years 2025 and 2030. These targets are detailed in full in the targets section of this table. The Ministry of Natural Resources and Environment (MoNRE) is the department primarily responsible, although cooperation is outlined across multiple departments.</p> |
| Policy     | <p>Viet Nam's National Action Plan on Sustainable Production and Consumption (2021-2030) was approved in 2020 under Decision No. 889/QD-TTg <sup>[2]</sup> with the aim of promoting efficient and sustainable management and utilization of resources. Particularly relevant tasks relating to plastic are:</p> <ul style="list-style-type: none"> <li>• Develop guidelines on the efficient use of plastics</li> <li>• Limit the use of single-use, non-degradable plastic items at wet markets, supermarkets, commercial centers and outlet stores.</li> <li>• To promote the application of a circular economy for waste plastics</li> <li>• Establish and develop a modern database to meet requirements of management and practice of sustainable consumption and production.</li> </ul>                                                                                                                                                                                                                                                                      | <p>Time-bound objectives were set within the action plan, for instance around awareness raising and development of legal frameworks and local action plans. Quantitative targets of relevance to plastic pollution are described in the targets section of this table.</p>                                                                                                        |
| Regulation | <p>The Environmental Protection Law (Law No. 72/2020/QH14) <sup>[6]</sup> made fundamental amendments to existing extended producer responsibility (EPR) laws in Viet Nam through Articles 54 and 55. Article 54 mandated producers and importers of recyclable products and packaging to self-organize the recycling of their products or pay a fee to the Vietnam Environment Protection Fund to support recycling. Article 55 addresses non-recyclable products, mandating producers to pay a fee for collecting, transporting and treating domestic solid waste generated from households.</p> <p>Scope was further clarified in Decree No. 08/2022/ND-CP <sup>[7]</sup> to only include producers having a revenue of at least 30 billion dong, and importers with imports of value exceeding 20 billion dong. The Decree further bans the import of non-biodegradable plastic bags from 2026, and all single-use plastics and non-biodegradable plastic by 2030 (with none to be sold in shopping malls, supermarkets, hotels and tourism areas by 2025).</p> | <p>The Environmental Protection Law (Law No. 72/2020/QH14) was strengthened in 2023 with the Promulgate Decision No. 252/QD-BTNMT, which established the National EPR Council. The National EPR Council role is to support the Ministry of Natural Resources in managing and using the financial contributions of the EPR fund.</p>                                               |

# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Notes                                                                                                                                                                                                                                                                                                                                                                  |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Policy     | Decree No. 05/2025/ND-CP dated January 06, 2025 - Amending and supplementing several articles of Decree No. 08/2022/ND-CP dated January 10, 2022.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                        |
| Regulation | The National Waste Incident Response Plan (2023–2030) <sup>[9]</sup> was approved under Decision No. 146/QD-TTg in 2023. The plan establishes a national framework for responding to waste-related incidents. Specific mention is given to prevent and limit waste leaked into the environment, and incidents involving gaseous waste emissions from facilities (e.g., open burning at dumpsites).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Although the response plan appears to be developed as an emergency plan to limit environmental damage, the plan is potentially also relevant to more commonly occurring emissions, such as plastic leakage from disposal sites or open burning of waste.                                                                                                               |
| Policy     | Viet Nam launched the National Plastic Action Partnership (NPAP) <sup>[10]</sup> in 2020 in collaboration with the Global Plastic Action Partnership (GPAP) to catalyze action on plastic pollution. NPAP Viet Nam aims to support the existing national targets of reducing plastic litter in oceans by 50% by 2025, achieving a 75% reduction by 2030, collecting 100% of abandoned, lost or discarded fishing gear by 2030, and eliminating all single-use plastic from coastal tourist attractions by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                          | Although the roadmap is still under preparation, the Viet Nam Plastic Action Assessment and Roadmap Considerations report <sup>[11]</sup> released in 2022 highlights that plastic leakage mainly comes from areas with no waste collection coverage, and that system change is required to mitigate the problem.                                                      |
| Policy     | <p>The National Environmental Protection Strategy to 2030 and Vision to 2050 <sup>[8]</sup> was approved under Decision No. 450/QD-TTg in April 2022. The strategy encompasses all forms of environmental protection, with specific tasks relating to solid waste management such as:</p> <ul style="list-style-type: none"> <li>• Development of circular economy</li> <li>• Actively controlling facilities that pose a high risk of environmental pollution</li> <li>• Enhancing measures for preventing illegal import of waste in form of scraps</li> <li>• Monitor, supervise, actively prevent and respond to ocean pollution, multinational rivers</li> <li>• Increase management of solid waste and hazardous wastes, including: waste segregation, increased collection (particularly to rural areas), reuse and recycling, modernization of collection equipment, organise EPR, and banning of single-use plastics</li> </ul> | The tasks and targets outlined bring together other initiatives such as the National Strategy for Integrated Solid Waste Management to 2025 with a Vision to 2050 <sup>[3]</sup> and the National Action Plan on Sustainable Production and Consumption (2021-2030) <sup>[2]</sup> . Some amendments to the targets are detailed in the targets section of this table. |



