Building Data on the Plastics Value Chain

in ASEAN Member States

Regional Knowledge Centre for Marine Plastic Debris

ERIA

IGES Institute for Global Environmental Strategies

CCET IGES Centre Collaborating with UNEP on Environmental Technologies

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This study was conducted for the Regional Knowledge Centre for Marine Plastic Debris (RKC-MPD),
Economic Research Institute for ASEAN and East Asia (ERIA)

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Layout by Match-up Co. Ltd.
Cover design by Match-up Co. Ltd.

ISBN: 978-4-88788-265-2
DOI: https://doi.org/10.57405/iges-12696

Please cite as Asokan V.A., Abeynayaka A. and Hotta Y. 2023. *Building Data on the Plastics Value Chain in ASEAN Member States Report.* Economic Research Institute for ASEAN and East Asia (ERIA)

Acknowledgments

The authors wish to thank Regional Knowledge Centre for Marine Plastic Debris (RKC-MPD), Economic Research Institute for ASEAN and East Asia (ERIA), for funding this report. They are grateful to the members of ERIA's Expert Working Group on Marine Plastic Debris for reviewing the draft and for their comments. Gratitude is also extended to Thomas Hamilton and Stefan Wesiak for proofreading the report and providing comments, and to Chochoe Devaporihartakula, Ayako Mizuno, and Rajeev Singh for reading the manuscript.

Contents

1. Introduction 1

2. Background 2

2.1 Extant Estimation of Plastic Waste Leakage 2

2.2 Plastics Value Chain 2

3. Methodology and Reports Analysed 5

3.1 Material Flow Analysis 5

3.2 Studies Used 5

4. Current Assessment 7

4.1 Data Collection Capacity 7

4.2 Scope of Data 8

5. Recommendations 11

5.1 Stage 1: Build up Data on Production and Waste Generation 12

5.2 Stage 2: Build up Data on Consumption and Waste Management 13

5.3 Stage 3: Build up Scientific Knowledge on Plastics Leakage and Develop Data 14

5.4 Stage 4: Build Indicators 15

5.5 Stage 5: Link Plastics with Climate Adaptation 16

6. Conclusion 17

References 18

Appendix 1: Reports Used in the Analysis and Other Information 20

Appendix 2: Plastics Value Chain and Associated Data in the ASEAN Region 22

Appendix 3: Harmonized System Codes 23

1. Introduction

Plastic waste and marine plastic pollution have become key topics amongst Association of Southeast Asian Nations (ASEAN) public policy specialists since the publication of a landmark paper by Jambeck et al. (2015) asserting that ASEAN Member States (AMS) are significantly contributing to marine plastic pollution.[1] In response, many AMS developed national action plans, while ASEAN, with support from the World Bank, developed the *ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States, 2021–2025* (ASEAN Secretariat, 2021).

A circular economy – in which materials are recycled and used longer instead of being mismanaged and ending up in the sea – offers a potential solution to marine plastics pollution. In 2019, AMS announced the Bangkok Declaration on Combating Marine Debris in ASEAN Region (ASEAN, 2019), which stressed increasing resource efficiency through a circular economy and the 3Rs (i.e. reduce, reuse, and recycle), as well as capacity building and exchange of best practices amongst AMS and external partners.[2] Another report, *Circular Economy and Plastics: A Gap-Analysis in ASEAN Member States,* has facilitated discussions on circular economy strategies in dealing with plastics (Akenji and Bengtsson, 2019). It provided a snapshot of the current state of information on plastics in the ASEAN region and recommended improvements in data collection and plastics management.

This report aims to provide an overview of the information related to the plastics value chain in the ASEAN region. It focuses on the availability of local and national data used for material flow analyses (MFAs) – instead of actual data content – as this information aims to be a stocktaking exercise towards building capacity in the area of data collection on the plastics value chain. Indeed, data on plastics are necessary to assess, plan, and implement solutions to mitigate marine plastics pollution. In this context, the following questions are examined in this report:

(i) What is the data collection capacity of AMS?
(ii) What is the data availability on plastics in ASEAN across the plastics value chain?
(iii) How can AMS improve data collection on plastics?

The report is structured as follows. Section 2 defines the scope of marine plastics pollution and the plastics value chain. Section 3 presents the methodology used in the report. Section 4 details the significant findings based on the literature review, while Section 5 recommends how to develop capacities toward data collection. Section 6 concludes.

To understand the current state of data on plastics, the capacity of governments to collect data on plastics and the scope of the data collected are assessed, with a specific focus on publications on MFA that emphasise plastics and associated publications that discuss data availability in AMS.

The report is based on a literature review of publications from Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam – AMS with literature available on the topic. In compiling this report, due to the lack of primary source data on plastics, secondary sources are used. In the future, as data on plastics become more readily available, studies will need to include primary data in their analyses. To the best of the authors' knowledge, this report represents the first publication on the availability of data in AMS related to the plastics value chain.

1 After China, Indonesia (second), Philippines (third), and Viet Nam (fourth) are amongst the top five polluters. Thailand (sixth) and Malaysia (eighth) are in the top 10. Myanmar ias also in the top 20, ranking 17th.

2 AMS welcomed capacity building and exchange of best practices as well as private sector engagement and investment. The declaration emphasised multi-stakeholder cooperation, knowledge sharing, technology transfer, increased public awareness, and innovation dissemination.

2. Background

This section describes the various assumptions used and data sourced for global plastics leakage estimates; the plastics value chain, ranging from production to waste disposal and management; and how these data can be used to estimate plastics leakage to the environment.

2.1 Extant Estimation of Plastic Waste Leakage

To calculate the leakage of plastics into the ocean, researchers depend on estimates due to the lack of data on waste management and plastics leakage to the ocean from land and rivers. Such estimates are used in this report with data from field-based samples collected outside of Asia (Table 1).

In previous studies, data on waste management and collection were based on World Bank estimates from Hoornweg and Bhada-Tata (2012) and Kaza et al. (2018). Information on plastics leakage projections assumed coastal and riverine populations as a proxy.

In terms of data availability, the results in earlier studies should only be considered baselines, since plastics leakage estimates were only partially based on empirical data and little primary data, as no on-site sampling results existed. Moreover, special consideration on various categories of plastics data and the information on both microplastic and macroplastic need to be equally focussed. In this respect, both sampling and data collection methods need to be improved to identify current plastic leakage sources, enable projections of future leakage, and consider the necessary actions and mitigation measures to combat the leakage of plastics into the ocean. This crucial need for data on waste management and plastics leakage has also been noted in other studies (e.g. Meijer et al., 2021) and is underscored by the fact that the ASEAN region has become a hotspot for plastics pollution.

2.2 Plastics Value Chain

Information and data relating to the plastics value chain – from production to consumption, disposal, recycling, and leakage – need to be captured. Such information would assist stakeholders with planning, prototyping, and experimentation; products; business models; and other solutions to reduce marine plastic litter.

The plastics value chain is divided into three sub-categories and shown in Appendix 2: (i) production and use, (ii) waste collection and management, and (iii) leakage to the environment. Plastics are produced from crude oil and natural gas through a polymerisation or polycondensation process. Plastic leakage into the environment is dependent on various factors – plastics production, its use, and the state of waste collection.

There are various players in the plastics value chain: the plastics industry itself; companies producing products used in the construction, textile, agriculture, automotive, and electronics sectors; and the chemical industry. It is dominated by companies in developed countries and areas such as the United States, Europe, and East Asia. Once plastics are disposed of, the waste material is collected and recycled to varying extents by the formal sector such as local governments and the informal sector players. Plastics

Table 1: Data Used for Plastics Waste Leakage Estimation

Reference	Type and Source of Data	Type of Plastics Considered (Macro/Micro)	The Methods Estimating Plastics Leakage into the Ocean	Model inputs and outputs of Plastic Concentration in Rivers
Jambeck et al. (2015)	Daily plastic waste production per inhabitant from World Bank estimates	Only Macroplastics	Based upon a 50 km coastal buffer created in GIS with population density and economic status	No river data inputs considered No outputs on river plastic flow
Lebreton et al. (2017)	Daily plastic waste production per inhabitant from World Bank estimates	Both Microplastic and Macroplastic	Plastics load inputs from 40,760 river basins into oceans worldwide using geospatial data on population density	River data inputs cosidered No studies yet from the ASEAN region Model outputs provide 40,700 rivers including ASEAN region
Lau et al. (2020)	Eight geographic archetypes based on income and population density to capture geographic differences in plastics consumption, waste generation	Both Microplastic (few categories) and Macroplastic	Proportion of each archetype's population living within 1 km of a river or coastal waterway using GIS Post-consumption waste management pathways and different material categories were considered	No river data inputs to the model No model outputs focussing on rivers
Meijer et al. (2021)	From Lebreton and Andrady (2019), combining country-level data on self-reported per capita municipal solid waste generation[a], with high resolution (i.e. 30 arc second) distributions of the global population[b], and GDP[c]	Both Microplastic and Macropalstic	Distributed probabilistic modelling to more accurately represent driving mechanisms of plastics transport (e.g. wind, runoff, and river discharge), differentiating between areas with various land uses and terrain slopes, and including plastics retention on land and within rivers	River data considered Data from ASEAN region rivers are adequately considered

ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product, GIS = geographic information system, km = kilometre.
[a] Waste Atlas, http://www.atlas.d-waste.com/ (accessed 1 February 2022).
[b] Oak Ridge National Laboratory, LandScan 2014, https://landscan.ornl.gov/downloads/2014 (accessed 1 February 2022).
[c] UNEP/GRID-Geneva, (2012), *Global Risk Data Platform*, https://preview.grid.unep.ch/index.php?preview=data&events=socec&evcat=1 (accessed 1 February 2022).
Source: Authors.

are also recycled by producer responsibility organisations in areas where extended producer responsibility regulations are in effect. The challenge, therefore, is in the collection and assimilation of data on each sub-category from the large range of stakeholders, as these data are crucial for downstream users (i.e. those collecting the waste and processing it).

