NATIONAL GUIDANCE **FOR PLASTIC POLLUTION HOTSPOTTING AND SHAPING ACTION**

FINAL REPORT FOR THAILAND

October 2020

Implemented with ea + Quantis

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SUMMARY AT A GLANCE

Global view on plastic in Thailand

70% Collection rate

58% Mismanaged rate

12% Collection for recycling

9% Domestic recycling rate

336 Kt Leakage

4.8 Kg Per capita leakage

Hotspots

Most critical polymers

- LDPE
- HDPE
- Polyester
- Synthetic Rubber
- PET
- PP
- PS
- PVC

Number of hotspots per waste management stage

- Waste generation
- Waste segregation
- Waste collection
- Leakage while waiting for collection
- Waste related behaviors
- Waste management infrastructure

18 out of 77 Provinces responsible for 50% of the plastic waste leakage

Shaping action from the hotspots

14 Actionable Hotspots

12 Priority Interventions

STRUCTURE AND OBJECTIVE OF THIS PRESENTATION

1

INTRODUCTION TO THE GUIDANCE

Provides the objectives of the Guidance, and introduces its associated workflow and main deliverables.

2

PLASTIC POLLUTION HOTSPOTS

Provides a detailed assessment of plastic leakage across five distinct yet complementary hotspots categories and draws clear statements to help shape action.

3

SHAPING ACTION

Provides a preliminary set of possible interventions and instruments in line with the plastic pollution hotspots results.

4

APPENDICES

Provides additional information including results data tables, hotspot score assessments and modelling assumptions.

5

BIBLIOGRAPHY

STRUCTURE AND OBJECTIVE OF THIS PRESENTATION

1

2

PLASTIC POLLUTION HOTSPOTS

3

4

5

2.1 Country Overview

Provides an outlook of the leakage assessment at the country level.

2.2 Detailed Hotspots Results

Provides a visual analysis and key interpretations across five complementary categories in which hotspots are prioritised based on a plastic leakage assessment.

- A. Polymer Hotspots
- B. Application Hotspots
- C. Sector Hotspots
- D. Regional Hotspots
- E. Waste Management Hotspots

2.3 Actionable Hotspots

Formulates clear statements based on the detailed hotspot analysis to help shape action towards plastic leakage abatement.

STRUCTURE AND OBJECTIVE OF THIS PRESENTATION

1
2
3

SHAPING ACTION

4
5

3.1	Interventions	Suggests meaningful actions based on the actionable hotspots drawn from the detailed plastic hotspot analysis.
3.2	Instruments	Provides a list of possible instruments to implement and monitor progress of suggested interventions.

STRUCTURE AND OBJECTIVE OF THIS PRESENTATION

1

2

3

4 APPENDICES

4.1 Data repository

Provides data tables with the detailed figures behind the graphs.

4.2 Data Quality Assessment

Provides an in-depth analysis of the quality scores behind the graphs.

5 BIBLIOGRAPHY

ICONS AND COLOUR CODE TO GUIDE THE READER

Reference to the methodology (module/tool)

Learnings, that complement the key take aways with more details, of information that is not necessarily visible on the graph

Reference to the appendices

Limitations of the study, can be inaccurate data or gap in the modelling

Key take away as the main conclusion of a graph or result in a writen format

Things we foresee to unlock the limitations. They can serve as guidance for future studies

Methodology and appendices

Sections slides

Results and interpretations

KEY DEFINITIONS

Hotspots: They refer to the most relevant plastic polymers, applications, industrial sectors, regions or waste management stages causing the leakage of plastics into the environment (including land, air, water and marine environment), as well as associated impacts, through the life cycle of plastic products.

Interventions: They are tangible actions that can be taken to mitigate hotspots and are to be prioritised and designed to address the most influential hotspots in the plastic value chain.

Instruments: They are the ways an intervention may be practically implemented through specific regulatory, financial or informative measures, in light of context factors such as country dynamics and existing measures. As an illustrative example, a country may identify "mismanaged polyethylene bottles" as one of its hotspots. A relevant intervention may be an increase in bottle collection rate. A relevant instrument may be to instate a bottle return deposit scheme.

Properly disposed: Waste fraction that is disposed in a waste management system where no leakage is expected to occur, such as an incineration facility or a sanitary landfill. We define a sanitary landfill as a particular area where large quantities of waste are deliberately disposed in a controlled manner (e.g., waste being covered on a daily basis, as well as the bottom of the landfill designed in a way to prevent waste from leaching out). Landfilling is mainly the result of a formal collection sector.

Improperly disposed: Waste fraction that is disposed in a waste management system where leakage is expected to occur, such as a dumpsite or an unsanitary landfill. A dumpsite is a particular area where large quantities of waste are deliberately disposed in an uncontrolled manner, and can be the result of both the formal and informal sectors. A landfill is considered as unsanitary when waste management quality standards are not met, thus entailing a potential for leakage.

Littering: Incorrect disposal of small, one-off items, such as: throwing a cigarette, dropping a crisp packet, or a drink cup. Most of the time these items end-up on the road or side-ways. They may or may not be collected by municipal street cleaning.

Uncollected: Waste fraction (including littering) that is not collected by the formal sector.

Mismanaged waste: It is defined as the sum of uncollected and improperly managed waste. The mismanaged waste index is the ratio of the mismanaged waste and the total waste. It is abbreviated as MWI and its value given in percentage.

Leakage: Plastic that is released to the environment, specifically to rivers and oceans. The leakage rate is ratio between leakage and total waste generated, and its value is given in percentage.

Release rate: It is defined as the ratio between leakage and total mismanaged waste, and its value is given in percentage.

Macro-plastic: Large plastic waste readily visible and with dimensions larger than 5 mm, typically plastic packaging, plastic infrastructure or fishing nets.

Micro-plastic: Small plastic particulates below 5 mm in size and above 1 mm. Two types of micro-plastics are contaminating the world's oceans: primary and secondary micro-plastics. In this study, we focus on primary micro-plastics which are are plastics directly released into the environment in the form of small particulates.

Mass balance: Mass balancing is a mathematical process aiming at equalising inputs and outputs of a given material flow across a system boundary. In our case, inputs consist of domestic production and imports while outputs consists of exports, waste generation and increase of stock. A mass balance allows to check data consistency and helps reconcile different datasets when needed.

Formal sector: Waste management activities planned, sponsored, financed, carried out or regulated and/or recognized by the local authorities or their agents, usually through contracts, licenses or concessions

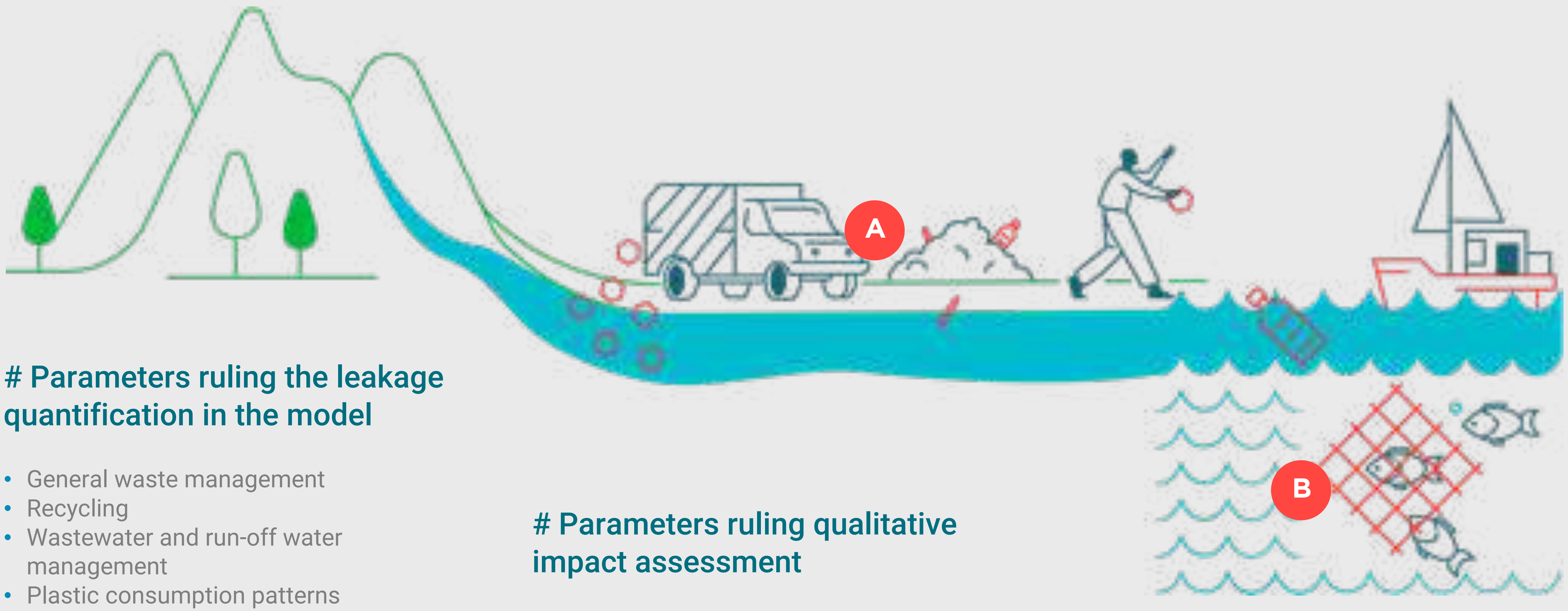
Informal sector: Individuals or a group of individuals who are involved in waste management activities, but are not formally registered or formally responsible for providing waste management services. Newly established formalized organizations of such individuals; for example, cooperatives, social enterprises and programs led by non-governmental organizations (NGOs), can also be considered as the informal sector for the purpose of this methodology.

For additional definitions, please refer to the publication: United Nations Environment Programme (2020). National guidance for plastic pollution hotspotting and shaping action - Introduction report. Boucher J.,; M. Zgola, et al. United Nations Environment Programme. Nairobi, Kenya. Definitions of formal and informal sector are taken from: United Nations Framework Convention On Climate Change - Clean Development Mechanism (UNFCCC-CDM) , 2010, AMS-III.AJ. EB70, Annex 28 - Small-scale Methodology: Recovery and Recycling of Materials from Solid Wastes.

WHAT WE MEAN BY PLASTIC LEAKAGE / IMPACTS

A By plastic leakage we refer to a quantity of plastic entering rivers and the oceans

B By plastic impact we refer to a potential effect the leaked plastic may have on ecosystems and/or human health

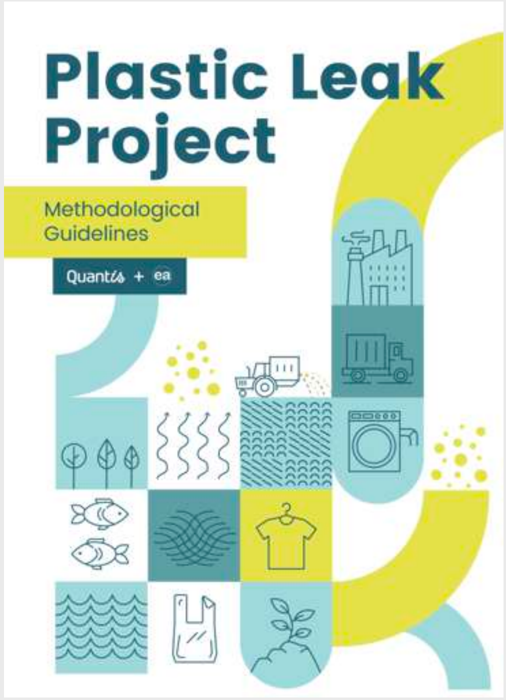


Parameters ruling the leakage quantification in the model

- General waste management
- Recycling
- Wastewater and run-off water management
- Plastic consumption patterns
- Population density
- Value of the polymer
- Size of application
- Type of use
- Distance to shore and rivers
- Hydrological patterns

Parameters ruling qualitative impact assessment

- Beach clean-up data
- Size and shape of applications
- Presence of toxic substances in polymers or additives



Leaked plastic stems from uncollected and improperly disposed waste.

Note that the rest of the uncollected and improperly disposed plastic may be leaking into other environmental compartments such as “soil”, “air” or “other terrestrial compartment” as defined in the Plastic Leak Project (PLP) guidance.

This information is not required to shape action but could be calculated using the PLP guidance.

LINK to the PLP guidance

LEAKAGE PATHWAY AT A GLANCE

KEY ABBREVIATIONS AND UNITS

Polymer abbreviations

NAME	ABBREVIATION
Polyethylene Terephthalate	PET*
Polypropylene	PP
Low-density Polyethylene	LDPE
High-density Polyethylene	HDPE
Polystyrene	PS
Polyvinyl Chloride	PVC

Calculation variables

NAME	ABBREVIATION
Mismanaged waste index	MWI
Leakage rate	LR
Release rate	RR

Key units

NAME	SYMBOL
Gram	g
Kilogram	kg
Tonne	t
Kilo tonne (or thousand tonne)	kt
Mega tonne (or million tonne)	Mt
Kilometer	km
Square kilometer	km^2

*In this study, PET resins are distinguished from Polyester which includes polyester fibres, polyester films and polyester engineered resins.

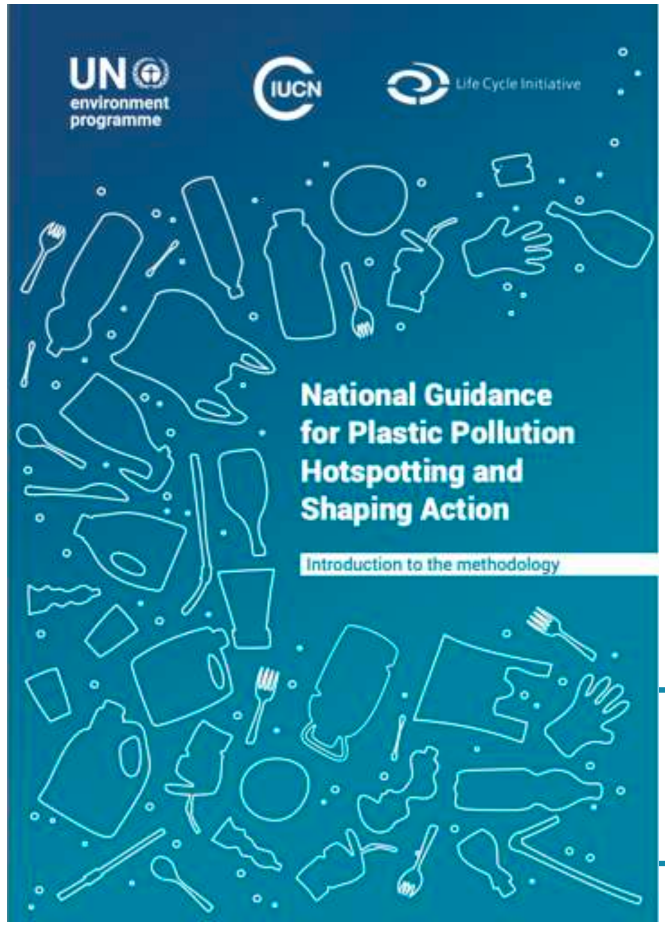
1 INTRODUCTION TO THE GUIDANCE

National guidance for plastic pollution hotspotting and shaping action

SCHEMATIC OF THE GUIDANCE

The guidance allows users to:

1. Generate country-specific plastic waste management datasets
2. Identify plastic leakage and pollution hotspots
3. Prioritise actions



[LINK to the guidance]

RELATIONSHIP BETWEEN HOTSPOTS, INTERVENTIONS AND INSTRUMENTS

The guidance is built upon the backbone of three questions: where to act? (Hotspots), what to do? (Interventions) and how to do it? (Instruments)

1 — **Hotspots**: A component of the system that directly or indirectly contributes to the magnitude of plastic leakage and/or its impacts. It can be a component of the system, a type of product/polymer or a region within the country.

2 — **Interventions**: An action that can be taken to mitigate the leakage from a given hotspot or reduce its impacts.

3 — **Instruments**: A practical way to implement the intervention and enable progress.

Examples

Hotspots

- Low recycling rate for flexible packaging
- Single-use plastic bags
- Low waste collection rate in rural areas

Interventions

- Implement better eco-design + chemical recycling
- Reduce plastic bag use in the country
- Increase waste collection

Instruments

- Develop funding mechanism through EPR scheme
- Ban on plastic bags / introduce re-usable alternative
- Help local waste pickers to create a revenue stream

STRUCTURE OF TOOLS ASSOCIATED WITH EACH MODULE

MODULES	INPUT TOOLS	ASSESSMENT TOOLS			OUTPUT TOOLS
T1 INVENTORY OF PLASTIC FLOWS	T1.1 Inventory of data sources and data gaps; T1.2 Data collection templates; T1.3 Fisheries model canvas	T1.4 COMTRADE data extraction			A Raw data repository
T2 CHARACTERISATION OF WASTE MANAGEMENT	T2.1 Inventory of data sources and data gaps; T2.2 Data collection templates; T2.3 Waste model canvas				
T3 MODELLING POLYMER/APPLICATION/ SECTOR HOTSPOTS	A	T3.1 Fisheries leakage calculation	T3.2 Polymer application/ sector MFA & leakage calculation	T3.3 MFA modelling quality assessment; T3.4 Polymer/application/sector hotspots prioritization canvas	B Project data repository
T4 IDENTIFICATION OF WASTE MANAGEMENT HOTSPOTS		T4.1 Waste management hotspot canvas			
T5 MODELLING REGIONAL HOTPOTS	T5.1 Waste data by archetype	T5.2 GIS model	T5.3 Leakage calculation	T5.4 GIS modelling quality assessment	
T6 ASSESSING IMPACTS		T6.1 Plastic application impact assessment			
S1 ACTIONABLE HOTSPOT FORMULATION	T3.4; B				C Actionable hotspot formulation
S2 INTERVENTION IDENTIFICATION	S2.1 Interventions library template	S2.2 Interventions selection	S2.3 Interventions prioritisation		D Final intervention and instrument pairing
S3 INSTRUMENT ALIGNMENT	S3.1 Instruments library template	S3.2 Instruments selection	S3.3 Instruments prioritisation		

DISCLAIMER

This report intends to present **only the results of the analysis** and not the detailed modelling process.

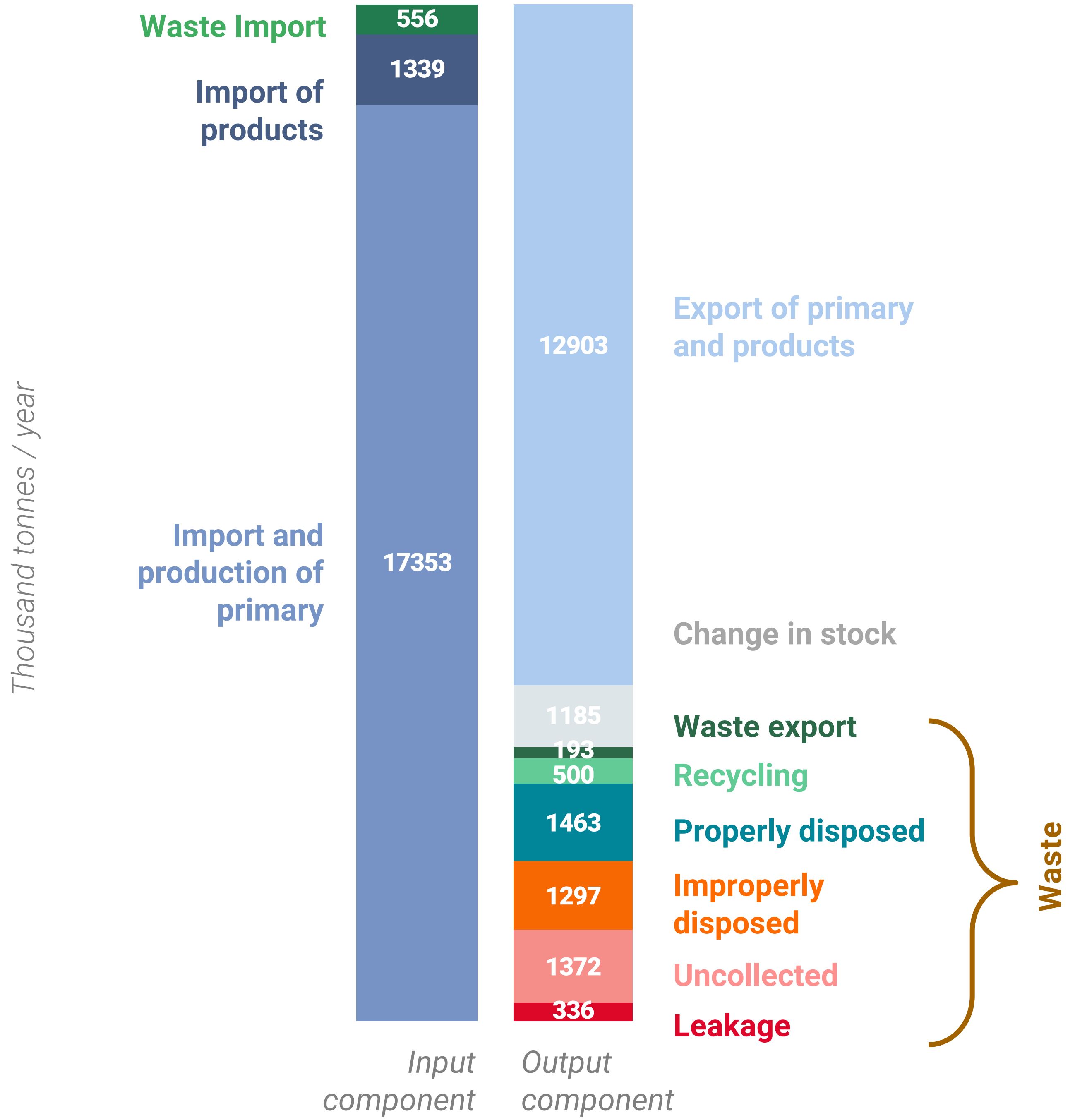
Additional information on the methodology and modelling process can be found directly in the **modules and tools** associated with the guidance and highlighted by this icon.

2 PLASTIC POLLUTION HOTSPOTS

2.1 COUNTRY OVERVIEW

COUNTRY PLASTIC MATERIAL FLOW [2018]

Summary of the results for all plastics in the country

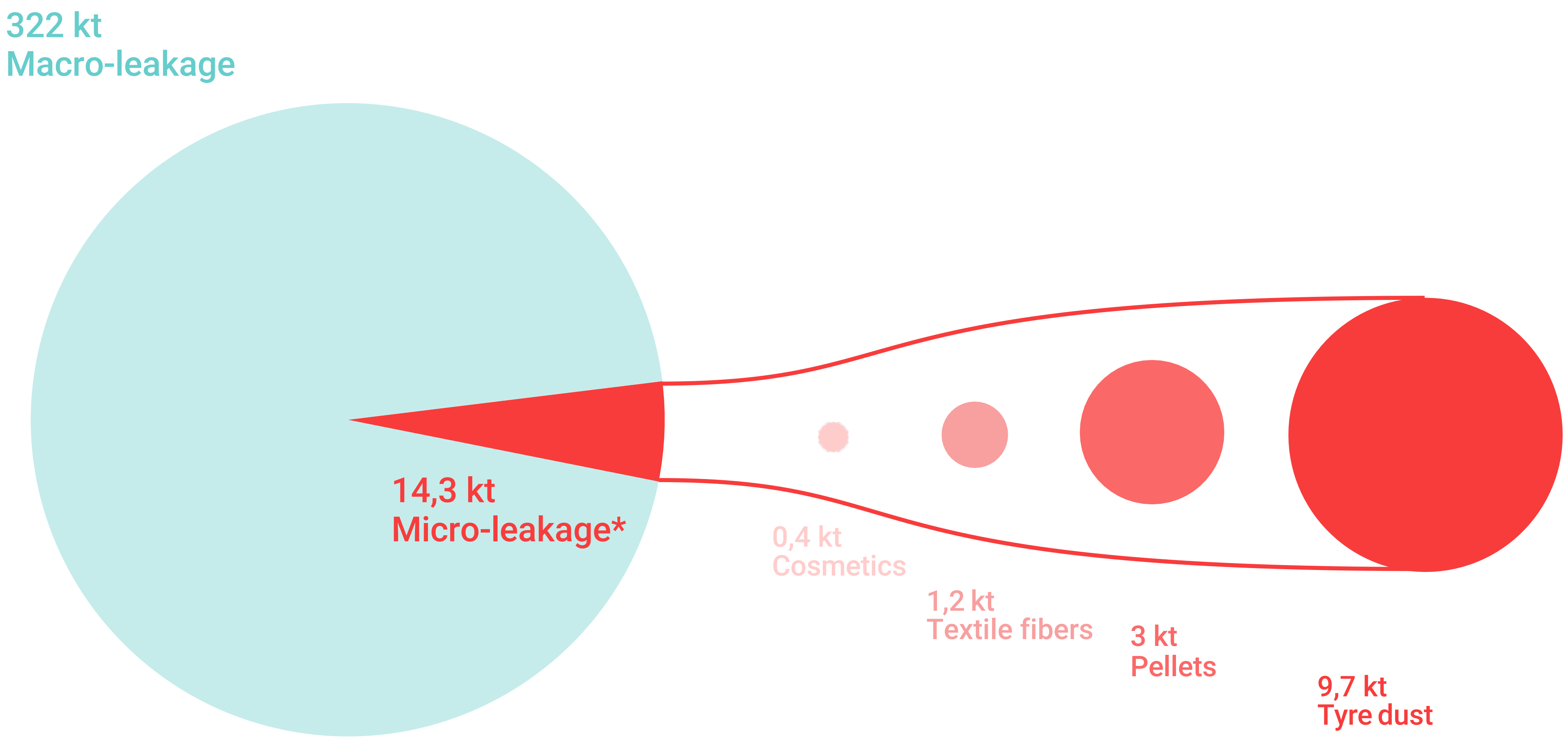


Key take-aways

- Thailand is a producer and exporter of plastic: more than half of the plastic produced (or imported) in Thailand ends up being exported.
- The average per capita plastic waste generation is **74 kg/capita/year**, more than twice the world average of 29 kg/capita/year (in 2018).
- There is more plastic waste imported (556 kt), than what the country can recycle (500 kt).
- Around **41%** of the collected plastic waste is improperly managed.
- **30%** of the plastic waste in the country is uncollected.
- In Thailand, **336 thousand tonnes** of plastic leaks to the ocean every year. This is equivalent to a plastic leakage of **4,8 kg/capita/year**.

* Average plastic waste generation per capita values are derived from the What a Waste 2.0 database (*Kaza et al., 2018*)

MACRO-LEAKAGE VS MICRO-LEAKAGE [2018]



TO WATERWAYS AND OCEANS:

336 kt

Key take-aways

- **Micro-leakage contributes to 4% of the overall country leakage.** This small contribution of micro-plastics is common for countries where the solid waste is still largely mismanaged.

Learnings

While tyre dust is often the first cause of plastic primary micro-leakage in a country, it is unusual though for micro-leakage of primary pellets to rank second in absolute leakage (with micro-leakage of pellets coming from losses during production and transport process). This can be explained by the fact that Thailand and is a big plastic producer and exporter: it produces 4% of the total plastic worldwide, while its population accounts for less than 1% of the world population.

More details available in Appendices

* The methodology used to calculate micro-plastics leakage is based on the Plastic Leak Project (2019)

OPEN BURNING: A ROUGH ESTIMATE

3’005 kt

Total plastic mismanaged

37%

released into the air as noxious chemical substances through open burning

POLLUTION TO THE AIR:

1’112 kt

Key take-aways

- **Open burning** of mismanaged plastic waste in Thailand poses significant risks for human health (due to the release of noxious chemical substances such as dioxine and particulate matters) and directly contributes to climate change.

