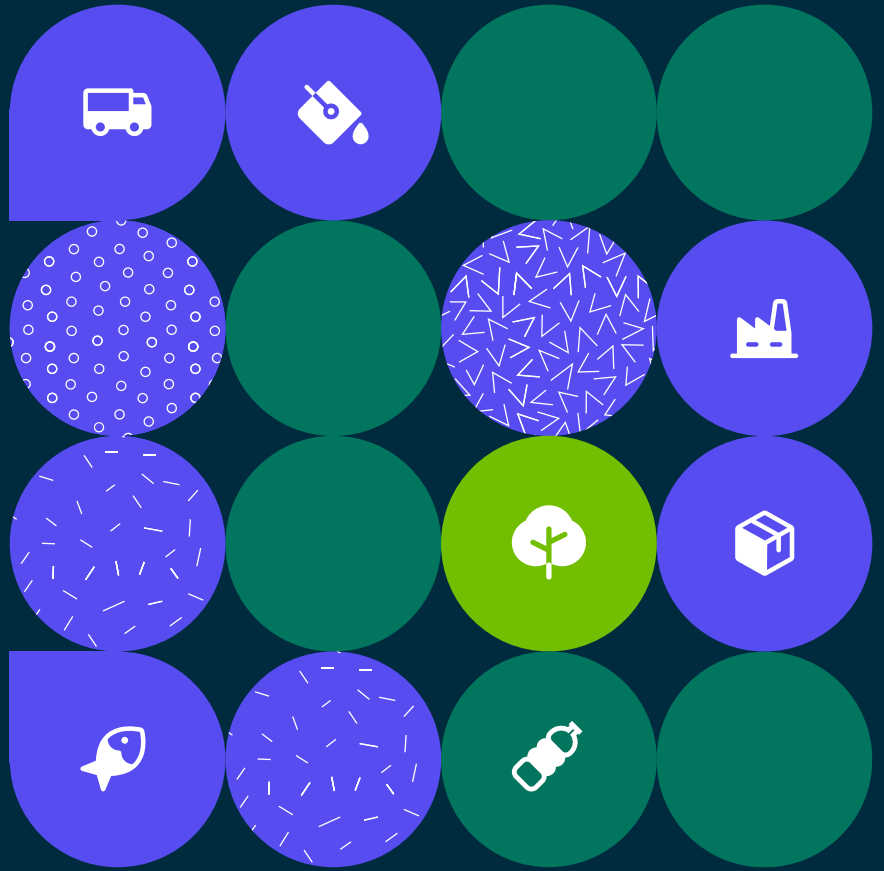
Plastic Footprint Network

Plastic Footprint Guidelines

Module on macroplastic - packaging

Version 1. November 2023



Convened by EA - Earth Action · www.plasticfootprint.earth

Introduction to the Plastic Footprint Network

Leading organizations have united within the Plastic Footprint Network to chart a new, more effective **path toward plastic pollution** mitigation.

The network's first priority was **unifying the framework** for measuring plastic leakage into a **single**, **science-based methodology** for organizations to accurately assess the environmental impact of their plastic use. Over **100 professionals** from **35 organizations** worked to establish the resulting **methodology**, which consists of **11 modules**, all optimized for usability and delivery of **actionable results**.

Objectives

Unifying the methodologies and perspectives of leading scientists, experts, and global practitioners, PFN enables organizations to understand the full impact, or footprint, from the use of plastic in their companies, products, and services.

1. Update and unify plastic footprinting methodologies
2. Ensure the methodology is used consistently by practitioners
3. Disseminate and scale the use of plastic footprinting
4. Explore link with plastic credit schemes, and how to prevent greenwashing claims

What will you find in this module?