# COUNTRY PROFILES

| Type   | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Notes                                                                                                                                                                                                                                                                                                                                                               |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Target | By 2025, all special-grade and grade-I urban centers as well as 85% of other urban centres shall have MSW recycling facilities, which are suitable for source segregated household waste.                                                                                                                                                                                                                                                                                   | Targets established in the National Strategy for Integrated Solid Waste Management to 2025 with a Vision to 2050 (decision No.491/QD-TTg) <sup>[3, 12]</sup> . Only targets applied to municipal solid waste (MSW) are shown as these are the most relevant to plastic pollution. No details were found of the methods for monitoring and evaluating these targets. |
| Target | By 2025, 90% of urban MSW to be collected and treated, satisfying the environmental protection requirements (i.e., increase the capacity to recycle, reuse and treat solid waste in combination with energy recovery or composting; strive to reach the goal of achieving less than 30% of collected solid waste disposed at landfills). This target increased to 95% as part of the National Environmental Protection Strategy to 2030 and Vision to 2050 <sup>[8]</sup> . |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, 80% of municipal solid waste from rural settlements must be collected and treated satisfying the environmental protection requirement (i.e., reuse or recycle organic waste into compost using centralized composting facilities or home-composting). This target increased to 90% as part of the National Environmental Protection Strategy to 2030 and Vision to 2050 <sup>[8]</sup> .                                                                           |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, 100% use of environmentally-friendly plastic bags in trade centres and supermarkets.                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, 90 – 95% of municipal solid waste landfills in urban centers that have been closed will have their lands rehabilitated and reused.                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, 95% of MSW landfill in rural areas that have been closed will have their lands rehabilitated and reused; strive to reach the goal of handling 100% spontaneous landfills.                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, less than 20% of urban solid waste will be disposed of in landfills. This target decreased to 10% as part of the National Environmental Protection Strategy to 2030 and Vision to 2050 <sup>[8]</sup> .                                                                                                                                                                                                                                                            | Targets established as part of the National Action Plan for Management of Marine Plastic Litter by 2030 <sup>[1]</sup> . No details were found of the methods for monitoring and evaluating these targets.                                                                                                                                                          |
| Target | By 2025, reduce marine plastic litter by 50%, with this increasing to 75% by 2030.                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, collect 50% of abandoned, lost, or discarded fishing gear, with this increasing to 100% by 2030.                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, prevent the use of single-use plastics and non-biodegradable plastic bags in 80% of coastal tourism areas, tourist attractions, tourist accommodations, and other coastal tourism services. This increases to 100% by 2030.                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, ensure nationwide beach cleanup campaigns are launched at least twice a year.                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, strive for 80% of marine protected areas to be free of plastic litter, with this increasing to 100% by 2030.                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | By 2025, monitor marine plastic litter annually and assess marine plastic litter every 5 years at several estuaries in the 5 major drainage basins in the North, North Central Coast, central region of Central Vietnam, South Central Coast and the South, and islands with tourism potential located in the 12 insular districts. All 11 major drainage basins are to have monitoring by 2030.                                                                            | Targets outlined as 'specific objectives' in the National Action Plan on Sustainable Production and Consumption (2021-2030) <sup>[2]</sup> . No details were found of the methods for monitoring and evaluating these targets.                                                                                                                                      |
| Target | 7-10% reduction in plastic usage for production sectors by 2030.                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                     |
| Target | 100% of supermarkets, commercial centers use eco-friendly packaging which gradually replace single-use, non-degradable plastic items by 2030.                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                     |



