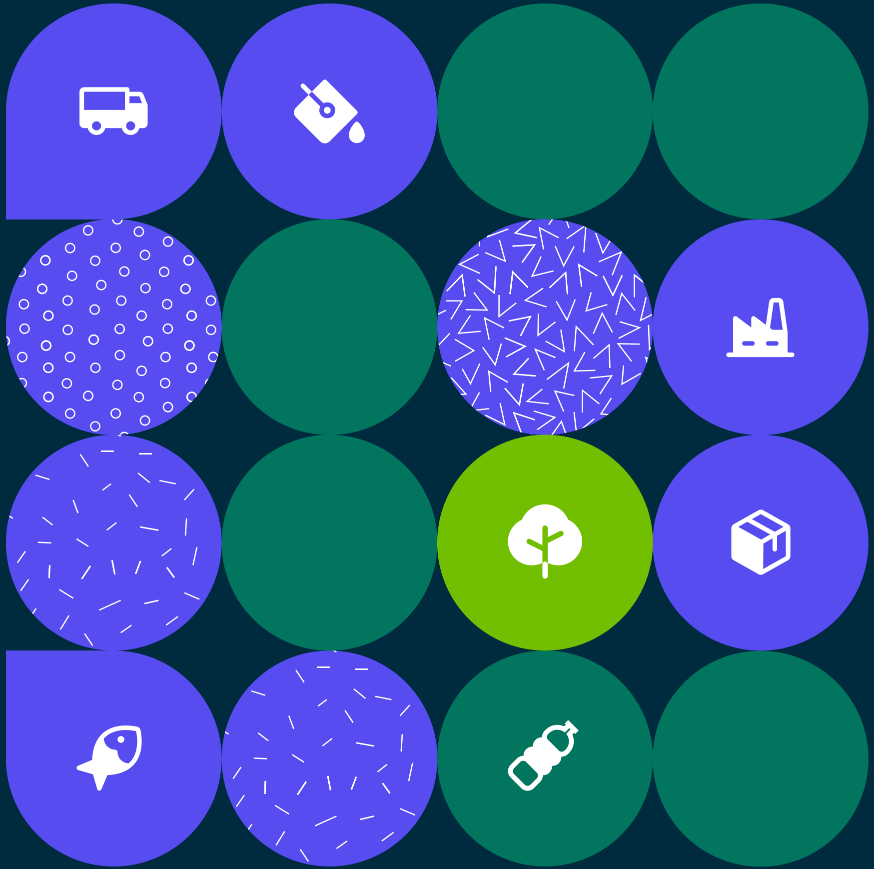
PFN

Plastic Footprint Network

Plastic Footprint Guidelines

Technical introduction to plastic leakage

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**.

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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 are the objectives of this module?

This module introduces the user to the concept of plastic leakage assessment. To achieve this, the following questions will be addressed.

1. What is a plastic leakage assessment, and why is it crucial in understanding the environmental impacts of plastic pollution?

2. How is plastic leakage calculated for macroplastic and microplastic, and what are the key differences in their assessment methodologies?

3. What are the critical considerations in accounting for the plastic leakage of long-lasting products, and how do these impact the overall assessment process?

At the end of this module, users should know what plastic leakage is and know how it is calculated in the case of macroplastic and microplastic.

Where does this module fit in the PFN landscape?

Guidance

Strategic | Cross-cutting or specific issue

- Introduction to plastic footprinting
- Scopes and boundaries — Alignment with environmental reporting standards
- Data governance (new)
- Target setting and mitigation (2024)

Technical

- Technical introduction to plastic leakage (Current module)
- Glossary

Inventory: Macroplastics

- Packaging
- Textile
- Fishing gears (new)
- Leakage from export (new)
- Release rates (new)
- Automotive (2024)
- Construction (2024)

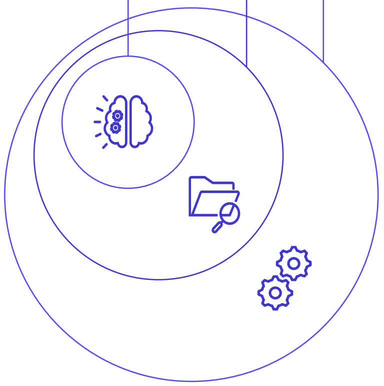
Inventory: Microplastics

- Micro tire dust
- Micro textile fibres
- Micro pellets (2024)
- Micro paint (2024)
- Micro agriculture (2024)

Impact

- Impact MariLCA (new)

Structure of each technical module



1 Introduction

Quick introduction to the concept of a plastic leakage assessment.