Since the production of plastics and management of plastics waste are sequential processes, data from these categories influenced the modelling and estimation exercise. For this reason, a sequential process is adopted, showing the implications of data collection and estimation in each stage (Figure 1).

Scientific researchers estimated/modelled waste collection and waste leakage using a combination of primary data and estimates (Borrelle et al., 2020; Jambeck et al., 2015; Ryberg et al., 2019). Based on such categorisation, the estimation exercise can be divided into three sequential sub-categories:

i. **Plastics production and use:** The estimation of current levels of plastics production, usage, and types in an economy.

ii. **Waste collection and management:** The estimation of amounts of waste collected, sorted, recycled, and disposed of.

iii. **Leakage:** The estimation of the quantity of plastic leaked into the environment (leakage A) and then the fate (leakage B) such as ending up in the ocean. This stage is the most challenging, as data availability and holistic knowledge of the plastic end-of-life mismanagement practices such as open burning, and interaction amongst plastics, the environment, and humans are needed.

Of the plastics put in the market, some does not reach waste disposal sites immediately or in the same year as consumption. For this reason, knowledge of in-use plastics is necessary; thus, information on product usage and related lifetimes needs to be estimated or validated. Figure 2 shows how in-use plastics determine the amount of plastics disposed of in subsequent years if not disposed of in the first year.

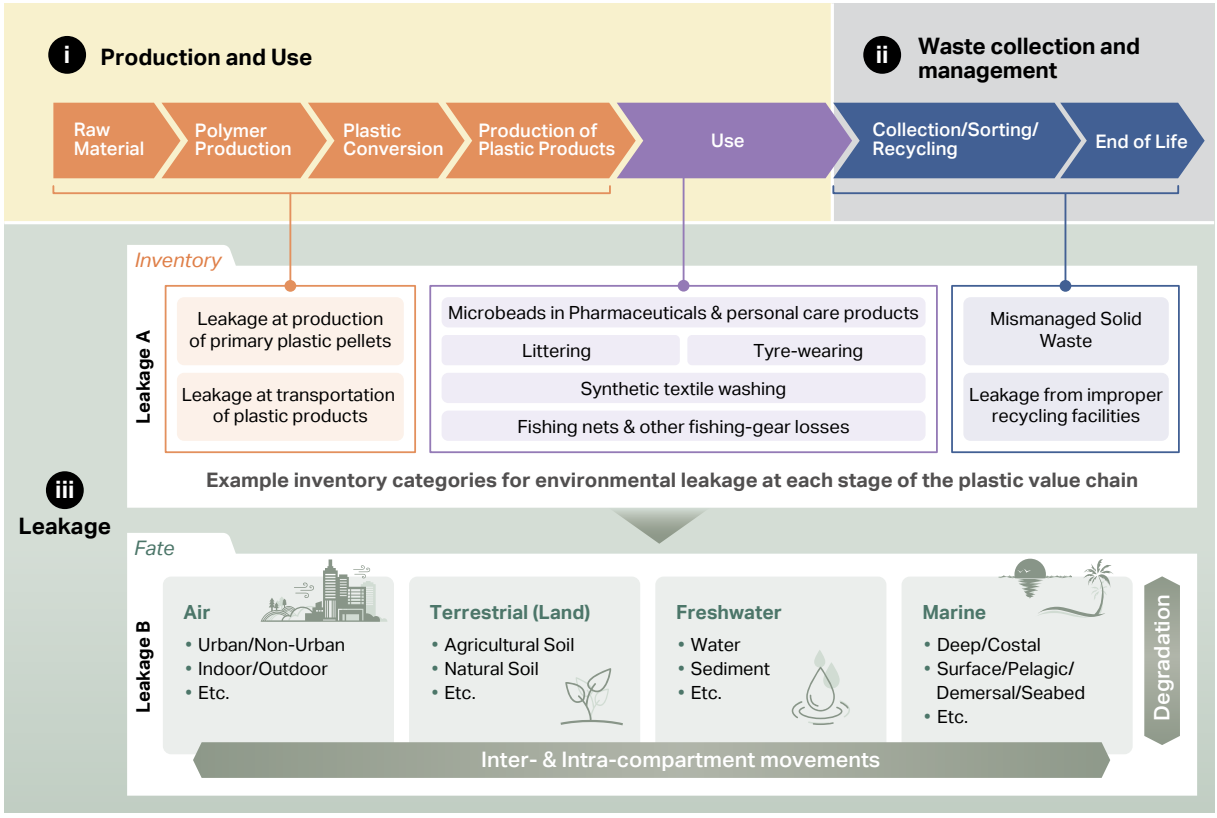
The leakage of plastics can also be expressed mathematically as a function of environmental leakage and marine leakage rates. However, as the mechanism of

environmental leakage of plastic and release to the aquatic environment is not well understood, marine leakage pathways and rates must be estimated or assumed. As Figure 1 fate component illustrated, the plastics in the environment pose inter- and intra- compartment movements and degradation, which makes the predictions difficult.

Adopting the above approach enables data to be reported and used holistically, which can also be used to inform policymakers on the challenges of data collection in the ASEAN region.

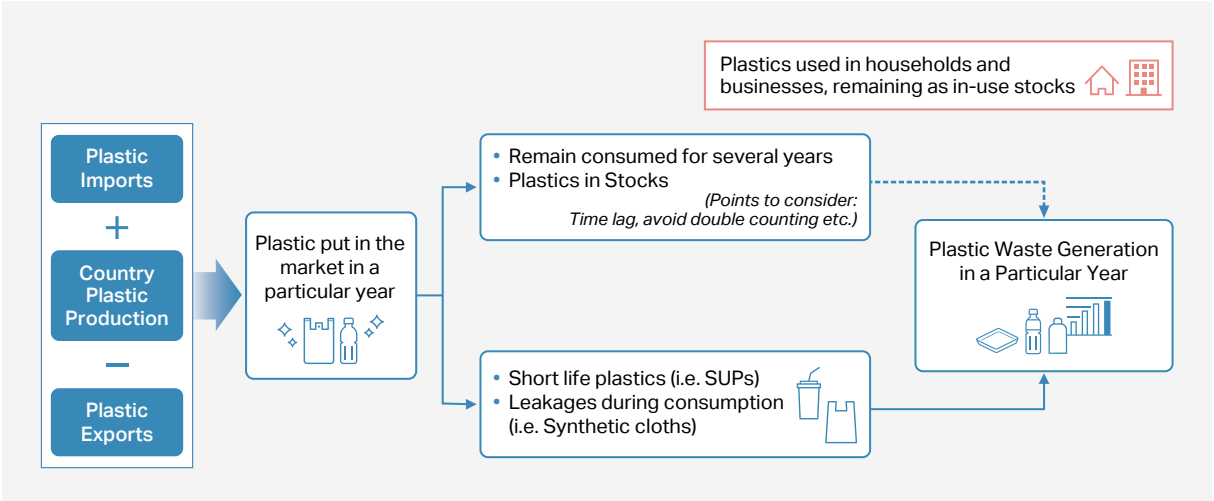
Researchers have also developed waste input–output tables representing the flow of goods and waste, which have been applied to plastics in Japan (Nakatani, Maruyama, and Moriguchi, 2020). These tables can provide potentially valuable input for the ASEAN region. However, as mentioned above, this process rests on empirical data.

Figure 1: Three Major Data Components of the Plastics Value Chain and its Leakage



Source: Modified from Abeynayaka et al. (2022).

Figure 2: Non-Linear Flow of Plastics



Note: Features some types of plastics as in-use stocks, taking many years to reach recycling, sorting, or disposal facilities.
Source: Modified form Abeynayaka and Gamaralalage (2022).

3. Methodology and Reports Analysed

This section describes the studies and reports involved in the literature review. Specifically, country capacity was studied by reviewing information from websites, reports, and scientific publications. Information from ASEAN+3 countries[3] was examined to highlight the variance in capacity between developed and developing countries (i.e. to benchmark AMS with their East Asian counterparts).

The plastics value chain from production to disposal is highlighted, using data from relevant publications based on data from AMS. As this report is directly related to improving the available data on plastics at the national level, international or regional studies were not used.

To cover the topic concisely, MFAs of Indonesia, Malaysia, Philippines, Thailand, and Viet Nam were conducted as a proxy to capture the situation on data availability. Information on existing national and local data was used to conduct the MFAs; however, the focus is not on the MFAs themselves but on the assessment of the data availability in the region.

Due to the lack of MFAs covering other AMS, this report is restricted to Indonesia, Malaysia, Philippines, Thailand, and Viet Nam. The MFA framework was used to obtain an understanding of the plastics value chain in AMS, due to the overlap between the MFA categories and plastics value chain categories.

3.1 Material Flow Analysis

An MFA is a tool used in environmental management for analysing the flow and stocks of material or energy used in processes, which in this case is plastics (Zhang, 2013). Brunner and Rechberger (2016) defined an MFA as a systematic assessment of the flow and stock of materials within a certain system defined in space and time. It represents the mass balance between inputs and outputs, and as a tool, it helps identify waste and can help minimise the volume of materials used and the mass balance equation can be expressed as:

Input (extractions + produced + imports) =
Output (consumed and in use + waste + exports)

3.2 Studies Used

Different stakeholders have conducted individual baseline MFAs in the region, and some have involved the government. In Malaysia, a study was contracted under the National Solid Waste Management Department of the Ministry of Housing and Local Government (GOM, 2011). In Indonesia, a multi-stakeholder partnership contracted a consultancy firm to generate knowledge on plastics waste leakage and scenarios (Global Plastic Action Partnership and Indonesia National Plastic Action Partnership, 2020). In Viet Nam, a business-led alliance produced an MFA report (Vietnam Materials Marketplace, 2019), and in the

3 Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam plus China, Japan, and the Republic of Korea.

