NATIONAL GUIDANCE FOR PLASTIC POLLUTION HOTSPOTTING AND SHAPING ACTION

FINAL REPORT FOR VIETNAM

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SUMMARY AT A GLANCE

Global view on plastic in Vietnam

72%
Mismanaged rate

36%
Collection rate

6% Collection for recycling

6% Domestic recycling rate

453 Kt
Leakage

4.7 Kg
Per capita leakage

Hotspots

Most critical Polymers

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

Number of hotspots per waste management stage

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

17 out of 63 Provinces responsible for 50% of the plastic leakage

Shaping action from the hotspots

15
Actionable Hotspots

14
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
3
4
5

PLASTIC POLLUTION HOTSPOTS

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.

2.3 Actionable Hotspots

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

A. Polymer Hotspots

B. Application Hotspots

C. Sector Hotspots

D. Regional Hotspots

E. Waste Management Hotspots

STRUCTURE AND OBJECTIVE OF THIS PRESENTATION

1
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5

SHAPING ACTION

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)

Reference to the appendices

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

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

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

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

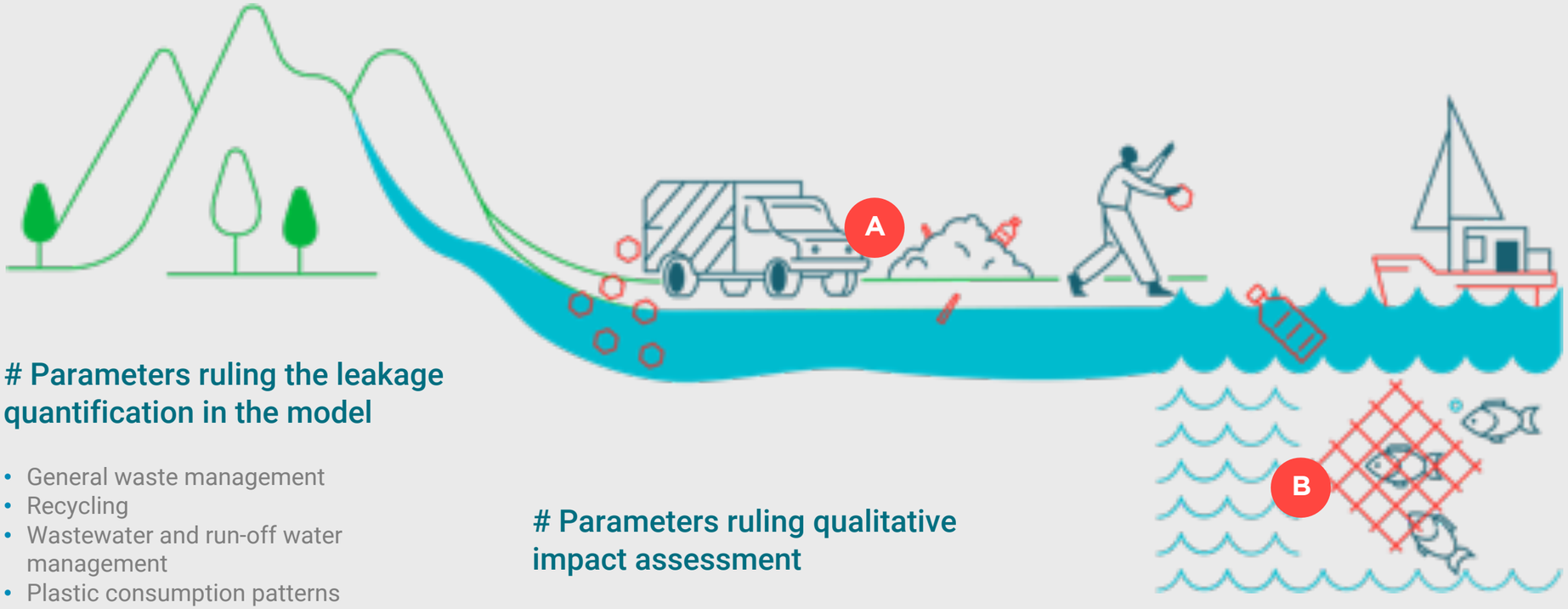
Informal sector: Individuals or a group of individuals who are involved in waste management activities, but are not formally registered or formally responsible for providing waste management services. Newly established formalized organizations of such individuals; for example, cooperatives, social enterprises 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

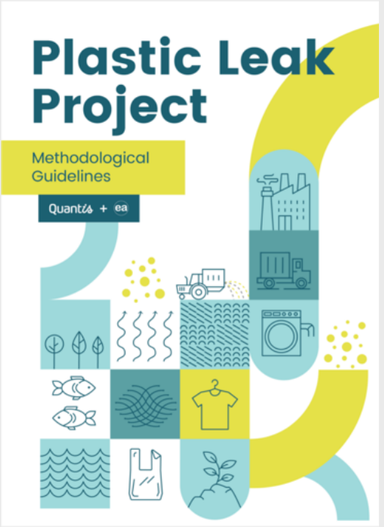


Parameters ruling the leakage quantification in the model

- 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.

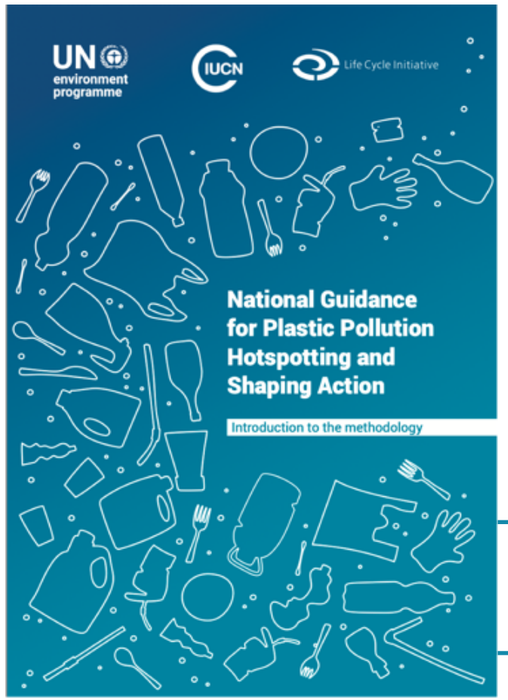
1 INTRODUCTION TO THE GUIDANCE

National guidance for plastic pollution hotspotting and shaping action

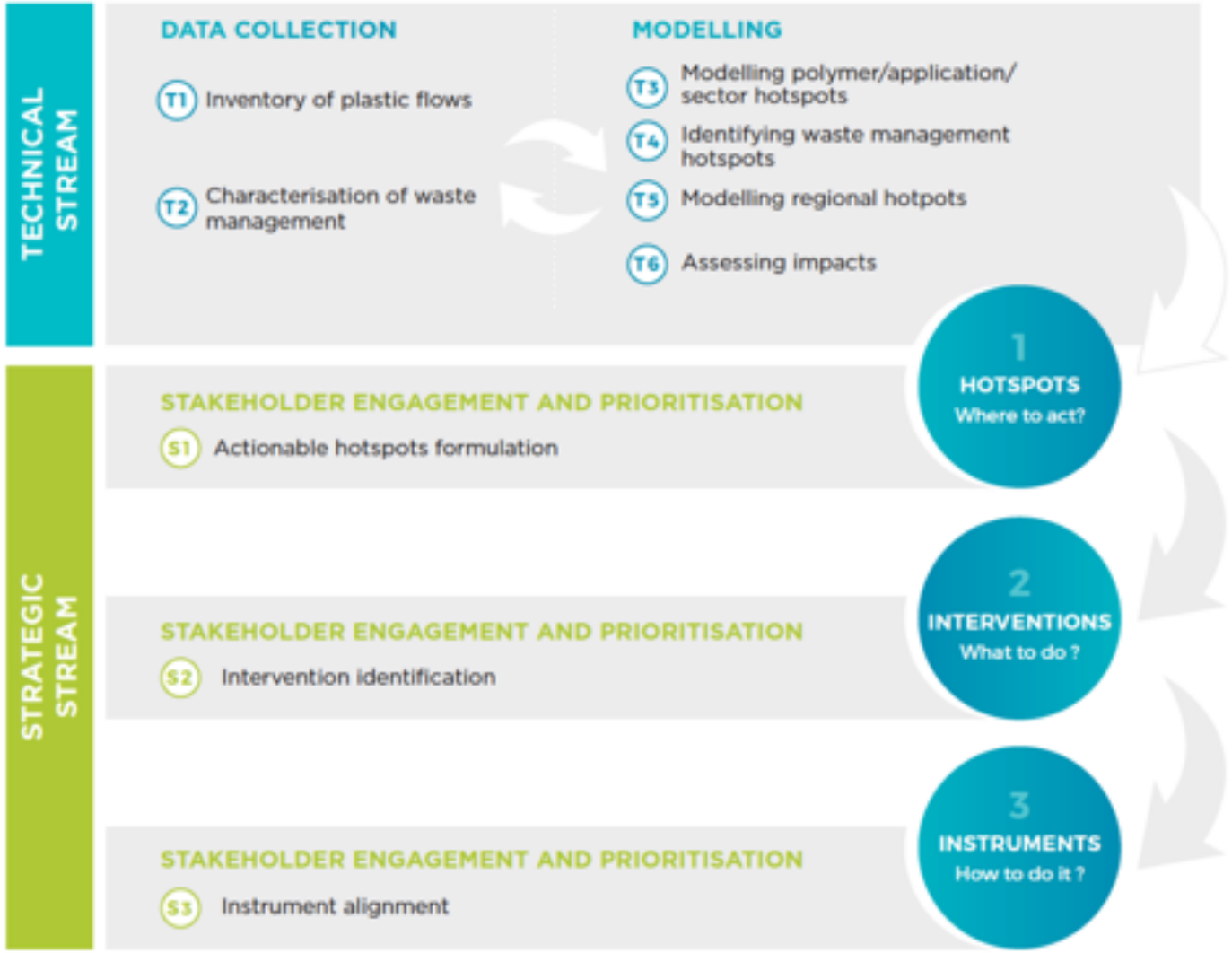
SCHEMATIC OF THE GUIDANCE

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 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 An action that can be taken to mitigate the leakage from a given hotspot or reduce its impacts.