Target audience: scientist, experts

2 Methodology

High level overview of a plastic leakage assessment for macroplastics and microplastics.

Target audience: scientist, experts

3 Background assumptions

The main assumptions for the modeling.

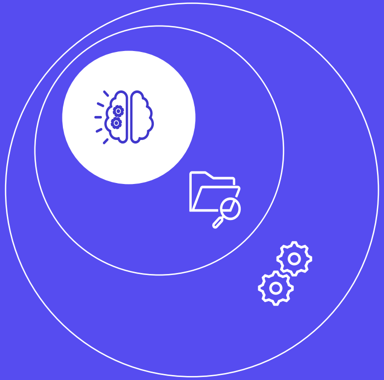
Target audience: scientist aiming at performing a plastic footprint.

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

Part. 1

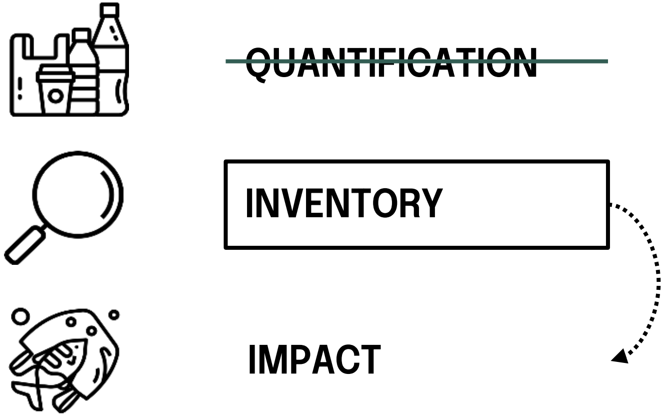
Introduction

Quick introduction to the concept of a plastic leakage assessment.



What is a plastic leakage assessment?

A plastic leakage assessment aims at measuring the plastic leakage, which is defined as the plastic leaving the technosphere and accumulating in the natural environment (be it soil, air, or rivers and ocean).



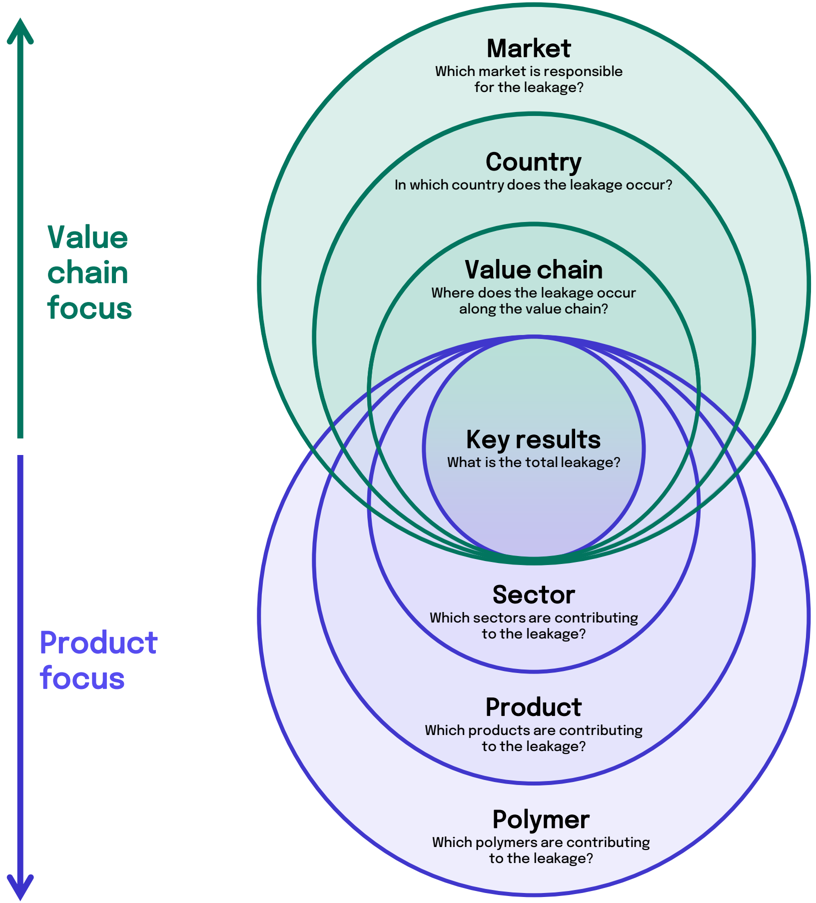
The concept of plastic leakage assessment aims at taking into account the sources and distribution of plastic leakage to different environmental compartments. By doing so, it will become easier to identify the potential impact of plastic leakage on human health and the environment. By understanding the sources and geographical distribution of plastic leakage, measures can be taken to reduce plastic usage or implement better waste management practices to mitigate its impact.