The goal of this module is to provide a unified approach to estimate the contribution of plastic packaging waste in the context of a plastic footprint. To achieve this, we will address the following questions:

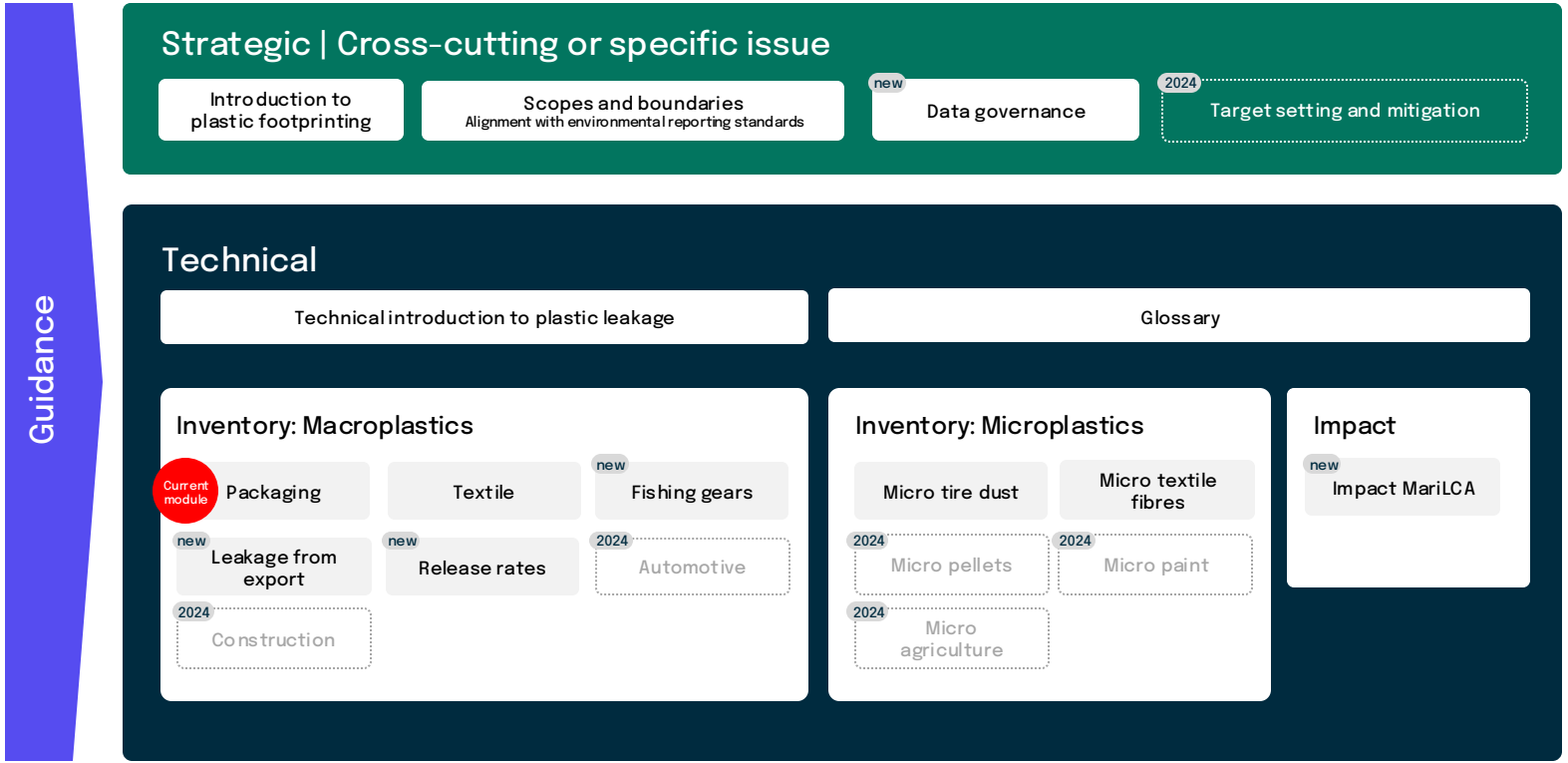
1. What are the essential components of the methodology proposed in this module for estimating the contribution of plastic packaging waste in a plastic footprint?

2. How does this module integrate and build upon existing approaches and literature to ensure a thorough and up-to-date assessment of the plastic footprint?