Philippines, a consultancy firm initiated an MFA study for an environmental conservation group (WWF-Philippines, 2020). However, no MFA reports produced by the government or businesses related to Thailand could be found, although a scientific paper was sourced (Bureecam, Chaisomphob, and Sungsomboon, 2018). Further, the World Bank conducted market studies on the plastics circulation of specific resins used in packaging in Thailand, Malaysia, and the Philippines (World Bank, 2020, 2021b, 2021a), which can serve as baselines; thus, these data and assumptions are included in this report.

1 **Malaysia**	The Malaysia MFA report involved collection of secondary information on plastics production, export, import, consumption and usage, and recycling. The consultations collected information from the Department of Statistics, Malaysia External Trade Development Corporation, Malaysian Investment Development Authority, Malaysian Plastics Manufacturers Association, Ministry of International Trade and Industry, Royal Malaysian Customs Department, and local authorities. Questionnaires were distributed to collect primary data on recycling. The report highlighted challenges regarding the availability of data. For example, it stated that no data are available on plastics production in terms of weight; thus, the report used a proxy and conversion from monetary values. Many estimations were made throughout, but the report presented data on many components as well as the assumptions used. It ended up focussed on plastics production and aggregated waste disposal estimates, due to the lack of information on disaggregated waste collection and disposal. Note that the Government of Malaysia commissioned the study, owing to the policy relevance for the region.
2 **Viet Nam**	A business-led initiative, the Vietnam Business Council for Sustainable Development, published an MFA report on plastics in Viet Nam. It aimed to assist in the development of a secondary market for recycled materials to steer the country towards a circular economy. The report focussed on plastics production, with aggregated waste disposal estimates. Information on waste flows (i.e. disaggregated data on waste collection and disposal) was not comprehensively covered. The report was based on secondary data and surveys from recyclers in Viet Nam; hence, information on recycled plastics was obtained from data collected from the recycling industry.
3 **Indonesia**	Indonesia is the second-biggest contributor to marine plastics pollution in ASEAN, a situation that has led to increased focus on marine plastics in the region. As a result, international actors have become involved in Indonesia, resulting in the formation of the National Plastic Action Partnership, a multi-stakeholder partnership including government, industry, and community members. The scenario analysis methodology used was adapted from global research carried out by the Pew Charitable Trusts and SYSTEMIQ, with a focus on waste generation and management, meaning that the study did not capture information on waste production and consumption (Global Plastic Action Partnership and Indonesia National Plastic Action Partnership, 2020). The report also presented data from Badan Pusat Statistik, Asosiasi Industri Olefin, Aromatik and Plastik Indonesia Data from a Ministry of Industry presentation. The report's remit extended beyond the MFA and included systems change scenarios for use in decision making on substitution of certain plastics materials and waste collection rates for cities, towns, and rural areas.
4 **Thailand**	These data are from a scientific paper featuring an MFA based on both primary and secondary resources. The authors collected primary data from stakeholders in the plastics waste management chain. Survey respondents comprised manufacturers, distributors, retailers, formal and informal waste collectors, plastics recovery units, and recycling operators. Secondary data were collected from the Office of Industrial Economics, Office of the National Economic and Social Development Board, Petroleum Institute of Thailand, Plastics Institute of Thailand, and Pollution Control Department (Bureecam, Chaisomphob, and Sungsomboon, 2018).
5 **Philippines**	The MFA report in the Philippines was published by WWF-Philippines, prepared by consultants based on primary and secondary data obtained from informal waste collectors and recyclers. Data were derived from AMH Philippines, Manila Water Total Solutions, Philippine Statistics Authority, Solid Waste Management Commission, and other sources. The report seemed more balanced than the others, yet the content was based on estimates for waste collection due to data limitations in waste management and used a computed collection efficiency (i.e. national scale) of 40%.
6 **World Bank**	In 2020, the World Bank conducted three separate studies for the Philippines, Malaysia, and Thailand to identify opportunities and barriers for plastics circularity. MFAs were conducted as part of these studies for four significant types of plastics, owing to their domination in these economies: polyethylene terephthalate (PET), PET polyester polypropylene, high-density polyethylene, and low-density polyethylene. The study largely relied on national data (i.e. import–export) and survey questionnaires from recyclers and focussed on production-based information, with little data on waste management.

4. Current Assessment

Based on the literature review, this section outlines AMS data collection capacity and the current scope of data on plastics, which provide the basis for the recommendations aimed at developing data on the plastics value chain.

4.1 Data Collection Capacity

Owing to their developed status, some countries and areas – including Japan, Korea, Singapore, and Taiwan – exhibit adequate waste management infrastructure and maintain robust data on waste management (i.e. collection, sorting, and disposal). China is fast developing its waste management and recycling infrastructure as well.

In Thailand and Viet Nam, data on waste management and disposal are collected from local governments. Similarly, in the Philippines, many local governments submit waste management reports, including waste and waste characterisation data, but not all. Malaysia started reporting its waste generation data in 2018. In all of these countries, the collection of data on plastics is currently being established, which will ultimately increase their overall capacity in terms of data collection but will require countries with the know-how to provide support and technical guidance.

Other AMS lack such capacity and data on plastics (Table 2); therefore, in these countries, efforts are needed to augment human resources, know-how, and technical infrastructure to enhance collection capacity and data generation. Guidelines must be established in parallel with developments in data collection efforts in these countries. Further, central governments need to present clear guidelines to provincial and local governments on the collection of waste management information.

Table 2: Current State of Data on Waste Management

Waste Management	Ability to Collect	Data Availability
OECD countries, Japan, Korea, Singapore	Yes	Yes
Indonesia, Malaysia, Philippines, Thailand, and Viet Nam	Partly	Partly
Brunei Darussalam, Cambodia, Lao PDR, and Myanmar	In development	In development

Lao PDR = Lao People's Democratic Republic, OECD = Organisation for Economic Co-operation and Development.
Source: Authors.

Data on plastics leakage to the ocean are not yet part of the official statistics released by some countries, and methodologies to collect data on plastics leakage are under development in others, with more progress being made by several developed countries. Data availability is generally lacking except in developed counties, which have the required technical capacity and human resources. However, apart from Singapore, most AMS likely do not possess such technical, financial, or human resources.

Table 3: Current State of Data on Plastics Leakage

Plastics Leakage	Capacity to Collect	Data Availability
OECD countries, Japan, Korea, Singapore	Yes	No
Indonesia, Malaysia, Philippines, Thailand, and Viet Nam	No	No
Brunei Darussalam, Cambodia, Lao PDR, and Myanmar	No	No

Lao PDR = Lao People's Democratic Republic, OECD = Organisation for Economic Co-operation and Development.
Source: Authors.

4.2 Scope of Data

Tables 4, 5, 6, and 7 summarise the data from various studies and the scope of coverage shown in Figure 2, allowing AMS to map their progress, assess their current capabilities, and focus on developing areas that are lacking. In terms of data coverage, there are two kinds of studies – those based on production and those based on waste management. The studies from Viet Nam, Malaysia, and the World Bank focussed on production-related data, with a minor focus on waste management. The studies from the Philippines and Indonesia focussed on waste management and disposal.

Data are based on estimates, as raw data are lacking in many instances. The input and output masses do not match, as estimates based on mass balance are not precise. For example, in the Viet Nam study, inputs are higher than outputs, so 2,098,000 tonnes are not accounted for.

Table 4: Estimates on Plastics across the Value Chain from Existing Material Flow Analyses (kilotonnes/year)

Country	Year	Imported Plastics Waste	Imported Plastics Resin	Domestic Plastics Resin	Total Plastics Resin	Exports of Plastics Resin	Total Consumption of Plastics Resin	Imports of Plastics Products
Malaysia	2010	81.88	1,087.76	2,000.00	3,087.76	1,466.96	1,620.79	468.28
Viet Nam	2018	615.00	5,900.00	1,000.00		807.00		797.00
Philippines (packaging)	2019	15.00	1,881.00	528.00	NAD	NAD	NAD	NAD
Thailand	2013	NAD	NAD	NAD	7,827.48	NAD	NAD	1,007.69
Indonesia[a]	2017	NAD	NAD	NAD	NAD	NAD	NAD	
Indonesia[b]	2017	NAD	1,670.00	2,310.00	5,635.00	NAD	NAD	120.00

[a] Badan Pusat Statistik, Asosiasi Industri Olefin, Aromatik and Plastik Indonesia Data from a Ministry of Industry presentation.
[b] Global Plastic Action Partnership.
NAD = No available data.
Source: Government of Malaysia (2011), Government of Indonesia (2020), Bureecam et al. (2018), Vietnam Materials Marketplace (2019), WWF Philippines (2020).

Table 5: Estimates on Plastics Production, Use, Waste, and Recycled across the Value Chain from Existing Material Flow Analyses (kilotonnes/year)

Country	Local Plastics Products	Total Plastics Products	Local Consumption of Products	Exports of Plastics Products	Total Waste	Plastics as Stocks	Landfill Waste Disposed	Valuable Plastics + Industrial Waste Plastics
Malaysia	1,588.38	1,976.71	898.29	1,114.82				
Viet Nam	NAD	3,690.00		3,803.00	2,815.00–3,115.00	NAD	NAD	NAD
Philippines	NAD	2,592.00	2,150.00	442	NAD	NAD	705.00	312.00
Thailand	5,774.87	NAD	6,782.56	2,130.27	3,560.00	NAD	NAD	NAD
Indonesia[a]	NAD	NAD	NAD	NAD	6,800.00	NAD		NAD
Indonesia[b]	NAD	5,760.00	NAD	NAD	2,700.00	3,060.00	1,522.00	NAD

[a] Badan Pusat Statistik, Asosiasi Industri Olefin, Aromatik and Plastik Indonesia Data from a Ministry of Industry presentation.
[b] Global Plastic Action Partnership
NAD = No available data.
Source: Government of Malaysia (2011), Government of Indonesia (2020), Bureecam et al. (2018), Vietnam Materials Marketplace (2019), WWF Philippines (2020).