Note : MariLCA is working on a tool to evaluate the environmental impact of plastic pollution on marine life.

Key questions

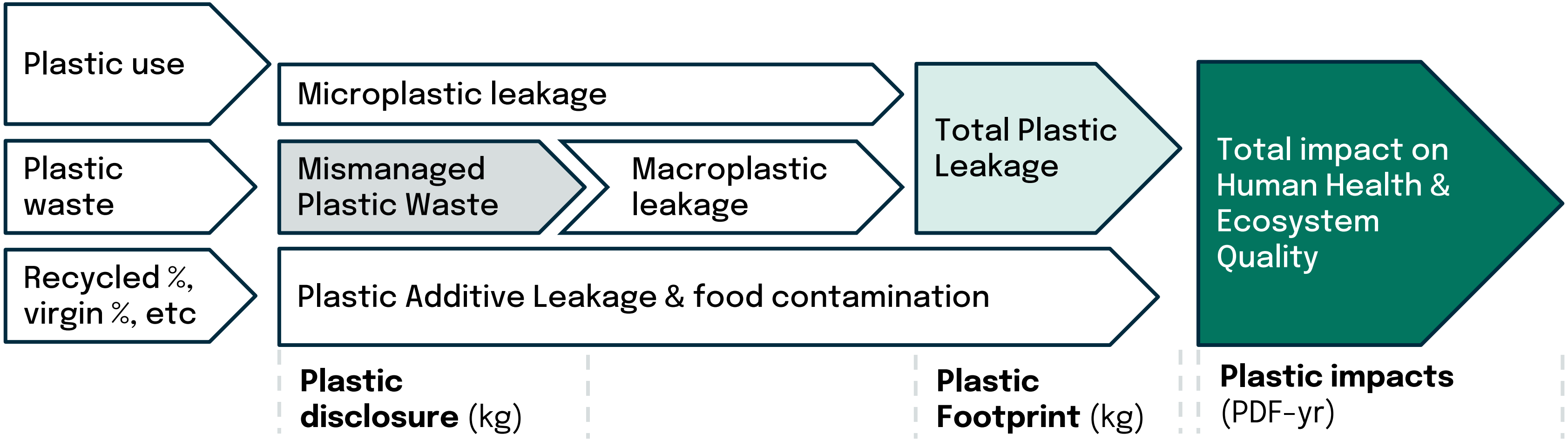
A plastic leakage assessment answers the questions these questions

Answering these questions help identify hotspots and implement the most effective interventions at a systemic level.



Key metrics

A plastic leakage assessment provides metrics to assess plastic mismanagement, leakage into oceans and land and finally, its impacts.



Part. 2

Methodology

High level overview of a plastic leakage assessment for macroplastics and microplastics.

The basics of MACRO plastic leakage calculation

For the leakage stemming from mismanaged macroplastic waste.