Limitations

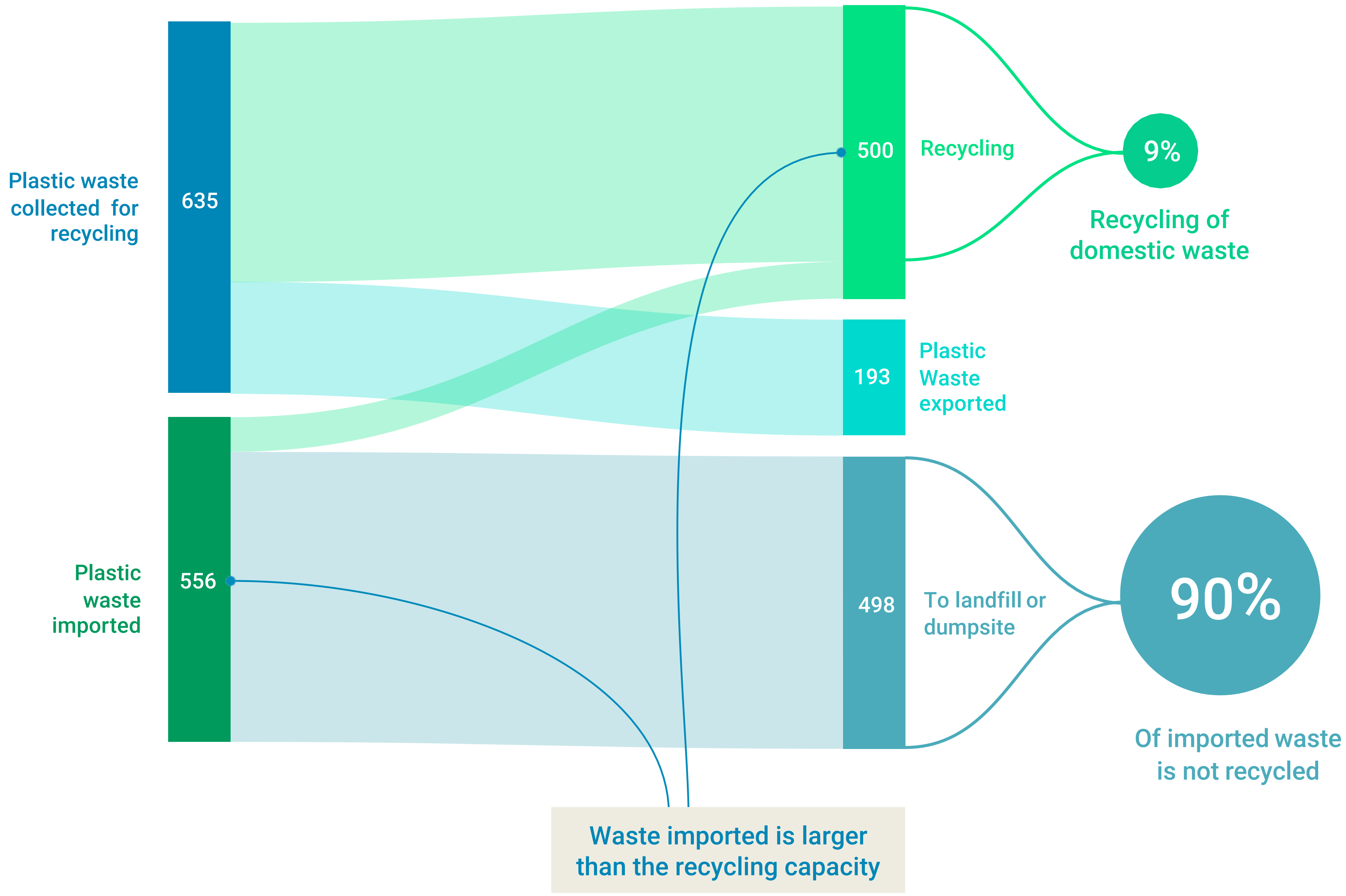
Although we do not have specific data on burning, we suggest a rough estimate of how much plastic could be polluting the air by using the assumptions made in the *Breaking the Plastic Wave* report (*Lau et al, 2020*): 60% of uncollected plastic waste and 13 % of plastic waste at dumpsites are burnt on average worldwide. In the case of Thailand, it would translate into having 37% of the total plastic mismanaged ending up polluting the air through open burning.

Unlocking limitations

Investigate open burning practices and conduct field studies to estimate the amount of mismanaged plastic waste that is burned.

RECYCLING: IMPORT OF WASTE AND RECYCLING CAPACITY

Quantities in thousand tonnes



Key take-aways

- Thailand's recycling capacity is not sufficient to recycle both imported waste and domestic waste collected for recycling.

Learnings

12% of the plastic waste generated in Thailand is collected for recycling. Of it, some is exported, but most is locally recycled (recycling rate: 9%). Since the total recycling capacity in the country is 500 kt (*PCD, 2018*), and 442 kt are used to recycle domestic plastic waste, most of the 556kt of plastic waste imported into Thailand in 2018 ended up in landfills or dumpsites.

Limitations

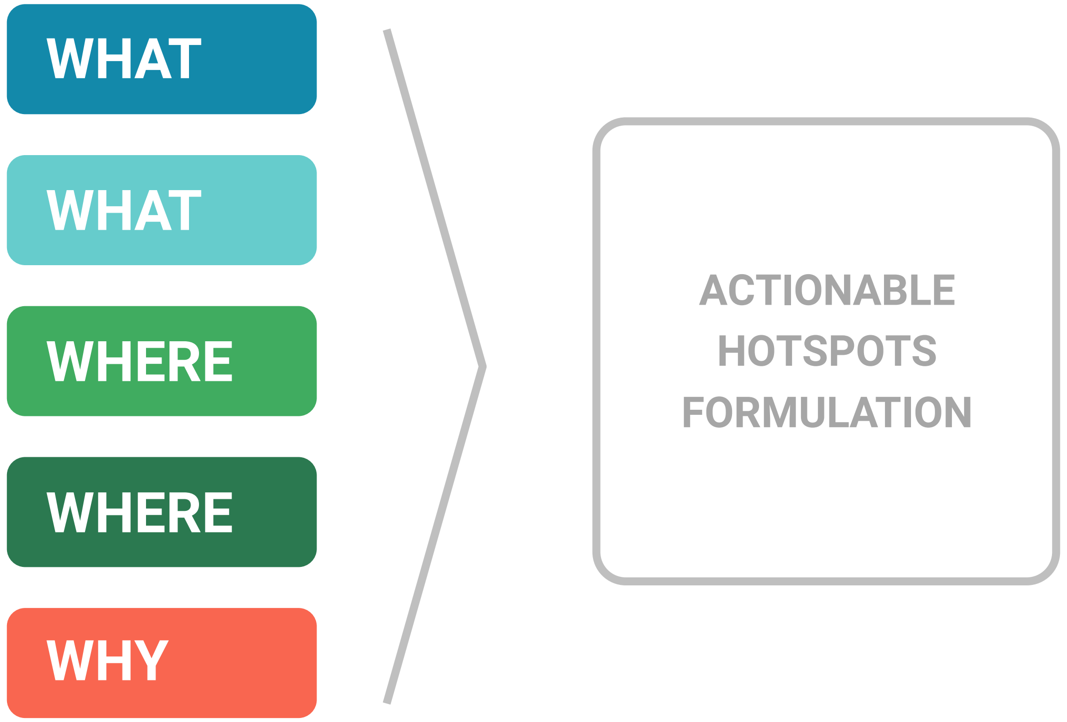
Although improper disposal of imported plastic waste in Thailand is a known issue (*GAIA, 2019*), the drivers behind waste trade in Thailand remain unclear.
Furthermore, little information is available regarding the recycling capacity of the country, either in terms of polymers, companies or evolution throughout the years.

Unlocking limitations

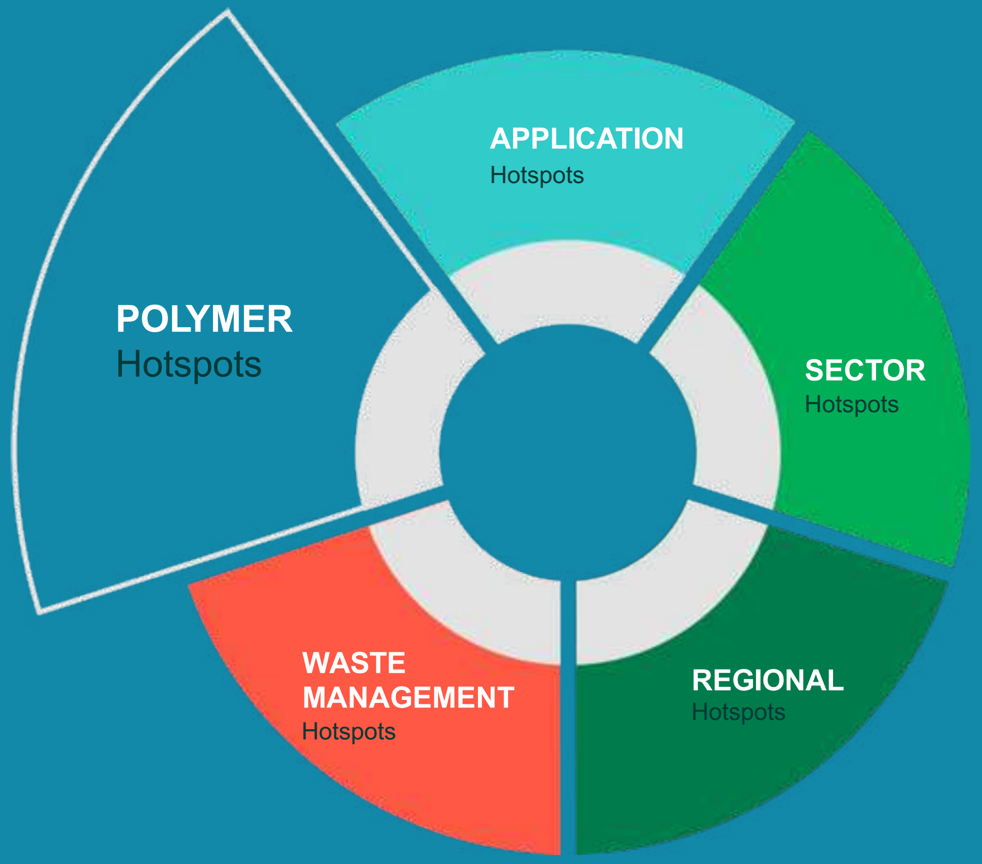
Put in place a reporting system for recycling companies in order to gain better insight onto the recycling sector. Investigate waste trade.

2.2 DETAILED HOTSPOTS RESULTS

5 CATEGORIES OF HOTSPOTS



A POLYMER HOTSPOTS

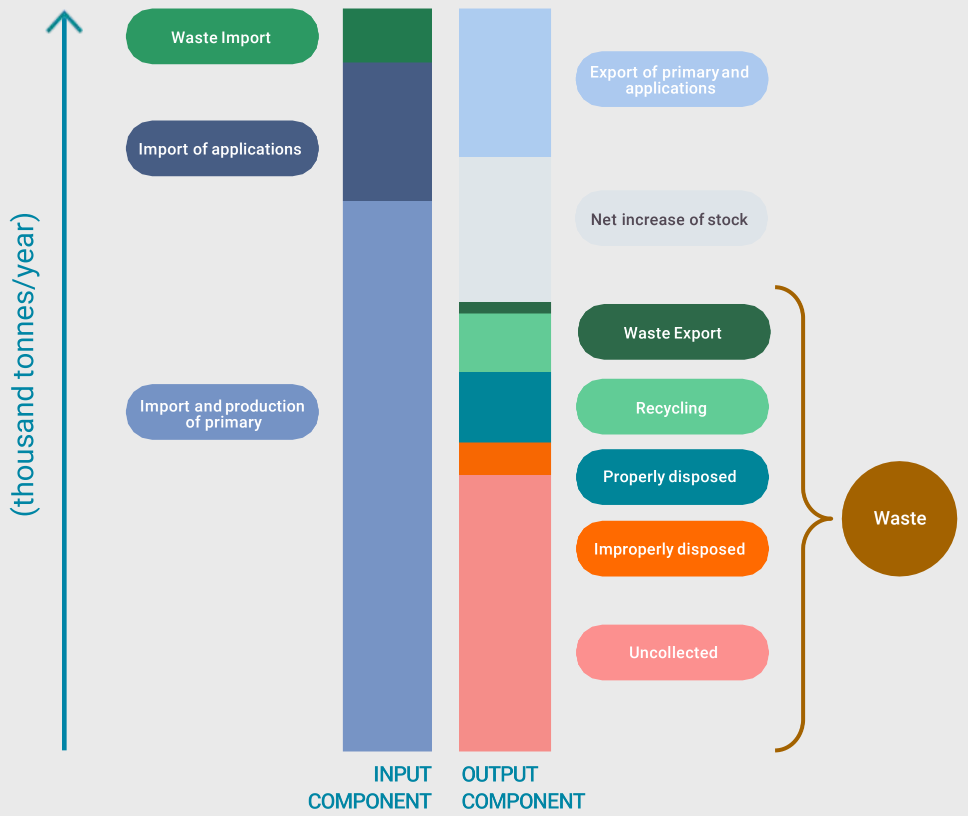


OBJECTIVE AND INSTRUCTIONS

Key question answered:

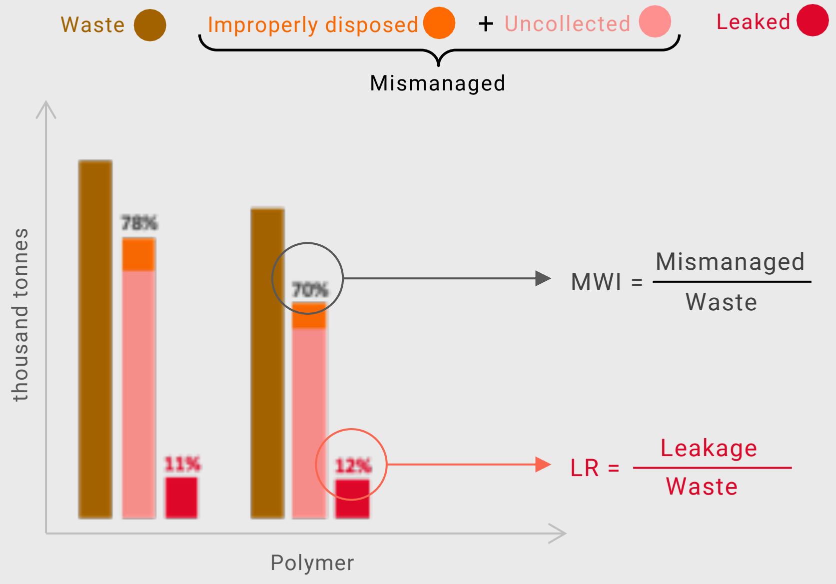
Which polymers are most critical in the country regarding plastic leakage?

What are the bar components of the polymer mass balance graph?

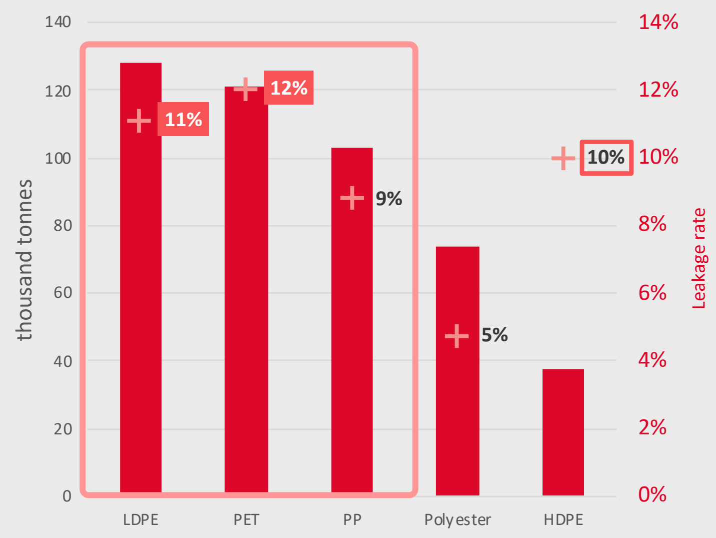


How to read the polymer hotspot graph?

1. Determine leakage from mismanaged waste



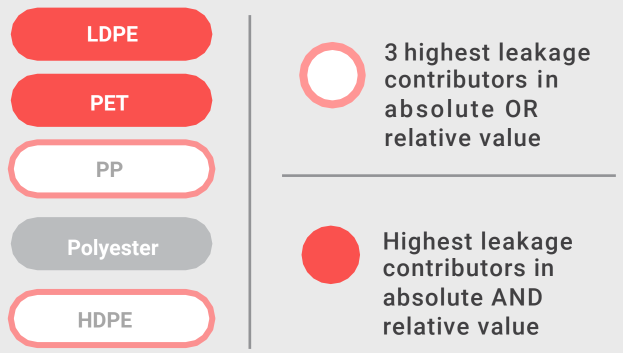
2. Focus on leakage and leakage rate



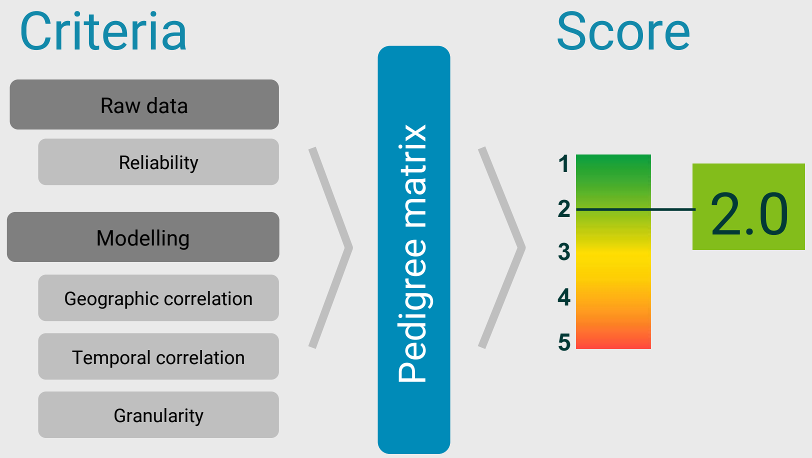
For more details, please read the Methodology

T3

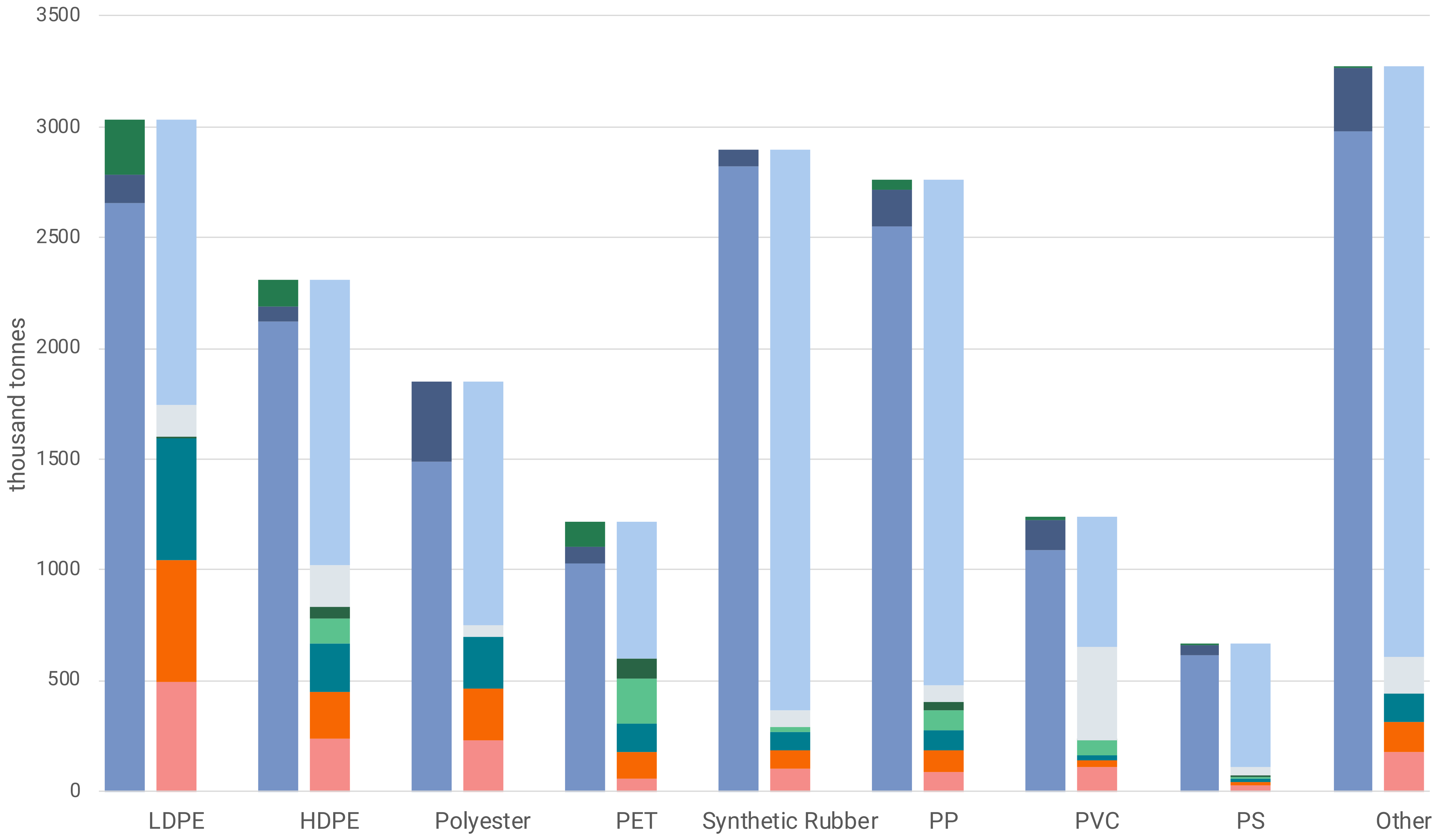
3. Select hotspots based on absolute and relative leakage



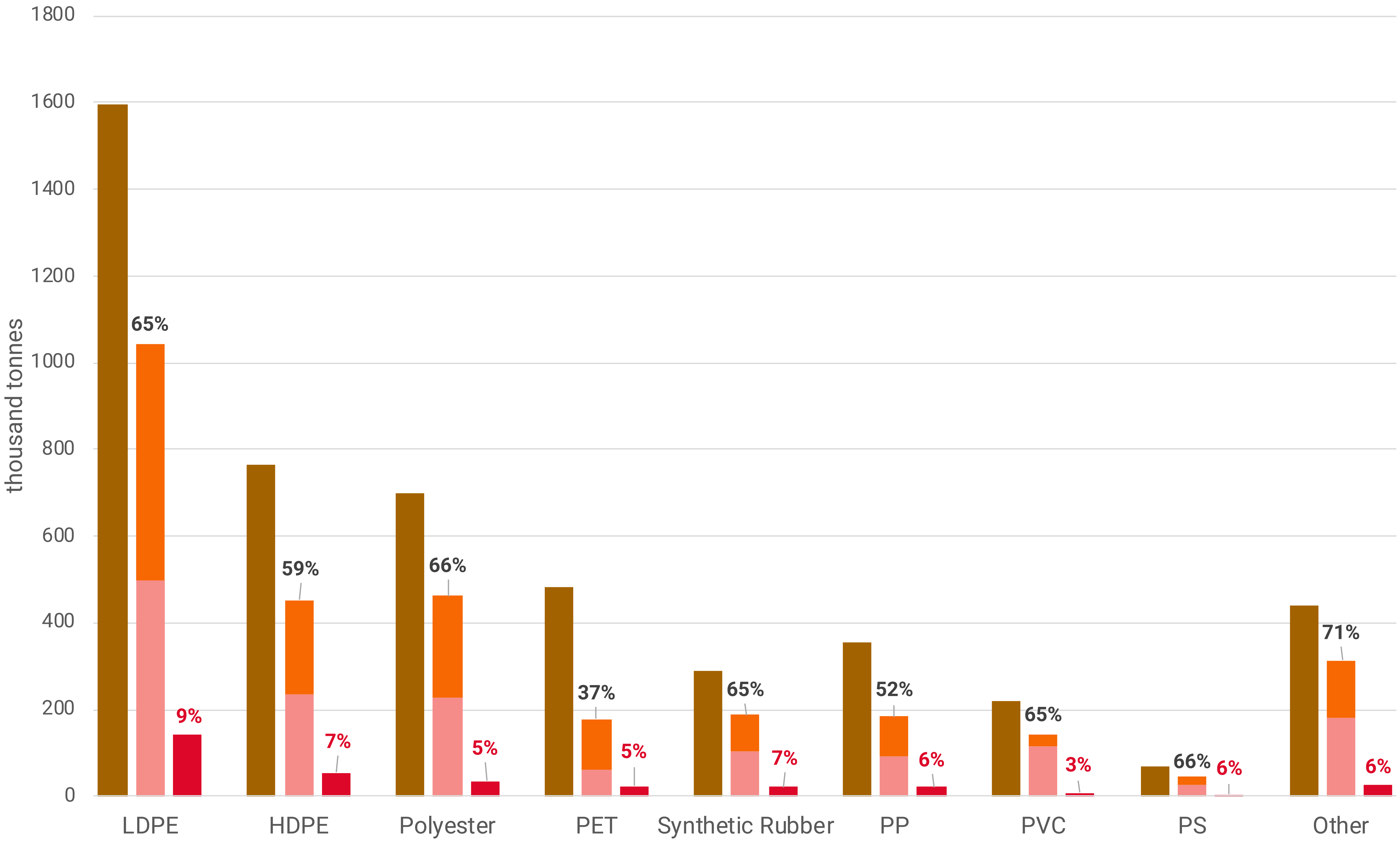
4. Assess the quality score of the results



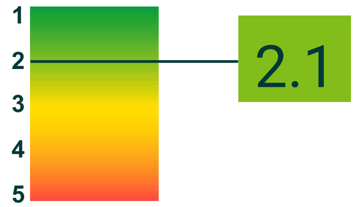
MASS BALANCE BY POLYMER [2018]



MISMANAGED WASTE AND LEAKAGE BY POLYMER [2018]



Quality Score



Waste

Improperly disposed
+
Uncollected

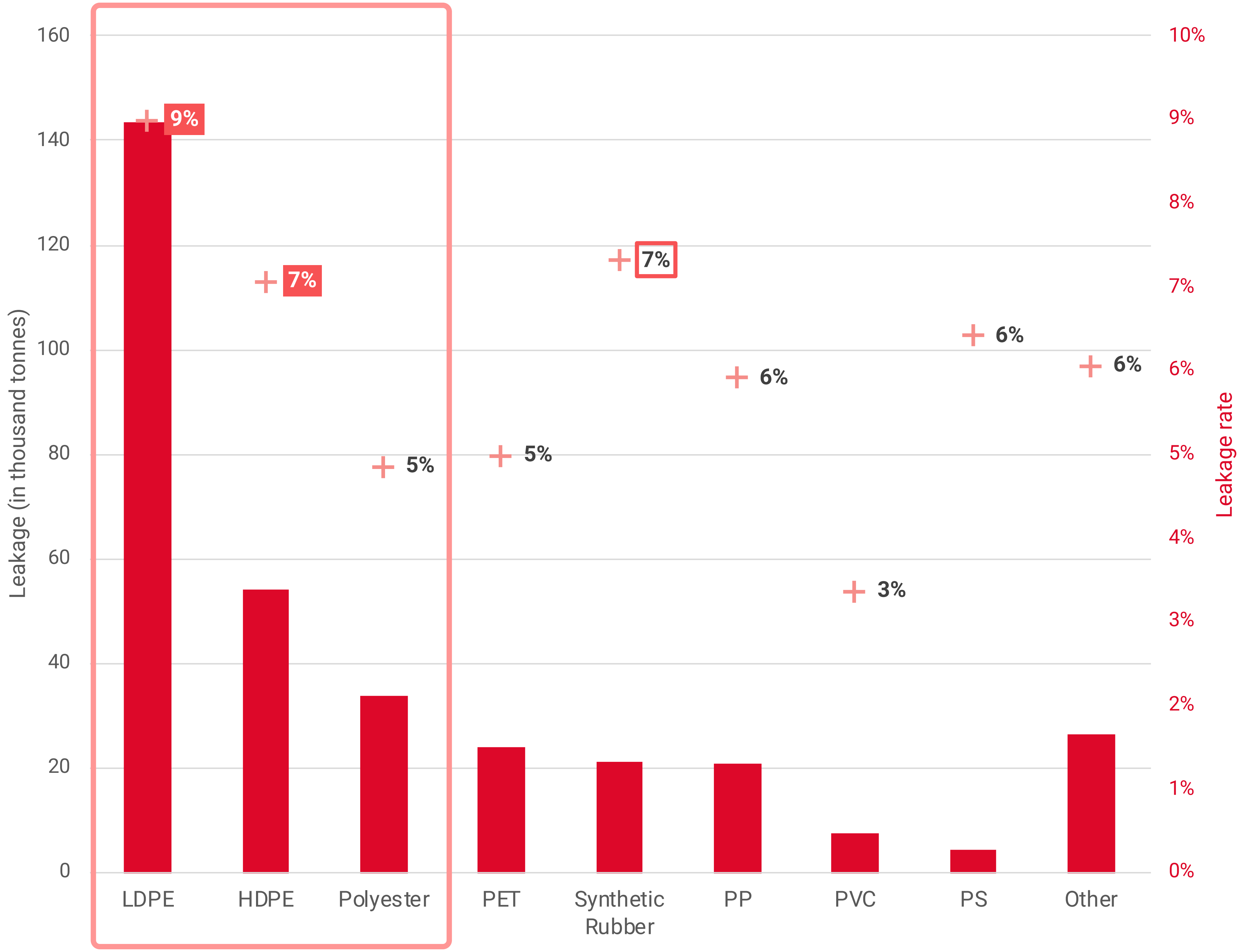
Mismanaged

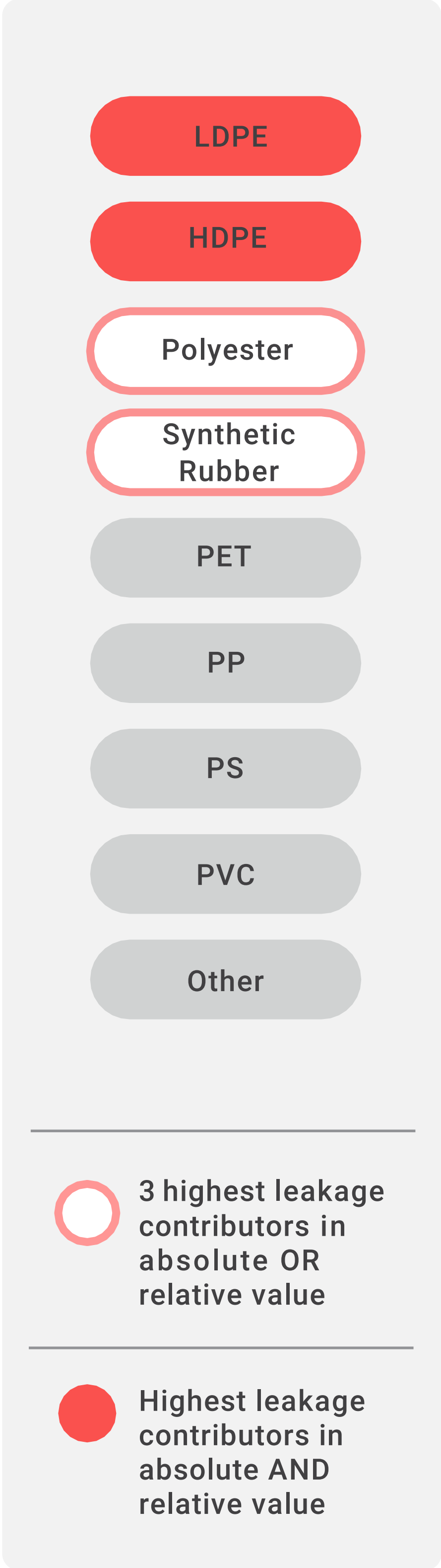
Leaked

X% | Mismanaged Waste Index (MWI)

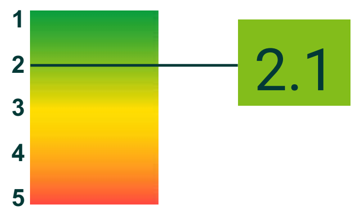
X% | Leakage Rate (LR)

POLYMER HOTSPOTS [2018]





Quality Score



Key take-aways:

- **LDPE** is the top contributor in absolute leakage (144 kt), with a leakage rate of 9%.
- **HDPE** is the 2nd contributor to leakage (54 kt), with a leakage rate of 7%.
- **Polyester,** extensively used in textile, is the 3rd polymer by absolute leakage (34 kt).
- **Synthetic Rubber** is a hotspot due to its high relative leakage (7%).