3 A practical way to implement the intervention and enable progress.

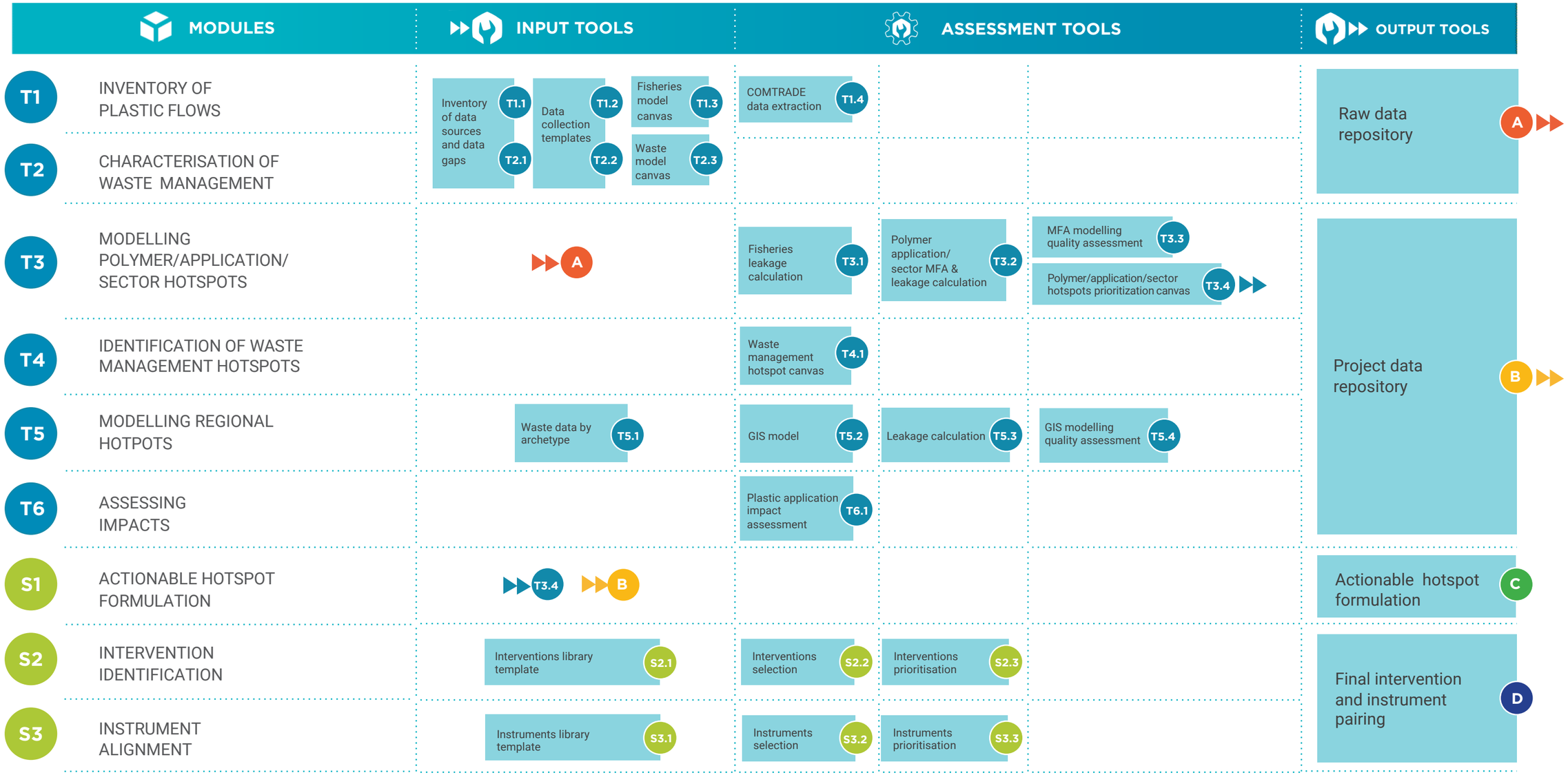
Examples

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

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

- 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



DISCLAIMER

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

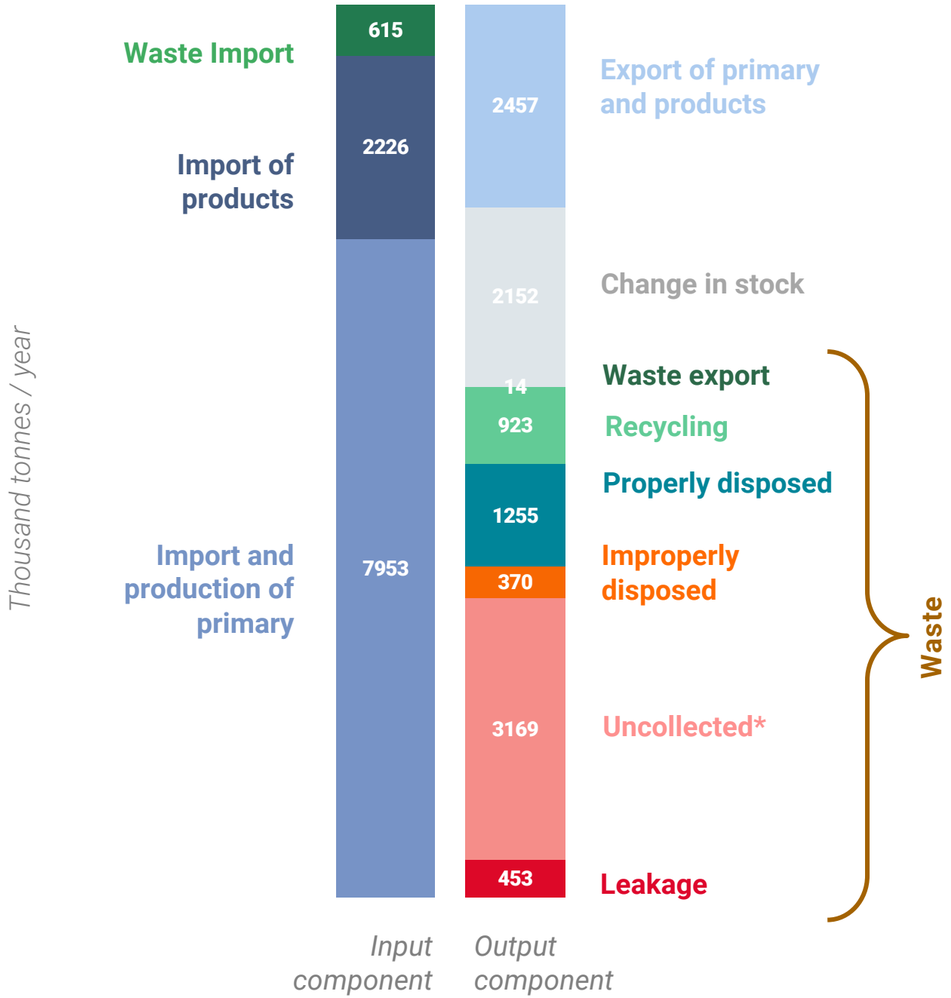
Additional information on the methodology and modelling process can be found directly in the **modules and tools** associated with the guidance and highlighted by this icon.

2 PLASTIC POLLUTION HOTSPOTS

2.1 COUNTRY OVERVIEW

COUNTRY PLASTIC MATERIAL FLOW [2018]

Summary of the results for all plastics in the country

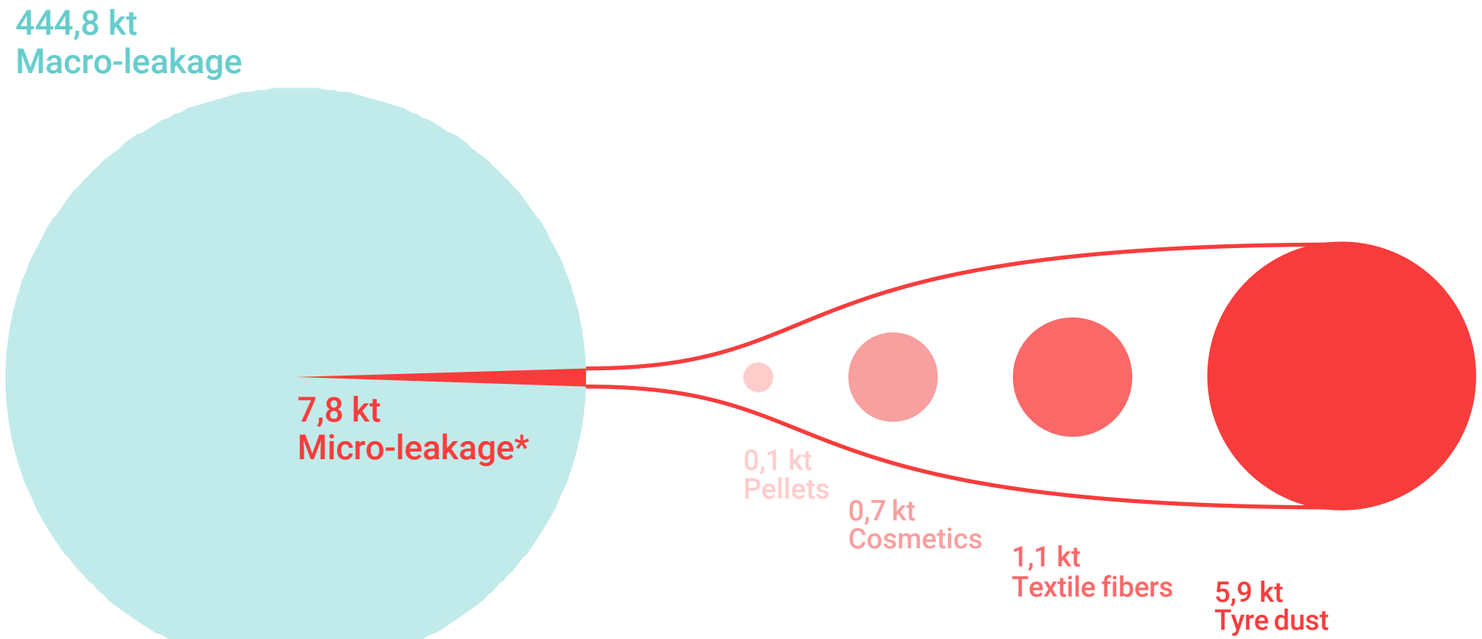


Key take-aways

- Currently, Vietnam imports most of the plastic it consumes.
- The average per capita plastic consumption is 81 kg/person/year, of which **58 kg/capita/year go to waste** and 23 kg/person/year go to increase the stock (due to high industry growth in recent years).
- 93% of the waste recycled through formal processes is imported, while the remaining 7% comes from waste generated within the country (but is recycled in craft villages where proper environmental practices are not applied).
- More than half of the plastic waste generated in Vietnam remains uncollected (3.6 Mt/year). This is due to low collection rates outside city centres, high littering rates and open burning of waste prior to collection.
- In Vietnam, **453 kt** of plastic waste leaked into the ocean in 2018. This is equivalent to a plastic leakage of **4,7 kg/capita/year**.