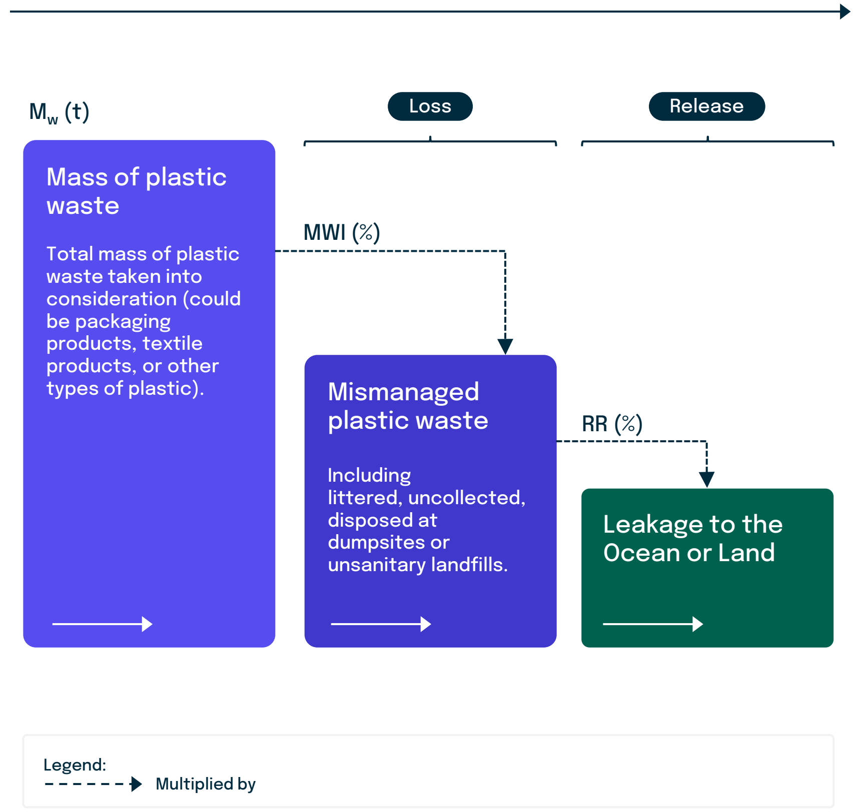
Macroplastics considered in this methodology include packaging, synthetic textile products and fishing nets. Macroplastic from the sectors automotive, construction and other durable goods will be taken into consideration in the next version (2024).

MWI = Mismanaged Waste Index: ratio between mismanaged plastic waste and total mass of plastic waste.

RR = Release Rate: ratio between leakage and total mismanaged waste. It is influenced by different factors, such as the size of the item, as well as the geography of the country, the distance to water and the amount of precipitations.

Release rate are specific to environmental compartments, so there is a RR for Oceans and water ways and another RR for terrestrial compartments.

Leakage = Mass of waste (kg) * Mismanaged Waste Index (%) * Release Rate (%)



MACRO, Loss

Loss rates are specific to the type of macroplastic and strictly depend on the activity which is the driver of the loss.

PACKAGING

Loss of packaging during waste mismanagement

- 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.
- Plastic packaging pollutes the environment when it becomes waste at the end of its life and ends up being mismanaged. 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.