POLYMER HOTSPOTS: INTERPRETATION AND LIMITATIONS

LDPE

Learnings

LDPE is widely used in Thailand especially to make plastic bags, which in some places constitute more than 60% of all plastics found at landfills/dumpsites (*Pasukphun, 2019*). There is very little recycling of LDPE in Thailand (*WWF, 2020*) 6kt. One explanation could be that Informal collectors are reluctant to transport plastic bags as these are light and voluminous items. Large amounts of waste generated and lack of recycling, combined with its use in light packaging application (with a high release rate), make LDPE the top hotspot for plastic leakage in Thailand.

Polyester

Learnings

Polyester is the single most produced polymer in Thailand for the textile market. Around 700 kt of polyester fibres waste is generated in 2018, from which 66% is mismanaged. This is mainly due to an insufficient capacity of sanitary landfills causing more than 30% of the collected polyester fibres waste to be disposed at unsanitary landfills or dumpsites. Also, about 30% of this polyester fibres waste remains uncollected. Moreover, there is no recycling of polyester fibres in Thailand. As a result, 34 kt of polyester leaked into the oceans in 2018, making polyester a hotspot in absolute leakage.

Synthetic Rubber

Learnings

Synthetic Rubber used for tyres leaks to the environment because of waste mismanagement (macro-leakage: 11 kt), but also because of tyre abrasion (micro-leakage: 10 kt). The microplastics from tyre abrasion increase the total leakage and leads to a high leakage rate with respect to other polymers.

HDPE

Learnings

Contrary to LDPE, HDPE is collected for recycling. The informal sector recycled 102 kt of HDPE in 2018 (in second position after PET with 178 kt). Nonetheless, because of it's frequent use in the packaging sector (higher chances of littering and leakage), HDPE is more likely than most other polymers to leak into waterways once it is mismanaged. Overall, HDPE ranks third by absolute leakage (54 kt) and has a relatively high leakage rate (7%), which makes it one of the main polymer hotspots in Thailand.

All polymers

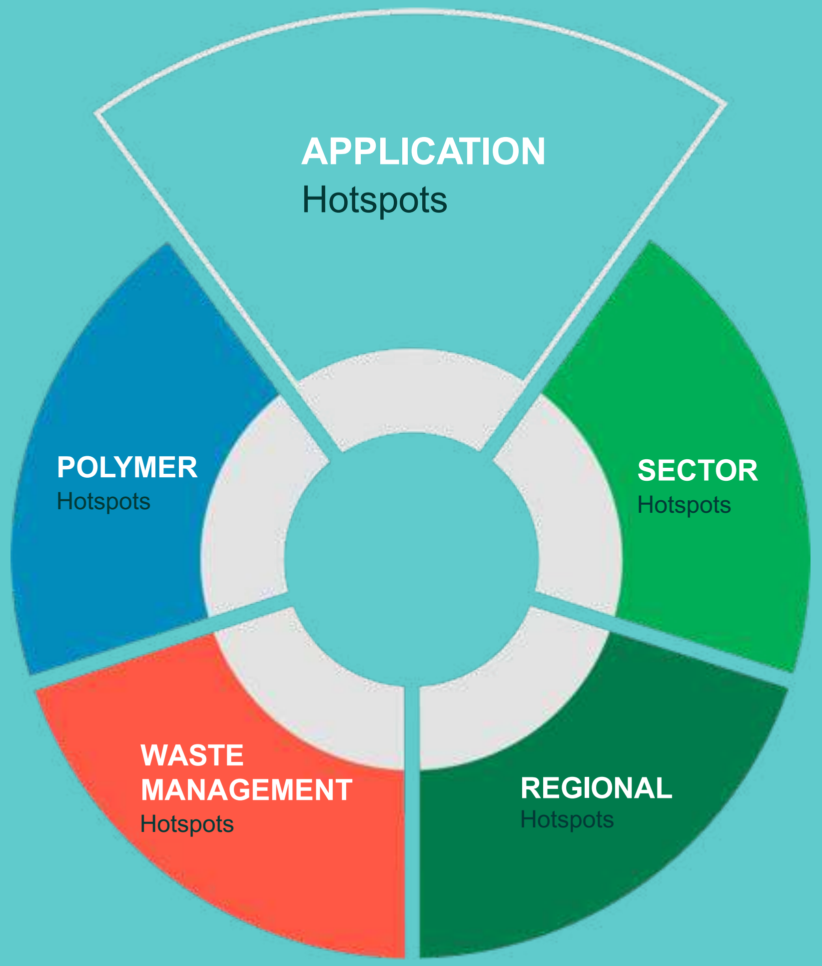
Limitations

- Illegal import of waste may be an issue in Thailand, especially after the policy enforced by China in 2018 banning the import of most plastics and other materials. We could not assess the magnitude of the phenomenon.
- Although the total amount of waste legally imported is known thanks to Comtrade database (*2020*), the database lacks details on which type of polymer is imported. So we assumed that the polymer composition of imported waste matches that of the global market.
- The stock assessment by polymer, as well as the proper and improper management of waste, are derived from the sector analysis through a sector to polymer mapping. This mapping is based on the EU market (from *Plastics Europe, 2018*).

Unlocking limitations

- Investigate illegal trade of waste.
- Improve tracking of waste trade by polymer type. This effort has to be performed at a global level.
- Having a sector to polymer mapping based on the Thailand market would improve the quality of the analysis.

B APPLICATION HOTSPOTS

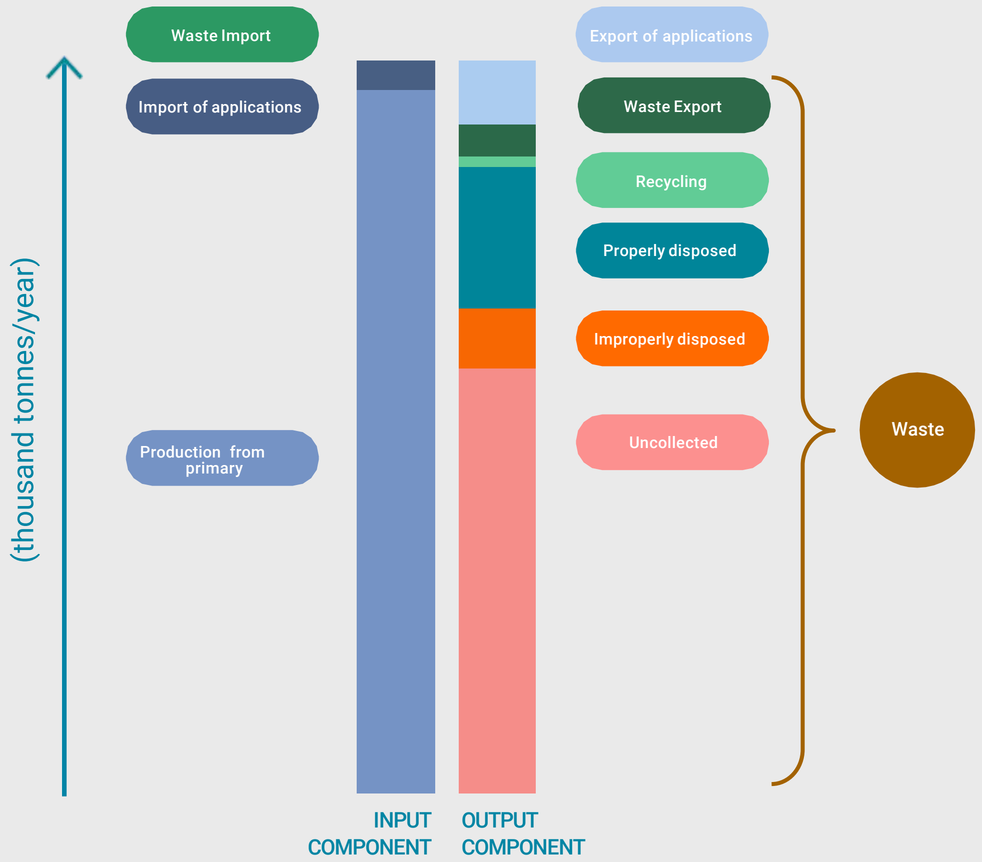


OBJECTIVE AND INSTRUCTIONS

Key question answered:

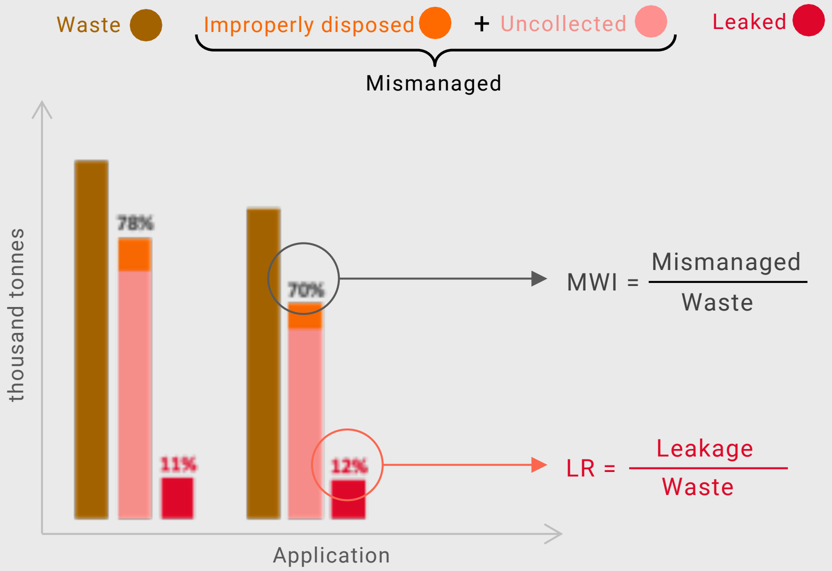
Which applications are most critical in the country regarding plastic leakage?

What are the bar components of the application mass balance graph?

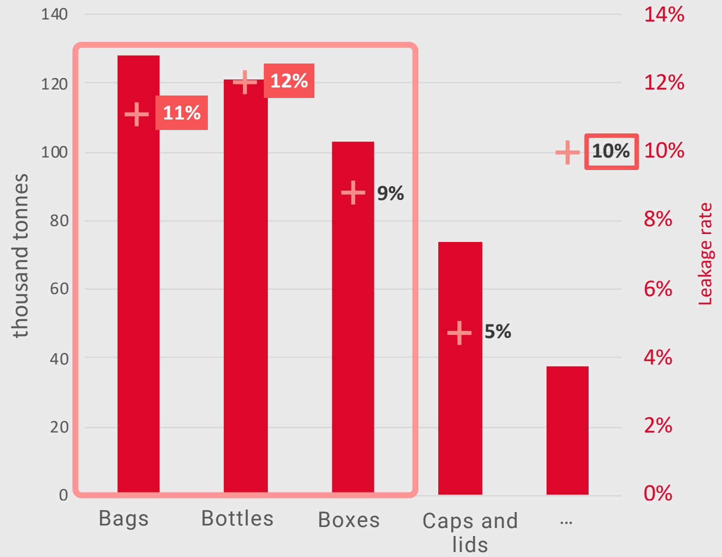


How to read the application hotspot graph?

1. Determine leakage from mismanaged waste



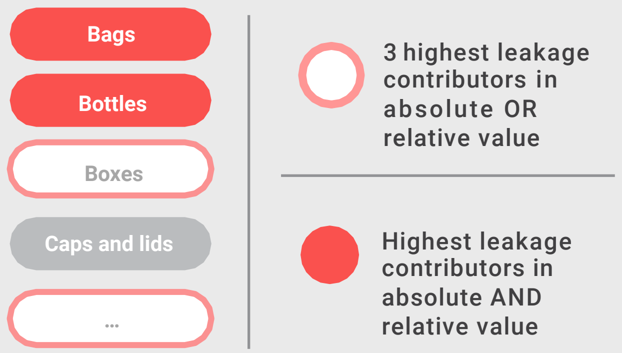
2. Focus on leakage and leakage rate



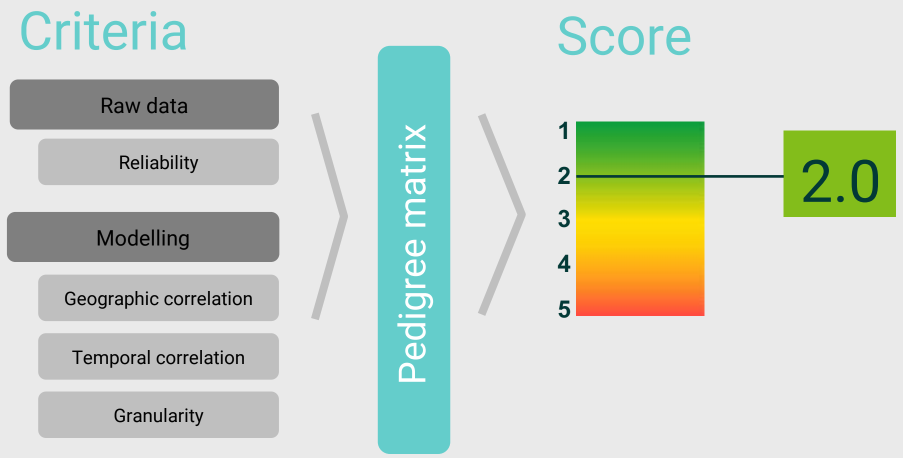
For more details, please read the Methodology

T3

3. Select hotspots based on absolute and relative leakage

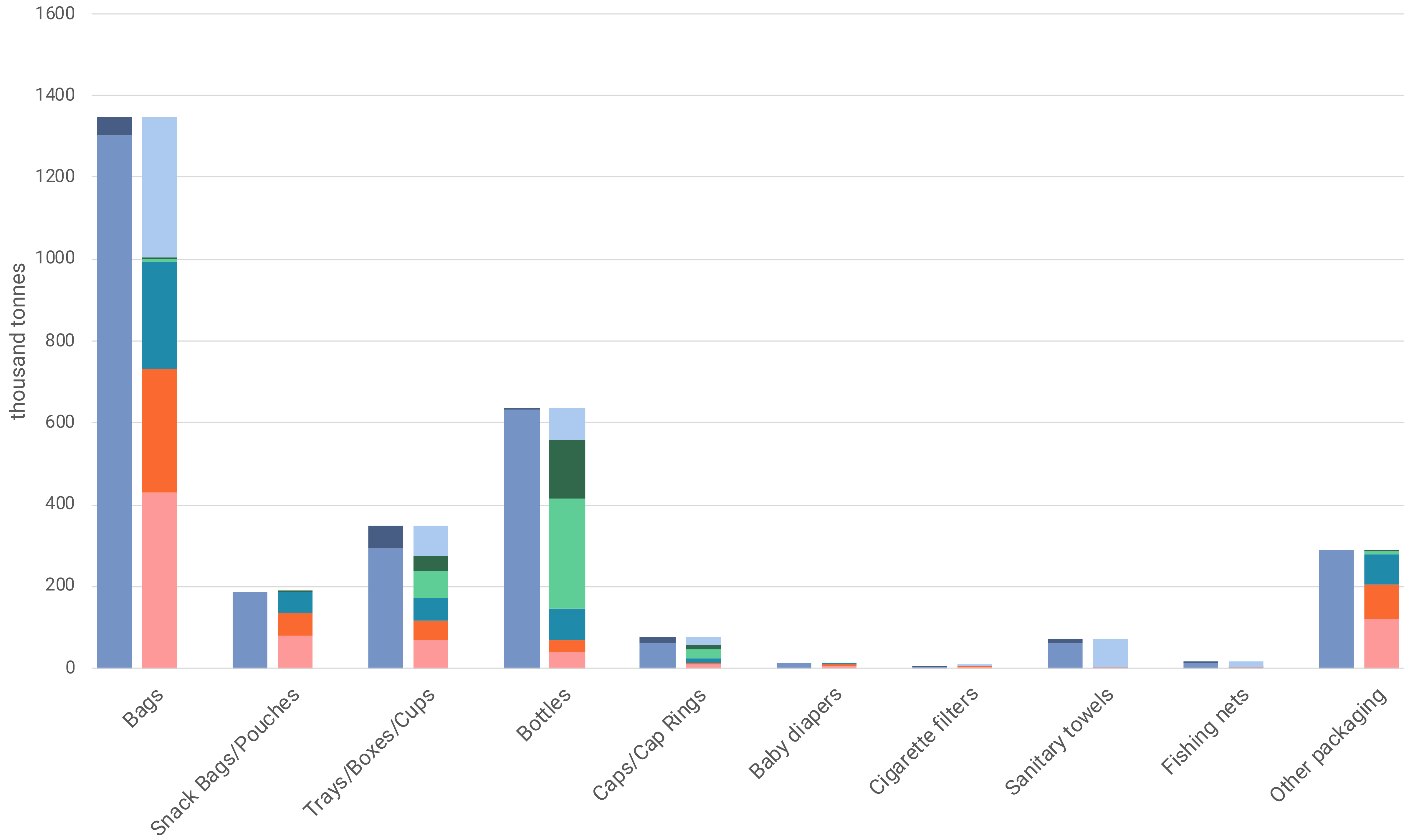


4. Assess the quality score of the results

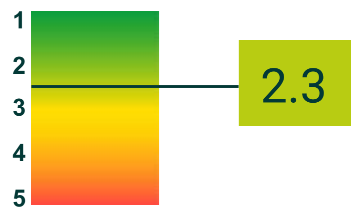


MASS BALANCE BY APPLICATION [2018]

The application analysis covers most of known short-lived products, which corresponds to **52% of total plastic waste** generated in the country in 2018.



Quality Score



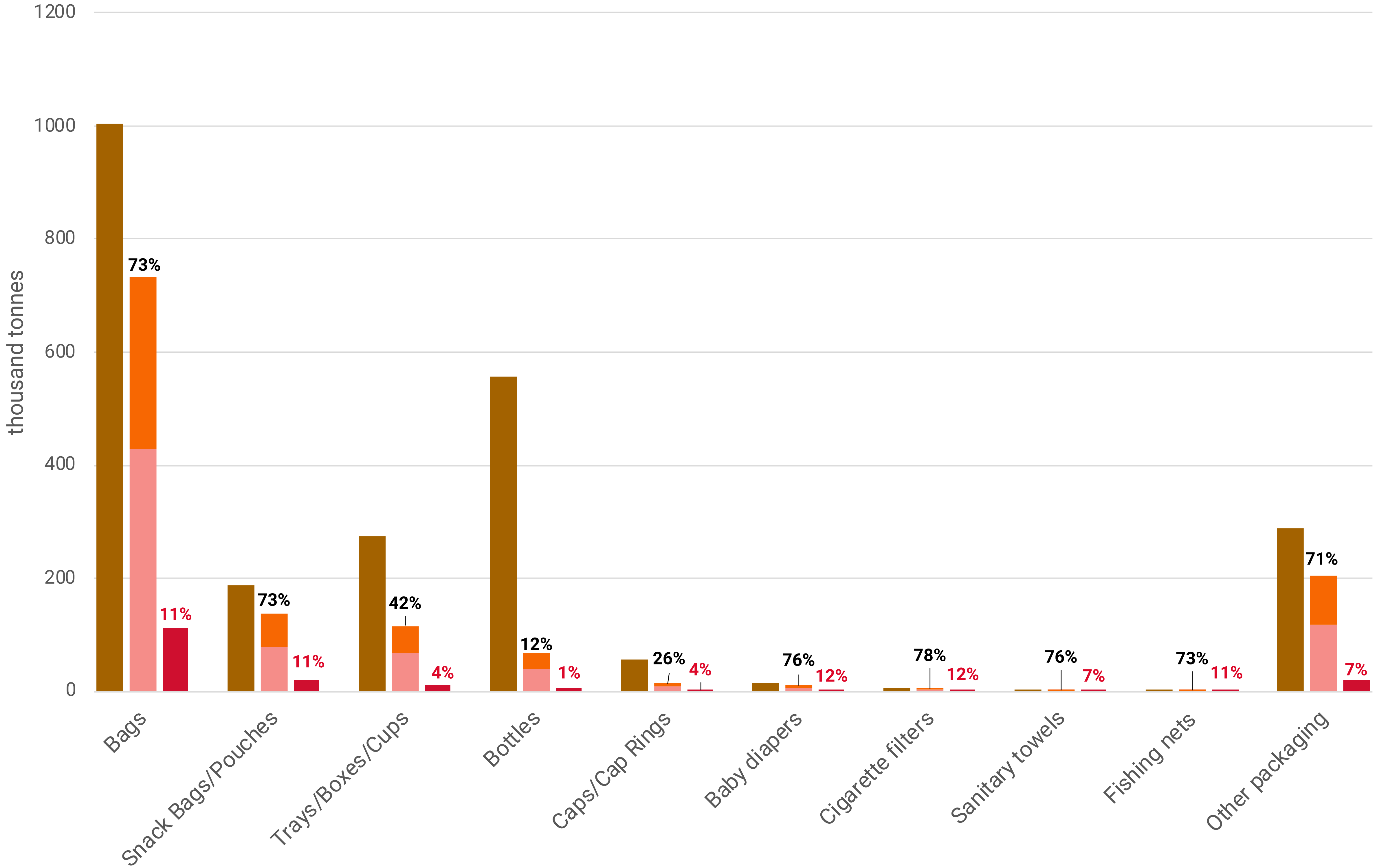
INPUT

- Waste Import
- Import of products
- Production from primary

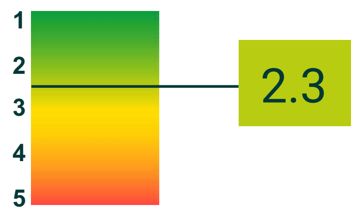
OUTPUT

- Waste Export
- Export of applications
- Recycling
- Properly disposed
- Improperly disposed
- Uncollected

MISMANAGED WASTE AND LEAKAGE BY APPLICATION [2018]



Quality Score



Waste

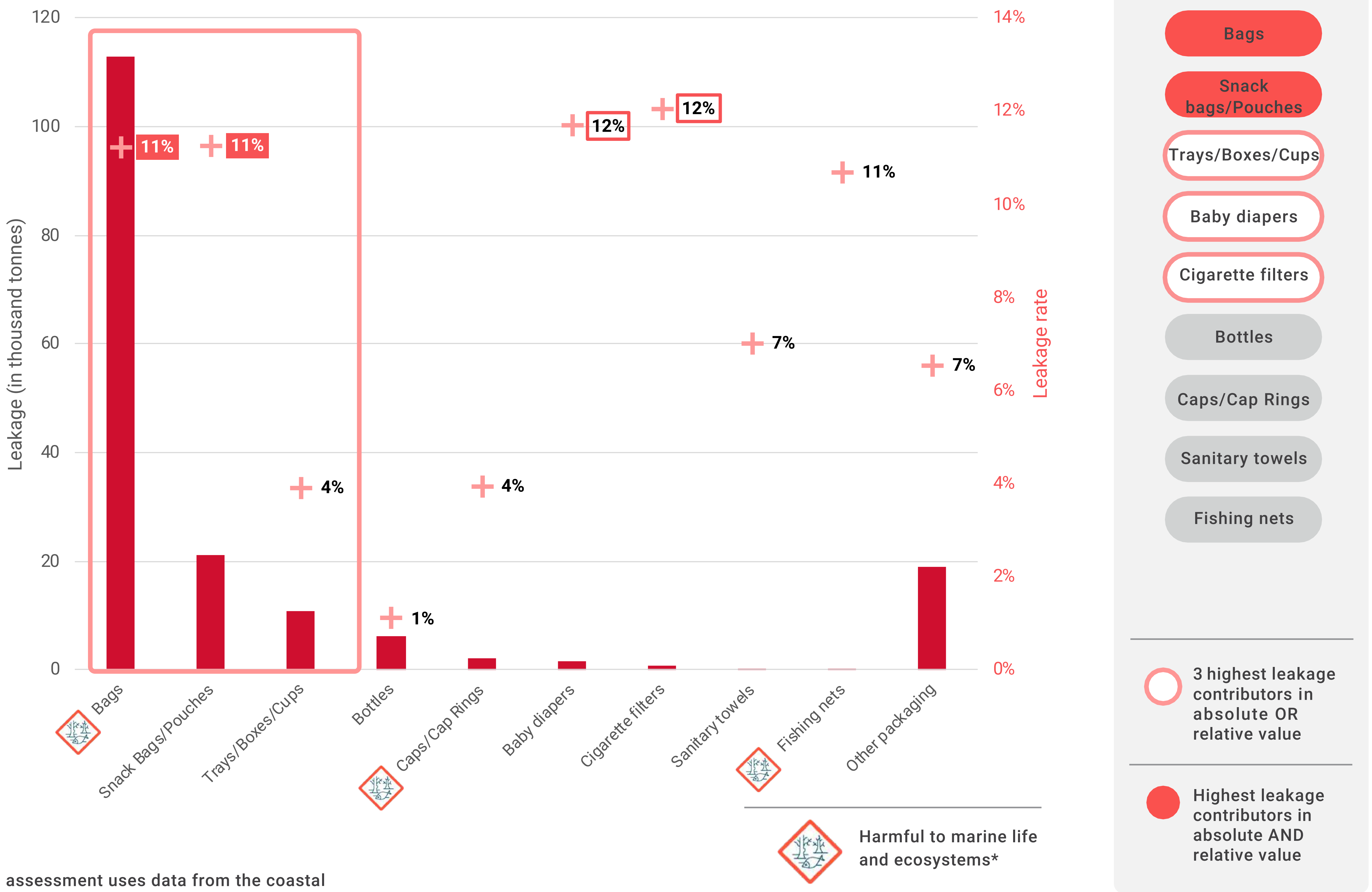
Improperly disposed + Uncollected } Mismanaged

Leaked

X% | Mismanaged Waste Index (MWI)

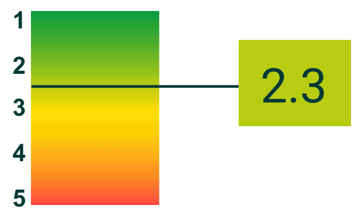
X% | Leakage Rate (LR)

APPLICATION HOTSPOTS [2018]



*The impact assessment uses data from the coastal clean-up report from *Ocean Conservancy (2019)*

Quality Score



Key take-aways

- **Plastic bags** are by far the highest contributors in absolute leakage (113 kt) and rank 3rd in leakage rate (11%). They are highly harmful to marine life.
- **Snack bags and pouches** are the 2nd highest contributor in absolute leakage (21 kt) with a high leakage rate (11%). **Trays, boxes and cups** are 3rd in absolute leakage (11 kt).
- Although **baby diapers and cigarette filters** rank low in absolute leakage (respectively 2 kt and 1 kt), almost 1/10th of their waste generated tend to leak into the oceans.