Table 6: Estimates on Plastics across the Value Chain from Existing Material Flow Analyses (kilotonnes/year)

Country	Recycled	Incinerated	Final Disposal	Landfill	Cement Coprocessing	Plastics Waste to the Ocean	Plastics Waste to the Environment	Total Recyclable Plastics	Local Supply of Plastics Waste	Exports of Plastics Waste	Balance
Malaysia	29.773	NAD	868.52	NAD	NAD	NAD	NAD	150.48	11.49	138.99	NAD
Viet Nam	NAD	NAD	NAD	1,308.00	NAD	NAD	730.00	NAD	NAD	NAD	2,098.00
Philippines	183.00	NAD	706.00	NAD	54.00	NAD	760.00	NAD	NAD	117.00	NAD
Thailand	765.88	220.94	NAD	1,986.64	NAD	0	1,076.41	NAD	NAD	NAD	NAD
Indonesia[a]	680.00	NAD	NAD	1,360.00	NAD	680.00	4,080.00	NAD	NAD	NAD	NAD
Indonesia[b]	1,660.00	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD

[a] Badan Pusat Statistik, Asosiasi Industri Olefin, Aromatik and Plastik Indonesia Data from a Ministry of Industry presentation.
[b] Global Plastic Action Partnership.
NAD = No available data.
Source: Government of Malaysia (2011), Government of Indonesia (2020), Bureecam et al. (2018), Vietnam Materials Marketplace (2019), WWF Philippines (2020).

Table 7: Data Estimates on Resins

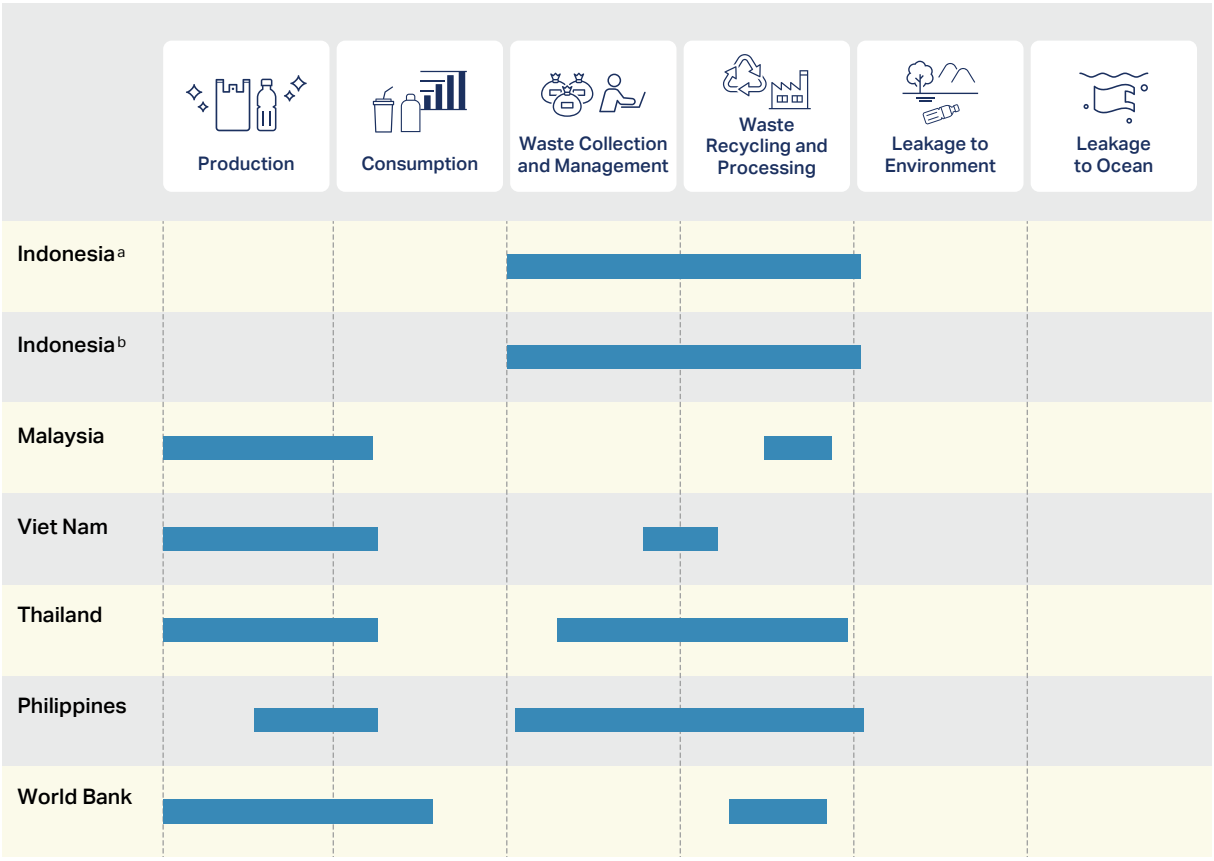
Category	Domestic Products Produced (kt/year)	Total Consumption as Goods + Exports (kt/year)	Waste Generated (kt/year)	Recycled (%)
Philippines (PET)	NAD	195.5	172.9	40–55
Philippines (PP)	213.0	478.4	375.9	25–35
Philippines (HDPE)	NAD	279.6	229.8	25–35
Philippines (LDPE)	NAD	314.2	285.5	5–15
Malaysia (PET)	174.0	180.0	148.1	28–45
Malaysia (PET polyester)	411.0	314.5	30.7	0–5
Malaysia (PP)	576.0	516.0	425.8	25–35
Malaysia (HDPE)	409.5	659.5	429.6	20–35
Malaysia (LDPE)	544.5	764.5	374.2	5–15
Thailand (PET)	662.1	415.1	382.3	31–62
Thailand (PET polyester)	973.9	860.9	437.1	0–5
Thailand (PP)	2,241.0	1,362.0	1,177.8	10–20
Thailand (HDPE)	1,813.0	767.0	658.5	8–25
Thailand (LDPE)	2,072.0	857.1	835.3	9–25

kt = kilotonne, LDPE = low-density polyethylene, LLDPE = linear low-density polyethylene, PET = polyethylene terephthalate, PP = polypropylene.
NAD = No available data.
Sources: World Bank (2020), World Bank (2021a) and World Bank (2021b).

The category 'plastics stocks in use' is the least understood; the MFAs are calculated yearly, so they do not adequately capture data on plastics stocks from previous years and plastics stocks in use. Nevertheless, some studies attempted to calculate plastic stocks in use - The World Bank's studies made this distinction; the Philippines report also assumed 10% of raw materials imported and produced domestically are plastics stocks in use, accounting for polyvinyl chloride and polyethylene used in construction.

Data on plastics are therefore limited, as the studies used only available data on production and waste management. Primary data based on surveys and secondary source estimates are taken as proxy data to calculate recycling data. The MFA mass-balance equation is used to estimate some entries. Conversely, conducting MFAs at the city level had the opposite challenge, as city-level import and export data are non-existent, and waste information is more easily obtainable through local surveys and field studies.

Figure 3: **Scope of Data Availability in the ASEAN Region Based on a Review of Material Flow Analyses**



Note: Primary data are unavailable, highlighting the need for improvement.
[a] Badan Pusat Statistik, Asosiasi Industri Olefin, Aromatik and Plastik Indonesia Data from a Ministry of Industry presentation.
[b] Global Plastic Action Partnership
Source: Authors.

Information on production from statistical agencies and data on recycling industries are available to a certain degree in various sub-categories. Data on waste management, representing waste collection and disposal information, are not readily available, but estimates are easily available, as local governments manage the process of waste collection and sorting. Information on waste characteristics is missing, as disaggregated information is challenging to obtain. Coverage in the two categories of consumption and plastics leakage to the environment and ocean, in terms of the level of scientific understanding as well as data collection, must be significantly increased.

To develop a body of data related to the flow of plastics throughout the whole value chain, data on consumption, recycling, and leakage to the environment and ocean need to be substantially ramped up.

5. Recommendations

Based on the analysis presented in the previous sections, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam are well equipped to collect data on waste management, which can be extended to cover the entire range. Brunei Darussalam, Cambodia, the Lao People's Democratic Republic, and Myanmar have limited capacity in this respect. In both cases, however, data availability on waste management and plastics leakage are incomplete or insufficient; therefore, both sets of countries need to enhance their capacities to generate and to collect the required data.

Organisation for Economic Co-operation and Development (OECD) and developed countries have a robust capacity to collect data on waste management and plastics leakage. However, plastic leakage into the environment and ocean has only recently become an issue of concern; thus, these countries are in the midst of building up these data but have well-defined indicators based on the circular economy and 3Rs. AMS need to develop indicators to assess their progress in waste management and plastics leakage. Data indicators proposed by the European Union, China, and Japan can serve as a guideline, and some based on circular economy principles for plastics are also recommended.

This section elaborates on stages that AMS can follow to develop plastics data and data-driven policymaking on plastics. A five-stage strategy, based on practical considerations, is proposed (Table 8).

Table 8: **Five-Stage Phased Strategy to Build Data on Plastics**

Stage	Approach
1 **Production and waste management**	Build on existing capacity and collect data
2 **Consumption and waste recycling**	Build new capacity and collect data
3 **Leakage to environment and ocean**	Establish knowledge and build new capacity
4 **Indicators**	Monitor and assess policy objectives
5 **Linking plastics and climate adaptation (future issues)**	Explore connections and establish knowledge

Source: Authors.

The proposed five-stage process can be undertaken in sequence or in parallel, with AMS deciding on the actual flow in accordance with their requirements (Figure 4).