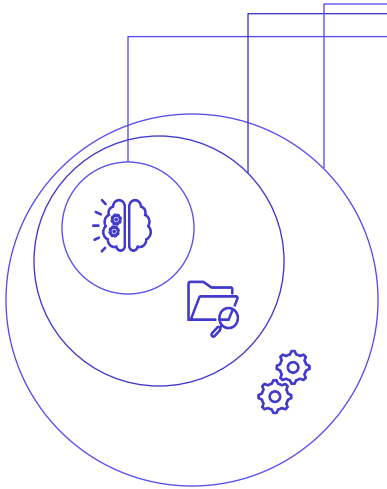
3. What secondary data sources are essential for conducting accurate estimations and how can these inputs be integrated into the overall assessment process?

At the end of this module, the users should know how to include packaging in their plastic footprint assessment.

Where does this module fit in the PFN landscape?



Structure of each technical module



1 Methodological choice

High level overview and different methodologies available at the moment, which one(s) to use and when.

Target audience: busy reader, scientific journalist

2 System map and calculation routes

- The different elements to take into account during a plastic footprint.
- How these elements interact.
- The calculation routes to follow.

Target audience: scientist, experts

3 Key data & background assumptions

The secondary data needed to perform the assessment and the main assumptions for the modeling.

Target audience: scientist aiming at performing a plastic footprint.

Reading keys: Main take away | Supporting information | Key warning

Part. 1

Methodological choice

The different methodologies available at the moment, which one(s) to use and when.

An overview on packaging – definition and effects

Definition: Plastic packaging is a type of plastic used to provide a protective covering to a product. It protects the product during material handling, storage or still transport. In 2021, 44% of the world's plastic production was used for packaging.

How does plastic packaging impact the environment?

Plastic packaging pollutes the environment when it becomes waste at the end of its life and ends up being mismanaged (uncollected, littered or improperly disposed of, for example in a dumpsite or unsanitary landfill).
The physical effect of plastic packaging pollution involves causing harm to various organisms in ecosystems. This harm may be a result of obstruction or physical damage caused by discarded plastic packaging.
Moreover, plastic packaging will degrade in nature. During this process, the packaging releases chemical toxicants and may act as a carrier for foreign species, which can further affect ecosystems negatively.

Photograph from Dustan Woodhouse

Sources: PlasticsEurope, 2022. The Facts. Available online on https://plasticseurope.org/knowledge-hub/plastics-the-facts-2022/ and GESAMP, 2015. Sources, fate and effects of microplastics in the marine environment: a global assessment. Available online on http://www.gesamp.org/publications/reports-and-studies-no-90

An overview on packaging – in numbers

PRODUCTION :

139 millions tons of single-use plastic (most of them being packaging) were produced in 2021 according to the Minderoo Foundation.

Minderoo, Plastic Waste Makers Index 2023. Available online on https://www.minderoo.org/plastic-waste-makers-index;

WASTE :

OECD predicts that there will be 1'014 million tons of plastic waste in 2060. The model predicts that the quantity of plastic waste generated will triple between 2019 and 2060.

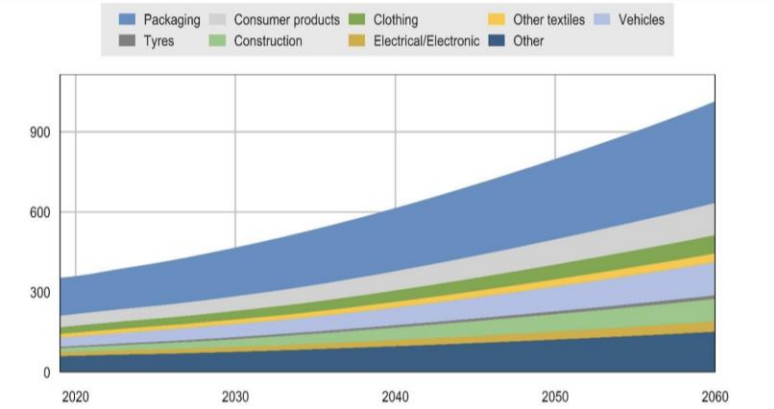
OECD, 2022. Modelling plastics in ENV-Linkages. Available online on https://www.oecd.org/environment/plastics/Technical-Report-Modelling-plastics-in-ENV-Linkages.pdf

LEAK IN THE OCEAN :

The leakage of plastic into the ocean was estimated to be around 11 million tons in 2016.