* In the case of Vietnam, the “uncollected” waste also includes an unknown quantity of waste disposed at unverified dumpsites (which normally belongs to “improperly disposed” waste). The “improperly disposed” waste only encompasses waste disposed at unsanitary landfills.

MACRO-LEAKAGE VS MICRO-LEAKAGE [2018]



TO WATERWAYS AND OCEANS:

453 kt

Key take-aways

- **Micro-leakage contributes for 2% of the overall country leakage.** This small contribution of micro-plastics is common for countries where the solid waste is still largely mismanaged.

Limitations

Recycling has not been considered as a source of leakage although informal practices may generate leakage of microplastics. No data was found on this aspect.

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 [2018]

3’991 kt
Total plastic mismanaged

55%
released into the air as noxious chemical substances through open burning

POLLUTION TO THE AIR:
2’197 kt

Key take-aways

- **Open burning** of mismanaged plastic waste in Vietnam 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

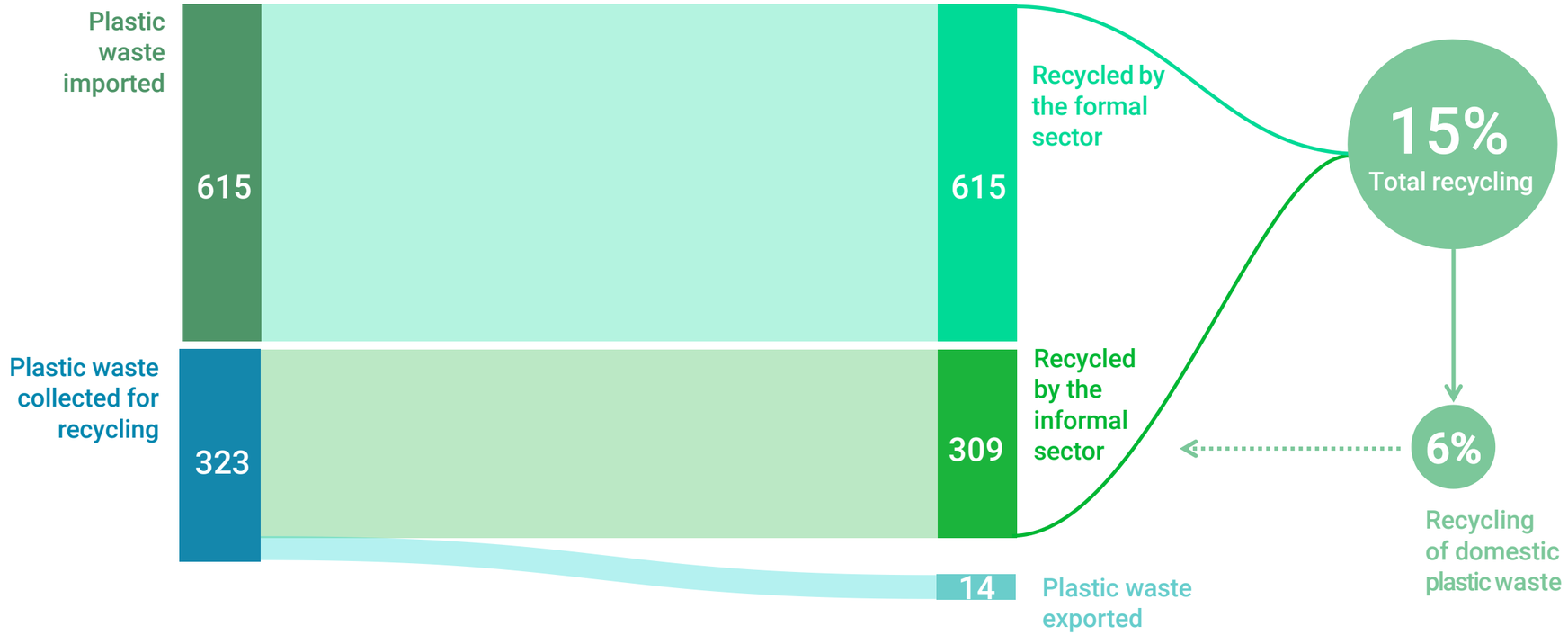
Although we do not have specific data on burning, we suggest a rough estimate of how much plastic could be polluting the air by using the assumptions made in the *Breaking the Plastic Wave* report (*Lau et al, 2020*): 60% of uncollected plastic waste and 13 % of plastic waste at dumpsites are burnt on average worldwide. In the case of Vietnam, it would translate into having 55% 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: ROLE OF FORMAL AND INFORMAL SECTORS
[2018]

Quantities in thousand tonnes



Key take-aways

- **Only 6%** of the domestically generated plastic waste is recycled.

Learnings

In 2018, Vietnam recycles 924 kt of plastic waste (15% of total plastic waste), but most of it (615 kt) comes from imported waste, which is then recycled by the formal sector. The remaining 309 kt of recycled plastic waste come from domestically generated plastic waste and is recycled by the informal sector. Consequently, only 6% to the domestically generated plastic waste is recycled.

2.2 DETAILED HOTSPOTS RESULTS

5 CATEGORIES OF HOTSPOTS

WHAT

WHAT

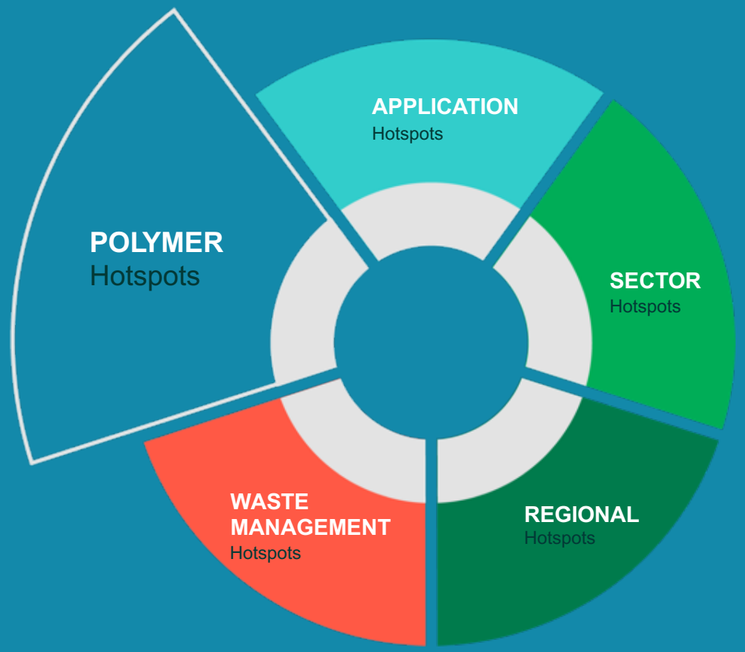
WHERE

WHERE

WHY

ACTIONABLE HOTSPOTS FORMULATION

A POLYMER HOTSPOTS

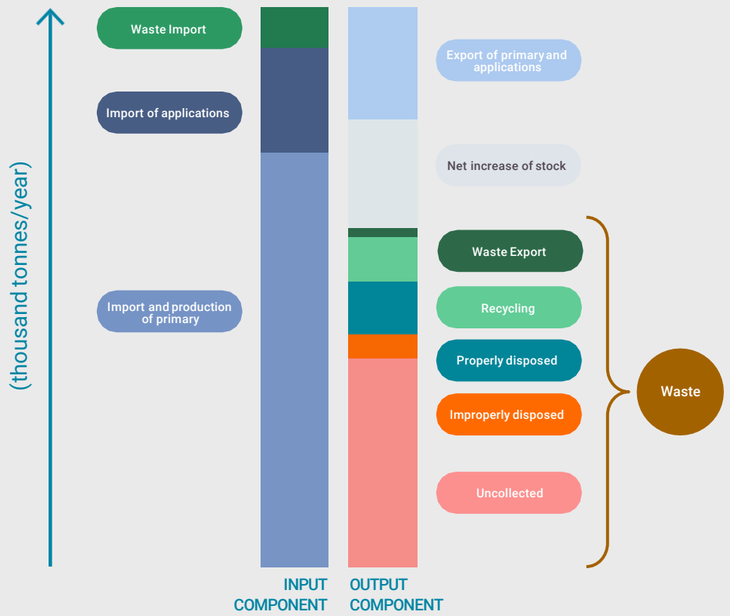


OBJECTIVE AND INSTRUCTIONS

Key question answered:

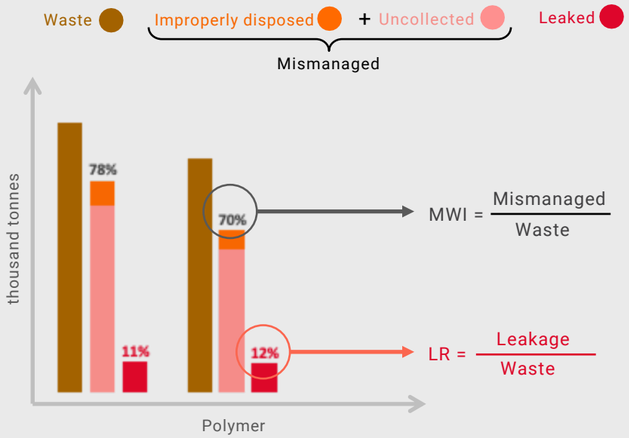
Which polymers are most critical in the country regarding plastic leakage?

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

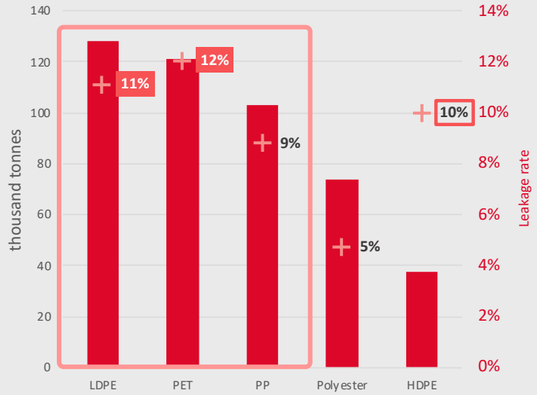


How to read the polymer hotspot graph?