Bags

Learnings

One million tonnes of plastic bags were put on the Thai market in 2018 and went to waste. That is equivalent to 8 plastic bags being discarded by a single person every day. In 2018, recycling of plastic bags is limited to 7 kt, 260 kt are properly disposed and 733 kt are mismanaged (MWI 73%). As a result 113 kt of plastic bags leak to the ocean every year, making plastic bags the main application hotspot.

Bottles

Learnings

Bottles are the second most common plastic packaging application on the market with more than 550 kt of bottles discarded every year, corresponding to approximately 50 billion bottles. According to WWF estimates (*WWF, 2020*) 70% of all the bottles going to waste are collected for recycling, from which a majority is domestically recycled and a remaining part is exported for recycling.

Snack bags and pouches

Learnings

Snack bags and pouches are usually made of multi-layer packaging, mixing plastic with other materials, and cannot be recycled. For this reason even if “only” 186 kt were put on the market in 2018, 11% of it leaked into the ocean. The total leakage from snack bags and pouches amounts to 21 kt, ranking second by absolute leakage. Therefore, snack bags and pouches are one of the main hotspots in the country.

Baby diapers

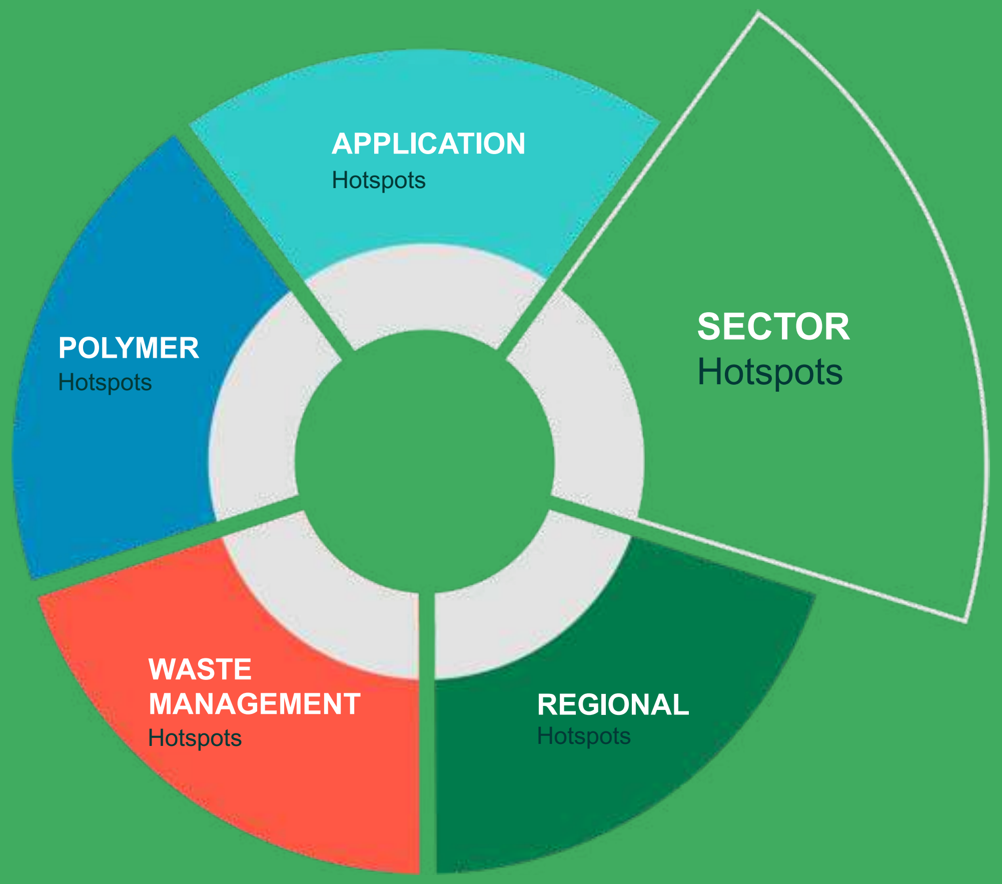
Limitations

Baby diapers are computed considering the 0-2 years old population of Thailand (*UN, 2018*) and an average consumption of 4.16 baby diapers a day (*Mendoza et al., 2015*). The high leakage rate of 12% that makes baby diapers a hotspot for the country is mostly due to the high littering rate of 21%, estimated based on littering rates for sanitary towels in Europe (*European Commission, 2018*).

Unlocking limitations

Perform in Thailand a data collection on the ground similar to that conducted by ICF and Eunomia in Europe (*European Commission, 2018*), in order to have a specific littering rate for baby diapers in Thailand.

C SECTOR HOTSPOTS

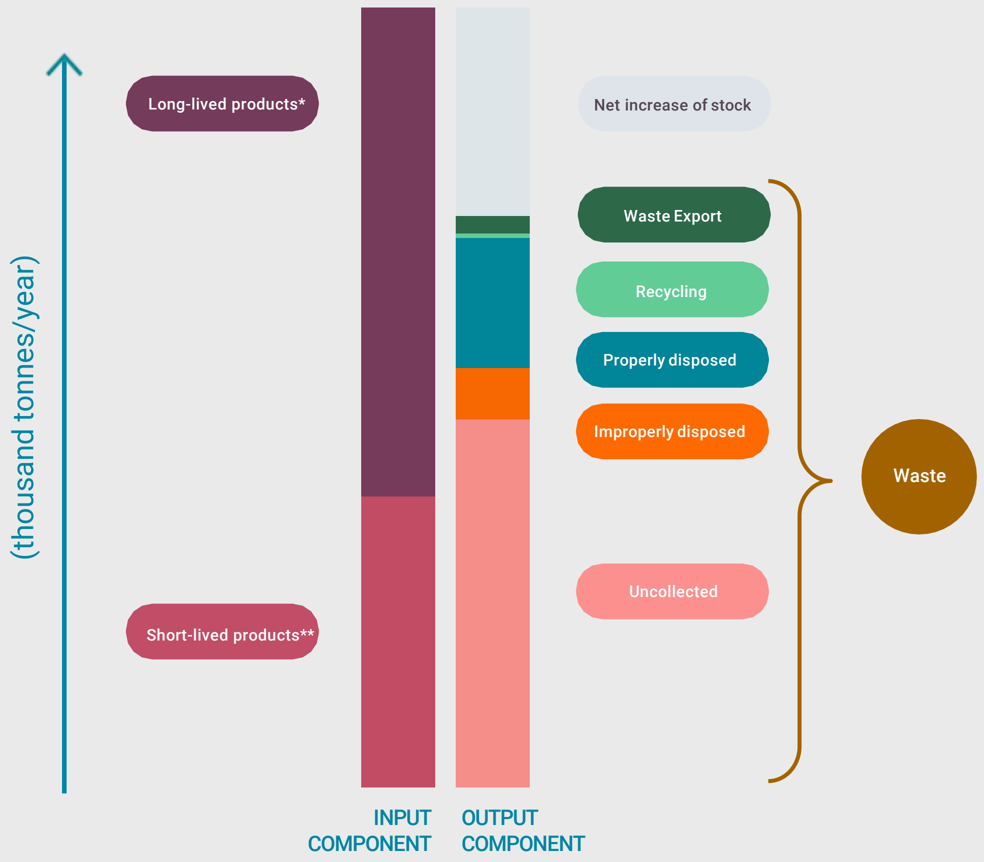


OBJECTIVE AND INSTRUCTIONS

Key question answered:

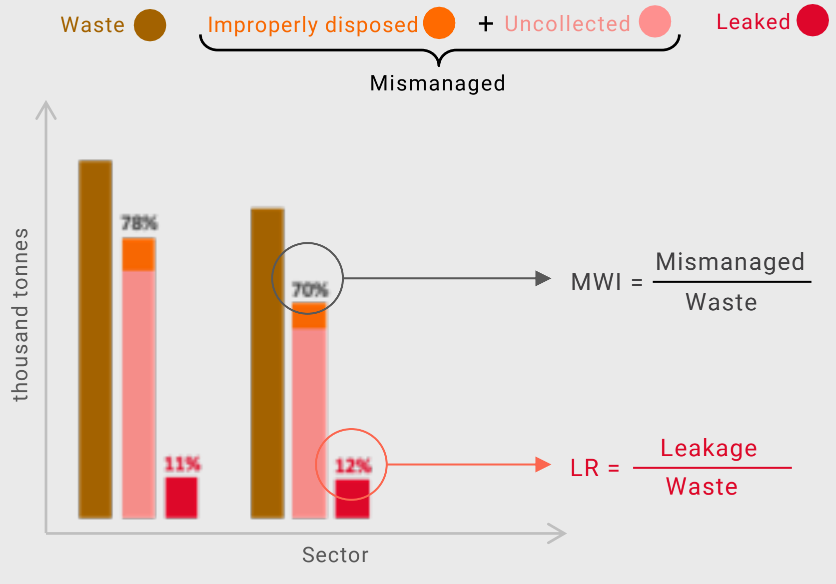
Which sectors are most critical in the country regarding plastic leakage?

What are the bar components of the sector mass balance graph?

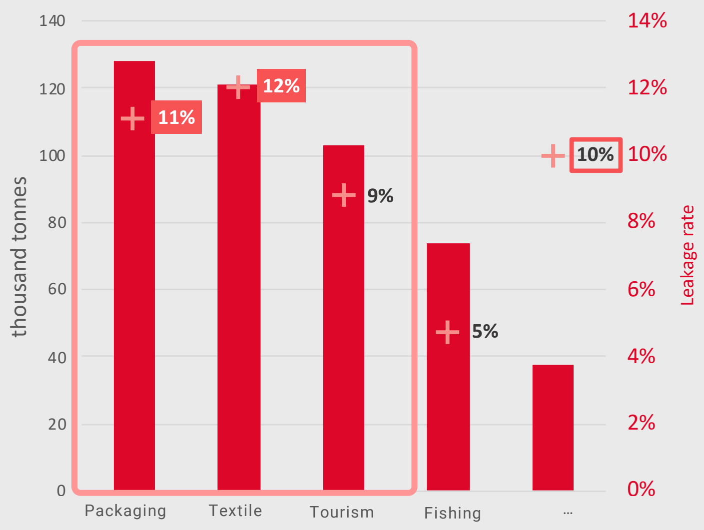


How to read the sector hotspot graph?

1. Determine leakage from mismanaged waste



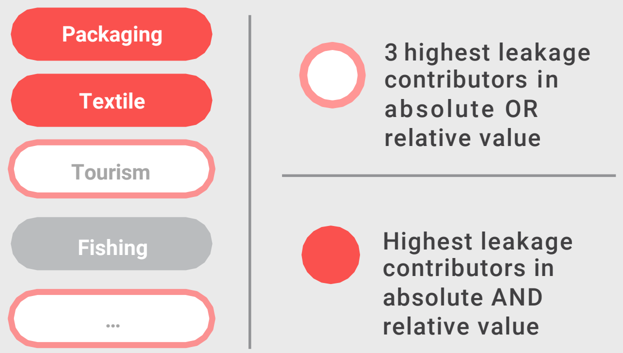
2. Focus on leakage and leakage rate



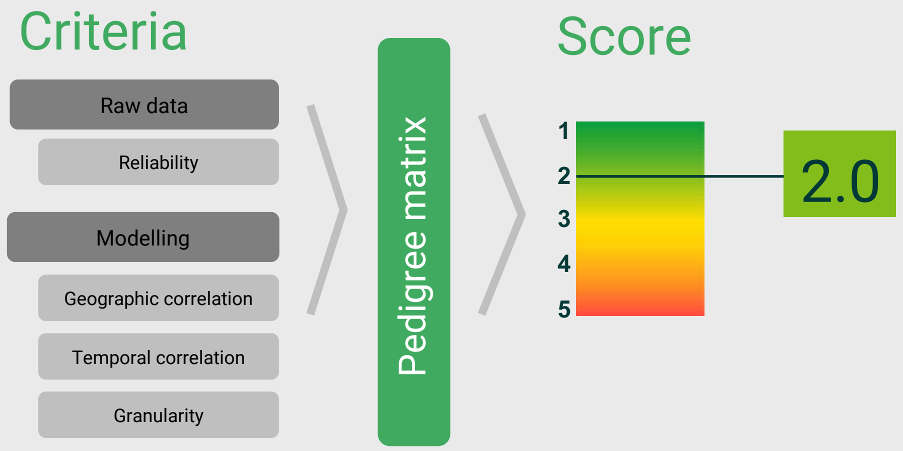
For more details, please read the Methodology

T3

3. Select hotspots based on absolute and relative leakage

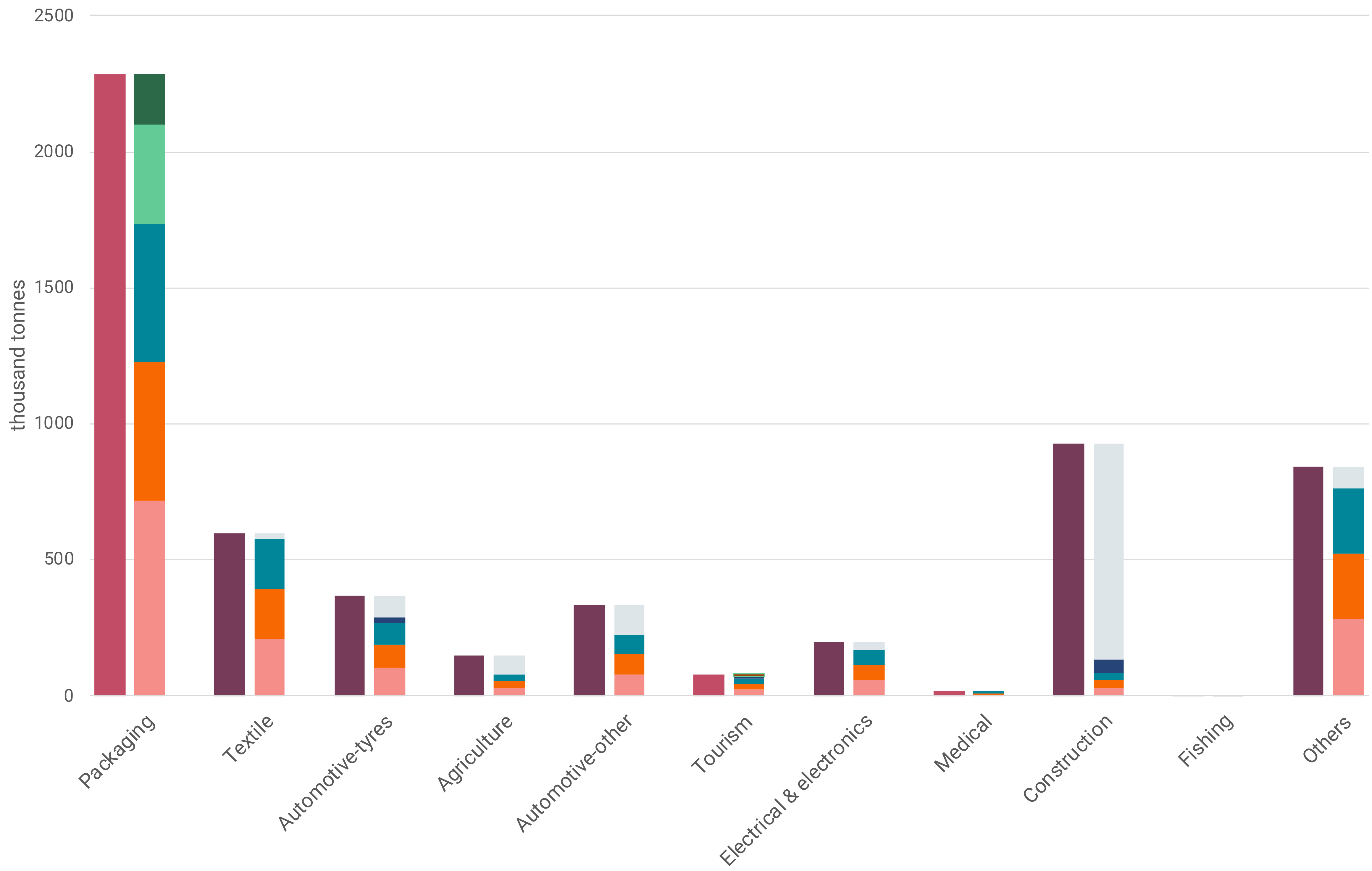


4. Assess the quality score of the results

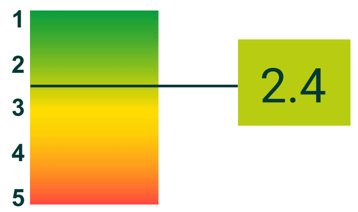


* **Short-lived products**: products that are disposed within the year of study (Life-time < 1 year)
** **Long-lived products**: products that are disposed after the year of study (Life-time > 1 year)

MASS BALANCE BY SECTOR [2018]



Quality Score



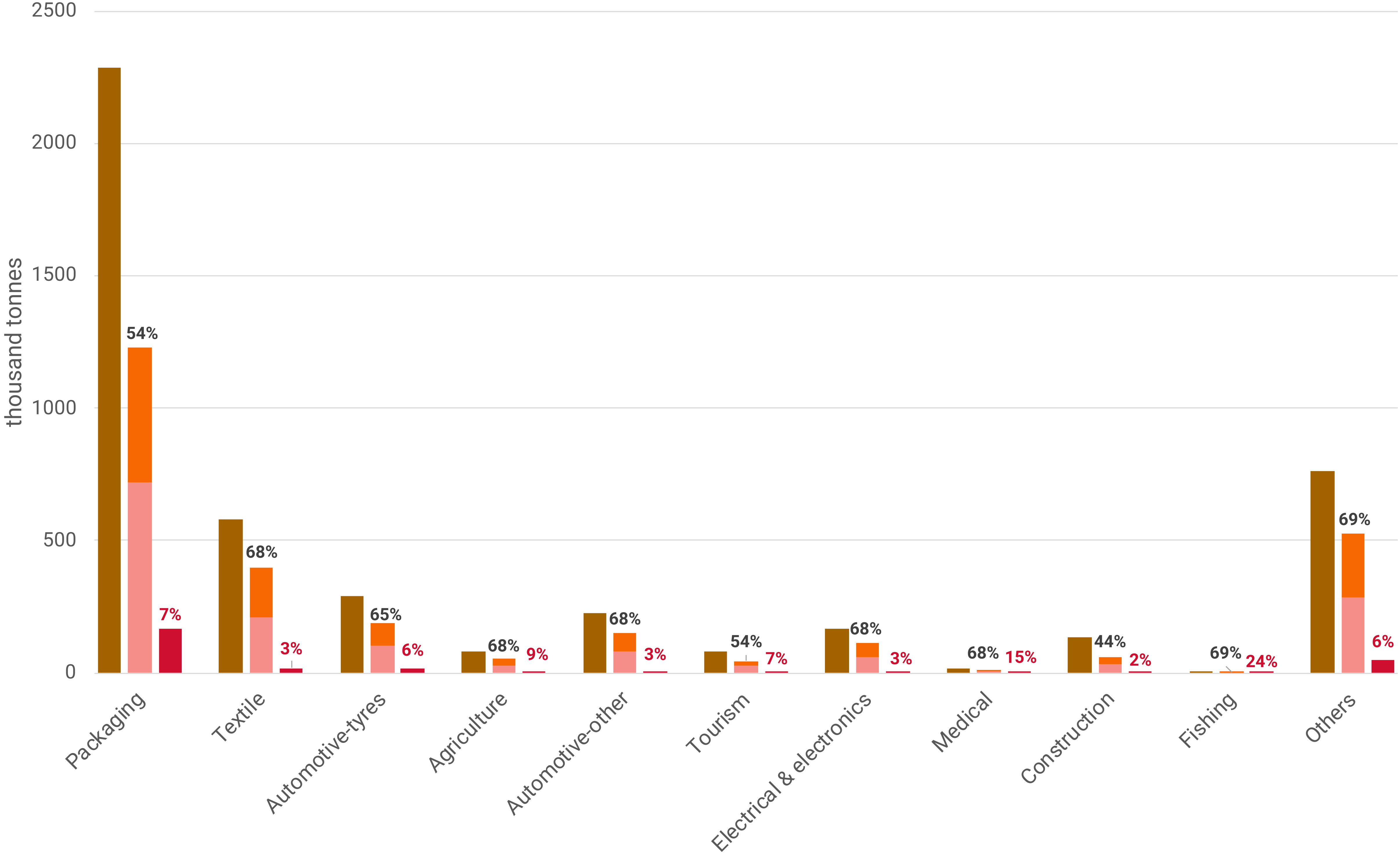
INPUT

- Short-lived products
- Long-lived products

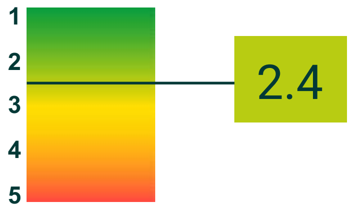
OUTPUT

- Charge in stock
- Waste Export
- Export of primary and products
- Recycling
- Properly disposed
- Improperly disposed
- Uncollected

MISMANAGED WASTE AND LEAKAGE BY SECTOR [2018]



Quality Score



Waste

Improperly disposed
+
Uncollected

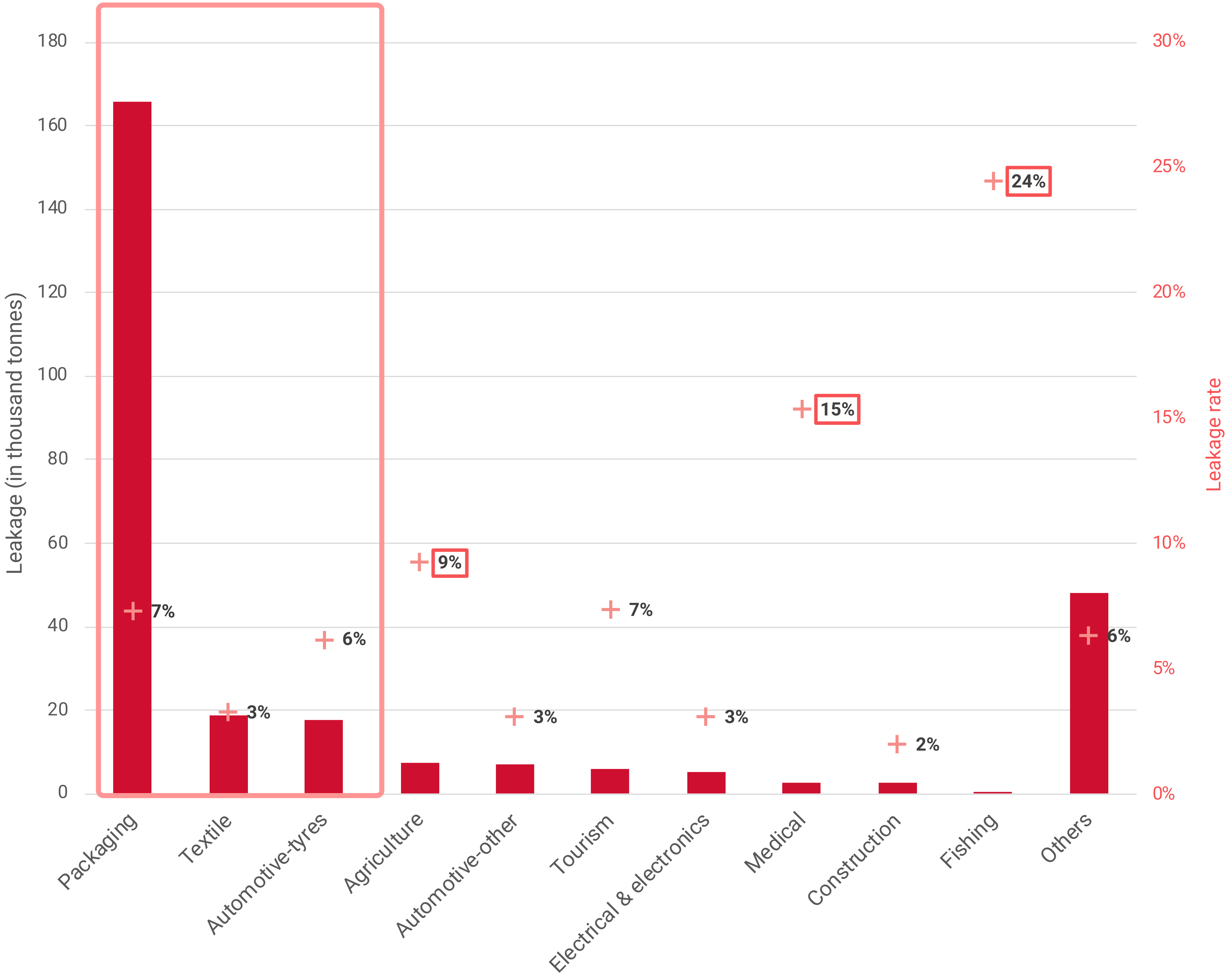
Mismanaged

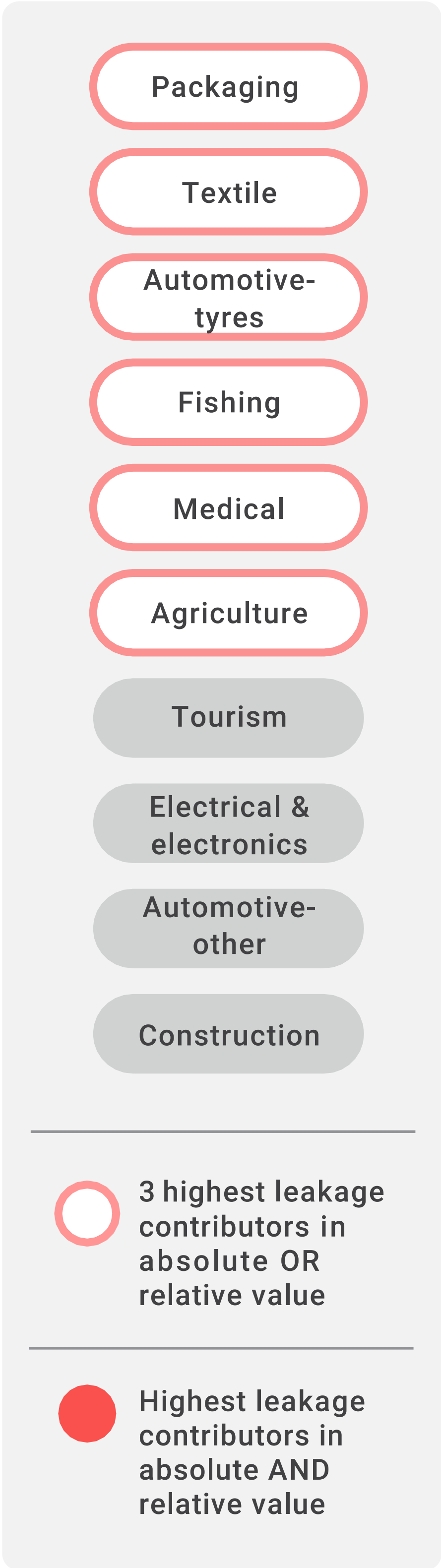
Leaked

X% | Mismanaged Waste Index (MWI)

X% | Leakage Rate (LR)

SECTOR HOTSPOTS [2018]





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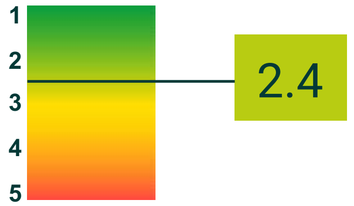


Key take-aways

- **The packaging sector** contributes to almost 60% of the total plastic leakage with 166 kt of packaging waste leaking into oceans and waterways.
- **The textile sector** is the 2nd highest contributor to plastic leakage in absolute value (19 kt).
- **Fishing, medical and agriculture sectors** have a relatively low contribution in absolute leakage but have very high leakage rates (respectively 24%, 15% and 9%).