PEW Charitable Trusts and SystemIQ. "Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution," 2020 Available online on https://www.systemiq.earth/wp-content/uploads/2020/07/BreakingThePlasticWave_MainReport.pdf

Plastic waste by application in million tonnes (Mt)

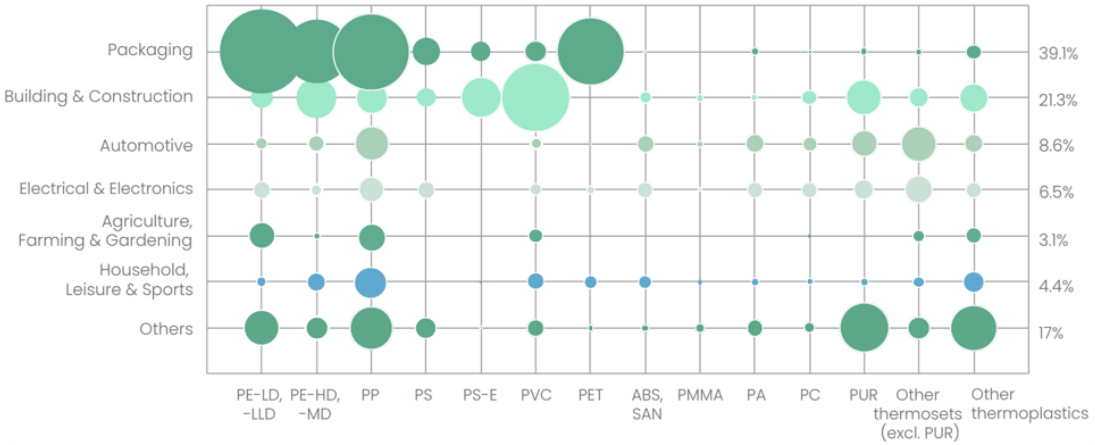


Source: OECD ENV-Linkages model

Which polymers are used in the packaging industry?

The packaging industry has considerably increased its share of plastic production with almost 40% of the plastic production in Europe in 20221. The most used polymers are low density PE, PP, PET and high-density PE.

The example of Europe



Source: PlasticsEurope, 2022. The Facts

Useful definitions

Residual value

A product/polymer residual value can be assumed to be equal to its market price, or recalculated as a function of product homogeneity, time to collect and resale price.

Size

The size of a packaging product is defined by its larger dimension and expressed in cm.

- Small (<5cm) ;
- Medium (5-25 cm) ;
- Large (>25cm)

Mismanaged Waste Index

The ratio (%) between the mismanaged waste and the overall waste produced.

Mismanaged waste includes littered, uncollected, disposed at dumpsites or unsanitary landfills.

Release rate

The fraction of the mismanaged plastic that is ultimately released into a specific environmental compartments : waterways and ocean, soils, other terrestrial environment, air.

In this case, this is the fraction of mismanaged waste which is released to waterways and oceans, or to soil and other terrestrial compartments.

Plastic leakage to the environment

Plastic leakage is defined as the plastic leaving the technosphere (human environment) and accumulating in the natural environment.

Source: Quantis & EA, 2019. Plastic Leak Project. Available online on https://quantis.com/who-we-guide/our-impact/sustainability-initiatives/plastic-leak-project/

Methodology from Plastic Leak Project (PLP)

Leakage calculation for both aquatic and terrestrial environments :

$$\text{Leak\_macro}_{\text{life cycle stage X}} = \sum(\text{MPW}_{\text{at life cycle stage X}}(\text{kg}) * \text{LR}_{\text{country}}(\%) * \text{RelR}(\%) * \text{RedR}(\%))$$

$$\text{With RelR} = \text{RelR}_{\text{terrestrial environment}} \text{ for terrestrial and RelR} = \text{RelR}_{\text{ocean}} + \text{RelR}_{\text{frw}} \text{ for aquatic}$$

Mass of Plastic Waste (MPW)

- Mass of plastic waste generated during the stage X of its life cycle in kg. The life cycle stage could be production, use or end-of-life. In general, most leaks occur at the end-of life.