TEXTILE

Loss of textile during waste mismanagement

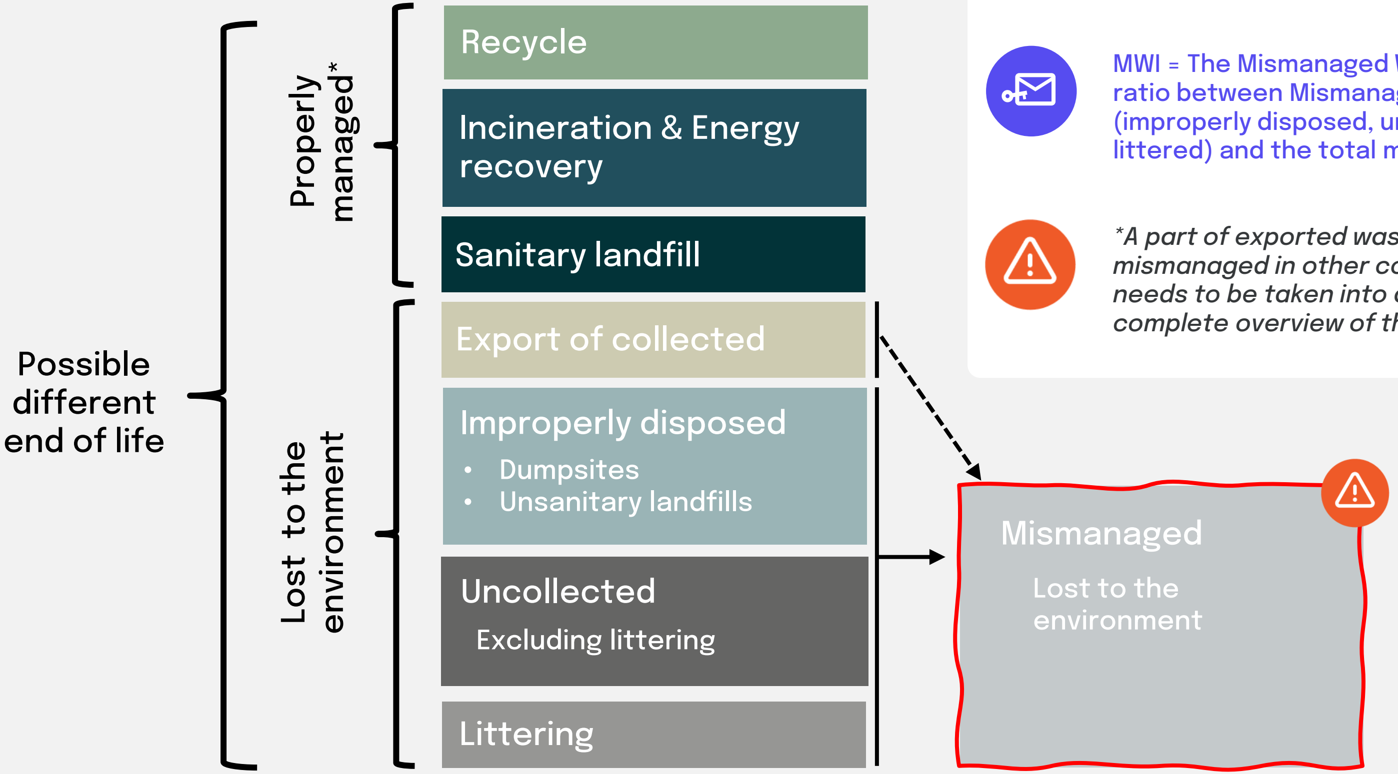
- Synthetic textile become macroplastic pollution when they are improperly disposed, which is to say, when they end up in unsanitary landfills or dumpsites, or they are uncollected or littered. It is estimated that one garbage truck of textiles is landfilled or incinerated every second.
- The export of textile waste from the Global North to the Global South is a significant source of textile macroplastic pollution, as the Global south often lacks the waste infrastructure to properly manage or dispose of the textile waste. Thus, exported textile waste becomes a source of macroplastic leakage to the environment.

FISHING

Loss of fishing gears

- Plastic debris: Fishing nets, often made of non-biodegradable materials, lost or discarded in the ocean contribute to macroplastic pollution and then in time microplastic pollution as it breaks down into smaller plastic fragments, exacerbating the plastic pollution crisis.
- Ghost nets: Abandoned or lost nets, also known as "ghost nets," remain adrift in the ocean, continuing to entangle and trap marine animals for hundreds of years until it breaks down. And it does so indiscriminately of the species.
  Further, trapped or dead animals in the nets attract other marine animals which, as a consequence, also get caught.
  They also damage and destroy coral reefs and essential habitats, disrupting the delicate balance of marine ecosystems.