SECTOR HOTSPOTS:
INTERPRETATION AND LIMITATIONS

Packaging

Learning

The packaging sector is the first sector by absolute leakage, contributing to around 60% of the plastic leakage in the country. Some aspects drive the leakage and some reduce it. One of the drivers is the high plastic consumption by the packaging sector, the highest of all sectors. This is in part counter-balanced by the fact that most of the recycled plastic comes from the packaging sector, resulting in the collection of 69% of the plastic coming from packaging. The high recycling rate of packaging waste results in in a MWI of 54%, lower than the overall average of 63% for all sectors. When looking at the amount of mismanaged waste by sector, packaging falls behind the textile sector which has the highest mismanaged rate. However, 1.2 Mt of plastic packaging is mismanaged, and the release rate of packaging applications to the environment is increased by their relatively small size (RR 16% compared to 10% country average RR).

Construction

Learning

Even though construction has the second highest plastic input, more plastic goes to stock (building construction) than to waste (buildings demolition). Hence, plastic waste from the construction sector is not a hotspot in our analysis.

Textile

Learning

The amount of plastic put on the market by the textile sector is around 600 kt. Since the capacity of sanitary landfill and incinerators is limited and plastic fibres in textiles are not recycled, textile is the first sector by relative mismanaged plastic waste with a 68% mismanaged rate. Nonetheless, because of their size, mismanaged textile applications are less likely to end up in waterways compared to packaging applications, thus leading to a lower final leakage than the packaging sector. Overall, in 2018, approximately 19 kt of plastic in the form of textile fibres leaked to the ocean.

Limitation

Applications from the textile sector are on average long-lived (they last more than one year). Here we considered an average life-time of two years (*The heightec Group Ltd, 2012*), which means that the textile that went to waste in 2018 was put on the market in 2016. By looking at the manufacturing GDP growth, we estimated the input of plastic in the textile sector in 2016 to be only slightly smaller than in 2018, which results in a small increase in stock. It is possible though that textile applications have a longer lifetime in Thailand.

Unlocking limitations

Collect more accurate data on average life-time of textile application in Thailand and of amount of plastic used in textile in earlier years.

SECTOR HOTSPOTS: INTERPRETATION AND LIMITATIONS

Fishing

Learning

Although low in absolute value, the fishing sector has the highest relative leakage due to the widespread practice by fishermen of throwing waste overboard. Around 50% of the leakage from fisheries comes from littering of plastic packaging overboard. Loss of fishing gears and improper disposal of fishing gears on land contribute to the remaining 50%.

Tourism

Limitation

We consider the daily plastic consumption of a tourist to match the daily plastic packaging consumption of a local citizen.

Medical

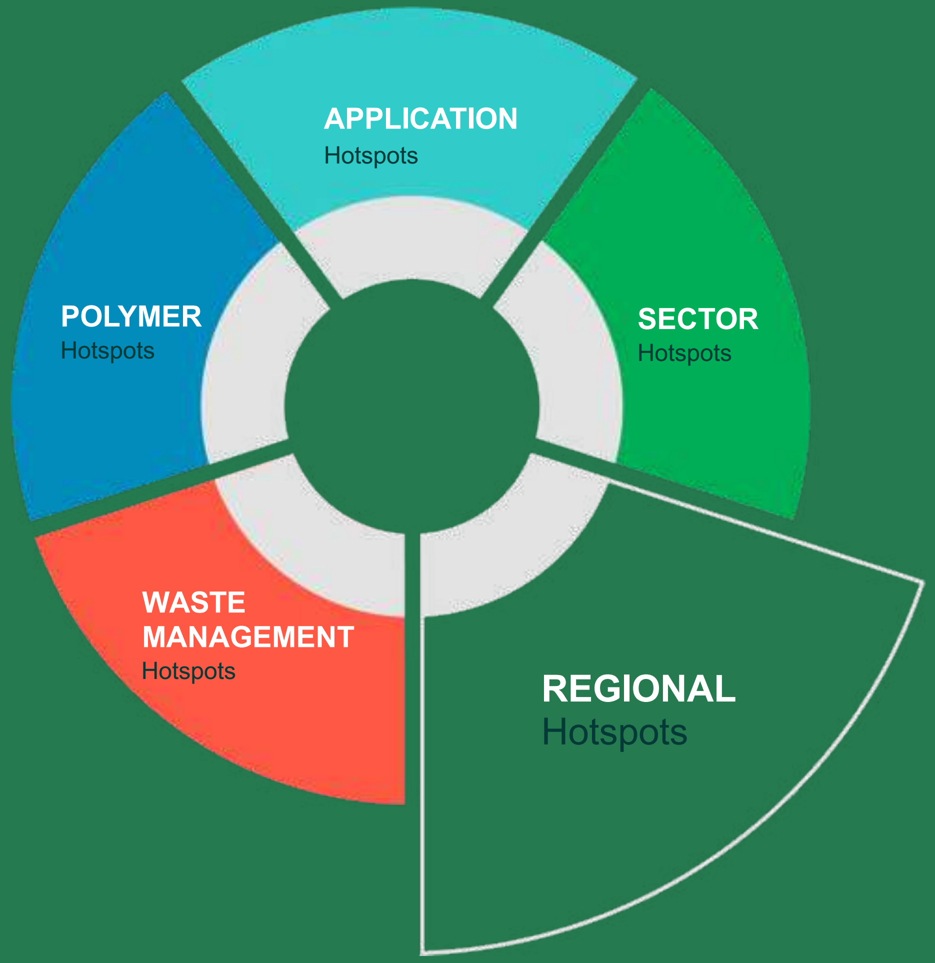
Learning

Medical waste has a high relative leakage but a low absolute leakage.

Limitation

The high relative leakage is most likely not accurate, as we do not assume that there is a special treatment of medical waste, as should be the case in most countries, with the majority of the medical waste being incinerated. We assume instead that medical waste is managed as normal waste, and since it is contaminated it has low value for recyclers. In reality, we witness some recycling of used syringes in informal villages in Thailand. We are nonetheless confident that plastic medical waste is orders of magnitude lower than packaging plastic waste, thus less critical for what concerns plastic leakage.

D REGIONAL HOTSPOTS



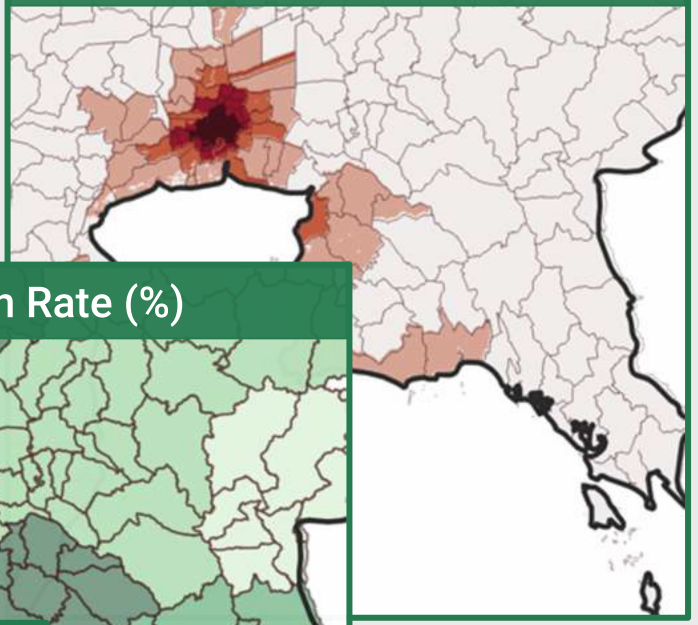
OBJECTIVE AND INSTRUCTIONS

Key question answered:

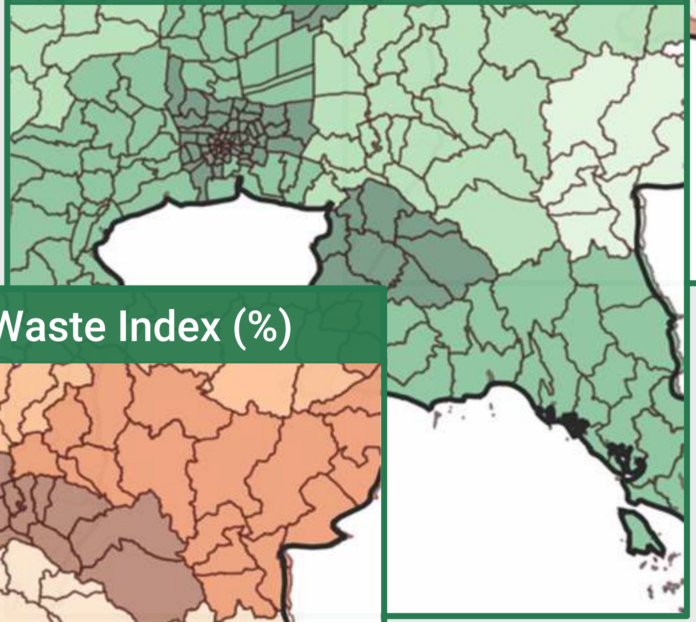
Which areas are most critical in the country regarding plastic leakage?

1) Overlaying different information available at city / district / sub-district level and/of modelled through archetypes…

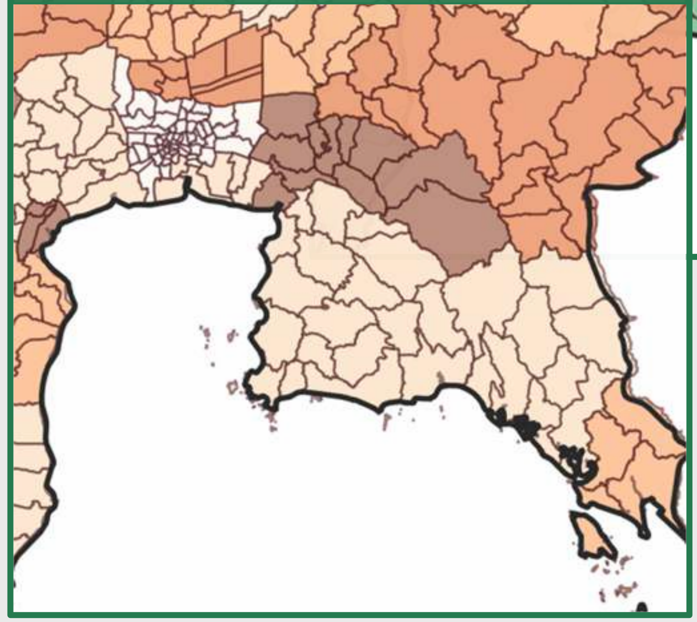
Waste Generation (tonnes)



Waste Collection Rate (%)



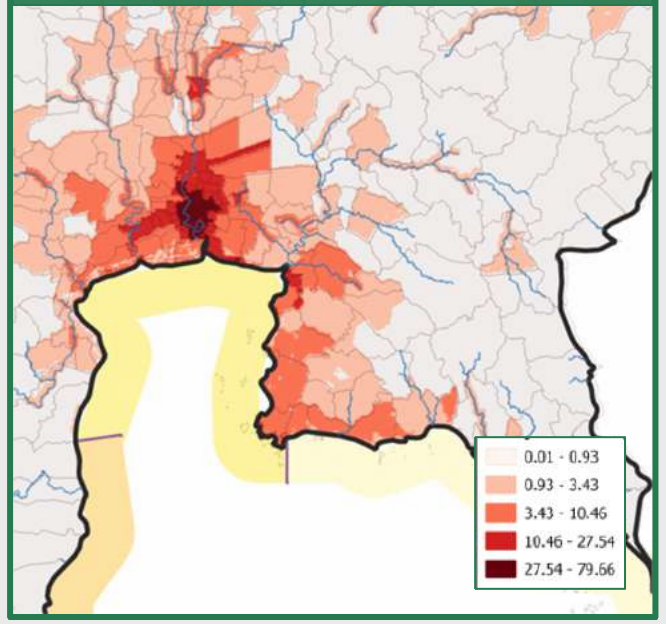
Mismanaged Waste Index (%)



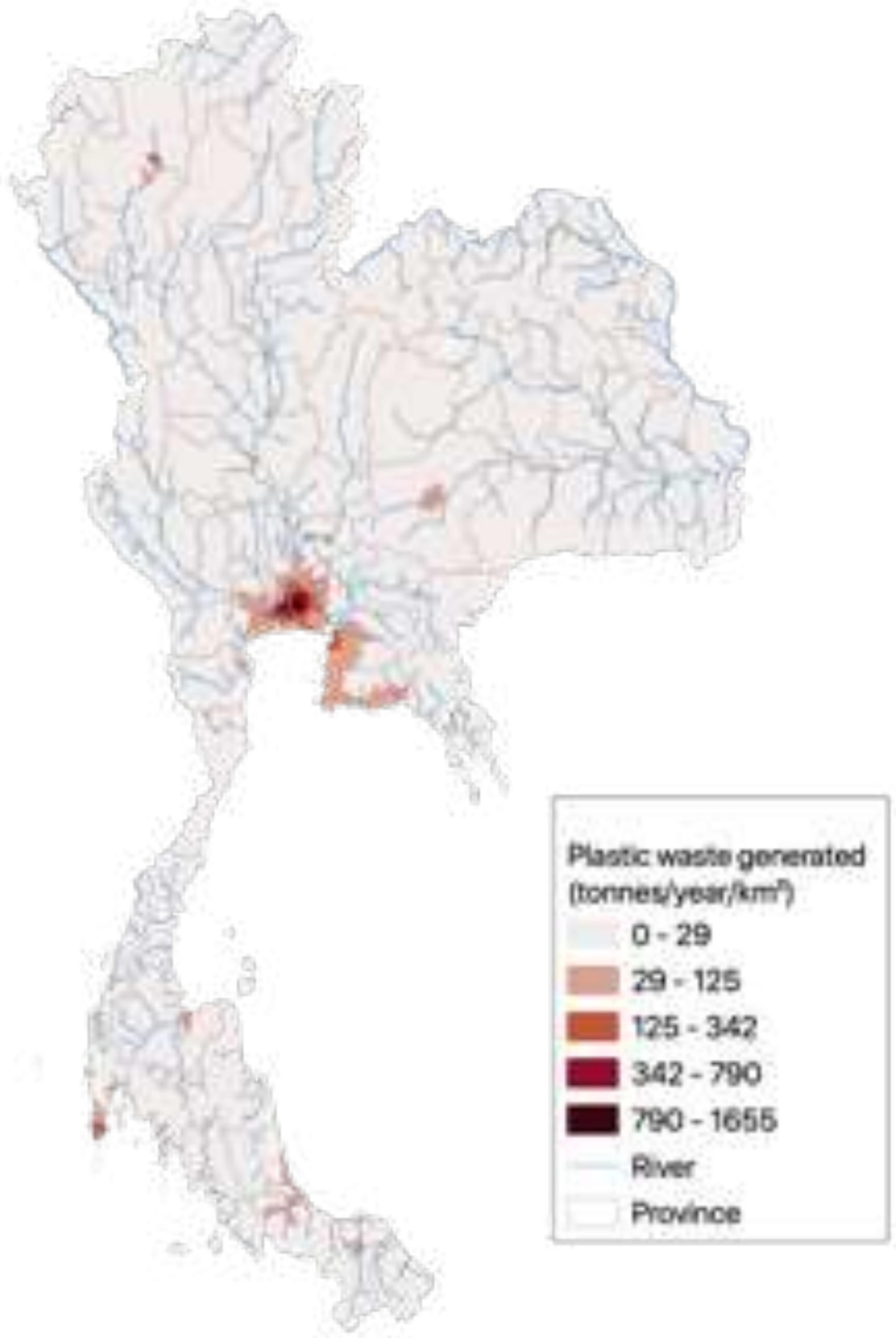
2) … and using geographic, hydrographic and demographic information…

3) … allows to compute a leakage map and identify regional hotspots

Plastic leakage (tonnes)



WASTE GENERATION: MAP AND INTERPRETATIONS



Key take-aways

- Plastic waste generation is concentrated around Bangkok, Chon Buri, Rayong, Chiang Mai and Pukhet areas, where the population density is higher.
- All of the areas with the highest waste generation are close to the coast or crossed by rivers, which favours the leakage.

Limitations

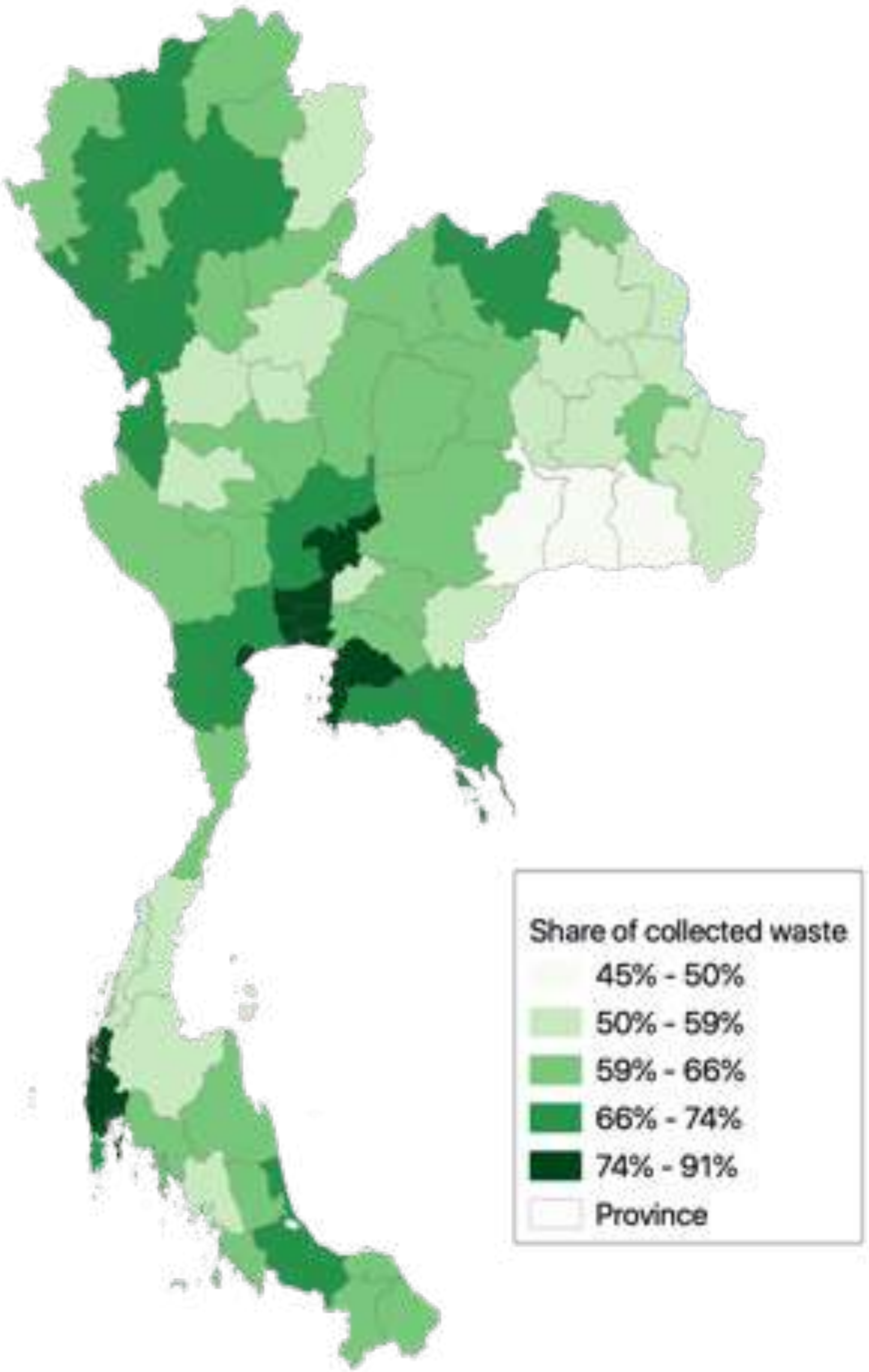
The waste generation estimates displayed on the map are based on population points and do not account for the locations of specific industries and businesses (such as hotels) nor touristic areas.

Unlocking limitations

For the areas with the highest generation a more in depth study could be conducted to better understand where waste is disposed: touristic areas, restaurants, hotels etc.

More details available in Appendices

WASTE COLLECTION:
MAP AND INTERPRETATIONS



Key take-aways

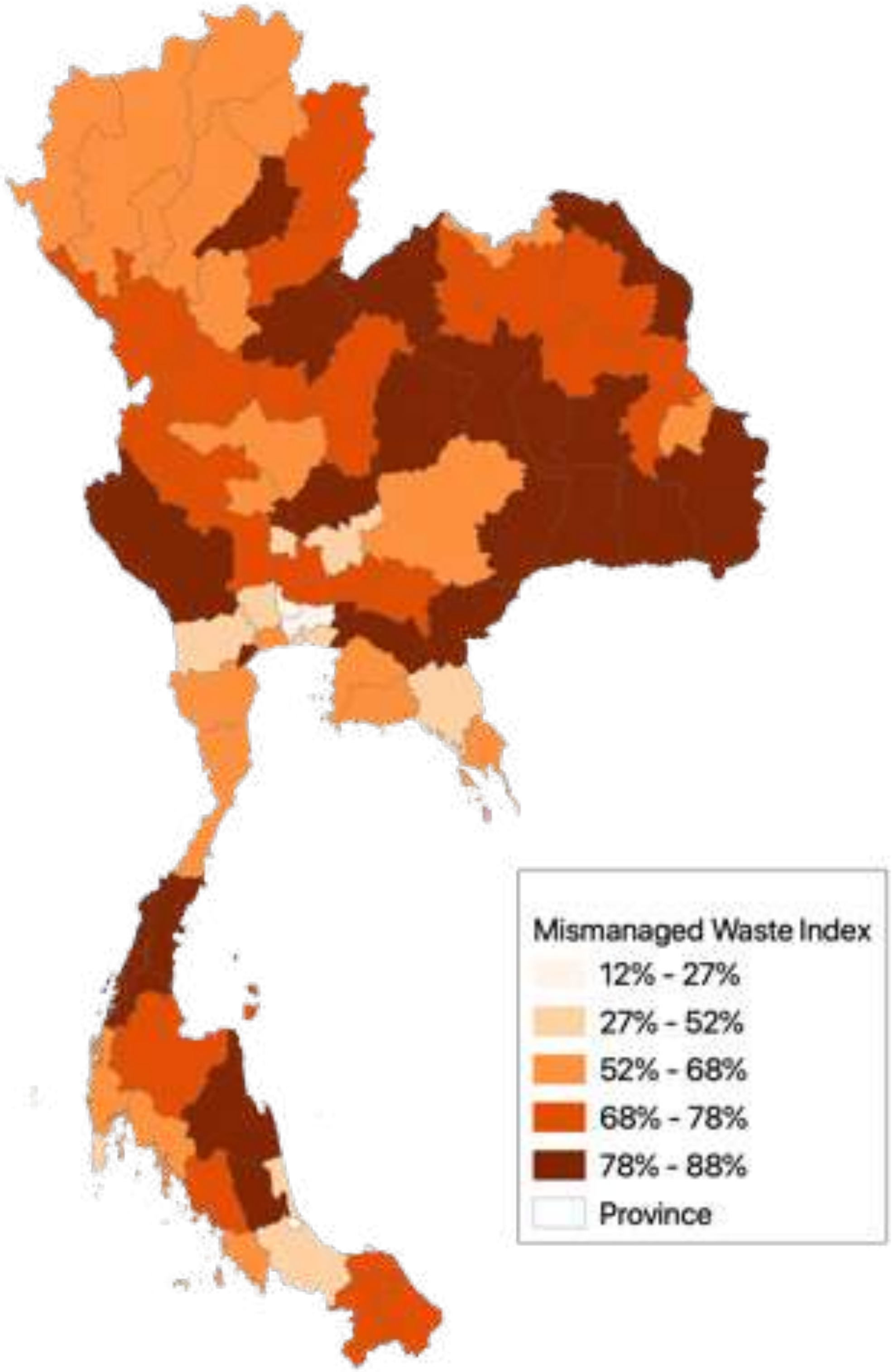
- Waste collection is above 46% in all provinces, with an average of 70%.
- Bangkok Metropolis has a collection rate of 91%.

Learning

In Thailand, waste collection rates range from 46% to 91%. The provinces with the highest collection rates are: Bangkok Metropolis, Saraburi and Nonthaburi. The provinces with the lowest collection rates are: Buri Ram, Si Sa Ket and Surin. Collected waste is then either recycled, properly disposed or improperly disposed.

More details available in Appendices

MISMANAGED WASTE INDEX: MAP AND INTERPRETATIONS



Key take-aways

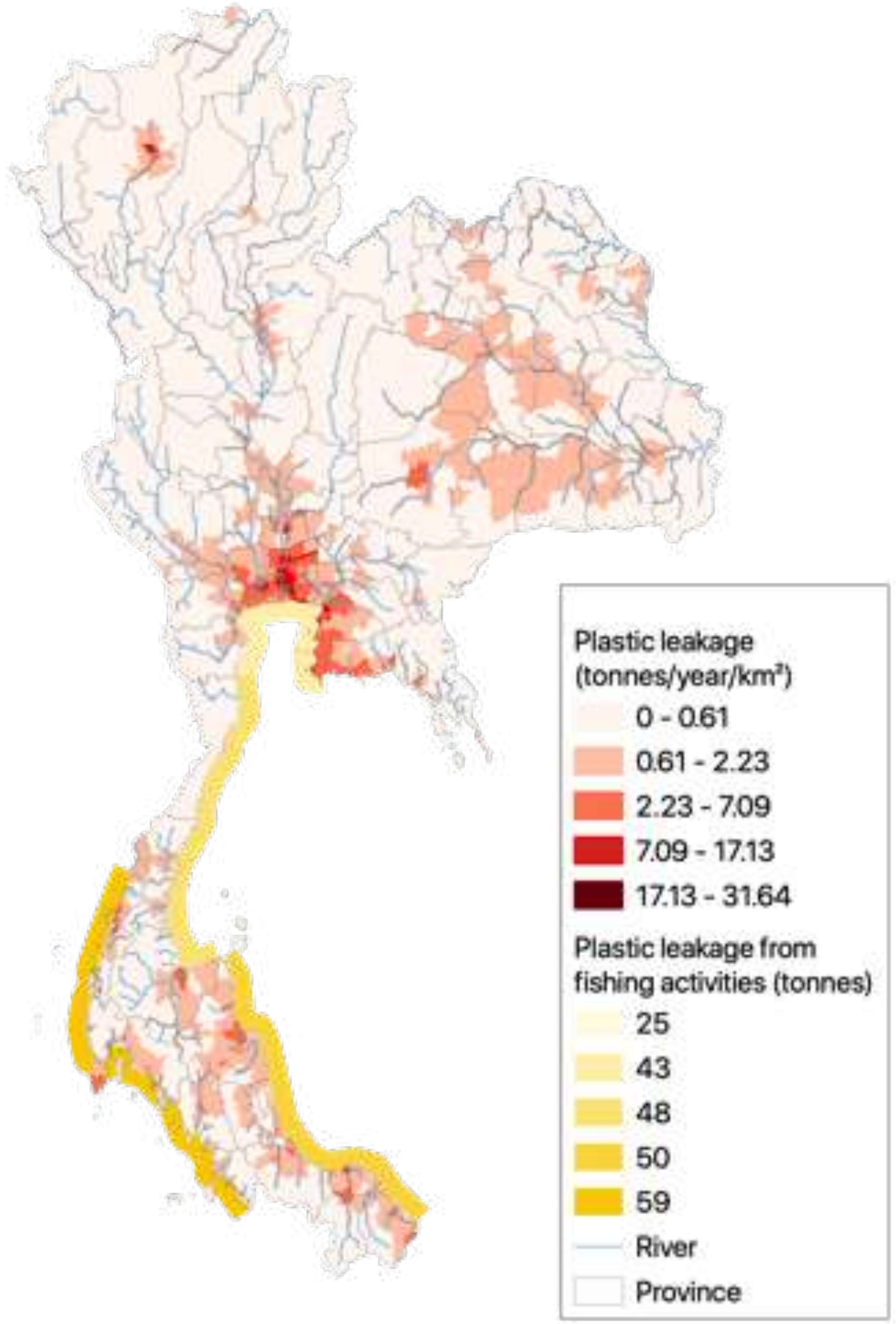
- MWI is the lowest in Bangkok Metropolis (12%)
- The average MWI in Thailand is 59%

Learning

- In Bangkok Metropolis, the mismanaged waste comes mostly from uncollected waste, as 96% of the waste collected is either properly managed or sent to recycling.
- Some areas, like Chon Buri, have both high MWI and collection rate. This is due to the fact that the collected waste is often disposed at unsanitary landfills or dumpsites, therefore considered as mismanaged.