Release Rate (RelR)

- Release Rate : Fraction in % of lost waste that will end up in a compartment
- Depends on the waste's residual value (low, medium, high value)
- Depends on the waste's size (<5cm, 5-25cm, >25cm)

Loss Rate (LR)

- The lost mass is the mass of packaging waste leaving the well-managed system, which is mismanaged, i.e. uncollected, littered or improperly disposed (unsanitary landfills, dumpsites and open burning).
- The fraction of mismanaged waste on the total waste mass is the loss rate, wich is also called Mismanaged Waste Index (MWI).

Redistribution Rate (RedR)

- Redistribution Rate : Exchange between compartments
- Macroplastics released into freshwater and ocean are considered to reach oceans. Those released into terrestrial compartment remain there. There is no spilt between different compartments.
- Therefore, RedR = 100%

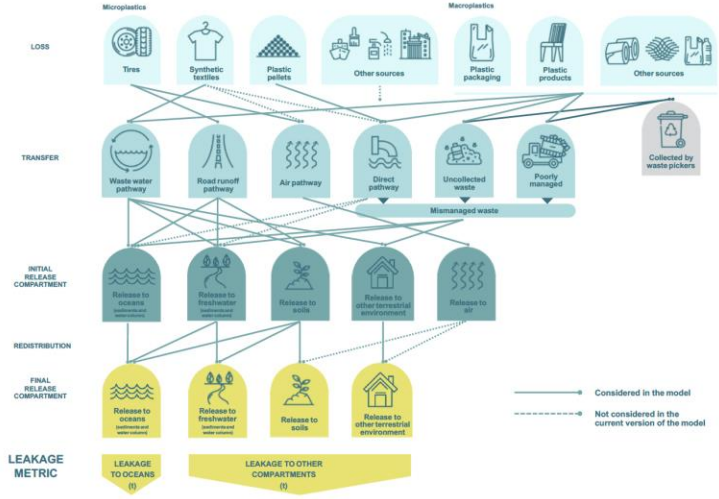
Import/Export between countries of plastic waste is not considered in the PLP

Methodology from Plastic Leak Project (PLP)

This figure represents all the pathways included in the Plastic Leak Project.

Two final environments are taken into account :

- The ocean
- Terrestrial environments.



Source: PLP - Section 8 - Inventory of microplastic leakage from tire abrasion - page 113, 114

Recommended methodological approach

Methodology to apply in case the product is packaging, or the company is a packaging producer, distributor, etc…

Primary data needed:

- Total weight (kg) of plastic packaging produced or used (Number of sale and weight of packaging item produced)
- Type of polymers involved per item (if multi-material, share (%) of polymer used)
- Rigidity/flexibility of plastic packaging and size
- Countries where products are sold, the share and total volume of packaging sold to each of these (annually)

All secondary data are provided in this module

Secondary data needed:

- Mismanaged packaging waste index (country specific and category specific) (MWI)
- Release rates (global) (RR)

Release rates should be adapted to the geography and should vary according to the type of waste mismanagement (uncollected, dumpsite, etc). If this is not possible, use 10% as a global value.