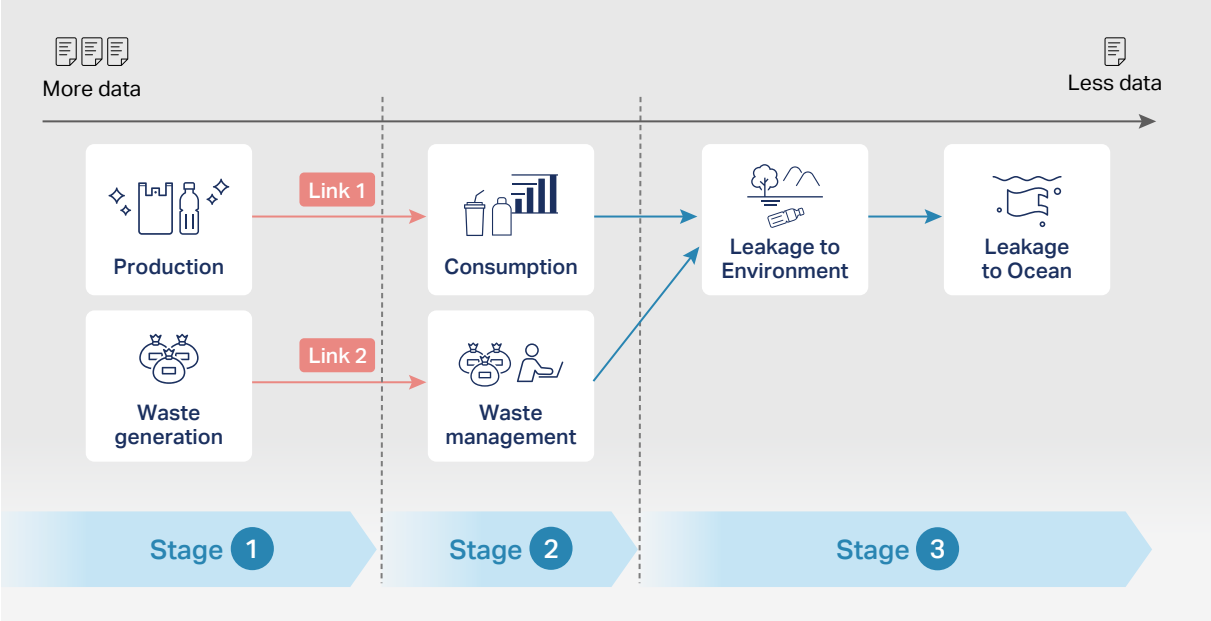
The previous section listed approaches focussing on two distinct data sources – production data and waste generation data – and these two sub-categories can be further exploited to build up data on the plastics value chain. Data on production are linked to consumption (Link 1), and data on waste generation are linked to waste recycling (Link 2); in other words, data on consumption can be developed from those on production, as consumption and production are complementary and sequential activities.

Similarly, data on waste management and recycling are sequential and paired. Thus, data on waste recycling and consumption can be collected through surveys and understood in conjunction with data on production and waste management that serve as a base.

Information on leakage to the environment and ocean is generally based on estimates rather than hard data and can be the final focus. This requires scientific knowledge that is not currently available, necessitating research to develop environmental leakage and marine leakage rate estimates relevant for AMS. This section elaborates on an approach to develop data on the plastics value chain, which comprises the five-stage process below:

(i) Build up data on production and waste generation
  (a) Data on production
  (b) Data on waste generation
(ii) Build up data on consumption and waste management
  (a) Link data from production with consumption
  (b) Link data from waste generation to waste management
(iii) Build up scientific knowledge on plastics leakage, and develop data
(iv) Develop indicators
(v) Link plastics and climate adaptation

Figure 4: **Stages of Building Data for Plastics Waste Management**



Source: Authors

5.1 Stage 1: Build up Data on Production and Waste Generation

Data on production can be obtained from plastics producers, and local authorities can collect data on waste management. Thus, these stakeholders possess some data on plastics, providing fertile ground for building data on the plastics value chain.

5.1.1 Production

Data on production are the easiest to access amongst the sub-categories and can be strengthened by augmenting existing capacity. Plastics producer associations (international and domestic) also maintain data on plastics production. Further, the International Monetary Fund, World Bank, and/or national statistical agencies maintain import and export data. Statistical agencies and governments can therefore emulate such systems to estimate plastics produced locally.

Table 9 lists some standardised codes of items that AMS can track to build up this body of information (see Appendix 3 for a further discussion on codes). The Harmonized System (HS) uses international nomenclature to classify international trade-related statistics and can serve as a reference when developing data.

Table 9: **Harmonized System Codes Used to Collect Data under Production Sub-Categories**

Data	Data Source	HS codes
Imports and exports: virgin plastics	International: International Monetary Fund, World Bank National: country statistics	HS390110 (LDPE) HS390120 (HDPE) HS390210 (PP) HS390319/390311 (PS) HS390330 (ABS) HS390760 (PET/PETE) HS390740 (PC) HS390730 (Epoxide resins) HS390690 (Acrylic) HS390610 (PMMA) HS390410/390422/390421(PVC)

ABS = acrylonitrile butadiene styrene, HDPE = high-density polyethylene, HS = Harmonized System, LDPE = low-density polyethylene, PC = polycarbonate, PET = polyethylene terephthalate, PMMA = polymethyl methacrylate, PP = polypropylene, PS = polystyrene, PVC = polyvinyl chloride.
Note: HS 39 comprises plastics and articles thereof.
Source: Japan Customs (2011).

5.1.2 Waste Management

In terms of data handling, local governments are concerned with waste management, waste collection, and disposal data that can be submitted to regional or national governments. In cases where data are not available, estimates can be made through the combined efforts of local governments – who coordinate waste management and possess key information on waste infrastructure – and experts.

The sub-category of waste management connects the production and consumption sub-categories with waste disposal and recycling. Information on the rate of the waste collection; rates of open dumping, landfill, and incineration; and plastics ratio related to waste are vital for designing recycling, waste reduction, and waste sorting/collection systems (Table 10). In this respect, the capacity of local governments in data collection and other areas represents the linchpin in the chain of information on plastics. Data on the informal sector are also lacking, so local governments can adopt a systematic approach by collecting data via the informal sector and make efforts to formalise operators in this sector.

Table 10: **Data under the Waste Management Sub-Category**

Data	Data Sources
Sewage treatment rate	Ministries of housing or urban development
Leakage of microplastics from road and cosmetics use to water sources	
MSW collection rate	
MSW collection rate (informal)	
MSW open dump	
MSW landfill	
MSW stock (total plastics waste in landfill)	
MSW incineration	

MSW = municipal solid waste.
Source: Authors.

5.2 Stage 2: Build up Data on Consumption and Waste Management

Once a body of data on production and waste management is created, linkages (i.e. Link 1 and Link 2) to create new capacities can be explored, which would bolster the existing body of production and waste management data capacity.

5.2.1 Link 1 Consumption and Plastics in Stocks

After building data on production, data on consumption is the next item of interest. Consumption of plastics is linked to domestically produced and imported plastics and not all plastics are disposed of in the same year; some are also stored in use. This usage depends on the plastics type and product; hence, data on plastics types and their lifetimes are essential.

The consumption of imported plastics products can be tracked with HS codes, and if statistics agencies and governments are to replicate them to categorise domestically consumed plastics products, these agencies can build up a body of information on plastics types and products. Plastic producers are in a position to share such information with national statistics agencies. Surveys on plastics consumption by households is another way to understand the topology of plastics types and products.

Microplastics are less than five millimetres in length. They are of two types: (i) primary microplastics, which are tiny plastic particles used in commercial applications such as cosmetics, textiles, and fishing nets, and (ii) secondary microplastics, which breakdown from larger plastic items, such as plastic bags and PET bottles. On their consumption in households and industries is also necessary to create a fuller picture of the consumption of plastics. Imports of these products can be easily tracked from import data maintained by international agencies, such as the International Monetary Fund and World Bank.

On consumption – one of the most challenging sub-categories in terms of data collection – information needs to be collected indirectly, and for in-use plastics, product usages and lifetimes need to be estimated or validated. One manner is by using the HS code system, as explained above. However, it may not be possible to use HS codes to track all plastics (e.g. those used in automobiles or packaging). Further, a grey area is created due to the system's structure, in which, for example, juice packaging can involve high-density polyethylene or glass as the container – and both are categorised by the same HS code.

Indirect methods are thus also needed to estimate the 'plastics intensity' – that is, the intensity of plastics use and waste generation – of different industrial sectors for plastics usage. For this, input–output tables are used, and studies on waste input–output are also valuable. For example, Nakatani, Maruyama, and Moriguchi (2020) used waste input–output MFA tables to estimate the use of plastics packaging and containers in Japan. Such approaches may be relevant for countries that import plastics used in

automobiles or packaging. Credible production and trade data are necessary to understand the consumption and product lifetimes of various products, which highlights the importance of Link 1.

Table 11: Harmonized System Codes for Collecting Data under the Consumption Sub-Category

Data	Data Source	HS Code (some examples)
Production and consumption by industry	International: IMF, World Bank National: country statistics	HS3917 Tubes, pipes, fittings, and hoses HS3918 Floor, wall, and ceiling coverings HS3919 Self-adhesive plates, sheets, films, foils, strips, tapes, etc. HS3920 Plates, sheets, films, foils, strips, tapes, etc.; non-cellular and not reinforced, laminated HS3921 Other plates, sheets, films, foils, strips, tapes HS3922 Baths, wash-basins, seats and covers, and other building materials HS3923 Sacks and bags, boxes, casings, bottles, and containers HS3924 Tableware, kitchenware, other household articles, and toilet articles HS3925 Windows, doors, frames, tanks, and other building materials HS3926 Other plastics articles
Production and intermediary consumption	International: IMF, World Bank National: country statistics	
Production and household consumption		Imports HS4011 Tyres HS4012 Re-treaded or used pneumatic tyres of rubber; solid or cushion tyres, tyre treads, and tyre flaps, of rubber HS5903 Textile fabrics impregnated, coated, covered, or laminated with plastics HS5407 Woven fabrics of synthetic filament yarn Domestic production – data from producers HS5902 Tyre cord fabric of high-tenacity yarn of nylon or other polyamides, polyesters or viscose rayon, whether or not dipped or impregnated with rubber or plastic

HS = Harmonized System, IMF = International Monetary Fund.
Note: HS 39 comprises plastics and articles thereof.
Source: Japan Customs (2011).