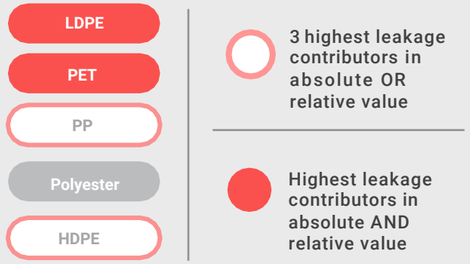
1. Determine leakage from mismanaged waste



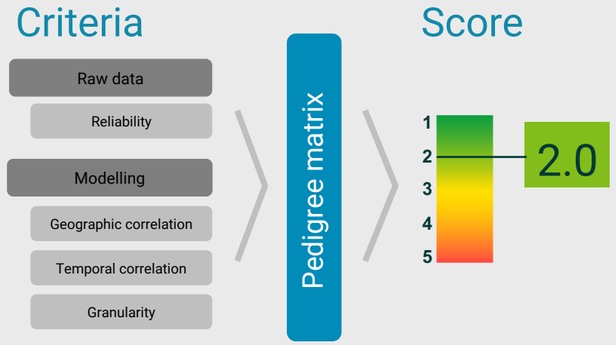
2. Focus on leakage and leakage rate



3. Select hotspots based on absolute and relative leakage

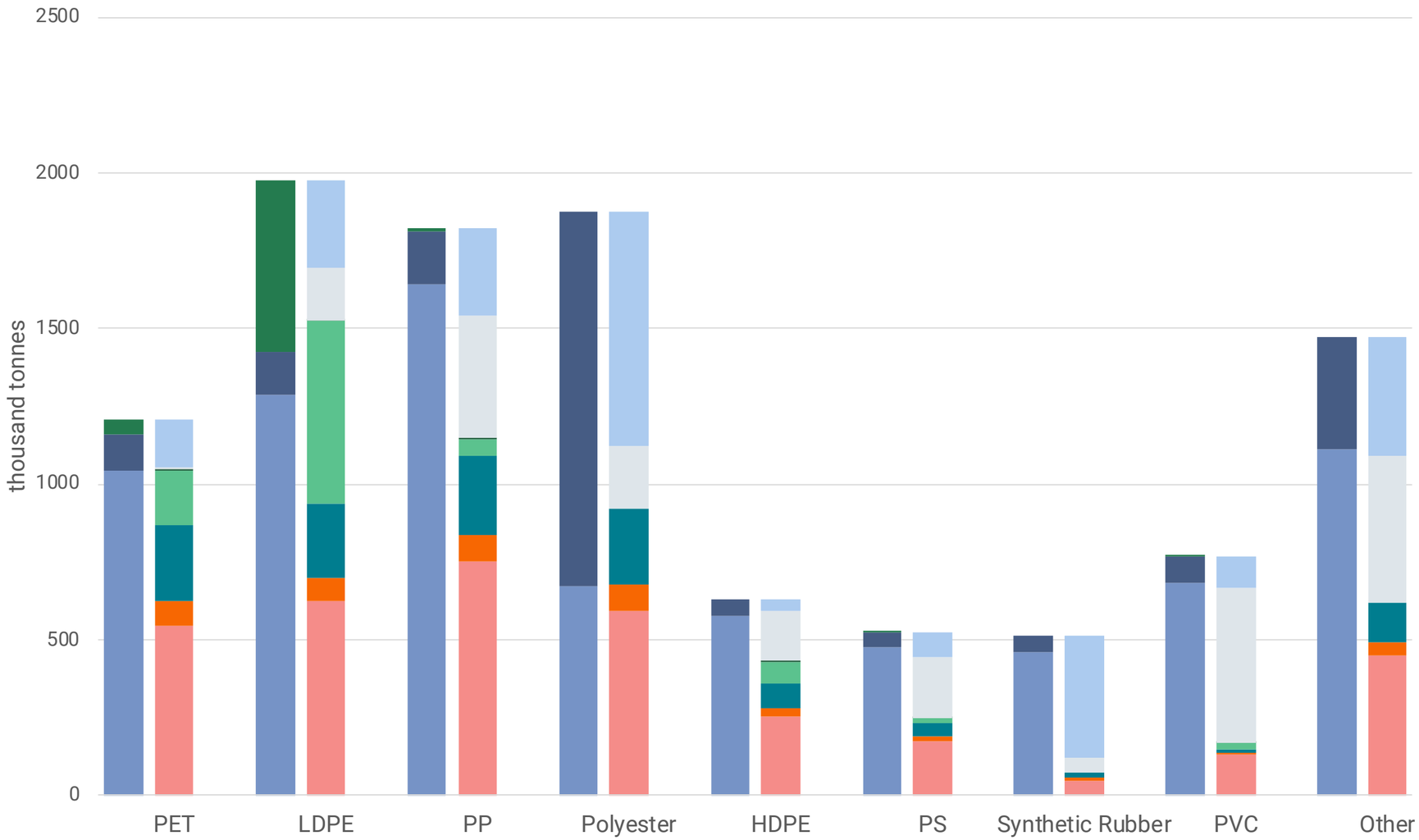


4. Assess the quality score of the results

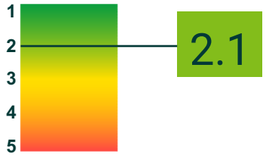


For more details, please read the Methodology

MASS BALANCE BY POLYMER [2018]



Quality Score



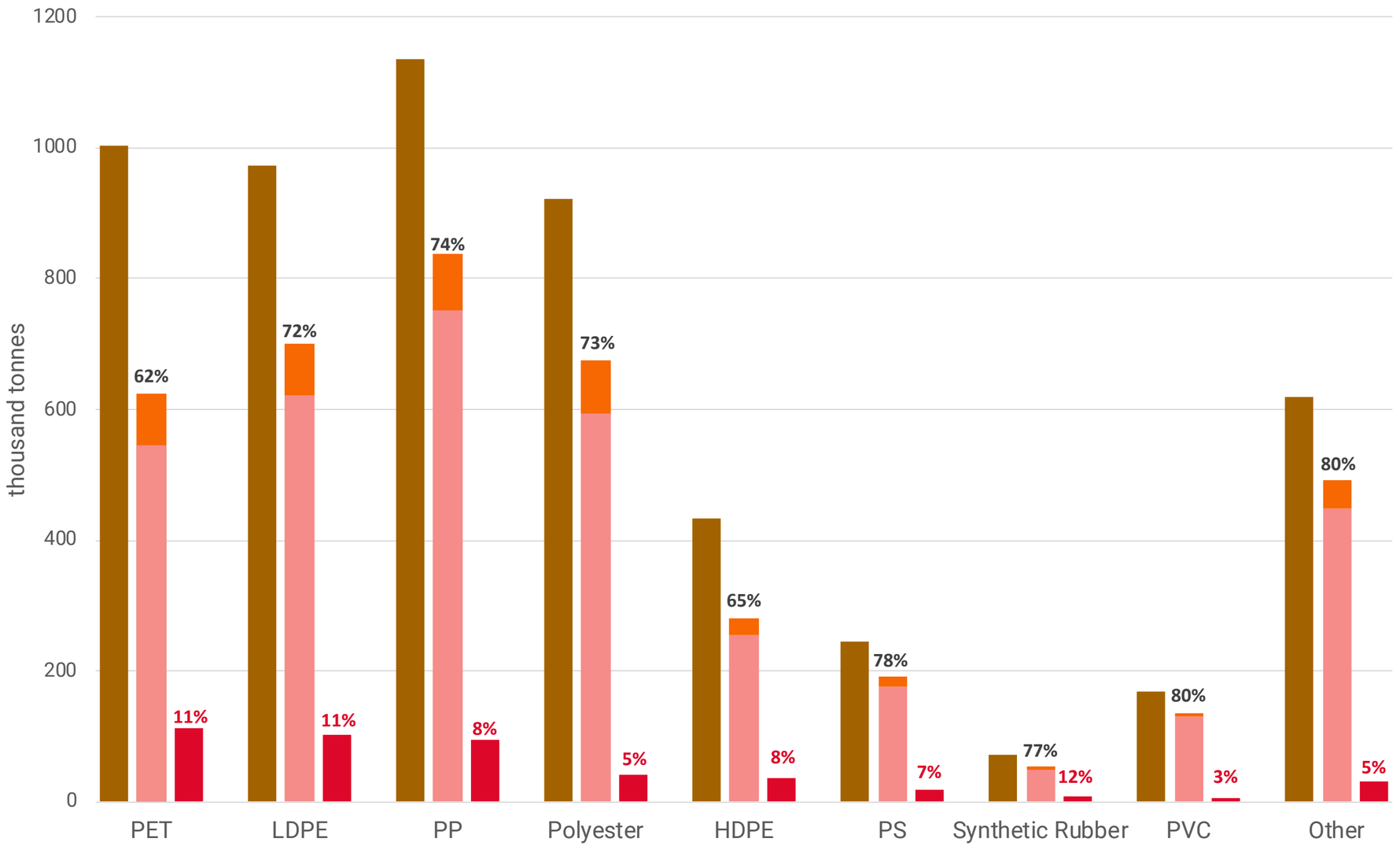
INPUT

- Waste Import
- Import of products
- Import and production of primary

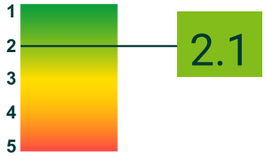
OUTPUT

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

MISMANAGED WASTE AND LEAKAGE BY POLYMER [2018]