More details available in Appendices

REGIONAL LEAKAGE:
MAP AND INTERPRETATIONS



More details available in Appendices

Key take-aways

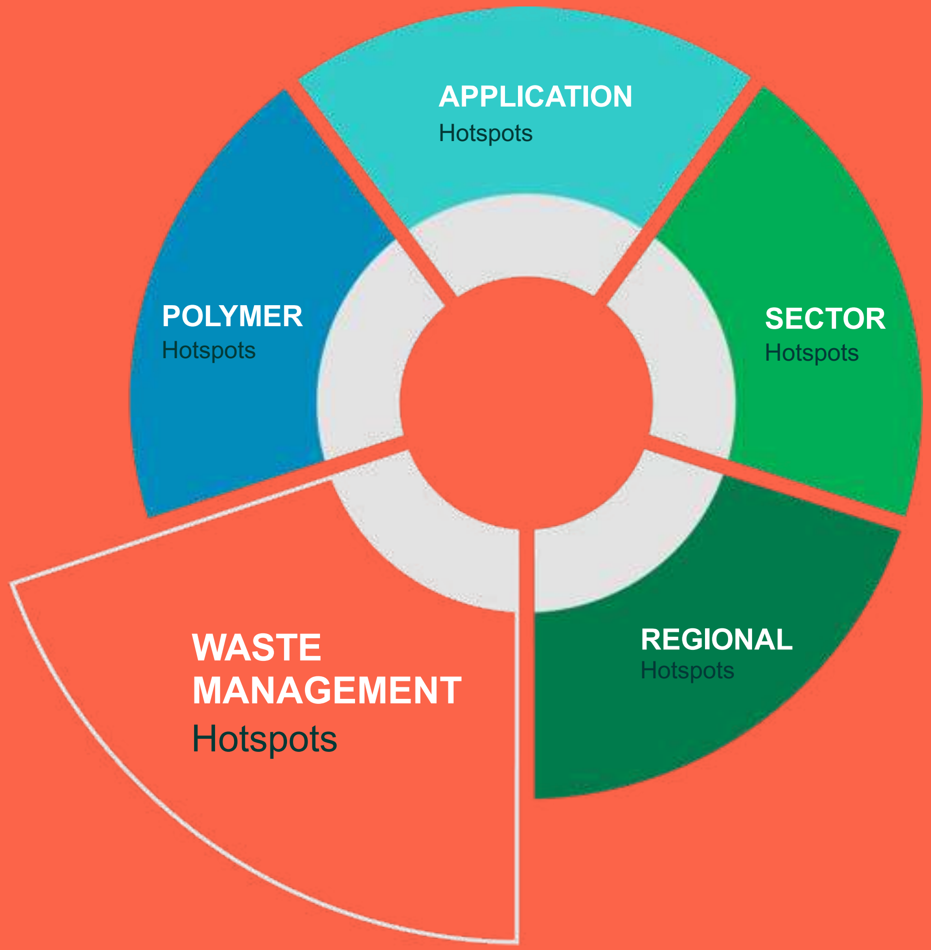
- Annual leakage of mismanaged waste: 321’853 tonnes
- Annual leakage from mismanaged/lost at sea fishing gears and from overboard litter: 225 tonnes

Learning

Several parameters drive the leakage across Thailand:

- Populated areas with high waste generation are usually located close to a waterway or the coast. From any place in Thailand, it is possible to find a river or a coast within a 70 km radius. This increases the possibility of wastetransfer to the marine environment.
- Large quantities of waste are mismanaged due to low collection and/or disposal of waste at unsanitary landfills and dumpsites.
- High surface water runoff, especially in late summer/early autumn, drives leakage. In Thailand, 96% of the country is classified as either “high” or “average” runoff.

E WASTE MANAGEMENT HOTSPOTS



OBJECTIVE AND INSTRUCTIONS

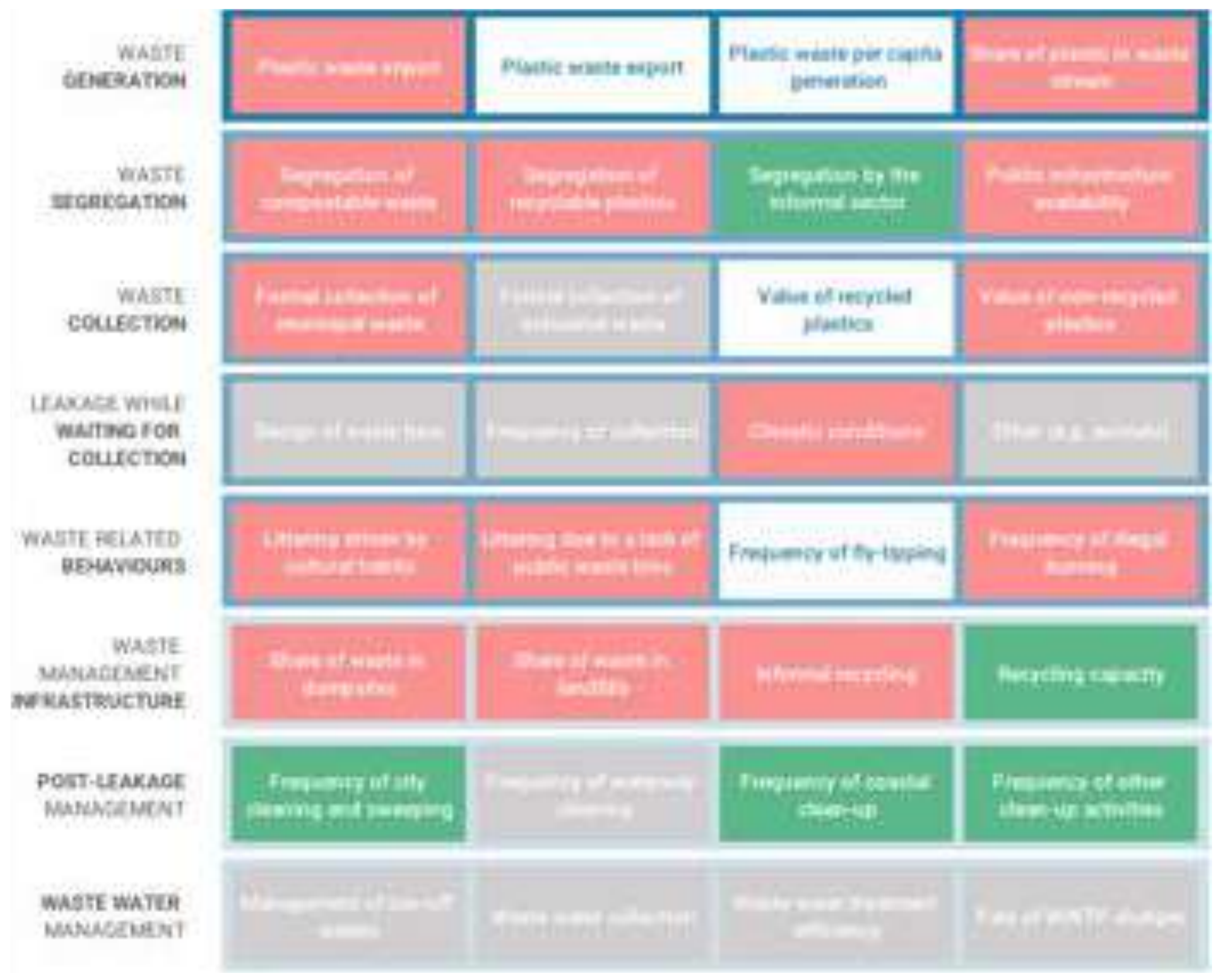
Key question answered:

Which waste management stages are most critical in the country regarding plastic leakage?

1) Decide for each element* of the waste management system if its contribution to leakage mitigation is positive (coolspot), neutral or negative (hotspot)

Waste management stage	Potential hotspot	Is it a hotspot?	Justification	Source
Waste generation	Plastic waste import	HOTSPOT	Only 7% of the waste recycled in the country is locally sourced, the remaining 93% in imported. The formal sector only recycles imported waste (around 850kt a year) and it does not recycled domestic waste (cit. VPA, VCCI). Domestic waste is recycled by the informal sector in improper conditions.	VPA interview and VCCI report VN_r14
	Plastic waste export			
	Plastic waste per capita generation		Vietnam produces around 50 kg of plastic waste per person per year	IA - Country baseline analysis
	Share of plastic in waste stream	HOTSPOT	Vietnam is a LMC (8% of plastic in waste stream on average), but the share of plastic in the waste stream is from 15% to 20% depending on the source	VN_r10 GA Circular summarises the waste characterisation studies

2) Understand at a glance the status of the waste management system in the country



*For detailed element descriptions and methodology, refer to tool T4.1

T4

WASTE MANAGEMENT HOTSPOTS

Stage	Category				
SOURCE	WASTE GENERATION	Plastic waste import	Plastic waste export	Plastic waste per capita generation	Share of plastic in waste stream
COLLECTION	WASTE SEGREGATION	Segregation of compostable waste	Segregation of recyclable plastics	Segregation by the informal sector	Public infrastructure availability
COLLECTION	WASTE COLLECTION	Formal collection of municipal waste	Formal collection of industrial waste	Value of recycled plastics	Value of non-recycled plastics
COLLECTION	LEAKAGE WHILE WAITING FOR COLLECTION	Design of waste bins	Frequency of collection	Climatic conditions	Other (e.g. animals)
COLLECTION	WASTE RELATED BEHAVIOURS	Littering driven by cultural habits	Littering due to a lack of public waste bins	Frequency of fly-tipping	Frequency of illegal burning
END-OF-LIFE	WASTE MANAGEMENT INFRASTRUCTURE	Share of waste in dumpsites	Share of waste in landfills	Informal recycling	Recycling capacity
END-OF-LIFE	POST-LEAKAGE MANAGEMENT	Frequency of city cleaning and sweeping	Frequency of waterway cleaning	Frequency of coastal clean-up	Frequency of other clean-up activities
END-OF-LIFE	WASTE WATER MANAGEMENT	Management of run-off waters	Waste water collection	Waste water treatment efficiency	Fate of WWTP sludges

For more details and justifications, check tool T4.1

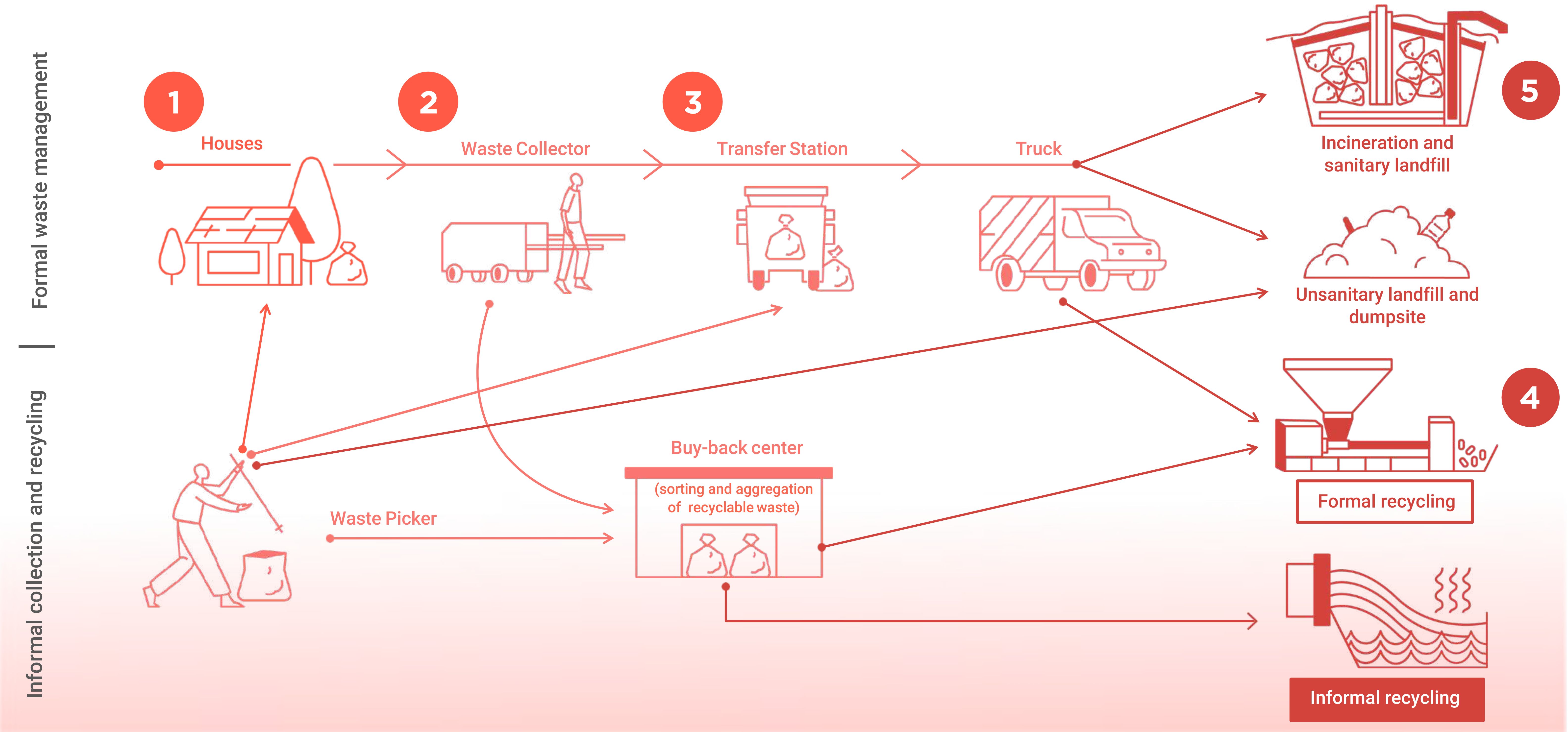
- Negative contribution to the leakage
- Neutral contribution
- Positive contribution
- Not assessed

Key take-aways

- More plastic waste was imported in 2018 than what could be recycled in the country.
- The per capita plastic waste generation in Thailand (66 kg/cap/yr) is above the world average* (29 kg/cap/yr)
- Plastic accounts for 20 to 30% of all waste generated.
- The informal sector plays a key role in collecting and segregating plastic for recycling.
- Sanitary landfill and incinerator capacity covers only a third of the country waste generation.
- Open burning is a rampant practice in rural areas.
- Flooding events are recurrent in Thailand and this induces significant leakage.

* Average plastic waste generation per capita values are derived from the What a Waste 2.0 database (*Kaza et al., 2018*)

PLASTIC WASTE JOURNEY IN PICTURES



1

Waste generation

2

Waste collection at canals communities

3

Cleaning of transfer station

4

Formal recycling of PET

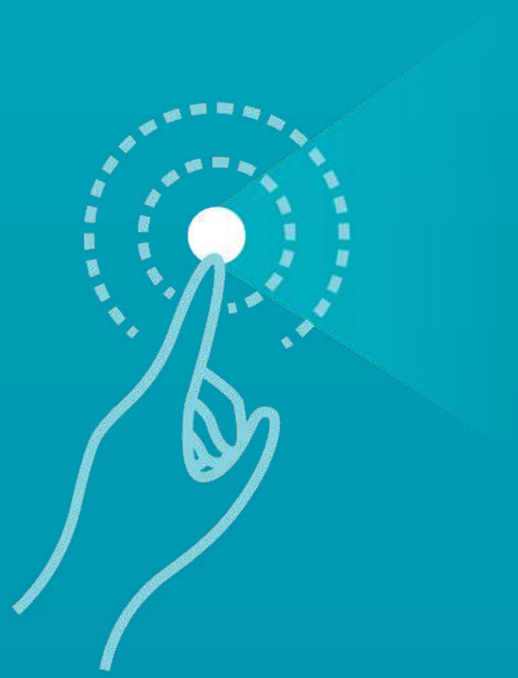
5

Sanitary landfill

Consumption of plastic bags

Fly-tipping and burning of waste

Example of post leakage collection



2.3 ACTIONABLE HOTSPOTS

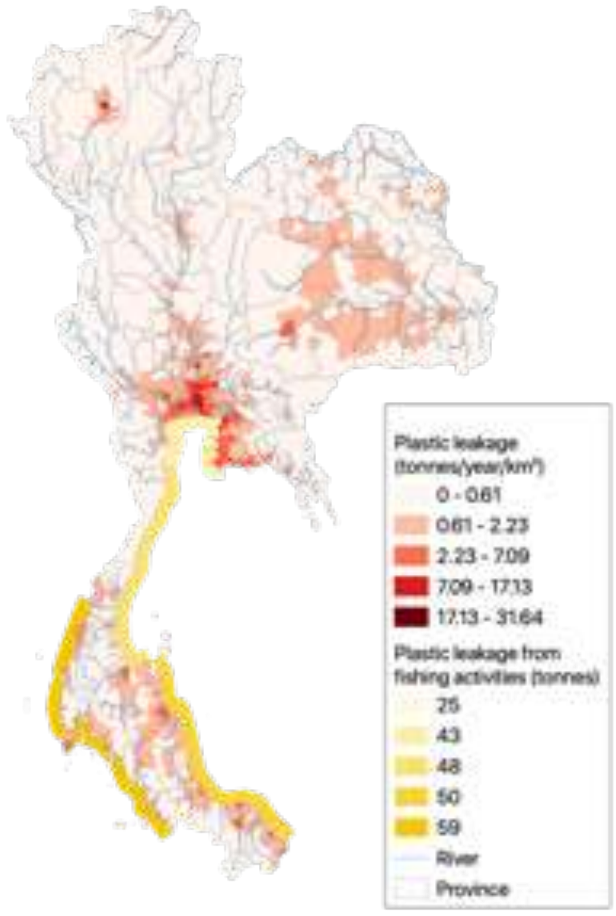
HOTSPOTS IN BRIEF

Polymer	Application	Sector
LDPE	Bags	Packaging
HDPE	Snack bags/Pouches	Textile
Polyester	Trays/Boxes/Cups	Automotive-tyres
Synthetic Rubber	Baby diapers	Fishing
PET	Cigarette filters	Medical
PP	Bottles	Agriculture
PS	Caps/Cap Rings	Tourism
PVC	Sanitary towels	Electrical & electronics
Other	Fishing nets	Automotive-other
		Construction

3 highest leakage contributors in absolute OR relative value

Highest leakage contributors in absolute AND relative value

Regional



Waste management

WASTE GENERATION	Plastic waste import	Plastic waste export	Plastic waste per capita generation	Share of plastic in waste stream
WASTE SEGREGATION	Segregation of compostable waste	Segregation of recyclable plastics	Segregation by the informal sector	Public infrastructure availability
WASTE COLLECTION	Formal collection of municipal waste	Formal collection of industrial waste	Value of recycled plastics	Value of non-recycled plastics
LEAKAGE WHILE WAITING FOR COLLECTION	Design of waste bins	Frequency of collection	Climatic conditions	Other (e.g. animals)
WASTE RELATED BEHAVIOURS	Littering driven by cultural habits	Littering due to a lack of public waste bins	Frequency of fly-tipping	Frequency of illegal burning
WASTE MANAGEMENT INFRASTRUCTURE	Share of waste in dumpsites	Share of waste in landfills	Informal recycling	Recycling capacity
POST-LEAKAGE MANAGEMENT	Frequency of city cleaning and sweeping	Frequency of waterway cleaning	Frequency of coastal clean-up	Frequency of other clean-up activities
WASTE WATER MANAGEMENT	Management of run-off waters	Waste water collection	Waste water treatment efficiency	Fate of WWTP sludge

Negative contribution to the leakage

Positive contribution

Neutral contribution

Not assessed

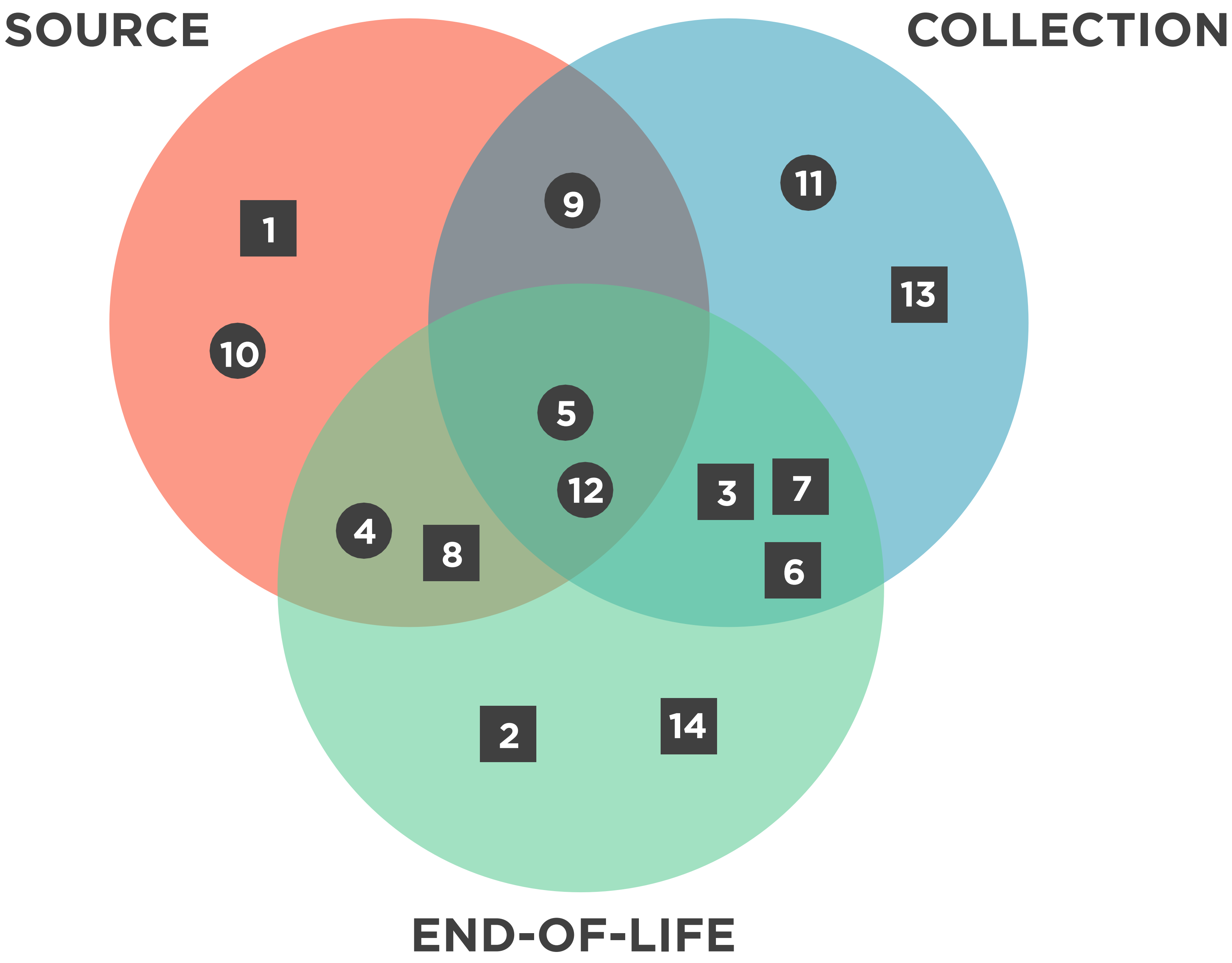
ACTIONABLE HOTSPOTS LIST

[#]	[ACTIONABLE HOTSPOT]	[■/●]
1	The high plastic waste generation in Thailand (twice the world average) is a root cause of the country plastic leakage.	■
2	Sanitary landfill and incinerators facilities treat only a third of the plastic waste generated, leaving the rest of the plastic waste susceptible to leakage.	■
3	Plastic leaks in Thailand because of the diffuse practice of open burning of waste, especially outside urban areas, which reduces the amount of plastic available for recycling.	■
4	LDPE leaks in Thailand because it is the most used polymer by the packaging sector and it is not recycled.	●
5	Plastic bags leak in Thailand because they are the most consumed plastic item and they are not likely to be collected for recycling by the informal sector due to their low per item value	●
6	The lack of waste segregation at source reduces the chances of plastic being collected for recycling and increases plastic leakage in Thailand.	■
7	Plastic leaks in Thailand due to frequent flooding, high surface water runoff (especially during monsoon season), and proximity to waterways	■
8	Import of waste in Thailand exceeds the country recycling capacity and it is eventually disposed in landfills and dumpsites, contributing to an increase of plastic leakage.	■
9	Plastic from the packaging sector leaks in Thailand due to high consumption, littering and release rate.	●
10	Polyester leaks to waterways because it is extensively used by the textile sector, and has a high mismanagement rate once discarded.	●
11	HDPE leaks in Thailand do to its use in packaging applications that have higher littering and release rate.	●
12	Snack bags and pouches leak to waterways in Thailand because of high consumption, high littering and lack of recycling.	●
13	Plastic leaks in Thailand due to a lack of waste collection and segregation infrastructure.	■
14	Lack of economical incentives for plastic waste collection and recycling, keep recycling rates low (10%).	■

■ **GENERIC** (Concerns all plastic types and all regions)

● **SPECIFIC** (Concerns specific plastic types and all regions)

ACTIONABLE HOTSPOTS CHARACTERISATION



Each actionable hotspot can address plastic pollution at one or multiple stages along the plastic value chain. We notice that the list of actionable hotspots for Thailand calls for a well-balanced set of actions across the value chain, yet with an emphasis on the end-of-life.