Steps:

1. Collect primary data: the amount of plastic packaging used, countries shares, and if possible polymer and category share in the packaging item.
2. Compute mass: Give the total mass of plastic packaging implied in the country of usage. It is possible to multiply the numbers of sale in this country with the weight of the plastic packaging.
3. Compute lost mass: Apply the country/category specific mismanaged waste index to the quantities that are sold in each country to get the lost mass of packaging in the environment.
4. Compute released mass: Multiply the lost mass with the release rate to get the leakage to ocean (by country and possibly by polymer).

important **5. Leakage from export: Go to module leakage from export to add the mismanaged and released quantities coming from export of packaging waste.**

$$\text{Leak}_{compartment} = \sum_{Country,category} M_{packaging}(t) * share_{category}(\%) * \text{MWI}_{\boldsymbol{country,category}}(\%) * RR_{compartement}(\%)$$

where compartment = ocean, land
category = flexible, rigid (or more granular categorisation if using PLASTEAX data)

Generally speaking, always prefer primary data if available but be sure they are reliable. In case of doubt, use secondary data.

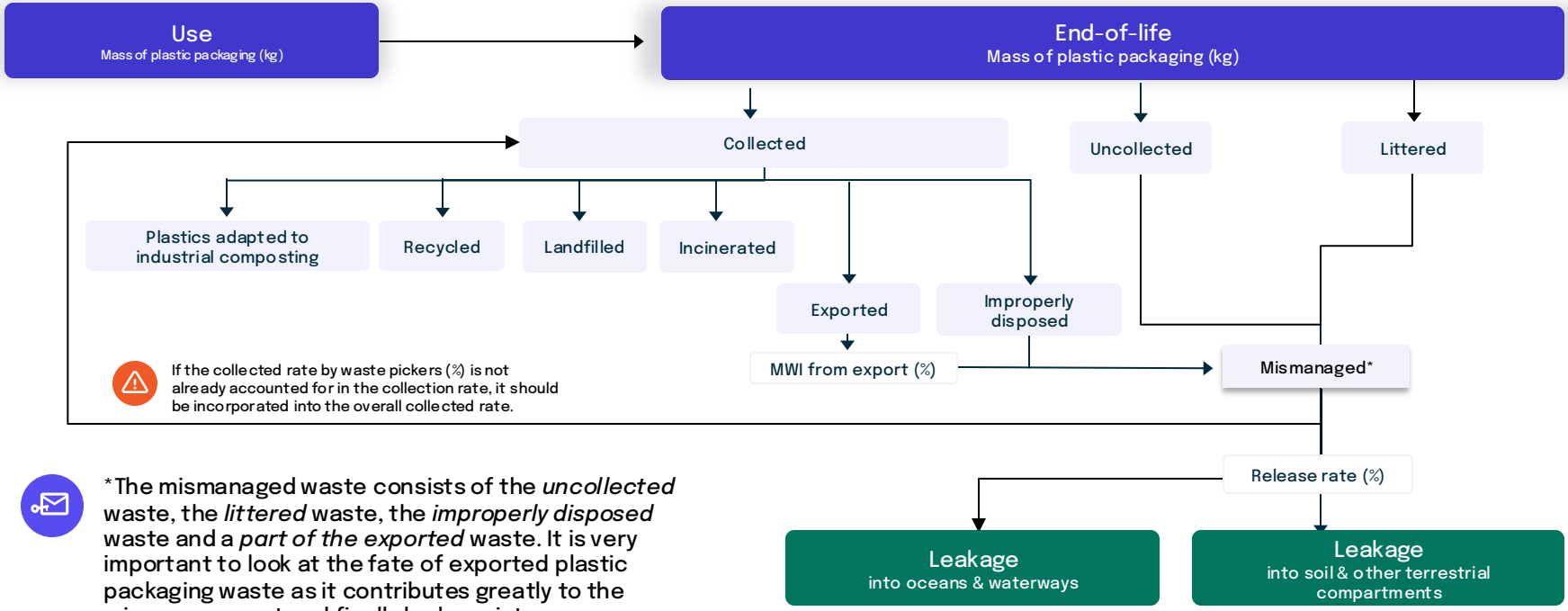
Part. 2

System map & calculation routes

The different elements to take into account during a plastic footprint. How these elements interact? Which calculation routes to follow?

System map

The path of plastic packaging, from use to final release



*The mismanaged waste consists of the *uncollected* waste, the *littered* waste, the *improperly disposed* waste and a *part of the exported* waste. It is very important to look at the fate of exported plastic packaging waste as it contributes greatly to the mismanagement and finally leakage into oceans.