Quality Score



Waste

Improperly disposed
+
Uncollected

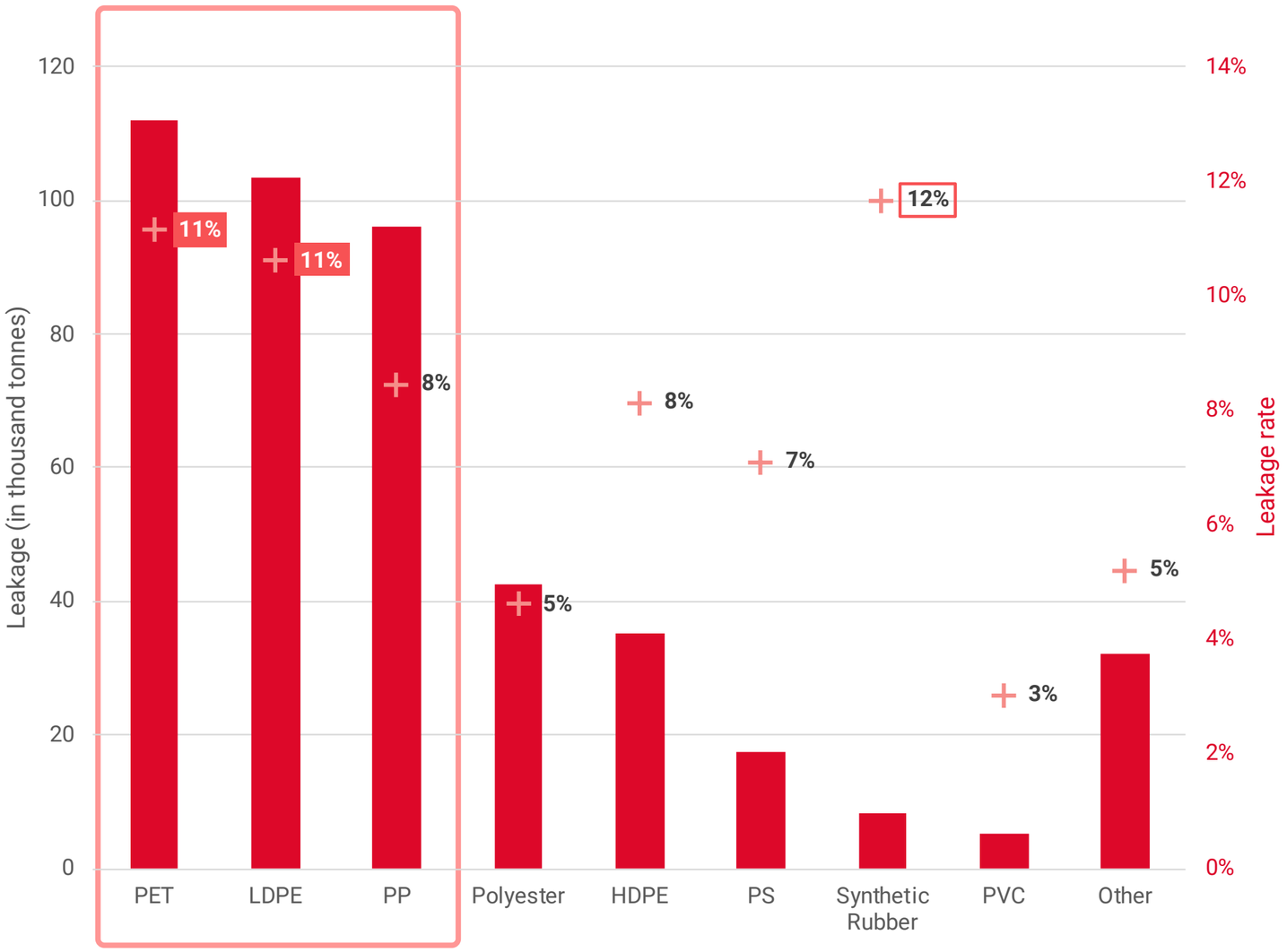
Mismanaged

Leaked

X% | Mismanaged Waste Index (MWI)

X% | Leakage Rate (LR)

POLYMER HOTSPOTS [2018]

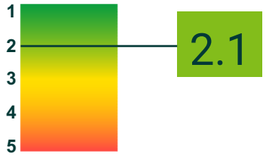


PET
LDPE
PP
Synthetic Rubber
Polyester
HDPE
PS
PVC
Other

3 highest leakage contributors in absolute OR relative value

Highest leakage contributors in absolute AND relative value

Quality Score



Key take-aways:

- **PET** is the top contributor in absolute leakage (112 kt), with a leakage rate of 11%. More than one in ten of PET put on the market leaks to the ocean.
- **LDPE** and **PP** follow with 103 kt and 96 kt of leakage respectively.
- Although **Synthetic Rubber** ranks low in absolute leakage (8 kt), 12% of its generated waste leaks into the oceans and waterways.

POLYMER HOTSPOTS:
INTERPRETATION AND LIMITATIONS

PET

Learnings

PET is one of the polymers most likely to be collected by the informal sector for recycling (because of its high value for waste pickers and because of it PET bottles are easily recognisable). Nonetheless, it is also one of the polymers with the highest chance of being littered and leaked (high release rate). For this reason is one of the hotspots, both by absolute and by relative leakage.

Limitations

Capturing recycling quantity by the informal sector is particularly challenging, due to the multitude of small entities and individuals working in the sector and due to their reluctancy to share information with authorities. Here, the amount of PET collected for recycling comes from a study by GA circular (2020) on the informal sector collection patterns. The recycling of PET by the informal sector is not performed in environmentally friendly conditions and therefore a leakage rate should be associated with it, which is not the case in this study.

Unlocking limitations

Have a better insight of the informal sector. This could be achieved by linking informal waste collectors (waste pickers and waste crew workers) to the formal recycling sector.

LDPE

Learnings

LDPE is mainly recycled from imported scraps rather than domestic waste. LDPE waste generated in Vietnam is not recycled, as it has no value for the informal recycling sector. For this reason LDPE is one of the hotspots, both by absolute and by relative leakage.

Limitations

We consider that recycled material from year 2017 is included in the «import and production of primary» from 2018. We estimated the recycled material in 2017 by adjusting the one from 2018 through GDP growth rate. This accounts for more than 50% of the total LDPE production and import.

Unlocking limitations

Contact formal recyclers to have a better understanding of: how much LDPE is recycled, where it comes from and what is it's final use

POLYMER HOTSPOTS:
INTERPRETATION AND LIMITATIONS

PP

Learnings

Of the 1.5 Mt of PP input on the market, a third goes to stock, embedded in long-lived products, but around 1.1Mt becomes waste, making PP the second polymer by quantity of waste generated prior to recycling. The low recycling rate of PP and the general mismanagement of waste in Vietnam makes PP one of the top polymer by absolute leakage.

Limitations

Same as for PET for what concerns recycling.
We lack insight on the fate of 101 kt of PP waste from the automotive sector, we assume it to have the same MWI as municipal waste.

Unlocking limitations

Gain insight on waste management from the automotive sector.

Polyester

Learnings

More than 900 kt of polyester fibres are going to waste every year in Vietnam, mostly from the textile sector.

All polymers

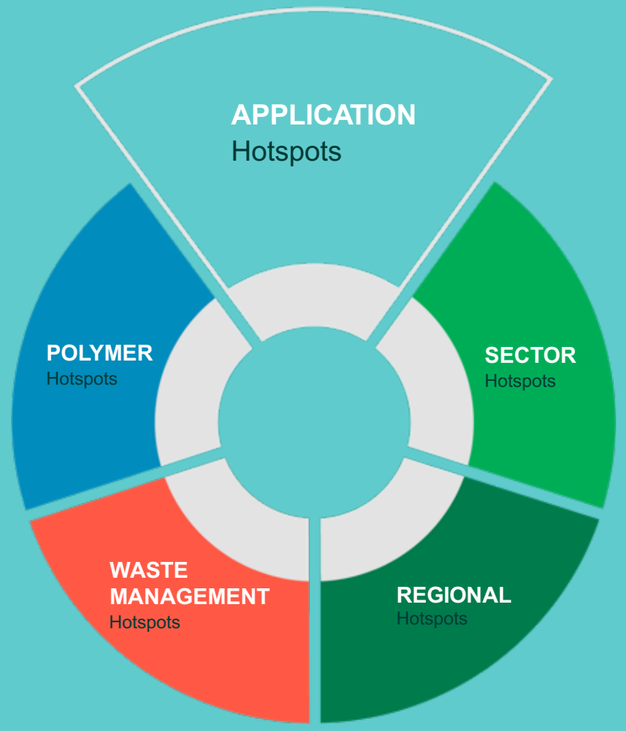
Limitations

- Illegal import of waste may be an issue in Vietnam, especially after the especially after China's 2018 policy banning the import of most plastics and other materials, but we could not assess the magnitude of the phenomenon.
- The stock assessment by polymer, as well as the proper and improper management of waste, are derived starting from the sector analysis, through a sector to polymer mapping. This mapping is based on the EU market (PlasticsEurope, 2018).

Unlocking limitations

Having a sector to polymer mapping based on the Vietnam market would improve the quality of the analysis.

B APPLICATION HOTSPOTS

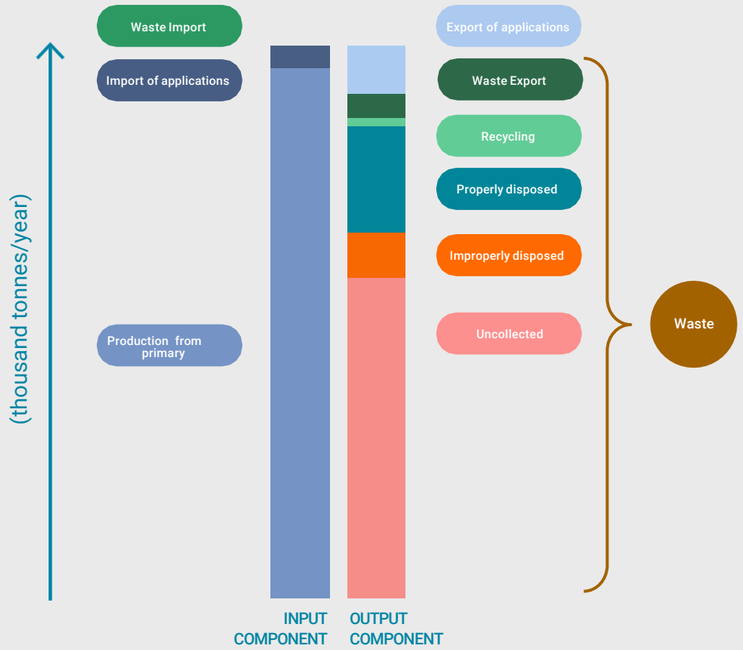


OBJECTIVE AND INSTRUCTIONS

Key question answered:

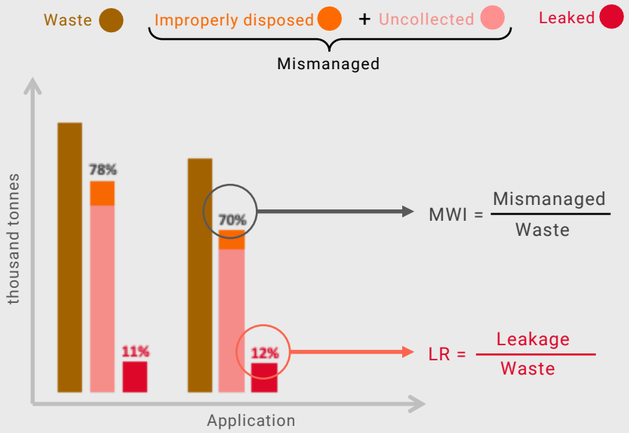
Which applications are most critical in the country regarding plastic leakage?