MACRO, Loss: Mismanaged waste index (MWI)



MWI = The Mismanaged Waste Index is the ratio between Mismanaged plastic waste (improperly disposed, uncollected and littered) and the total mass of plastic waste.

⚠ **A part of exported waste can be mismanaged in other countries and ideally needs to be taken into account for a complete overview of the leakage.*

MACRO, Loss: Littering

LITTERING RATE *Littering*	In-home (non-flushable)		In-home (flushable)		On-the-go	
Small or detachable (< 5cm)	0%		5%	E.g.,cotton swabs	5%	E.g.,wrapper, lid
Medium Size (5-25cm)	0%	E.g.,PET bottle	0%	E.g.,wet wipes	2%	E.g.,cup
Large Size (>25cm)	0%		0%		1%	E.g.,plastic shopping bag

Litt.R = Littering Rate, share of mass of plastic waste that ends up littered.

What is littering ?

“Littering is the improper disposal of small, one-off items, such as throwing a cigarette butt, dropping a snack packet or tossing a plastic drink cup. Most of the time these items end up on the road or sidewalk. They may or may not be removed by municipal street cleaning.”

Source: http://speedy-waste.co.uk/news/whats-the-difference-between-littering-and-fly-tipping

MACRO, Release Rate from Plastic Leak Project

	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 ($RelR_{terenv}$)
RELEASE RATE MATRIX	**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%

RR = Release Rate, ratio between leakage and total mismanaged waste. It is influenced by different factors, such as the size of the item, as well as its flexibility or its likelihood to be blown by the wind, but also the geography of the country, the distance to water and the amount of precipitations.

What is release rate?

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

Source: Boucher, J., Friot, D., 2017. Primary Microplastics in the Oceans: a Global Evaluation of Sources. IUCN

The basics of MICRO plastic leakage calculation

For the leakage stemming from activities creating microplastics.

Microplastics considered in this methodology are microtires and microtextiles.
Microplastics in the form of pellets, micropaint and microplastics used in agriculture will be taken into consideration in the next version (2024).

Activity: driver of the loss (e.g. washing, driving, painting, etc.), determines how much plastic is involved in the system.

LR: Loss Rate : share of mass of plastic removed from the plastic object during the activity (e.g. abrasion of tires during driving or textile fibre shedding during washing).

RR : Release Rate : Fraction of the loss that is released into the different environmental compartment. The infrastructure may capture some of the microplastics during the leakage pathway (e.g. a WWTP), so reducing the release rate.

Release rate are specific to environmental compartments, so there is a RR for Oceans and water ways and another RR for terrestrial compartments.

MICRO, Loss and release

Loss rates are specific to the type of microplastic and strictly depend on the activity which is the driver of the loss.

TEXTILE

Leakage of microfibres during production and usage

The activity of washing textile, both during industrial production and at household level, creates primary microplastics because of the abrasion and shedding of fibres. These microplastics are then discharged in sewage water and could end up in the ocean or captured in the sewage sludge and end up in the soil.

To this we should add also a quantity that is loss into air during usage, but the science is not progressed enough on the topic for us to include it in the methodology.

As we are interested in microplastic, we consider only the synthetic fraction of textile.

Natural fibres may have negative impact on the environment as well, due to presence of additives.

TIRES

Leakage of tire microparticles during rolling

From the road where they are emitted, tire microparticles may disperse and distribute into environmental compartments through different pathways including road runoffs, precipitation and wind circulation. Although partly treated in the wastewater treatment plants within urban areas, a large proportion of particles ultimately end up in the natural ecosystem, namely the soil near roads, other terrestrial environments, freshwater (and eventually groundwater), sediments and the ocean.

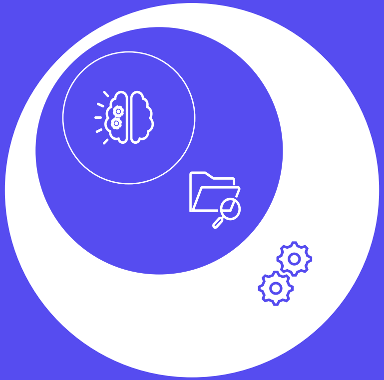
When assessing the microplastic leakage from tires, the focus is on the polymer share of the TRWPs (which represents 17.5 to 25% in mass of the TRWP) according to the assumed mass distribution.