5.2.2 Link 2 Waste Recycling and Recovery

Collecting information on the final disposal of plastics is also critical. In this area, the 3Rs and circular economy approaches encourage the recycling of materials, of which the sorted plastics waste needs to be recycled or recovered as energy. Governments can conduct individual surveys on recycling industries to collect data concerning the situation of plastics that are disposed of. In terms of energy recovery – a popular alternative to recycling – governments can collect data on plastics waste recovered as energy. Further, international agencies maintain data on imported and exported plastics scraps (Table 12).

Table 12: Harmonized System Codes for Collecting Data under Waste Recycling Sub-Category

Data	Data Source	HS Code
Imports and exports: plastics scrap with recycling	International: IMF, World Bank National: country statistics	HS3915 Plastics wastes, parings, scrap

HS = Harmonized System, IMF = International Monetary Fund.
Note: HS 39 comprises plastics and articles thereof.
Source: Japan Customs (2011).

Therefore, obtaining data on recycling and energy-recovered plastics is relatively straightforward, provided that formal players are involved. Making improvements to waste management data will improve the quality of data on recycling and recovery; thus, such improvements are necessary, which highlights the importance of Link 2.

5.3 Stage 3: Build up Scientific Knowledge on Plastics Leakage and Develop Data

Plastics leakage is an emerging issue, so conventional capacity is lacking. This third stage involves building scientific knowledge and collecting data on leakage to the environment. In this context, reference is made to hotspots, environmental leakage rates, and marine leakage rates (i.e. weathering rates), which are affected by geography, climate, and other factors, on which scientific research has not yet been conducted. Local studies and study-based assumptions can be helpful.

There are multiple pathways for plastics to enter the environment. Macroplastics and mismanaged solid waste can leak into the environment due to insufficient waste management, after which macroplastics break down into microplastics. Waste, such as fishing gear from the shipping industry, can directly enter the ocean or aquatic system. Cosmetics, tyre abrasions, city dust, road markings, and textiles can all leak into aquatic environments from human habitats through drainage systems, roads, and other pathways as a direct source of microplastics as well.

The body of information on plastics leakage to the environment is growing; however, while the scientific literature on the topic may increase, the rates of transfer of waste to the environment and ocean remain unknown. In addition to building capacity, knowledge needs to be established to strengthen capacity. For example, the volume of waste leakage from landfills and sewage plants depends on the quality of wastewater treatment and

landfills, so assumptions must be based on local contexts and experiments. This task can be handled specifically by researchers in the region.

5.4 Stage 4: Build Indicators

Once reliable data are provided, indicators can be developed and used to assess policy objectives and further develop, plan, and assess policies and outcomes. Resource efficiency, the 3Rs, and circular economy policies and indicator sets are more prevalent in Japan (Aoki-Suzuki, Bengtsson, Hotta, 2012). In terms of policy, China has followed Japan and the European Union in developing policies on the circular economy and created similar indicators. Further, the Institute for Global Environmental Strategies has published various 3R reports on waste management with indicators: (i) total municipal solid waste generation and municipal solid waste generation per capita; (ii) overall recycling rate and targets; and (iii) recovery rate, collection rate, diversion rate, and cyclic use rate (Liu et al., 2018).

Table 13 lists the latest indicators from the European Union, Japan, and China and matches them with plastics to assist policymakers in ASEAN to develop indicators, assess progress towards the circular economy, and prevent plastics leakage to the ocean. This list can also serve as a reference in developing the circular economy and 3R indicators for AMS, based on local contexts.

Table 13: List of Indicators

	Topic Based on Policy	Indicator Focus	Relevance for Tracking Plastics in ASEAN Member States
EU	Production and consumption	Self-sufficiency of raw materials for production in the EU	Yes
		Green public procurement (as an indicator for financing aspects)	Yes
		Waste generation (as an indicator for consumption aspects)	Yes
	Waste management	Recycling rates (the share of waste recycled)	Yes
		Specific waste streams (e.g. packaging waste, bio-waste, e-waste)	Yes
	Secondary raw materials	Contribution of recycled materials to raw materials demand	Yes
		Trade in recyclable raw materials between EU members and the rest of the world	Yes
	Competitiveness and innovation	Private investment, jobs, and gross value added	Yes
		Patents related to recycling and secondary raw materials as a proxy for innovation	Yes
Japan	Core indicators	Resource productivity	Yes (national plastics consumption/total GDP)
		Material recycling rate	Yes
		Weight of waste for final disposal	Yes
	Measures of efficiency	Type of resources recovered (e.g. type of plastic)	Yes
		Cost-effectiveness of institutional implementation of recycling	Yes
	General indicators	Size of the market for rental and leasing of goods	Yes
		Surveys of consumer awareness and actions related to circularity	Yes
		Per capita generation of municipal waste of consumers	Not applicable
China	Resource output rate	Output of main mineral resources, output of energy	Output of virgin plastics
	Resource consumption rate	Energy consumption per unit of GDP, energy consumption per added industrial value, energy consumption per unit of product in key industrial sectors, water withdrawal per unit of GDP, water withdrawal per added industrial value, water consumption per unit product in key industrial sectors, coefficient of irrigation water utilisation	Specific indicators for plastics, including national plastics consumption/total GDP, energy consumption per added industrial value (plastics), water withdrawal per added industrial value (plastics)
	Integrated resource utilisation rate	Recycling rate of industrial solid waste, industrial water re-use ratio, recycling rate of reclaimed municipal waste water, safe treatment rate of domestic solid waste, recycling rate of iron scrap, recycling rate of non-ferrous metal, recycling rate of waste paper, recycling rate of plastic, recycling rate of rubber	Recycling rate of plastics
	Waste disposal and pollutant emissions	Total amount of industrial solid waste for final disposal, total amount of industrial wastewater discharge, total amount of sulphur dioxide emissions, total amount of COD discharge	Not applicable

COD = chemical oxygen demand, EU = European Union, GDP = gross domestic product.
Source: EASAC (2016).

5.5 Stage 5 : Link Plastics with Climate Adaptation

An understanding of climate, especially rainfall as well as geography and drainage patterns, is necessary to realise the plastics leakage to the ocean and environment, as the flow of plastics mimics that of water, which acts as a carrier. In this respect, climate variability and rainfall play significant roles, as rain can wash plastics waste into oceans, rivers, or storm drains. If no storm water drainage is present, the entire body of plastics waste can leak into the environment, rivers, and ocean. Conversely, plastics can clog drainage systems and flood urban habitats. Improving waste management and drainage systems therefore provide multiple benefits.

Floods and rainfall variability shape the spatial and temporal concentration of plastics waste and microplastics. Plastics pollution needs to be managed at two levels: in the entire plastics value chain, and in the infrastructure related to flood mitigation. In addition to building waste management infrastructure, preventing floods and building proper drainage facilities should be part of the solution to plastics waste and its leakage into the ocean in the tropical ASEAN region. The region is susceptible to flooding and extreme rainfall, which can add further complexity to planning interventions to combat marine plastics pollution. On this point, as a country facing similar climatic phenomena in the region, Japan can share its expertise on infrastructure and flood mitigation. Building data, guidelines, and policies can steer natural hazard management and plastics waste management. Exploring policymaking connections is vital for building effective data-driven policy on plastics, as this link remains hidden and requires exploration in the country context.

6. Conclusion

This report introduced the key themes (i.e. the capacity to collect data and the availability of data on plastics), mapped the current state of waste management data and MFAs in the region by analysing the available data and literature, highlighted insufficiencies in the current waste management structure, and proposed themes and strategies to develop data on plastics for AMS based on current challenges.

It is recommended that data capacity in AMS be developed in a phased and sequential manner, together with indicators that target circular economy principles. Discussions should be initiated to determine suitable pathways, indicators, and methodologies for each AMS. The ASEAN and Economic Research Institute for ASEAN and East Asia (ERIA) Working Group Meeting presents an ideal opportunity to commence discussions on this topic.

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Appendix 1:
Reports Used in the Analysis and Other Information

Table A1: Reports Used in the Study

Country	Commissioned by	Year	Focus
Malaysia	Ministry	2011	Production
Viet Nam	Business association	2018	Production
Indonesia	National Plastic Action Partnership (the country's leading platform for public–private collaboration, comprising 150 members)	2017	Waste management
Thailand	Academia	2013	Academic material flow analysis with scenarios
Philippines	WWF	2019	Balanced, but data on waste management are lacking
Thailand, Malaysia, and Philippines	World Bank	2020; 2021	Production-centric

Source: Government of Malaysia (2011), Government of Indonesia (2020), Bureecam et al. (2018), Vietnam Materials Marketplace (2019), WWF Philippines (2020).

Table A2: Data Sources Used in Report

Country	Production	Consumption	Waste	Recycling
Malaysia	Malaysia External Trade Development Corporation Export and import data for plastics resins, plastics products No reference for local production of plastics products in terms of weight	No reference or available data on local consumption of plastics products	Assumption of 22,500 tonnes/day generated in 2010, based on population in 2010 of 22.5 million × 1.0 kilograms/capita/year × 365 days	No reported data About 29,773 tonnes of recyclable plastics, as reported by concessionaires and local councils
Indonesia	Not included	Not included	Population data obtained from Biro Pusat Statistik combined with tonnage and composition data from Jakstranas (2017–2018) and Adipura (2015)	
Viet Nam	Data sources include Vietnam Plastics Association, Ministry of Industry and Trade, and Ministry of Natural Resources and Environment	41 kilograms/year in 2015	Ministry of Construction in 2014 estimated household waste at about 63,000 tonnes/day Plastics average: 12.36% National Environment Report 2011–2015, household waste collection average of 84%–85%	Landfilled solid waste accounted for 76%–82% of collected waste, of which about 50% was controlled landfill and 50% uncontrolled National Environment Report 2011 recycling stated municipal solid waste around 8%–12% by volume
Philippines	Data for plastics imports Philippine Statistics Authority, and for locally produced plastics resins, the Association of the Petrochemical Manufacturers of the Philippines	20 kilograms/capita/year 16% stored and in use	15.43 kilograms/capita/year post-consumer plastics waste Generation (mass balance)	9% recycling rate and 2% waste to energy rate (calculated based on collected data) Disposal and landfill (mass balance)
Thailand	Field investigations/observations, surveys, and interviews with key stakeholders in waste plastics management chains			
World Bank	National statistical agency, import–export data for resin production, triangulated against industry data, UN Comtrade, and other data sources import/export data	Stakeholder interviews with convertors, brand owners, GA Circular modelling based on above data sources, modelling by GA Circular, developed from regional industry data sources for industry use applications and lifespan	Due to the limited scope of the project and data availability, some aspects of the flow were not examined.	Collected-for-recycling rates derived from data from private sector stakeholders

Source: Government of Malaysia (2011), Government of Indonesia (2020), Bureecam et al. (2018), Vietnam Materials Marketplace (2019), WWF Philippines (2020), World Bank (2020), World Bank (2021a) and World Bank (2021b).