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

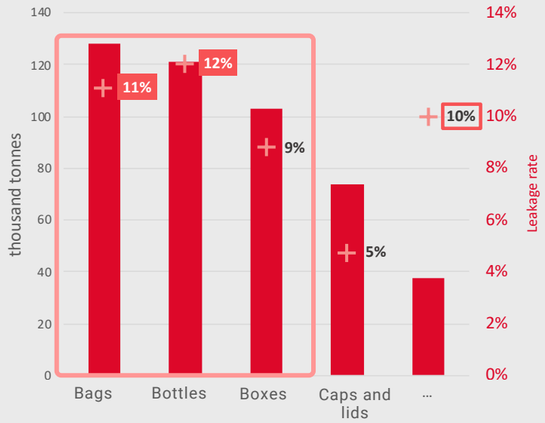


How to read the application hotspot graph?

1. Determine leakage from mismanaged waste

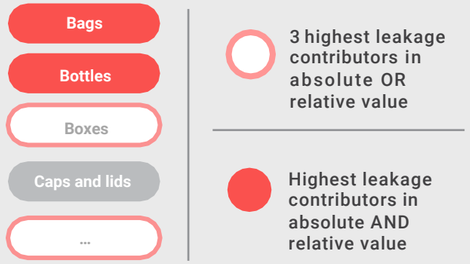


2. Focus on leakage and leakage rate

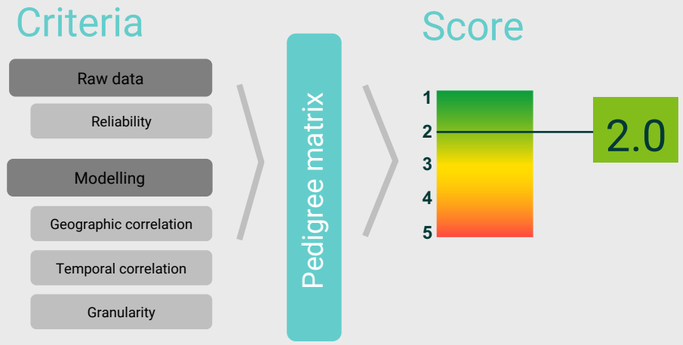


For more details, please read the Methodology

3. Select hotspots based on absolute and relative leakage

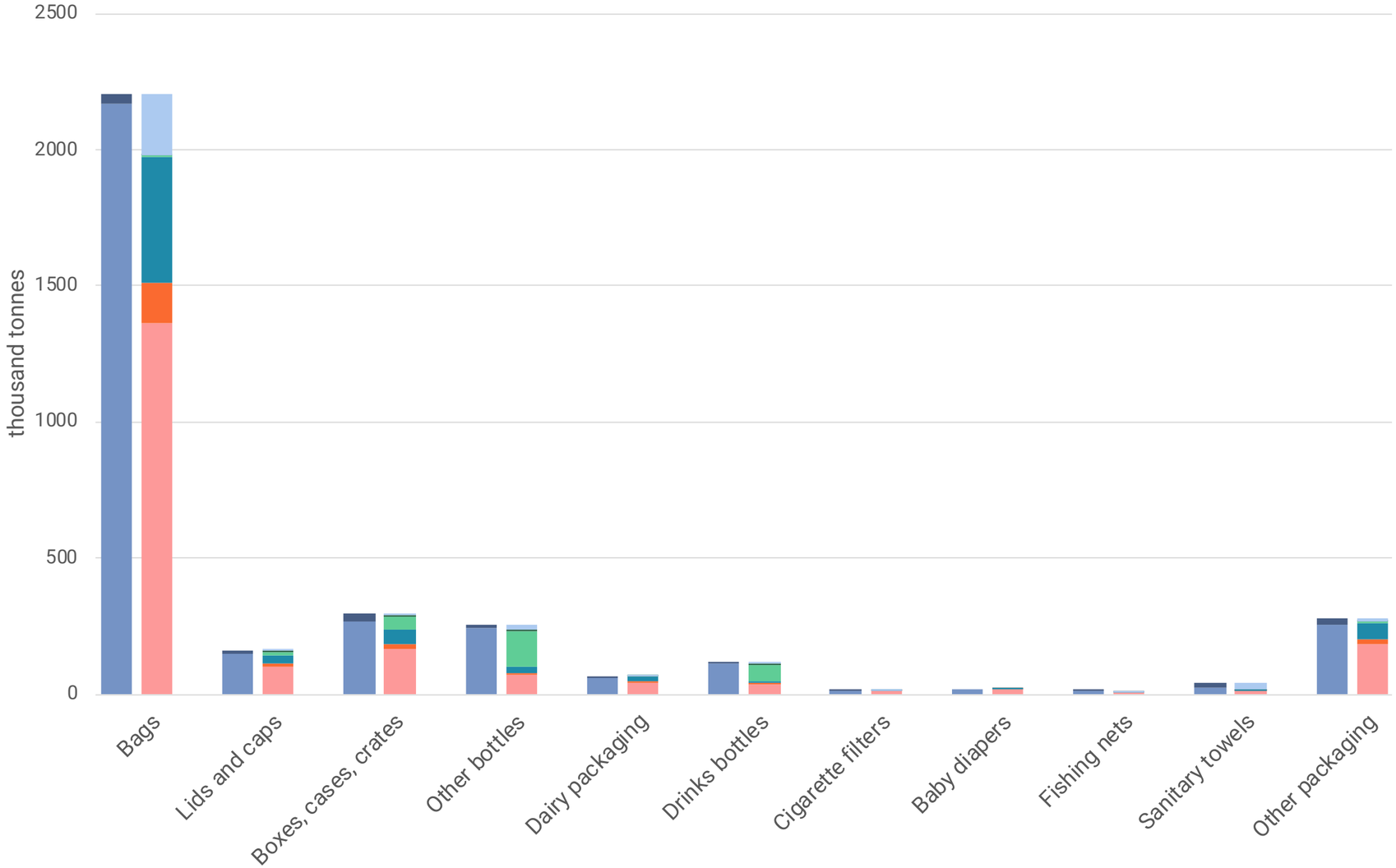


4. Assess the quality score of the results

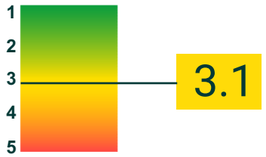


MASS BALANCE BY APPLICATION [2018]

The application analysis covers most of known short-lived products (mainly related to the), which corresponds to **57% of total plastic waste generated** in 2018.



Quality Score



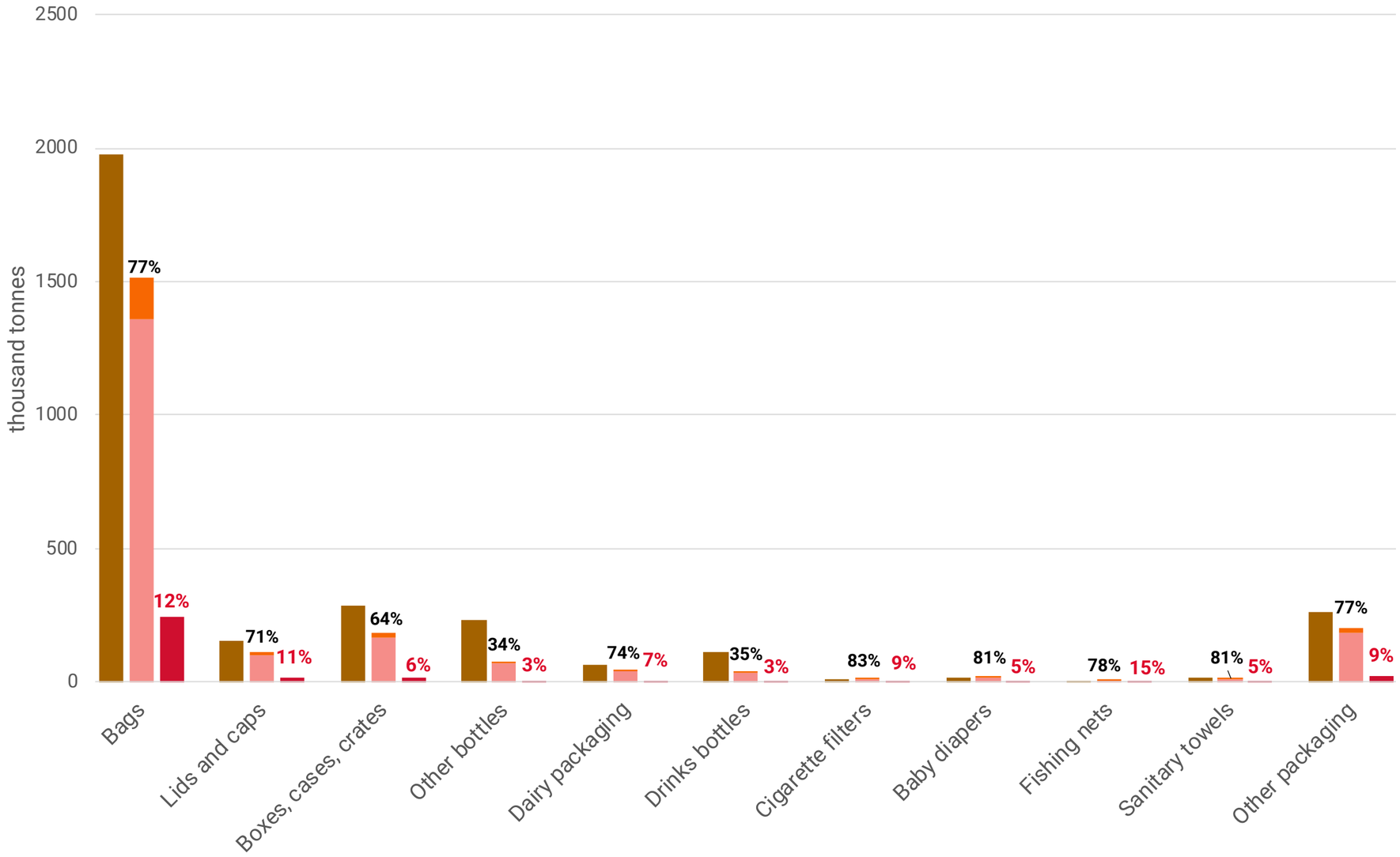
INPUT

- Waste Import
- Import of products
- Production from primary

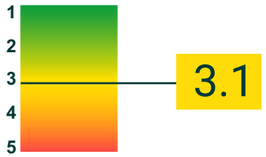
OUTPUT

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

MISMANAGED WASTE AND LEAKAGE BY APPLICATION [2018]