Calculation routes for leakage at end-of-life

$$MW = \sum_{Country,category} M_{packaging}(t) * share_{category}(\%) * MWI_{\boldsymbol{country,category}}(\%)$$

$$Leak_{compartment} = \sum_{Country,category} M_{packaging}(t) * share_{category}(\%) * MWI_{\boldsymbol{country,category}}(\%) * RR_{compartement}(\%)$$

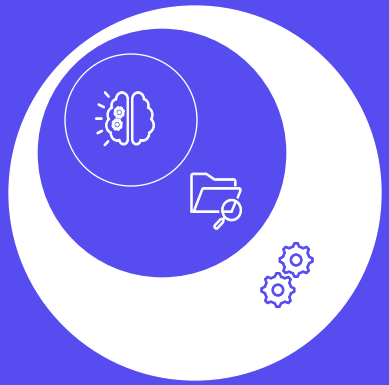
where compartment = ocean, land
Category = flexible, rigid (or more granular categorisation if using PLASTEAX data)

Symbol	Description	Unit	Value	Reference	Additional comments
$M_{packaging}$	Mass of packaging produced	Tonnes	From primary data		
$MWI_{country,category}$	Mismanaged Waste Index	%	From external module ---	Packaging country-specific and category specific data available for certain countries in PLASTEAX. For the others, based on World Bank What a Waste database, improved version by EA.	The required granularity of MWI varies with the specific footprinting purpose and must adhere to module Data Governance.
$share_{category}(\%)$	Percentage of category of total quantity produced	%	From primary data		
RR_{Ocean}	Release rate to ocean and waterways	%	From external module ---		Country specific and to be aligned with module on RR
RR_{Land}	Release rate to soil and other terrestrial compartments	%	From external module ---		Country specific and to be aligned with module on RR
MW	Quantity lost in the environment	Tonnes	Calculated		
$Leak_{compartment}$	Quantity released to ocean and waterways	Tonnes	Calculated		

Part. 3

Data

The secondary data needed to perform the assessment.



Overview from Plastic Leak project

Release rates from PLP

RELEASE RATE MATRIX	Ocean ($RelR_{ocean}$) and freshwater ($RelR_{frw}$)	Terrestrial environment ($RelR_{terenv}$)	Ocean ($RelR_{ocean}$) and freshwater ($RelR_{frw}$)	Terrestrial environment ($RelR_{terenv}$)	Ocean ($RelR_{ocean}$) and freshwater ($RelR_{frw}$)	Terrestrial environment ($RelR_{terenv}$)
	Small Size (<5cm)		Medium Size (5-25cm)		Large Size (>25cm)	
Low residual value	40%	60%	25%	75%	5%	95%
Medium residual value	25%	75%	15%	85%	5%	95%
High residual value	15%	15%	10%	5%	1%	1%

To update, more granularity will be discussed in the module Release Rates

Source: Peano, L., et al. (2020). Plastic Leak Project - Methodological Guidelines, Quantis and EA

Packaging waste management

The user can find data that can be used for packaging in the tool provided with this module.
The generic dataset PLASTEAX (www.plasteax.earth) and dataset What a Waste (dataset on Municipal Solid Waste) are provided for all fates of plastic packaging. For the MWI (Mismanaged Waste Index), data from PLASTEAX for the categories flexible and rigid packaging are also available.

Waste Management Flexible and Rigid Packaging

From PLASTEAX database, MWI and Leakage for flexible and rigid packaging.

More detailed and polymer/category specific data are available in PLASTEAX database.