TRWP = Tire and Road Wear Particles, “a complex mixture of tire tread fragment, pavement released due to tire during use on the road surface and road surface elements such as minerals and road dust“ (Jekel 2019)

Part. 3

Background assumptions

The main assumptions for the modeling.



Products lifetime - overview

Plastic footprint assessment is often focused on SUP (single-use plastic) and short-life plastic, i.e. plastic items designed for limited or brief usage before being discarded. Some examples are packaging, sanitary pads, plastic cutlery, plastic straws, etc. For all these products, we can assume that they become waste in the same year they are produced, and the baseline of product generation and waste generation coincide.
For other products, that are more long-life, different assumptions can be made.
Textile for example, are assumed to have a lifetime of 3 to 5 years, depending on the type of products and their quality. Of course, the lifetime can be longer or shorter, and some fast fashion products may even become waste in the same year they are produced.

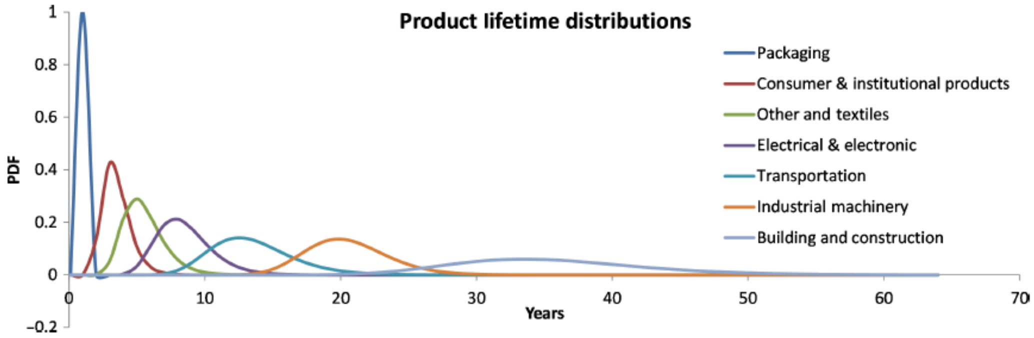


Fig. 1. Product lifetime distributions for the eight industrial use sectors plotted as log-normal probability distribution functions (PDF). Note that sectors other and textiles have the same PDF.

Source: Geyer et al. 2017, Production, use, and fate of all plastics ever made

Long life products – base for discussion

In plastic footprint assessments, we aim to measure a company's plastic leakage. However, it's important to consider that leakage from long-life products might occur many years into the future. This poses a critical question: how do we account for long-life products (such as textiles, equipment, furniture, long-lived packaging, etc.) in plastic footprinting? This is a matter that will be addressed in 2024.

QUESTION 1: When does the waste generation occur?

We have three possible approaches for products sold in year 1.

1. We account for its waste in year 1, independently from their lifetime.
2. We account for its waste in year 1 + 'lifetime of the product', meaning in the year when they most likely become waste based on their expected lifespan.
3. We amortize its waste over its lifetime, accounting for it 1/'years of lifetime' each year.

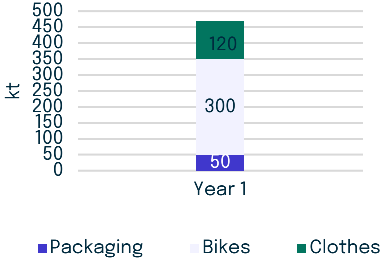
We could have a discount / uncertainty measure in place for leakage occurring at different years: leakage occurring at year 1 is 100% sure, leakage occurring in year 5 is x% sure and so on.

QUESTION 2: How is the generated waste managed?