Quality Score



Waste

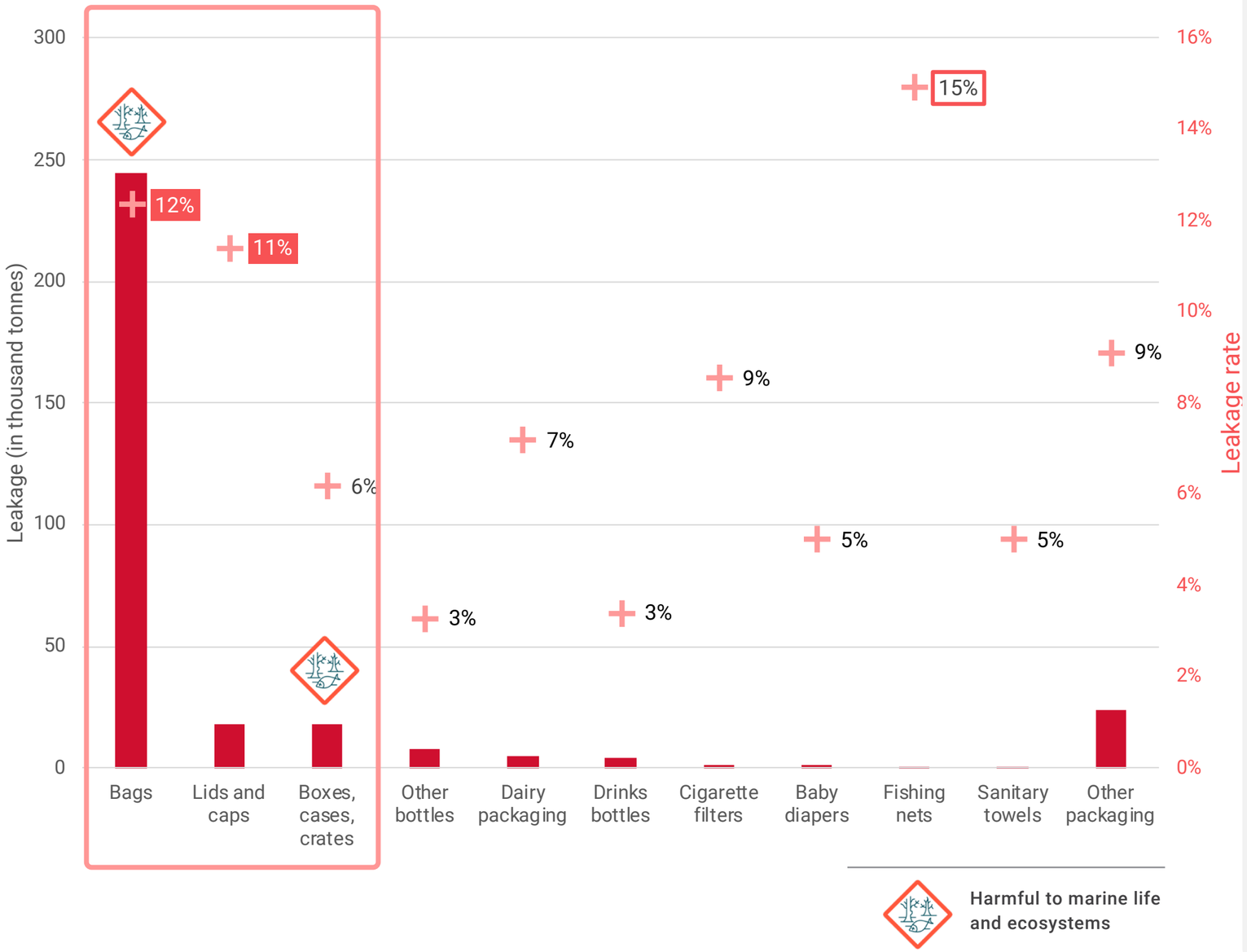
Improperly disposed + Uncollected = Mismanaged

Leaked

X% | Mismanaged Waste Index (MWI)

X% | Leakage Rate (LR)

APPLICATION HOTSPOTS [2018]



Bags

Lids and caps

Boxes and crates

Fishing nets

Cigarette filters

Drinks bottles

Other bottles

Dairy packaging

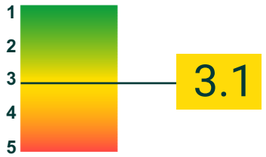
Baby diapers

Sanitary towels

3 highest leakage contributors in absolute OR relative value

Highest leakage contributors in absolute AND relative value

Quality Score



Key take-aways

- **Plastic bags** are by far the highest contributors in absolute leakage (244 kt) and rank 2nd in leakage rate (12%). They are highly harmful to marine life.
- **Lids and caps** are 2nd in absolute leakage (18 kt) with a 12% leakage rate. **Boxes and crates** are the 3rd highest contributor in absolute leakage (17 kt) and are harmful to marine life.
- Although **fishing nets** rank low in absolute leakage (1 kt), almost 1/6th of their waste generated tend to leak into the oceans.

APPLICATION HOTSPOTS:
INTERPRETATION AND LIMITATIONS

All applications

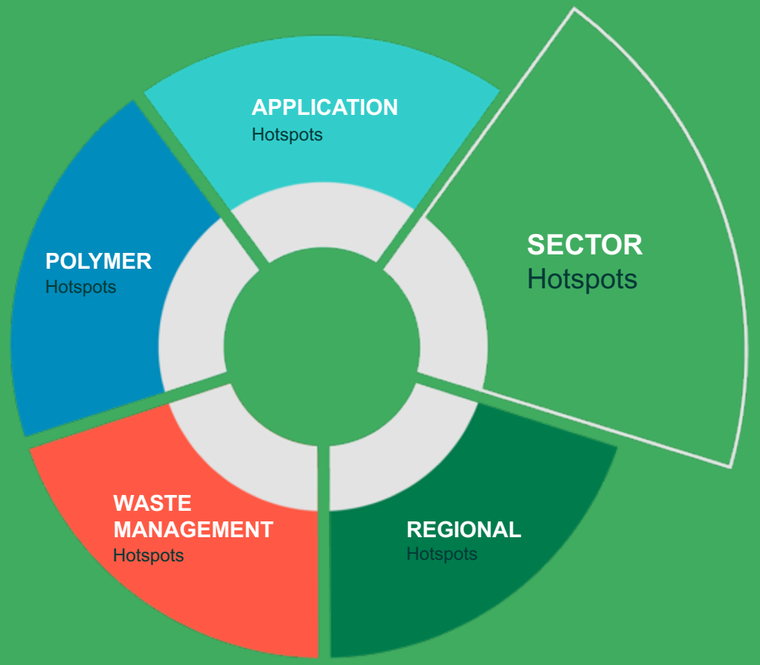
Limitations

- We have no data available on production quantities by applications type in Vietnam. The production quantities have been estimated using the assumption that the relative importance in the country production was reflected in the relative importance in trade. This is a strong assumption, and it seems not to be valid for Vietnam: this method leads to an estimate of more than 2Mt of plastic bags going to waste, when the LDPE waste (of which plastic bags are usually made of) amounts to around 1 Mt. Hence it seems that import and export are not representative of domestic production, and therefore we do not have an insight on application production in Vietnam.
- Specific littering rates were not available for this country. Average Littering rates for EU conditions have been used (ref. Plastic Leak Project (2019) and European Commission (2018)).

Unlocking limitations

Engage collaborative research projects to close the gap on these specific data.

C SECTOR HOTSPOTS

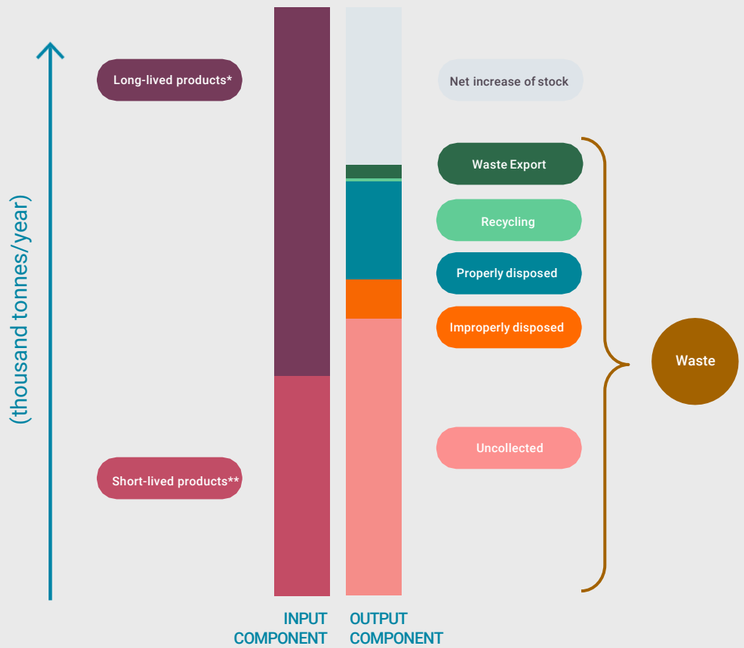


OBJECTIVE AND INSTRUCTIONS

Key question answered:

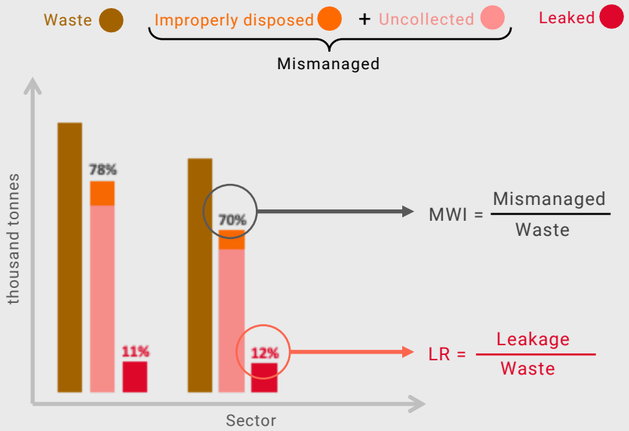
Which sectors are most critical in the country regarding plastic leakage?