Country	ISO	Category	MWI Mismanaged (incl. Littering)	LR Leakage rate to Ocean and Waterways	Year
Argentina	ARG	Flexible all polymer	45%	6%	2019
Australia	AUS	Flexible all polymer	9%	1%	2019
Austria	AUT	Flexible all polymer	4%	0%	2019
Bangladesh	BGD	Flexible all polymer	97%	14%	2019
Bulgaria	BGR	Flexible all polymer	58%	6%	2019
Brazil	BRA	Flexible all polymer	49%	7%	2019
Canada	CAN	Flexible all polymer	6%	1%	2019
Switzerland	CHE	Flexible all polymer	6%	1%	2019
Chile	CHL	Flexible all polymer	28%	4%	2019
China	CHN	Flexible all polymer	38%	5%	2019
Colombia	COL	Flexible all polymer	29%	4%	2019
Cyprus	CYP	Flexible all polymer	9%	1%	2019
Czech Republic	CZE	Flexible all polymer	7%	1%	2019
Germany	DEU	Flexible all polymer	4%	0%	2019
Denmark	DNK	Flexible all polymer	5%	0%	2019
Ecuador	ECU	Flexible all polymer	62%	8%	2019
Egypt	EGY	Flexible all polymer	94%	13%	2019
Spain	ESP	Flexible all polymer	14%	1%	2019
Estonia	EST	Flexible all polymer	14%	1%	2019
Finland	FIN	Flexible all polymer	4%	0%	2019
France	FRA	Flexible all polymer	4%	0%	2019
United Kingdom	GBR	Flexible all polymer	4%	0%	2019

Data with greater granularity can be accessed within the PLASTEAX database. However, it's important to note that data requirements can vary depending on specific objectives, so please ensure to review the module on data governance accordingly.

References

1. PlasticsEurope, 2022. The Facts. Available online on https://plasticseurope.org/knowledge-hub/plastics-the-facts-2022/
2. GESAMP, 2015. Sources, fate and effects of microplastics in the marine environment: a global assessment. Available online on http://www.gesamp.org/publications/reports-and-studies-no-90
3. OECD ENV-Linkages model
4. Minderoo, Plastic Waste Makers Index 2023. Available online on https://www.minderoo.org/plastic-waste-makers-index
5. OECD, 2022. Modelling plastics in ENV-Linkages. Available online on https://www.oecd.org/environment/plastics/Technical-Report-Modelling-plastics-in-ENV-Linkages.pdf
6. PEW Charitable Trusts and SystemIQ. “Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution,” 2020 Available online on https://www.systemiq.earth/wp-content/uploads/2020/07/BreakingThePlasticWave_MainReport.pdf
7. PlasticsEurope, 2022. The Facts
8. Peano, L., et al. (2020). Plastic Leak Project - Methodological Guidelines, Quantis and EA. v1.3. Available online on https://quantis.com/who-we-guide/our-impact/sustainability-initiatives/plastic-leak-project
9. PLP – Section 8 - Inventory of microplastic leakage from tire abrasion - page 113, 114

Our commitment to continuous improvement

The Plastic Footprint Network's successful collaboration is built on pillars of:

- Open
- Non-competitive and productive dialog
- Leveraging science and supporting ongoing research
- Broadly empowering global stakeholders (product manufacturers, brand owners, Treaty negotiators, regulators, consultants, NGOs, etc) to effectively do their part to address the plastic pollution crisis.

Given corresponding commitments to transparency and continuous improvement, we welcome and encourage your feedback and input on this document so that the methodology can continue to be enhanced and refined.

Thank you for supporting the work of the Plastic Footprint Network.

Contact us at: contact@plasticfootprint.earth

Our mission is to continuously advance Plastic Footprint Methodology, ensuring it remains at the forefront of sustainable practices and promoting its widespread adoption. By empowering companies to rigorously assess, enhance, and transparently report their plastic footprints, we aim to make significant strides in mitigating the plastic pollution crisis.

Plastic Footprint Network

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The Plastic Footprint Network is convened by EA – Earth Action

This working group was led by:

earth action & south pole

PFN secretariat is led by

earth action & south pole

Scientific Committee

Anthesis, earth action, SYSTEMIQ, Quantis, south pole, MarILCA, CIRAIG, Polytechnique Montréal, Minderoo Foundation, WWF

With the participation from:

Anthesis, ClimeCo, evea, Seven Clean Seas, DECATHLON, Quantis, SYSTEMIQ

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Illustrations by German Kopytkov

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