GENERIC (Concerns all plastic types and all regions)

SPECIFIC (Concerns specific plastic types or regions)

3 SHAPING ACTION

3.1 INTERVENTIONS

METHODOLOGY FOR IDENTIFYING INTERVENTIONS

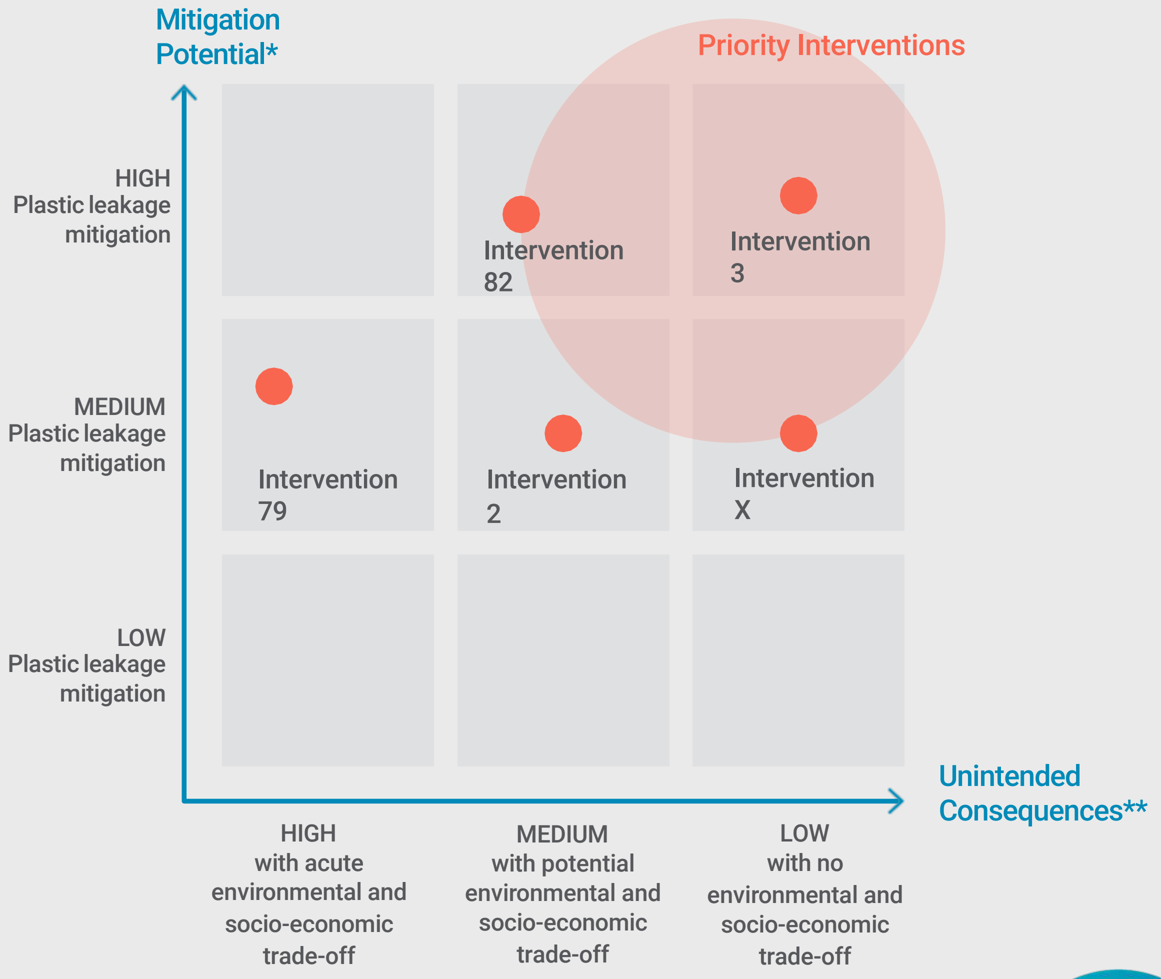
STEP 1: choose up to 3 interventions for each actionable hotspot

Actionable hotspots (AH)
AH 1
AH 2
AH 3
...
AH x

STEP 2: assess criteria levels for each chosen intervention

Interventions (I)	Leakage mitigation potential*	Unintended consequences**
I1		
I2	medium	medium
I3	high	low
I4		
I5		
...		
I79	medium	high
I80		
I81		
I82	high	medium
I83		

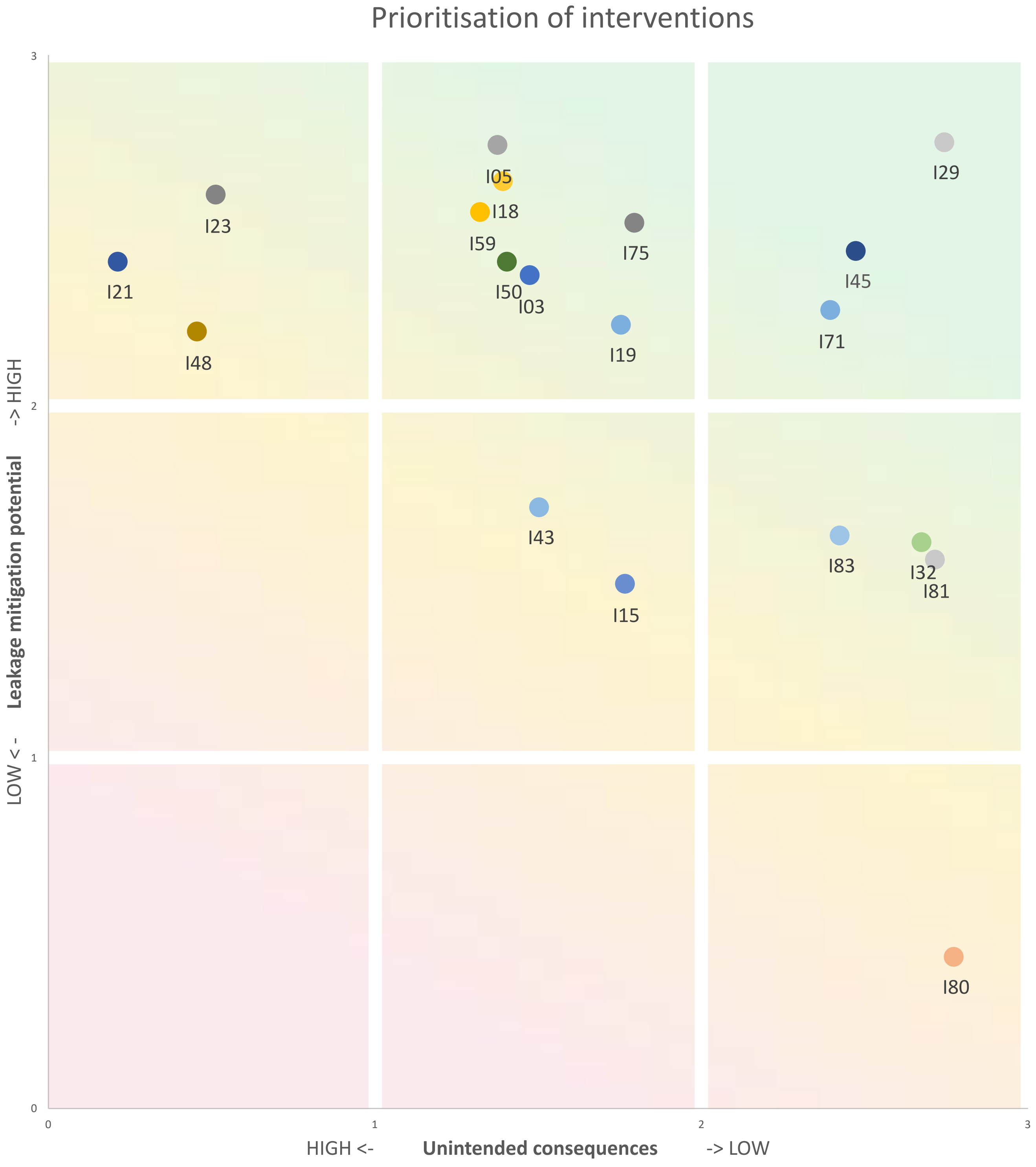
STEP 3: visualise priority interventions in the top right corner of the chart



* **Leakage mitigation potential:** high mitigation potential actions are those that contribute to meaningful reductions of plastic leakage and impacts.
** **Unintended consequences:** highly consequential actions are those most likely to generate unintended environmental or socio-economic trade-offs (e.g., substitution from plastic to another material may generate additional environmental impacts such as GHG emissions).

S2

PRELIMINARY SELECTION OF INTERVENTIONS



- I03: Increase recycling capacity for domestic plastic waste (all polymers)
- I05: Increase recycling capacity for domestic plastic waste (LDPE)
- I15: Reduce littering in rural areas
- I18: Reduce the demand for new synthetic fibres in textiles and recycle synthetic textiles back to raw materials
- I19: Reduce demand for, and use of, single-use, especially on-the-go, plastics
- I21: Increase demand for recycled material in the country (for all polymers)
- I23: Increase demand for recycled material in the country (LDPE)
- I29: Avoid producing / importing plastic objects that do not benefit from a recycling solution in the country
- I32: Reduce import and export of plastic waste
- I43: Reduce open burning of plastic waste
- I45: Plan more frequent waste collection prior to the rainy events
- I48: Increase plastic segregation at household level
- I50: Increase plastic segregation in businesses
- I59: Ensure plastic waste has a enough value to cover collection costs (for all polymers)
- I71: Increase capacity for proper waste disposal (sanitary landfills if other upstream solutions cannot be applied)
- I75: Reduce losses from non-sanitary landfills and dumpsites (from wind and floodings)
- I80: Increase density of waste bins in urban areas
- I81: Increase density of waste bins in rural areas
- I83: Increase density of waste bins in specific areas prone to leakage

Learning

Points are randomly distributed within the designated box to avoid overlapping. Each box on this 9 facets grid corresponds to a couple low/low or low/medium or low/high, etc. Only the facet in which the point falls into should be accounted for, not its relative position to points nearby.

Limitations

The list of interventions results from the hotspot analysis ; it is currently based on the authors perception. A final version of the interventions should be elaborated through a multi-stakeholder consultation process.

Unlock button

Set up a workshop for a multi-stakeholder process and repeat the interventions selection procedure.

INTERVENTIONS CLASSIFICATION

Interventions may occur at any point along the value chain.

We categorise them into six types of approaches along the value chain.

Approach	Intervention	Description	Value chain stage
RE-DESIGN	SUSTAINABLE PRODUCTION	Design plastic products with highly recoverable and recyclable materials while improving reusability and repairability, and rethink sustainable business models to minimise risks of plastic leakage	PRODUCT MANUFACTURING AND USE
REDUCE	SUSTAINABLE CONSUMPTION AND LIFESTYLES	Reduce demand for & use of problematic or unnecessary plastic materials and products	PRODUCT MANUFACTURING AND USE
RECUPERATE	WASTE COLLECTION SYSTEMS	Maximise collection of plastic waste	WASTE INFRASTRUCTURE AND MANAGEMENT
RENOVATE	WASTE INFRASTRUCTURE	Build capacity to increase efficiency of proper treatment and final disposal	WASTE INFRASTRUCTURE AND MANAGEMENT
RECYCLE	PLASTIC RECYCLING	Increase recycling rates through design and infrastructure that facilitate better segregation, collection, disassembly, recycling and recovery	WASTE INFRASTRUCTURE AND MANAGEMENT
REMOVE	CLEAN-UP SOLUTIONS	Post-leakage cleaning of the environment	POST LEAKAGE MANAGEMENT

S2

PRELIMINARY PRIORITY INTERVENTIONS LIST

[INTERVENTION CLASS]	[PRIORITY INTERVENTION]	[CODE]
SUSTAINABLE PRODUCTION	Reduce import and export of plastic waste	I32
	Avoid producing or importing plastic objects that do not benefit from a recycling solution in the country	I29
SUSTAINABLE CONSUMPTION AND LIFESTYLES	Reduce the demand for new synthetic fibres in textiles and recycle synthetic textiles back to raw materials	I18
	Reduce demand for, and use of, single-use, especially on-the-go, plastics	I19
WASTE COLLECTION SYSTEMS	Plan more frequent waste collection prior to the rainy events	I45
	Increase plastic segregation in businesses	I50
	Ensure plastic waste has a enough value to cover collection costs (for all polymers)	I59
WASTE INFRASTRUCTURE	Increase capacity for proper waste disposal (sanitary landfills if other upstream solutions cannot be applied)	I71
	Reduce losses from non-sanitary landfills and dumpsites (from wind and flooding)	I75
	Increase density of waste bins in rural areas	I81
	Increase density of waste bins in specific areas prone to leakage	I83
PLASTIC RECYCLING	Increase recycling capacity for domestic plastic waste (all polymers)	I03

3.2 INSTRUMENTS

METHODOLOGY FOR IDENTIFYING INSTRUMENTS

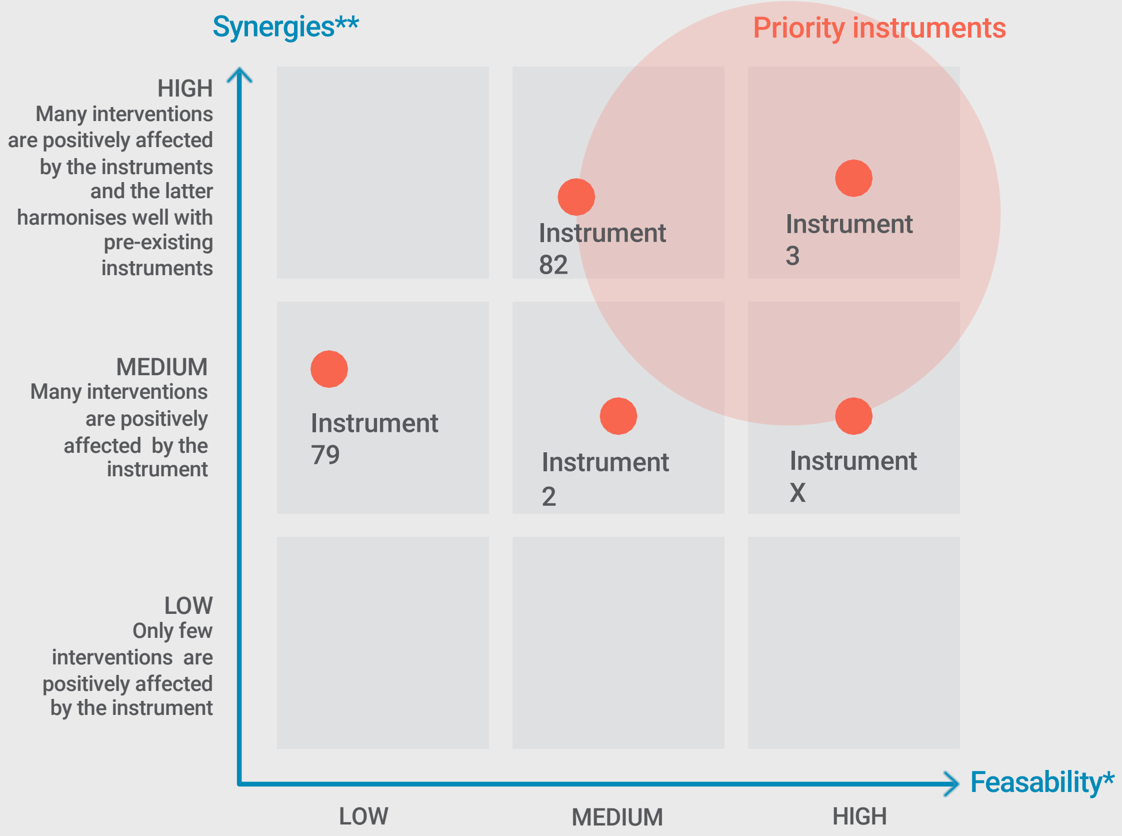
STEP 1: choose up to 3 instruments for each intervention selected in S2

Intervention (I)
I2
I3
...
I79
I82

STEP 2: assess criteria levels for each chosen instrument

Instruments (J)	Feasability*	Synergies**
J1		
J2	medium	medium
J3	high	high
J4		
J5		
...		
J79	medium	low
J80		
J81		
J82	high	medium
J83		

STEP 3: visualise priority instruments in the top right corner of the chart

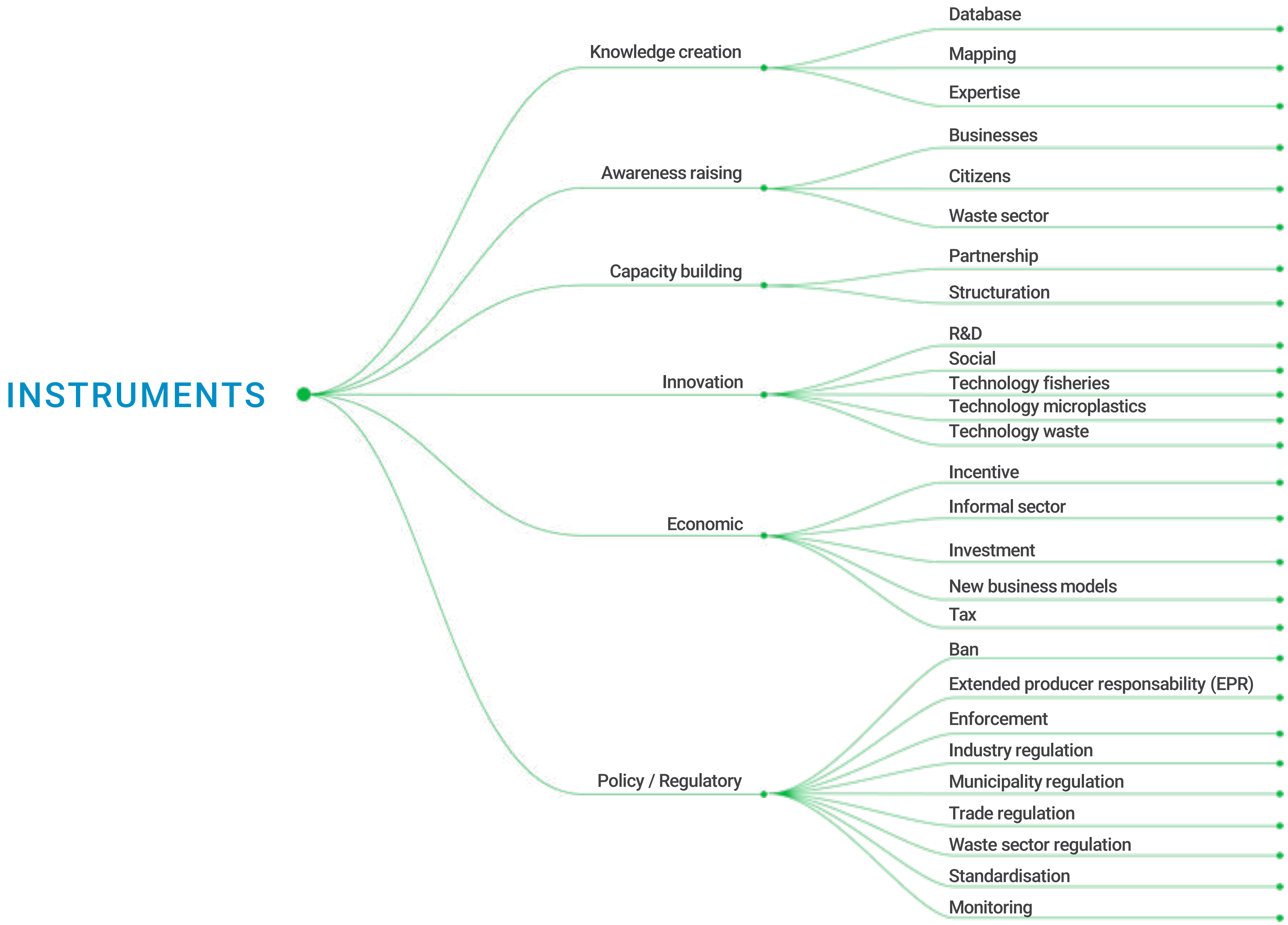


* **Feasability:** technical and socio-economic assessment of each instrument should be performed. We do not assert a method to perform the assessment as this is beyond the scope of the Guidance. The user can decide on the method to use based on resources available. A by default qualitative assessment with three levels is suggested.

** **Synergies**: Some instruments may be beneficial to multiple interventions, thus creating a positive synergetic effect. This criterion does not only evaluate the number of suggested interventions benefitting from an instrument, but also assess if the proposed instrument harmonises well with instruments already in place.

S3

LIST OF POSSIBLE INSTRUMENT CATEGORIES



S3

4 APPENDICES

4.1 DATA REPOSITORY

DETAILED SHARES BY POLYMER

Polymer Type	Waste produced in the country (kt)	Domestic recycling of collected	Export of collected	Properly disposed	Improperly disposed	Uncollected	*Tot*	Collected	Mismanaged	Leaked	Waste produced and imported (kt)	Domestic recycling incl imported
PET	*485*	37%	19%	17%	15%	13%	*100%*	87%	28%	4%	*598*	34%
PP	*359*	22%	11%	21%	21%	25%	*100%*	75%	46%	5%	*405*	22%
Polyester	*698*	0%	0%	34%	33%	33%	*100%*	67%	66%	5%	*698*	0%
LDPE	*1355*	0%	0%	32%	31%	37%	*100%*	63%	68%	9%	*1598*	0%
HDPE	*708*	14%	7%	22%	23%	33%	*100%*	67%	56%	7%	*832*	14%
PS	*64*	11%	6%	19%	21%	43%	*100%*	57%	64%	6%	*72*	11%
Other	*432*	0%	0%	28%	30%	42%	*100%*	58%	72%	6%	*439*	0%
Synthetic Rubber	*289*	6%	0%	29%	29%	36%	*100%*	64%	65%	7%	*289*	6%
PVC	*216*	25%	1%	9%	12%	53%	*100%*	47%	65%	3%	*230*	26%
All	*4605*	*10%*	*4%*	*26%*	*26%*	*33%*	*100%*	*67%*	*60%*	*7%*	*5161*	*10%*

- **Waste** = Collected + Uncollected
- **Collected** = Domestic recycling of collected + Export of collected + Properly managed + Improperly managed
- **Mismanaged** = Improperly managed + Uncollected

WASTE MANAGEMENT BY PROVINCE (1/2)

Province EN	Province TH	Population 2020	Generated t	Collected t	Collected for recycling t	Properly disposed t	Improperly disposed t	Uncollected t	Mismanaged t	Leaked t	Generated kg/hab	Collected for recycling kg/hab	Mismanaged kg/hab	Share of collected	Share of mismanaged	Leakage rate
Amnat Charoen	อำนาจเจริญ	225 157	18 876	10 586	2 247	3 843	4 496	8 290	12 786	1 339	84	10	57	56%	68%	7%
Ang Thong	อ่างทอง	238 569	14 356	9 596	1 817	5 570	2 208	4 760	6 968	778	60	8	29	67%	49%	5%
Bangkok Metropolis	กรุงเทพมหานคร	10 785 197	834 240	762 541	109 557	625 585	27 399	71 699	99 097	10 972	77	10	9	91%	12%	1%
Bueng Kan	บึงกาฬ	331 614	22 030	13 953	2 615	1 141	10 196	8 077	18 273	2 006	66	8	55	63%	83%	9%
Buri Ram	บุรีรัมย์	1 082 761	97 773	49 155	11 133	8 637	29 385	48 617	78 002	8 053	90	10	72	50%	80%	8%
Chachoengsao	ฉะเชิงเทรา	813 403	41 433	27 084	5 538	772	20 775	14 348	35 123	3 944	51	7	43	65%	85%	10%
Chai Nat	ชัยนาท	260 001	20 029	12 864	2 618	4 251	5 994	7 166	13 160	1 409	77	10	51	64%	66%	7%
Chaiyaphum	ชัยภูมิ	850 758	61 752	37 079	8 159	575	28 345	24 672	53 017	5 423	73	10	62	60%	86%	9%
Chanthaburi	จันทบุรี	471 645	32 874	24 280	4 274	13 086	6 920	8 594	15 513	2 321	70	9	33	74%	47%	7%
Chiang Mai	เชียงใหม่	2 002 596	156 304	106 184	21 620	43 675	40 889	50 120	91 009	9 699	78	11	45	68%	58%	6%
Chiang Rai	เชียงราย	1 189 139	67 159	41 134	7 574	15 519	18 041	26 025	44 067	4 699	56	6	37	61%	66%	7%
Chon Buri	ชลบุรี	2 191 356	273 936	223 032	36 273	78 058	108 701	50 904	159 605	14 764	125	17	73	81%	58%	5%
Chumphon	ชุมพร	486 237	35 089	20 301	4 453	2 389	13 459	14 789	28 248	3 054	72	9	58	58%	81%	9%
Kalasin	กาฬสินธุ์	738 430	54 171	31 077	6 746	5 616	18 714	23 094	41 808	4 383	73	9	57	57%	77%	8%
Kamphaeng Phet	กำแพงเพชร	941 721	37 471	21 074	4 307	6 539	10 228	16 397	26 625	2 781	40	5	28	56%	71%	7%
Kanchanaburi	กาญจนบุรี	873 919	66 700	42 021	8 109	2 212	31 700	24 679	56 379	6 089	76	9	65	63%	85%	9%
Khon Kaen	ขอนแก่น	1 744 760	133 100	85 967	16 726	11 095	58 146	47 133	105 278	11 038	76	10	60	65%	79%	8%
Krabi	กระบี่	368 811	38 920	25 314	4 604	9 327	11 383	13 606	24 989	3 338	106	12	68	65%	64%	9%
Lampang	ลำปาง	688 784	43 562	30 706	5 286	13 799	11 621	12 856	24 477	2 490	63	8	36	70%	56%	6%
Lamphun	ลำพูน	435 066	23 332	14 328	2 897	6 608	4 823	9 004	13 827	1 434	54	7	32	61%	59%	6%
Loei	เลย	492 763	34 209	22 246	3 970	1 248	17 027	11 964	28 991	3 013	69	8	59	65%	85%	9%
Lop Buri	ลพบุรี	796 088	44 921	30 899	5 168	2 656	23 075	14 022	37 097	3 951	56	6	47	69%	83%	9%
Mae Hong Son	แม่ฮ่องสอน	205 483	14 512	9 131	2 071	2 664	4 396	5 381	9 777	1 028	71	10	48	63%	67%	7%
Maha Sarakham	มหาสารคาม	723 603	50 180	28 253	5 518	1 626	21 108	21 927	43 035	4 435	69	8	59	56%	86%	9%
Mukdahan	มุกดาหาร	411 370	17 940	10 291	1 891	3 621	4 779	7 649	12 428	1 339	44	5	30	57%	69%	7%
Nakhon Nayok	นครนายก	255 296	16 303	9 687	1 834	3 325	4 528	6 615	11 143	1 198	64	7	44	59%	68%	7%
Nakhon Pathom	นครปฐม	1 098 572	78 664	57 189	9 441	30 536	17 212	21 475	38 687	4 190	72	9	35	73%	49%	5%
Nakhon Phanom	นครพนม	496 763	41 543	23 131	5 529	1 604	15 998	18 412	34 410	3 791	84	11	69	56%	83%	9%
Nakhon Ratchasima	นครราชสีมา	2 470 984	211 246	131 127	24 261	45 355	61 511	80 119	141 630	14 829	85	10	57	62%	67%	7%
Nakhon Sawan	นครสวรรค์	904 953	59 849	38 139	6 622	17 046	14 471	21 710	36 181	3 840	66	7	40	64%	60%	6%
Nakhon Si Thammarat	นครศรีธรรมราช	1 427 063	94 824	59 916	11 106	5 971	42 839	34 907	77 747	10 793	66	8	54	63%	82%	11%
Nan	น่าน	462 410	24 749	13 956	2 900	3 422	7 634	10 793	18 427	1 951	54	6	40	56%	74%	8%
Narathiwat	นราธิวาส	659 486	41 077	25 129	4 662	4 747	15 720	15 948	31 668	4 765	62	7	48	61%	77%	12%
Nong Bua Lam Phu	หนองบัวลำภู	488 399	25 077	15 517	3 129	2 356	10 031	9 560	19 591	2 044	51	6	40	62%	78%	8%
Nong Khai	หนองคาย	429 413	30 134	21 360	3 896	7 410	10 054	8 774	18 828	2 091	70	9	44	71%	62%	7%
Nonthaburi	นนทบุรี	2 184 692	112 868	92 643	17 009	65 922	9 713	20 225	29 938	3 424	52	8	14	82%	27%	3%
Pathum Thani	ปทุมธานี	2 611 522	121 885	95 920	18 399	11 449	66 072	25 965	92 037	9 618	47	7	35	79%	76%	8%

Per capita values are calculated by dividing total values by the 2020 population forecasted by NASA in 2015.