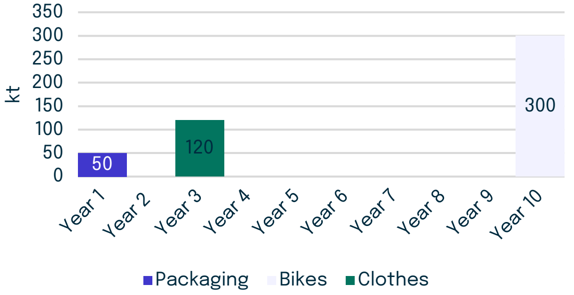
When projecting in the future, do we need to take into consideration the possible modifications to the waste management system?

Long life products – When do their leakage occur?

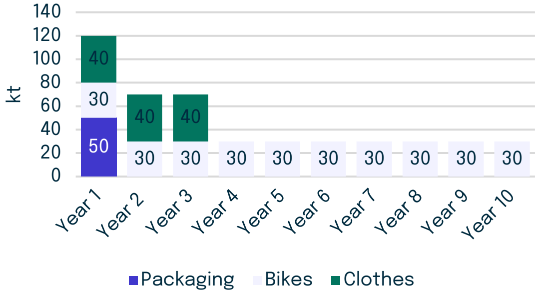
First approach:
Account for waste product in year 1, independently of their lifetime



Second approach:
Account for waste product in year 1 + lifetime of the product (when they most probably become waste)



Third approach:
Amortize the waste over the lifetime, accounting for it 1/(years of lifetime) each year



PROS:
- Easy to implement
- Keeps track of everything
- Aligned with carbon reporting for purchased goods and services

CONS:
- Does not represent reality.
- Long life products are accounted for as short life products
- No incentive to extend product lifetime

In the second approach, for more accuracy, we could model the end-of-life by putting a normal distribution curve around the expected lifetime.

PROS:
- Gives a fair representation of when the impact will occur
- Pushes companies to improve product lifetime AND waste management in the future

CONS:
- Introduces the problem of waste management in the future
- Problems in keeping track of everything (should we look at the past if we are looking at the future?)
- Lack of accuracy (e.g., will the product really be discarded after its projected lifetime?) - can be solved by modelling a normal distribution

PROS:
- Aligned with financial reporting for amortizable assets
- Aligned with carbon reporting of use of sold products, the carbon emissions from their use are split throughout their lifetime
- Pushes companies to improve product lifetime AND waste management in the future

CONS:
- Difficult to implement
- Introduces the problem of double-counting and how to avoid it. The amortization could lead to errors in accuracy, for example in the case of perfect circularity.
- All other cons of second approach

Long life products – waste management

How do we project waste management evolution over time?

- Pessimistic approach : it gets worse
- Conservative approach : it stays the same
- Optimistic approach : it gets better

Different approaches could be used based on

1. the purpose of the plastic footprint (disclosure, reporting, plastic credits, etc..) and/or
2. the knowledge of the geographical area and
3. the company effort (if the company is going to implement new collecting schemes, new recycling schemes, etc then we can adopt the optimistic approach).

In case nothing is known we suggest to adopt the conservative approach. The conservative approach seems to make sense for countries that have an established EPR and waste management. Due to long amortization times of plants and incremental improvement in mechanical recycling and incineration efficiency and considering stagnating collection & sorting systems, a big shift in numbers is not very likely. Also it makes sense where we are looking at a close future (<5 years).

QUESTIONS:

If we take the optimistic approach, how do we model it? Inspiration from LCA/Carbon world (i.e., policies and targets set by governments)? Based on GDP evolution? Breaking the Plastic Wave scenarios?
Same question for pessimistic approach: couple existing waste management capacity with projected increase in plastic production?
How many years in the future should we look at?

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References

1. http://speedy-waste.co.uk/news/whats-the-difference-between-littering-and-fly-tipping
2. Peano, L., et al. (2020). Plastic Leak Project - Methodological Guidelines, Quantis and EA. v1.3.
3. Boucher, J., Friot, D., (2017). Primary Microplastics in the Oceans: a Global Evaluation of Sources. IUCN
4. Geyer et al. (2017), Production, use, and fate of all plastics ever made.

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 manufactuers, 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

PFN

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

The Plastic Footprint Network
is convened by EA – Earth Action

earth action

This working group was led by:

earth action

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

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