# COUNTRY PROFILES

| Type       | Name / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Target     | Treatment of plastic waste at beaches, coastal tourism areas and marine protected areas to reach 100% by 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Target outlined in the Strategy for sustainable exploitation of resources of marine, island environment through 2030.                                                                                                                                                                                                                                                                                                                                                                               |
| Monitoring | <p><b>Manufacture and trade:</b> Viet Nam monitors plastic manufacturing and trade under the National Statistics Office <sup>[13]</sup>. The import and export of plastic materials and plastic products is reported in million USD. Data is also available according to HS codes through Comtrade; however, values are again only available on a monetary basis.</p> <p>Domestic production of plastic is reported in the National Statistics Office database according to the category 'Manufacture of rubber and plastic products', with values reported as an Index of Industrial Production. It is believed that raw data may have been collected for this following Viet Nam's Standard Industrial Classification of Economic Activities <sup>[14]</sup>, which classes the manufacture of plastic products under two sub-codes: Manufacture of containers of plastics (22201) and Manufacture of other plastics product (22209).</p> <p>Data on plastic packaging is further reported as part of the 'Main Industrial Products', with values reported on a mass basis.</p>                                                                                 | A web portal ( <a href="https://epr.monre.gov.vn/">https://epr.monre.gov.vn/</a> ) for companies to record their EPR compliance became available in January 2024; however, repeated attempts to access this database have been unsuccessful. It is unclear if any of the data collected via this portal is useful for the manufacture and trade of plastic products.                                                                                                                                |
| Monitoring | <p><b>Monitoring of solid waste management:</b> Data on waste is potentially available via MONRE's National Environment Database System <sup>[15]</sup>. Access to the data is restricted to those with login credentials; therefore, it is unclear if the system is actively used and what data is collected.</p> <p>The National Statistics Office also releases annual data on the disposal of solid waste by type of urban area, and the average collected solid waste treated per province, under its Society, Environment and Territory category <sup>[16]</sup>. The latest available years for these data points are 2017 and 2018 respectively; therefore, it is unclear if this data is still actively collected.</p> <p>Decision No. 849/QD-BTNMT issued by MONRE aims to contribute to the National Strategy for Integrated Solid Waste Management to 2025 with a Vision to 2050 <sup>[3]</sup> by engaging the Vietnam Environment Administration (VEA) to collect data on solid waste management facilities at a provincial level and report back to MONRE <sup>[17]</sup>. It is unclear if this information has been made publicly available.</p> | The National Strategy for Integrated Solid Waste Management to 2025 with a Vision to 2050 <sup>[3]</sup> calls for the creation "of a local and central data system of solid waste, to be specific, designing software and provide training in figure collecting and reporting" and "create and manage a data system of solid waste management nationwide". It is unclear whether MONRE's National Environment Database System <sup>[15]</sup> is the database created to fulfil these obligations. |
| Monitoring | <p><b>Monitoring of plastic pollution:</b> Several one-off baselining studies on plastic pollution have been conducted in Viet Nam. This includes the initial assessment of the Viet Nam National Plastic Action Partnership <sup>[11]</sup>, the National Guidance for Plastic Pollution Hotspotting and Shaping Action <sup>[18]</sup>, the World Bank Plastic Pollution Diagnostics <sup>[19]</sup> and CSIRO Survey methodology <sup>[20]</sup>. Despite these intensive efforts, no regular monitoring of plastic pollution is occurring.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | The National Action Plan for Management of Marine Plastic Litter by 2030 <sup>[1]</sup> calls for: the development of "a system for monitoring of marine plastic litter based on remote sensing and image interpretation technologies and a system of geological information combined with artificial intelligence and local knowledge"; and to "develop and manage the national marine plastic litter database." It is unclear whether such a monitoring system has been implemented.              |

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