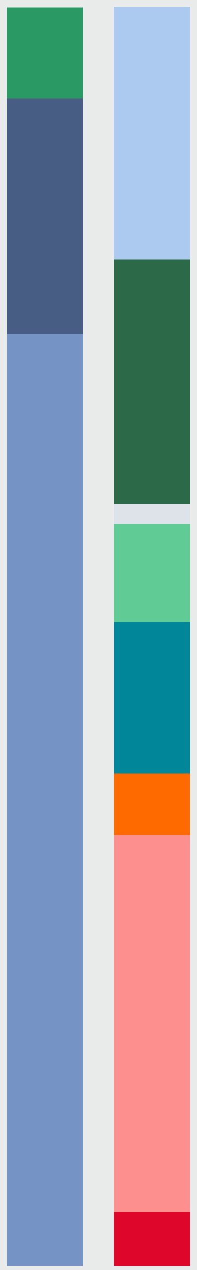
WASTE MANAGEMENT BY PROVINCE (2/2)

Province EN	Province TH	Population 2020	Generated t	Collected t	Collected for recycling t	Properly disposed t	Improperly disposed t	Uncollected t	Mismanaged t	Leaked t	Generated kg/hab	Collected for recycling kg/hab	Mismanaged kg/hab	Share of collected	Share of mismanaged	Leakage rate
Pattani	ปัตตานี	612 840	38 333	23 159	4 481	4 667	14 012	15 173	29 185	3 240	63	7	48	60%	76%	8%
Phangnga	พังงา	267 708	16 956	13 230	2 252	3 225	7 753	3 726	11 479	1 643	63	8	43	78%	68%	10%
Phatthalung	พัทลุง	448 278	28 509	17 519	3 246	2 080	12 194	10 989	23 183	2 473	64	7	52	61%	81%	9%
Phayao	พะเยา	340 529	24 154	14 939	2 766	5 748	6 424	9 216	15 639	1 614	71	8	46	62%	65%	7%
Phetchabun	เพชรบูรณ์	914 770	50 236	31 401	5 694	6 294	19 412	18 835	38 247	3 968	55	6	42	63%	76%	8%
Phetchaburi	เพชรบุรี	510 840	38 451	27 994	4 610	10 540	12 845	10 457	23 301	2 481	75	9	46	73%	61%	6%
Phichit	พิจิตร	523 832	27 576	15 780	2 832	3 526	9 421	11 796	21 217	2 318	53	5	41	57%	77%	8%
Phitsanulok	พิษณุโลก	1 048 573	66 928	36 259	6 554	6 463	23 242	30 669	53 910	5 883	64	6	51	54%	81%	9%
Phra Nakhon Si Ayutth	พระนครศรีอยุธยา	762 411	81 872	57 913	11 285	12 083	34 546	23 958	58 504	6 634	107	15	77	71%	71%	8%
Phrae	แพร่	510 079	22 697	16 469	3 002	1 523	11 945	6 228	18 172	1 927	44	6	36	73%	80%	8%
Phuket	ภูเก็ต	935 079	74 819	53 602	9 277	26 713	17 611	21 217	38 828	1 941	80	10	42	72%	52%	3%
Prachin Buri	ปราจีนบุรี	732 047	31 245	18 894	3 424	3 357	12 113	12 350	24 464	2 658	43	5	33	60%	78%	9%
Prachuap Khiri Khan	ประจวบคีรีขันธ์	482 641	36 830	24 128	4 705	11 132	8 291	12 702	20 993	2 013	76	10	43	66%	57%	5%
Ranong	ระนอง	354 672	39 316	21 289	7 132	218	13 940	18 027	31 967	3 633	111	20	90	54%	81%	9%
Ratchaburi	ราชบุรี	808 624	45 221	32 083	5 237	16 431	10 415	13 139	23 553	2 495	56	6	29	71%	52%	6%
Rayong	ระยอง	1 266 852	114 495	81 747	13 970	35 801	31 977	32 748	64 725	5 914	90	11	51	71%	57%	5%
Roi Et	ร้อยเอ็ด	936 516	65 782	37 959	7 195	735	30 029	27 822	57 851	6 130	70	8	62	58%	88%	9%
Sa Kaeo	สระแก้ว	621 068	28 860	16 277	3 759	1 874	10 644	12 583	23 226	2 468	46	6	37	56%	80%	9%
Sakon Nakhon	สกลนคร	853 004	59 280	32 343	6 804	6 236	19 303	26 937	46 240	4 945	69	8	54	55%	78%	8%
Samut Prakan	สมุทรปราการ	3 141 365	131 822	103 827	18 210	50 957	34 660	27 995	62 655	6 661	42	6	20	79%	48%	5%
Samut Sakhon	สมุทรสาคร	1 671 671	74 034	51 055	9 997	20 904	20 153	22 978	43 132	4 761	44	6	26	69%	58%	6%
Samut Songkhram	สมุทรสงคราม	164 619	10 570	8 285	1 338	332	6 614	2 285	8 899	1 042	64	8	54	78%	84%	10%
Saraburi	สระบุรี	910 984	38 620	31 832	4 974	18 804	8 053	6 788	14 841	1 562	42	5	16	82%	38%	4%
Satun	สตูล	276 371	16 405	10 768	1 909	3 298	5 561	5 637	11 198	1 163	59	7	41	66%	68%	7%
Si Sa Ket	ศรีสะเกษ	903 780	76 968	36 944	7 025	5 264	24 654	40 024	64 678	7 026	85	8	72	48%	84%	9%
Sing Buri	สิงห์บุรี	150 621	11 556	8 055	1 364	165	6 527	3 501	10 027	1 128	77	9	67	70%	87%	10%
Songkhla	สงขลา	1 707 065	132 351	93 998	16 277	49 510	28 212	38 353	66 564	6 626	78	10	39	71%	50%	5%
Sukhothai	สุโขทัย	667 407	31 057	20 271	3 599	7 112	9 560	10 786	20 346	2 137	47	5	30	65%	66%	7%
Suphan Buri	สุพรรณบุรี	834 369	42 695	26 278	4 891	6 328	15 059	16 417	31 476	3 451	51	6	38	62%	74%	8%
Surat Thani	สุราษฎร์ธานี	1 156 334	94 172	54 876	11 037	11 974	31 865	39 296	71 161	7 996	81	10	62	58%	76%	8%
Surin	สุรินทร์	947 200	77 148	35 108	6 995	4 022	24 090	42 040	66 130	6 939	81	7	70	46%	86%	9%
Tak	ตาก	569 734	32 864	23 388	4 279	3 430	15 679	9 477	25 155	2 692	58	8	44	71%	77%	8%
Trang	ตรัง	587 139	39 566	23 099	4 749	6 289	12 062	16 467	28 529	3 901	67	8	49	58%	72%	10%
Trat	ตราด	243 236	13 615	10 000	1 700	3 162	5 138	3 615	8 753	728	56	7	36	73%	64%	5%
Ubon Ratchathani	อุบลราชธานี	1 777 691	106 224	57 500	11 215	11 118	35 168	48 724	83 891	9 128	60	6	47	54%	79%	9%
Udon Thani	อุดรธานี	1 125 459	87 924	60 686	11 050	16 399	33 238	27 238	60 476	6 352	78	10	54	69%	69%	7%
Uthai Thani	อุทัยธานี	290 535	16 503	9 068	1 757	3 005	4 306	7 435	11 741	1 242	57	6	40	55%	71%	8%
Uttaradit	อุตรดิตถ์	411 492	23 011	13 985	2 550	4 074	7 361	9 025	16 387	1 776	56	6	40	61%	71%	8%
Yala	ยะลา	448 349	34 175	21 244	4 199	5 833	11 212	12 931	24 144	2 650	76	9	54	62%	71%	8%
Yasothon	ยโสธร	423 738	26 924	16 475	3 498	2 656	10 321	10 449	20 770	2 199	64	8	49	61%	77%	8%

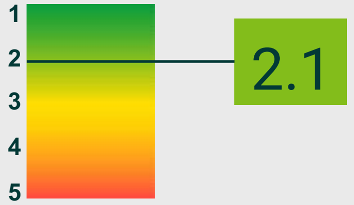
4.2 DATA QUALITY ASSESSMENT

POLYMER HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
*UN, 2020, COMTRADE database** | Total waste import and export (2018 data)	2	2018	1	Polymer composition of packaging sector used to compute shares of waste imported by Thailand is based on European market, while most of the TH plastic waste comes from Japan, USA and China (Hong Kong)	3	Total import and export are given by comtrade code 3915. While Polymer share is based on polymer composition of packaging sector (EU market)	3	Import of waste	3
PlasticsEurope, 2018 | Polymer composition in the packaging sector	1								
WWF, 2020 | Waste collected for recycling by polymer	1	2018	1	-	1	Recycling of imported by polymer = (tot capacity - total recycled of domestically collected)*polymer share of domestically collected. The result are adapted to ensure import of waste >= recycling of imported waste (by polymer).	2	Recycling of imported waste***	2.33
This study - Polymer | Import of waste by polymer	3								
PCD, 2018 | Total recycling capacity of Thailand	3								
*UN, 2020,, COMTRADE database ** | Import products (sometimes polymer is known) (2018 data)	2	2018	1	When polymer is not specified: PlasticsEurope matrix used to assign polymer based on sector.	2	See Comtrade flowchart.	2	Import of products	2
PlasticsEurope, 2018 |Polymers to Sectors correspondence matrix	1								
*UN, 2020, COMTRADE database ** | Export of products (polymer can be unknown) and primary (2018 data)	2	2018	1	For products for which the polymer is not specified: PlasticsEurope matrix used to assign polymer based on sector.	2	See Comtrade flowchart.	2	Export of primary and products	2
*UN, 2020, COMTRADE database** | Import of primary by polymer (2018 data)	2	2018 2018 2018 2014	1	-	1	Production: for Synthetic Rubber we use *Jacob et al, 2014* (extrapolated to 2018 using GDP) , for polymer cat. "Other" we use PIT, for all other polymers we use ICIS. Import: See comtrade flowchart.	1	Import and production of primary	1.5
PTIT, 2019 | Production capacity by polymer as of 2018	2								
ICIS, 2020 | Production quantity per polymer (no rubber)	1								
Jacob et al., 2014 | Net input** of Synthetic Rubber on Thai market	1								
This Study - Sector | Change in Stock by sector	2.5	2018	1	Mapping from Sector to Polymer based on EU, but adapted through TH net input by polymer	2.5	-	1	Change in stock	2.5
This Study - Polymer | Net input**	2.17								



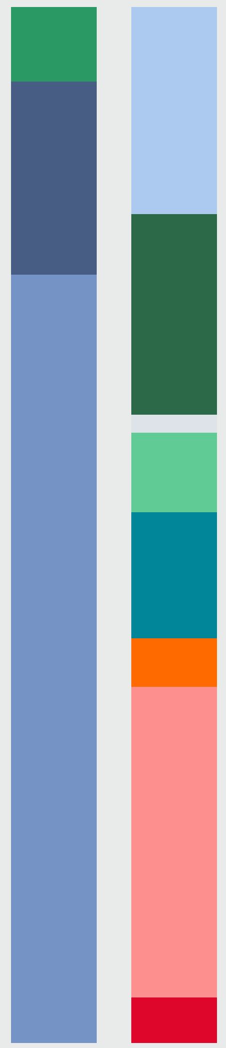
Quality Score



* Data as reported by Vietnam to UN
** Net input = Import waste - Recycling of import + import of products - Export of primary and products + Import and production of primary
*** "Recycling of imported waste" together with "recycling of domestic waste" constitute the country's "recycling" bar

POLYMER HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
WWF, 2020 | Packaging plastic collected for recycling by polymer	1	2018 2014 2017 2018	1	-	1	We use WWF data of collected for recycling and we remove the waste exported. For PVC we adjust the value using Khomchu work, for Synthetic Rubber we use *Jacob et al, 2014*.	2	Export of waste	2.0
Jacob et al., 2014 | Recycling of Synthetic Rubber	1							Domestic recycling of collected waste***	2.0
Khomchu,2017 | Recycling of PVC in Thailand	1								
*UN, 2020, COMTRADE database** | Total export of plastic waste (data 2018)	2								
This study - Sector| Properly disposed per sector	2.5	2018	1	Mapping from sector to polymer based on EU, but adapted through TH "remaining after recycling" by polymer. Properly disposed waste by sector is specific to TH	2	See Polymer flowchart	1	Properly disposed	2.0
This study - Polymer | Remaining after recycling = Waste + Import of Waste - Export of waste - Recycled of imported - Recycling of domestic	2.0								
PlasticsEurope, 2018 | Sector to polymer mapping based on EU market	1								
This study - Sector | Improperly disposed by sector	2.5	2018	1	Mapping from sector to polymer based on EU, but adapted through TH "remaining after recycling and properly managed" by polymer.Improperly disposed waste by sector is specific to TH	2	See Polymer flowchart	1	Imporperly disposed	2.0
This study - Polymer | Remaining after recycling and properly managed	2.0								
This study - Polymer | Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	2.0	2018	1	-	1	Uncollected = Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	1	Uncollected	2.0
This Study - Sector | Leakage by sector	2.42	2018	1	Mapping from sector to polymer based on EU, but adapted using TH "mismanaged" waste specific to TH	2	See Polymer flowchart	1	Leaked	2.0
This Study - Polymer | Mismanaged waste by polymer	2.0								



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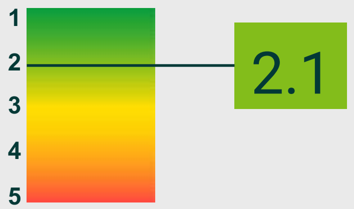
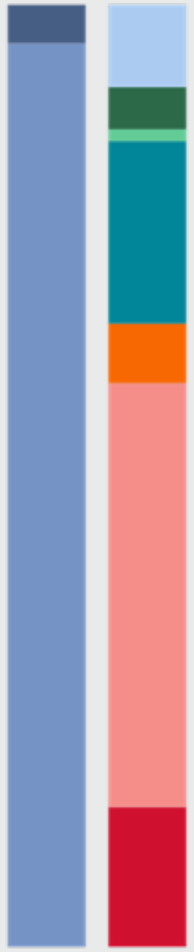


* Data as reported by Vietnam to UN
*** "Recycling of imported waste" together with "recycling of domestic waste" constitute the country's "recycling" bar

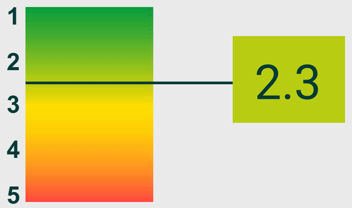
APPLICATION HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
*UN, 2020, COMTRADE database** | Import and export of products	2	2018	1	-	1	All applications except “Snack bags / pouches” have an equivalent in comtrade that was used to extract the traded qty. These are probably underestimated as they don’t include pre-packaged food.	3	Import of products	3
								Export of products	3
This study – Sector | Waste from Packaging and Tourism sector	2.5	2018	1	-	1	For Packaging applications : WWF data for known applications, "Other packaging" cat. accounts for the remaining part for consistency with packaging sector quantities. For other application see additional notes	2	Production from primary	2.25
WWF, 2020 | Waste generation per packaging application	2								



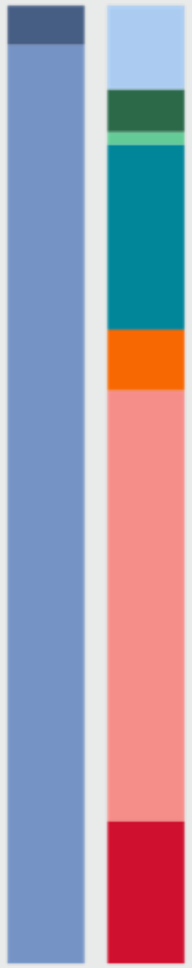
* Data as reported by Vietnam to UN

Quality Score



APPLICATION HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
WWF, 2020 | Recycling quantities per packaging applications	2	2018	1	-	1	For application in Packaging,recycling quantities from WWF Thailand. All other applications are not recycled.	2	Export of waste	2
								Domestic recycling of collected waste***	2
This study - Sector| Properly disposed per Packaging and Tourism sector	2.5	2018	1	European littering rates. Data on properly disposed plastic from packaging and tourism are from TH, as well as waste by application.	2	Littering rate is estimated following EU Commission study. Then for application in packaging we follow the application flowchart. For the other applications see additional notes.	2	Properly disposed	2.1
This study - Application | Remaining after recycling = Waste - Export of waste - Recycling of domestic	2.3								
European Commission, 2018 | Plastic packaging application ittering rate in EU	1								
This study - Sector | Improperly managed for Packaging and Tourism sector	2.5	2018	1	European littering rates. Data on improperly disposed plastic from packaging and tourism are from TH, as well as waste by application.	2	For packaging applications: See Application flowchart For other applications: See additional notes.	2	Imporperly disposed	1.8
This study - Application | Remaining after recycling and properly managed	2.2								
This study - Application | Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	2.1	2018	1	-	1	Uncollected = Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	1	Uncollected	2.1
Plastic Leak Project, 2019 | Release rate per packaging application	3	2018	1	-	2.5	Leaked to ocean = (Waste - Recycling – Properly)*Release Rate, adjusted so that the total leakage matches leakage from the geographical analysis	1	Leaked	2.5
This Study - Sector | Leakage from Packaging and Tourism sector	2.42								
This Study - Application | Mismanaged	1.9								



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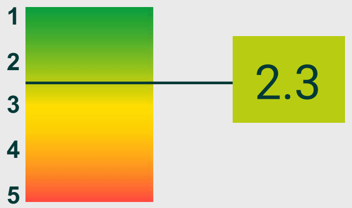


* Data as reported by Vietnam to UN
*** "Recycling of imported waste" together with "recycling of domestic waste" constitute the country's "recycling" bar

Cigarette filters

We estimate the number of cigarette filters from cigarette consumption data of the Tobacco Atlas project (src: *Kostova, D. et al. (2014)*). The plastic weight of a cigarette filter is 0.17gr (*Longwood University (2008)*). From these data we obtain the waste generated. Trade data on import and export are determined through comtrade (code: 240220). Recycling is set to zero. The share of properly managed is taken from the average share of properly managed (sector hotspot), applied to the cigarette filters that are not littered. Littering rate is set to 29% (*EuropeanCommission, 2018*). The improperly managed is based on the average share of improperly managed (sector hotspot), applied to cigarette filters not littered. The release rate is taken from *Plastic Leak Project (2019)* and applied to uncollected and improperly managed to determine de total leakage.

Sanitary towels

Import and export are determined through comtrade (code: 961900). Waste generation is estimated to be 140 million units (*Thai PBS World, 2019*), with one sanitary towel weighting 2gr. Recycling is set to zero. The share of properly managed is taken from the average share of properly managed (sector hotspot), applied to the sanitary towels that are not littered. Littering rate is set to 21% (*EuropeanCommission, 2018*). The improperly managed is based on the average share of improperly managed (sector hotspot), applied to sanitary towels not littered. The release rate is taken from *Plastic Leak Project (2019)* and applied to uncollected and improperly managed to determine de total leakage.

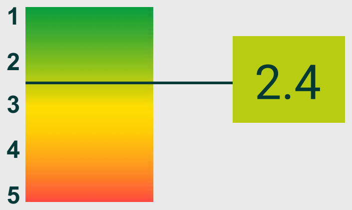
Baby diapers

To determine de waste generation we consider that the middle and high income population (55%) from 0-2 years old (half of the 0-4 pop in UN statistics database), uses 4.16 unit of diapers/day (*Mendosa et al., 2018*). Average weight of a baby diaper is 29,1 grams, from which 33% is made of plastic components (*Espinosa et al. 2015*). Recycling is set to zero. The share of properly managed is taken from the average share of properly managed (sector hotspot), applied to the baby diapers that are not littered. Littering rate is set to 21%, based on EU littering report (using sanitary towels as a proxy). The improperly managed is based on the average share of improperly managed (sector hotspot), applied to baby diapers not littered or properly managed. The release rate for baby diapers is the same as for sanitary towels. Release rate is applied to uncollected and improperly managed to determine de total leakage

SECTOR HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
PlasticsEurope, 2018 | Polymer to Sector mapping based on EU market	1	2018 2017 2018	1	Mapping from Polymer net input to Sector net input based on EU market, adapted through VN polymer net input	2.5	For net input quantity see Sector Hotspot flowchart for all sector except for fishing, medical and tourism. Tourism net input is removed from packaging, fishing and medical net input are removed from "Other" sector. To determine long and short lifetime from net input, see Sector hotspot flowchart	2	Short-lived products	2.5
Geyer et al., 2017 | Product lifetime by sector, mean and std.	1							Long-lived products	2.5
This study – Polymer | Net input by polymer*	2.17								
The World Bank, 2012 | Manufacturing, added value, GDP growth	1	2018 2017 2018 2012	1	-	1	See Sector hotspot flowchart. For medical, tourism and fishing we assume no change in stock. Low score because we assume the relative importance of every sector unchanged throughout the years in order to determine the stock.	2.5	Change in stock	2.5
Geyer et al., 2017 | Product lifetime by sector, mean and standard dev.	1								
This study – Sector | Net input* by sector	2.5								
The heightec Group Ltd, 2012| Product lifetime of textile sector	3								

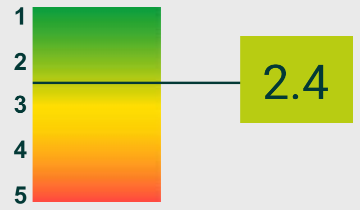
Quality Score



SECTOR HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
WWF, 2020 | Packaging plastic collected for recycling by polymer	1	2018 2014 2017 2018	1	-	1	Packaging: WWF data for collected for recycling (partly domestically collected, partly exported). Construction: PVC recycling data from *Khomchu, 2017.* Automotive-tyres: *Jacob et al, 2014*. For other sectors we assume no recycling	2	Export of waste	2.0
Jacob et al., 2014 | Recycling of Synthetic Rubber	1							Domestic recycling of collected waste***	2.0
Khomchu,2017 | Recycling of PVC in Thailand	1								
*UN, 2020, COMTRADE database** | Total export of plastic waste (data 2018)	2								
This study - Regional | Total plastic being properly disposed		2018	1	Country specific littering habits are not accounted for	2	See Sector flowchart. Low score mostly linked to littering rate by sector being based on PLP littering matrix for products.	2.5	Properly disposed	2.5
This study - Sector | Non recycled waste = Waste - Export of Waste - Recycled	2.0								
Plastic Leak Project, 2019 | Littering rate by Sector (based on product size and type of usage)	3								
This Study - Sector | Micro-leakage by sector (see additional notes)	2								
This study - Sector | Waste	2.07								
This study - Regional | Total plastic being improperly disposed		2018	1	Country specific littering habits are not accounted for	2	See Sector flowchart. Low score mostly linked to littering rate by sector being based on PLP littering matrix for products. Country specific littering habits are not accounted for.	2.5	Improperly disposed	2.5
This study - Sector | Waste - Properly managed - Recycled - Export of Waste	2.1								
This study - Polymer | Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	2.01	2018	1	-	1	Uncollected = Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	1	Uncollected	2.01
Wongpanit, 2019 | Value of recycling applications at Wongpanit collection center	3	2018	1	-	1	For Micro-leakage computation see additional notes, for Macro-leakage see sector hotspot flowchart, except for fishing (see additional notes)	2	Leakage	2.4
Plastic Leak Project, 2019 | Release Rate by sector (base on product size and value for informal recyclers)	3								
This Study - Geographical | Total Macro-leakage	2								
This Study - Sector | Mismanaged	2.26								

Quality Score



** Net input = Import waste - Recycling of import + import of products - Export of primary and products + Import and production of primary
*** "Recycling of imported waste" together with "recycling of domestic waste" constitute the country's "recycling" bar

SECTOR HOTSPOTS
MODELLING NOTES (1/2)

Fishing

Data on number of fishing gears comes from the Marine management plan of Thailand 2015-2019 published by FAO. By default plastic weights by fishing gear type were derived from technical designs found in multiple publications including FAO. Combining these two pieces of information yields the net plastic input from fishing gears. Plastic leakage from fisheries can be divided into three component:

1) Leakage due to gears lost at sea during fishing operations;

2) Leakage from gears discarded and mismanaged on land;

3) Leakage from plastic waste littered overboard by some fishermen.

(1) Leakage due to gears lost at sea is computed using loss rates by fishing gear type provided by Richardson et al. (2019). For some fishing gears, loss is considered for fragments of the gear only, thus we had to make an assumption on how big a fragment would be (10%, 50% or 90% of a gear unit). Our default calculation takes the assumption of a fragment representing 50% of a gear unit. (2) Leakage from gear waste mismanaged on land is computed from the difference between net input and loss at sea, to which specific loss and release rates are applied. (3) Overboard littering is estimated by taking the average daily littering rate for packaging products in the country and applying it to the number of days each fisherman is out at sea (assumption: 120 days per year at sea for full time fishermen). The number of fishermen comes also from the Marine management plan of Thailand 2015-2019 published by FAO.

Medical

Total plastic waste generated by the medical sector is computed by combining the number of hospital beds ‘B’ (WHO statistics 2010), the average bed occupancy rate ’OR’ (Abhicharttibutra et al., 2018), the total waste generated by bed ’Wb’ (Adsavakulchai, 2002) and the average plastic share in medical waste (Mohee, 2002). Data from another country was used to proxy the share of plastic in waste as no medical waste characterisation study was found for Thailand. No distinction was made infectious and non-infectious medical waste.

Tourism

Data on number of tourists and average stay length comes from the WTO Compendium of Tourism Statistics. We combine this information with the average plastic waste generation per capita per day derived from our calculations to estimate the plastic waste generated by the tourism sector. We make the assumption that a tourist will generate as much plastic waste as a Thai citizen.

NB: We assume these three sectors to be short-lived and for all the plastic in these sector to go to waste within the year, no stock generated. This is accurate for Medical and Tourism and it aligns with the way we computed the net input from these two sectors. For fishing instead it could mean that we are over-estimating the waste generated. Note that the waste generated from fishing gears is already quite low.

SECTOR HOTSPOTS
MODELLING NOTES (2/2)

Micro-leakage

Tyre dust: loss and leakage of synthetic rubbers particles from tyres to the marine environment is calculated based on the methodology described in *PLP (2019)*. Its contribution to leakage is included in “Automotive-tyres”. Data on vehicles numbers are taken from *ASEANStats (2017)* and average distance travelled are based on *Shabadin et al. (2018)*.

Textile fibers: loss and leakage of textile fibers to the marine environment is calculated based on the methodology described in the *Plastic Leak Project (2020)*. Its contribution to leakage is included in “Textile”.

Cosmetics: loss and leakage of plastic micro-particles from cosmetics to the marine environment is calculated based on the methodology described in *Plastic Leak Project (2020)*. Its contribution to leakage is included in “Others”.

Pellets: loss and leakage the marine environment of plastic pellets during transportation and production stages is calculated based on the methodology described in *Plastic Leak Project (2020)*. Its contribution to leakage is included in “Others”.

REGIONAL HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)

Raw data: Reliability		Modelling: Temporal		Modelling: Geographic		Modelling: Granularity		Final metric	Score
WWF, 2020 | Plastic packaging waste generated by province	2	2018 2018 2020	1	Waste generated by province = Total waste generated * (packaging waste gen by province/tot packaging waste generated). Per capita waste generated by province = waste generated by province / population (CIESIN, 2018). Waste generated by km2 = population per km2 * per capita waste generated (province specific)	2	-	1	Waste generated	2
This Study - Sector | Total plastic waste generated	2								
CIESIN, 2018 | NASA population forecast for 2020 on 1km2 grid	1.5								
WWF, 2020 | Recycling of plastic from packaging sector by province	2	2018	1	Collected for recycling by province = Packaging collected for recycling by province / tot packaging collected for recycling * Tot plastic collected for recycling.	2	-	1	Collected for recycling	2
This study - Polymer | Tot plastic collected for recycling	2								
WWF, 2020 | Recycling of plastic packaging by province due to separation by waste collection crew	2	2018	1	See additional notes	2	See additional notes	2	Properly disposed	2
WWF, 2020 | Properly managed plastic packaging waste by province	2								
WWF, 2020 | Recycling of plastic packaging by province due to separation by waste collection crew	2	2018	1	See additional notes	2	See additional notes	1	Improperly disposed	2
WWF, 2020 | Properly managed plastic packaging waste by province	2								
This study - Regional | Waste - Collected for recycling - Properly disposed - Improperly disposed (by province)	2.0	2018	1	-	1	Uncollected = Waste - Collected for recycling - Properly disposed - Improperly disposed	1	Uncollected	2

Quality Score

1
2
3
4
5

2.1

REGIONAL HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
This Study - Regional | Mismanaged = Uncollected + Improperly managed by province	2	2018	1	-	1.0	Share of mismanaged by province = Waste mismanaged by province / waste generated by province	1	Share of Mismanaged	2.0
This Study - Regional | Waste generated by province	2								
This study - Regional | Collected = Collected for recycling + Properly disposed + Improperly disposed	2	2018	1	-	1	Share of collected = Waste mismanaged by province / waste generated by province	1	Share of Collected	2
Richardson et al., 2019 | Loss rate by fishing gear type	2	1990 2015 2019	2.5	See additional notes	2	See additional notes (Sector Quality assessment)	2	Leakage from fishing sector	2.5
Nédélec et al., 1990 | Drawings of various fishing gear	2								
FAO, 2015 | Number of gear, fishermen, artisanal and commercial fishing vessel	2								
This study - Regional | MWI by province	2.0								
NASA - SEDAC population count | GIS Population on 1kmx1km grid	1.5	2020 2019 2017 2015	2	For each km^2 pixel: assign it to a watershed (based on its location) to know the runoff [R], compute the distance to shore or river (>10cms)[D], compute RR matrix*. Leakage of pixel = population of pixel x MWI of province x RR	2	-	1	Macro-leakage from land	2.0
WWF HydroRivers | Country rivers	2								
WWF HydroSHEDS | Country watersheds	1								
Lebreton et al., 2017 | Catchment run-off of watersheds	2								
Boucher et al., 2019, IUCN | Release Rate matrix based on distance to waterbody and surface runoff	2.07								
Jambeck et al., 2015 | Central estimate for maximum release rate	2								

Quality Score

1
2
3
4
5

2.1

*1 With max release rate from Jambeck et al., 2015: 25%; D1 short < 2 km, D2 long > 100 km (Sistemiq), R1 small < 1st quartile of world runoff, R3 large > 3rd quartile of world runoff (Lebreton et al; 2017)

REGIONAL HOTSPOTS
MODELLING NOTES

Properly disposed and Improperly disposed

Data on properly and improperly managed waste by province comes from WWF study on plastic waste, but it is limited to packaging. We first scaled it up to the total plastic waste with the following formula:

Properly managed by province = Properly managed packaging by province / Total packaging waste in country * Total plastic waste in country.

And similarly for Improperly managed.

In a second step, we adapt this value to account for the waste the fact that packaging plastic collected by the crew is in part segregated for recycling, but non-packaging plastic is less likely to be recycled (see sector hotspot). Which means that the share of properly and improperly managed waste is higher for non-packaging plastic than for packaging plastic. This additional term for each province is equal to:

(Packaging segregated by crew / Packaging waste * Plastic waste - Packaging segregated by crew / Packaging recycled * Plastic recycled)* Properly managed / (Properly managed + Improperly managed)

And similarly for Improperly managed.

5 BIBLIOGRAPHY

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