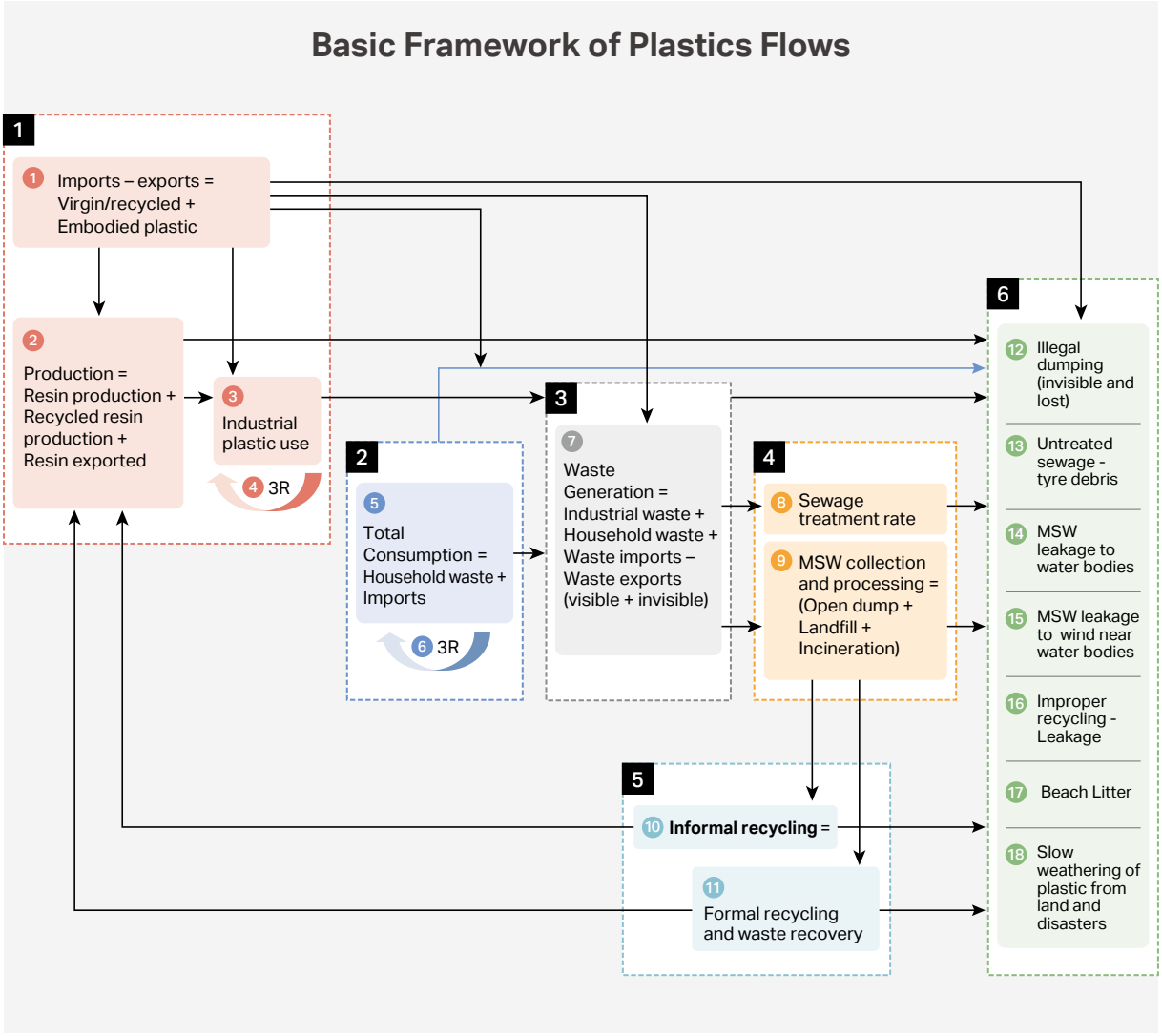
Table A3: **Assumptions Used in the Study**

Country	Production	Consumption	Waste	Fate of Plastic
Malaysia	Production in weight: average price of plastics products divided by resin consumption	Local consumption of products – deducting exports – 1,114,825 tonnes of products exported out of 941,840 tonnes	The waste generation rate of 1.0 kilograms/capita/year is used by projecting the 0.8 kilogram/capita/year rate reported in Ninth Malaysia Development Plan	Tonnage from plastics recyclers; the tonnage of 150,488 tonnes was projected from the average tonnage of recyclable plastics (total of 47,843 tonnes produced, divided by 55 plastics recyclers in the survey, then multiplied by a total of 173 plastics recyclers)
Indonesia	Not highlighted	Not highlighted	Formal collection rate in TPS 3R (Integrated Waste Processing Site – Tempat Pemrosesan Sampah Terpadu [TPST], or 3R Waste Management [TPS 3R]) from Jakstranas data (2017–2018), informal collection from academic papers and industry reports for Jakarta and Surabaya	Fate of plastics calculated from Riset Kesehatan Dasar (2018), and transfer rate for plastics waste from Breaking the Plastic Wave and International Solid Waste Association Plastic Pollution Calculator
Indonesia – (System Change Scenario)	Not highlighted	Not highlighted	Targets a 70% collection rate in 2025, assumes that collection operations cost 10%–30% more than in megacities, collection costs in remote regencies assumed to be 40% higher than megacities on average	Reduced and substitute levers were modelled on Breaking the Plastic Wave adapted for Indonesia
Viet Nam	Imported 6.5 million tonnes of plastics resin and scrap to produce 8.3 million tonnes of products	Not highlighted	Not highlighted	Secondary data from Vietnam Plastics Association, Ministry of Industry and Trade, and Ministry of Natural Resources and Environment and calculated based on the maximum possible rate of domestic scrap (700–1,000 kilotonnes)
Thailand	Analysis and modelling assumptions not available			
Philippines	Calculated based on the total inputs and outputs	10% of both domestic and imported raw materials (to account for polyvinyl chloride and polyethylene commonly used for construction), which are assumed to be stored and in use	Population of 110 million, waste disposal rate of 0.035 kilograms/capita/day from AMH Philippines field data Computed collection efficiency on a national scale is 40%	Capacity of cement companies/recycling companies, and interviews with stakeholders
World Bank	GA Circular analysis, and modelling assumption not available			

Source: Government of Malaysia (2011), Government of Indonesia (2020), Bureecam et al. (2018), Vietnam Materials Marketplace (2019), WWF Philippines (2020), World Bank (2020), World Bank (2021a) and World Bank (2021b).

Appendix 2:

Plastics Value Chain and Associated Data in the ASEAN Region



Source: Authors

Appendix 3: **Harmonized System Codes**

This appendix provides a list of Harmonized System (HS) codes that are directly classified as plastics as well as other HS codes with plastics components. Chapter 39 classifies several plastics products under the 'Plastics and articles thereof' section. Plastics are also present in other traded goods; thus, other HS codes that mention plastics and other associated products, such as nylon and polyester, are listed.

List of Harmonized System Codes Related to Plastics

Code HS Code		Description
I. - PRIMARY FORMS		
39.01		Polymers of ethylene, in primary forms
3901.1		Polyethylene having a specific gravity of less than 0.94
		1. In blocks of irregular shape, lumps, powders (including moulding powders), granules flakes and similar bulk forms
	20	- Linear low-density polyethylene
	60	- Other
	90	2. Other
3901.2		Polyethylene having a specific gravity of 0.94 or more
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3901.3		Ethylene-vinyl acetate copolymers
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3901.9		Other
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
39.02		Polymers of propylene or of other olefins, in primary forms
3902.1		Polypropylene
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes and similar bulk forms
	90	- Other
3902.2		Polyisobutylene
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3902.3		Propylene copolymers
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3902.9		Other
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
39.03		Polymers of styrene, in primary forms
		Polystyrene :
3903.11		Expansible
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3903.19		Other
	10	1. In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	2. Other
3903.2		Styrene-acrylonitrile (SAN) co-polymers
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3903.3		Acrylonitrile-butadiene-styrene (ABS) co-polymers
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3903.9		Other
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other

Code HS Code		Description
39.04		Polymers of vinyl chloride or of other halogenated olefins, in primary forms
3904.1		Poly (vinyl chloride), not mixed with any other substances
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
		Other poly (vinyl chloride) :
3904.21		Non-plasticised
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3904.22		Plasticised
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3904.3		Vinyl chloride-vinyl acetate co-polymers
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3904.4		Other vinyl chloride co-polymers
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3904.5		Vinylidene chloride polymers
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
		Fluoro-polymers :
3904.61		Polytetrafluoroethylene
	10	1. In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	20	2. Other
3904.69		Other
	10	1. In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	20	2. Other
3904.9		Other
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
39.05		Polymers of vinyl acetate or of other vinyl esters, in primary forms; other vinyl polymers in primary forms
		Poly (vinyl acetate) :
3905.12	0	In aqueous dispersion
3905.19	0	Other
		Vinyl acetate co-polymers :
3905.21	0	In aqueous dispersion
3905.29	0	Other
3905.3	0	Poly(vinyl alcohol), whether or not containing unhydrolysed acetate groups
		Other
3905.91		Co-polymers
	10	1. Of polyvinyl butyral blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
		2. Other
	91	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	99	- Other
3905.99	0	Other
39.06		Acrylic polymers in primary forms
3906.1		Poly (methyl methacrylate)
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3906.9		Other
	10	1. In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	2. Other

Code HS Code		Description
39.07		Polyacetals, other polyethers, and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallyl esters, and other polyesters, in primary forms
3907.1	0	Polyacetals
3907.2		Other polyethers
	100	- Polydibromophenylene oxide
		- Other
	910	-- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	990	-- Other
3907.3		Epoxide resins
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3907.4		Polycarbonates
	100	- Tetrabromobisphenol A polycarbonate
	900	- Other
3907.5		Alkyd resins
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3907.6	0	Poly (ethylene terephthalate)
3907.7	0	Poly (lactic acid)
		Other polyesters :
3907.91	0	Unsaturated
3907.99		Other
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
39.08		Polyamides in primary forms
3908.1	0	Polyamide-6, -11, -12, -6,6, -6,9, -6,10 or -6,12
3908.9		Other
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules flakes and similar bulk forms
	90	- Other
39.09		Amino-resins, phenolic resins, and polyurethanes, in primary forms
3909.1	0	Urea resins; thiourea resins
3909.2	0	Melamine resins
3909.3		Other amino-resins
	100	1. Polyethylene polyphenyl polyisocyanate
	900	2. Other
3909.4		Phenolic resins
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3909.5		Polyurethanes
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
39.1		
3910		Silicones in primary forms
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
39.11		Petroleum resins, coumarone-indene resins, polyterpenes, polysulphides, polysulphones, and other products specified in Note 3 to this chapter, not elsewhere specified or included, in primary forms
3911.1		Petroleum resins, coumarone, indene, or coumarone-indene resins and polyterpenes
	10	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other
3911.9		Other
	30	- In blocks of irregular shape, lumps, powders (including moulding powders), granules, flakes, and similar bulk forms
	90	- Other

Code HS Code		Description
39.12		Cellulose and its chemical derivatives, not elsewhere specified or included, in primary forms
		Cellulose acetates
3912.11	0	Non-plasticised
3912.12	0	Plasticised
3912.2	0	Cellulose nitrates (including collodions)
		Cellulose ethers
3912.31	0	Carboxymethylcellulose and its salts
3912.39		Other
	10	- Non-plasticised
	90	- Plasticised
3912.9		Other
	10	- Non-plasticised
	90	- Plasticised
39.13		Natural polymers (e.g. alginic acid) and modified natural polymers (e.g. hardened proteins, chemical derivatives of natural rubber), not elsewhere specified or included, in primary forms
3913.1	0	Alginic acid, its salts, and esters
3913.9	0	Other
39.14		
3914		Ion-exchangers based on polymers of headings 39.01 to 39.13, in primary forms
	10	- Of polystyrene
	20	- Of acrylic resins
	90	- Other
II. - WASTE, PARINGS, AND SCRAP; SEMI-MANUFACTURES; ARTICLES		
39.15		Waste, parings, and scrap, of plastics
3915.1	0	Of polymers of ethylene
3915.2	0	Of polymers of styrene
3915.3	0	Of polymers of vinyl chloride
3915.9	0	Of other plastics
39.16		Monofilament of which any cross-sectional dimension exceeds 1 mm, rods, sticks, and profile shapes, whether or not surface-worked but not otherwise worked, of plastics
3916.1	0	Of polymers of ethylene
3916.2	0	Of polymers of vinyl chloride
3916.9	0	Of other plastics
39.17		Tubes, pipes and hoses, and fittings therefor (e.g. joints, elbows, flanges) of plastics
3917.1		Artificial guts (e.g. sausage casings) of hardened protein or of cellulosic materials
	10	1. Of hardened protein
	20	2. Of cellulosic materials
		Tubes, pipes, and hoses, rigid
3917.21	0	Of polymers of ethylene
3917.22	0	Of polymers of propylene
3917.23	0	Of polymers of vinyl chloride
3917.29	0	Of other plastics
		Other tubes, pipes, and hoses
3917.31	0	Flexible tubes, pipes, and hoses, having a minimum burst pressure of 27.6 MPa
3917.32		Other, not reinforced or otherwise combined with other materials, without fittings
	10	- Of polymers of ethylene
	20	- Of polymers of vinyl chloride
	90	- Of other plastics
3917.33	0	Other, not reinforced or otherwise combined with other materials, with fittings
3917.39		Other
	10	1. Of polymers of vinyl chloride or vinyl acetate
	90	2. Other
3917.4	0	Fittings

Code HS Code		Description
39.18		Floor coverings of plastics, whether or not self-adhesive, in rolls or in the form of tiles; wall or ceiling coverings of plastics, as defined in Note 9 to this chapter
3918.1	0	Of polymers of vinyl chloride
3918.9	0	Of other plastics
39.19		Self-adhesive plates, sheets, film, foil, tape, strip, and other flat shapes, of plastics, whether or not in rolls
3919.1		In rolls of a width not exceeding 20 cm
	10	- Of polymers of propylene
	20	- Of polymers of vinyl chloride
	90	- Of other plastics
3919.9		Other
	10	- Of polymers of ethylene
	30	- Of polymers of vinyl chloride
	50	- Of polyesters
	90	- Other
39.2		Other plates, sheets, film, foil, and strip, of plastics, non-cellular and not reinforced, laminated, supported, or similarly combined with other materials
3920.1	0	Of polymers of ethylene
3920.2	0	Of polymers of propylene
3920.3	0	Of polymers of styrene
		Of polymers of vinyl chloride
3920.43	0	Containing by weight not less than 6% of plasticisers
3920.49	0	Other
		Of acrylic polymers
3920.51	0	Of poly (methyl methacrylate)
3920.59	0	Other
		Of polycarbonates, alkyd resins, polyallyl esters, or other polyesters
3920.61	0	Of polycarbonates
3920.62	0	Of poly (ethylene terephthalate)
3920.63	0	Of unsaturated polyesters
3920.69	0	Of other polyesters
		Of cellulose or its chemical derivatives
3920.71	0	Of regenerated cellulose
3920.73	0	Of cellulose acetate
3920.79		Of other cellulose derivatives
	10	- Of vulcanised fibre
	90	- Other
		Of other plastics
3920.91	0	Of poly (vinyl butyral)
3920.92	0	Of polyamides
3920.93	0	Of amino-resins
3920.94	0	Of phenolic resins
3920.99		Of other plastics
	20	- Of fluorine resins,
	90	- Other
39.21		Other plates, sheets, film, foil, and strip, of plastics
		Cellular
3921.11	0	Of polymers of styrene
3921.12	0	Of polymers of vinyl chloride
3921.13	0	Of polyurethanes
3921.14	0	Of regenerated cellulose
3921.19		Of other plastics
	10	- Of polymers of ethylene
	90	- Other

Code HS Code		Description
3921.9		Other
	10	- Of polymers of ethylene
	20	- Of polymers of propylene
	30	- Of polymers of vinyl chloride
	40	- Of fluorine resins
	60	- Of polyesters
	90	- Other
39.22		Baths, shower-baths, sinks, wash-basins, bidets, lavatory pans, seats and covers, flushing cisterns, and similar sanitary ware, of plastics
3922.1	0	Baths, shower-baths, sinks, and wash-basins
3922.2	0	Lavatory seats and covers
3922.9	0	Other
39.23		Articles for the conveyance or packing of goods, of plastics; stoppers, lids, caps, and other closures, of plastics
3923.1	0	Boxes, cases, crates, and similar articles
		Sacks and bags (including cones)
3923.21	0	Of polymers of ethylene
3923.29	0	Of other plastics
3923.3	0	Carboys, bottles, flasks, and similar articles
3923.4	0	Spools, cops, bobbins, and similar supports
3923.5	0	Stoppers, lids, caps, and other closures
3923.9	0	Other
39.24		Tableware, kitchenware, other household articles, and hygienic or toilet articles, of plastics
3924.1	0	Tableware and kitchenware
3924.9		Other
	10	- Hygienic or toilet articles
	90	- Other
39.25		Builders' ware of plastics, not elsewhere specified or included
3925.1	0	Reservoirs, tanks, vats, and similar containers, of a capacity exceeding 300 l
3925.2	0	Doors, windows, and their frames and thresholds for doors
3925.3	0	Shutters, blinds (including venetian blinds), and similar articles and parts thereof
3925.9	0	Other
39.26		Other articles of plastics and articles of other materials of headings 39.01 to 39.14
3926.1	0	Office or school supplies
3926.2	0	Articles of apparel and clothing accessories (including gloves, mittens, and mitts)
3926.3	0	Fittings for furniture, coachwork, or the like
3926.4	0	Statuettes and other ornamental articles
3926.9		Other
	10	1. Chassis spring and leaves thereof, for motor vehicles
		2. Other
	21	- Woven fabrics obtained from strip, entirely coated or covered on both sides with plastics
	29	- Other

HS = Harmonized System.
Source: Japan Customs (2011).

Other Harmonized System Code Sections Relevant to Plastics

There is a multitude of goods made from plastics not covered in Chapter 39 (Government of United Kingdom, 2012, 2022), such as

- textiles and textile articles in Section XI (e.g. knitted or woven polyester or nylon articles);
- footwear, headgear, umbrellas, walking sticks, whips, or riding crops in Section XII;
- imitation jewellery;
- machines and mechanical or electrical appliances, parts of aircraft, or vehicles in Section XVII;
- optical, photographic, cinematographic, measuring, checking, precision, medical, or surgical instruments; clocks and watches; musical instruments; and accessories in Section XVIII;
- furniture, lamps and lighting fittings, illuminated signs, or prefabricated buildings in Chapter 94;
- toys, games, and sports requisites in Chapter 95;
- brushes, buttons, slide fasteners, combs, mouthpieces or stems for smoking pipes, cigarette holders, pens, or propelling pencils in Chapter 96; and
- plastics that have been printed with motifs, text, or pictures that define the goods (apart from floor, wall, or ceiling coverings) in Chapter 49.

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