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

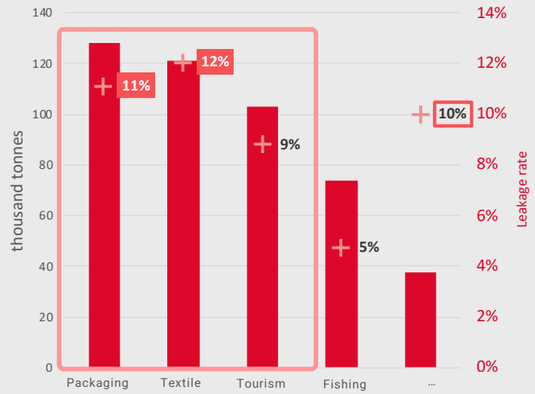


How to read the sector hotspot graph?

1. Determine leakage from mismanaged waste

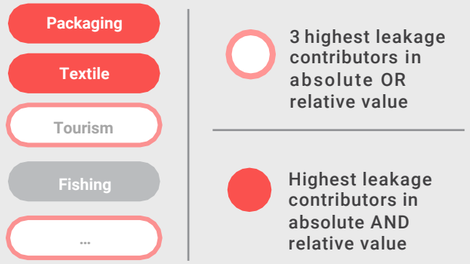


2. Focus on leakage and leakage rate

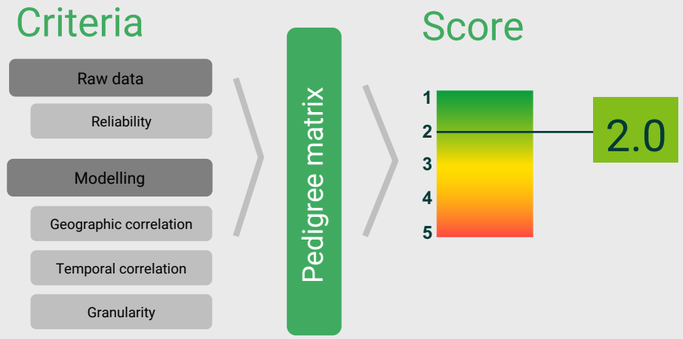


For more details, please read the Methodology

3. Select hotspots based on absolute and relative leakage

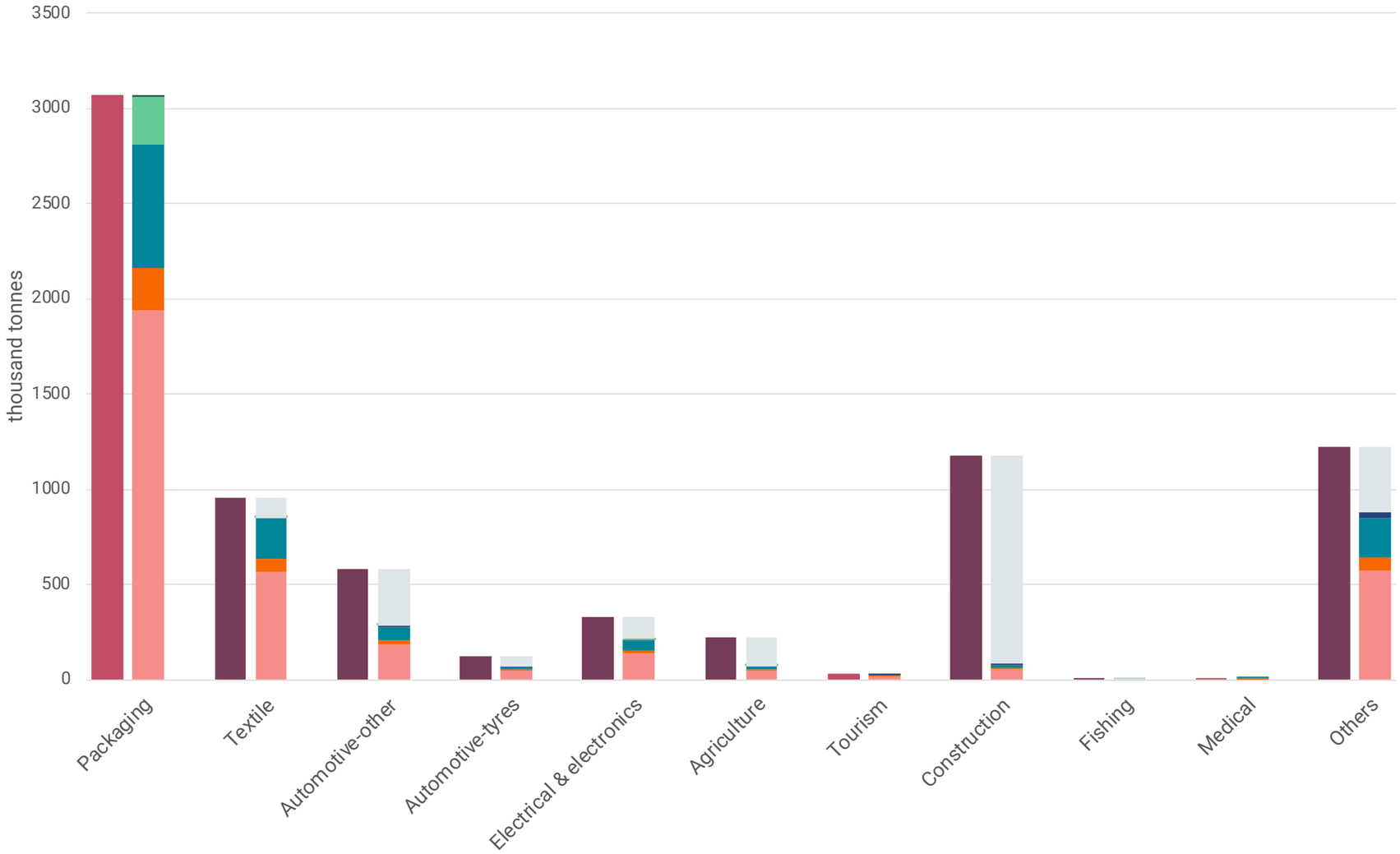


4. Assess the quality score of the results

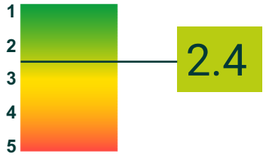


* **Short-lived products**: products that are disposed within the year of study (Life-time < 1 year)
** **Long-lived products**: products that are disposed after the year of study (Life-time > 1 year)

MASS BALANCE BY SECTOR [2018]



Quality Score



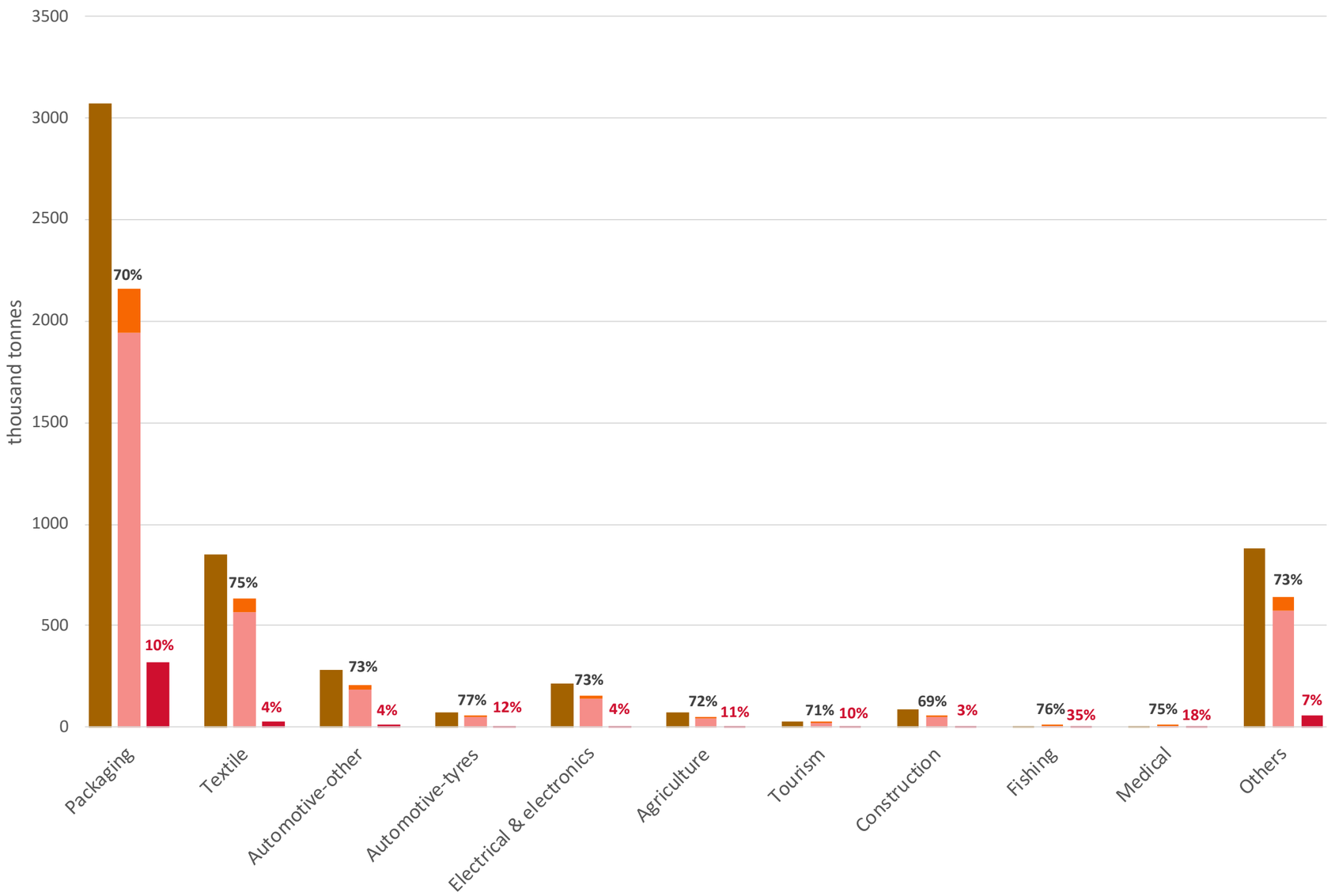
INPUT

- Short-lived products
- Long-lived products

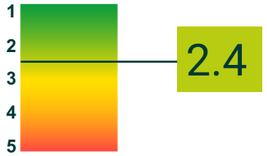
OUTPUT

- 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

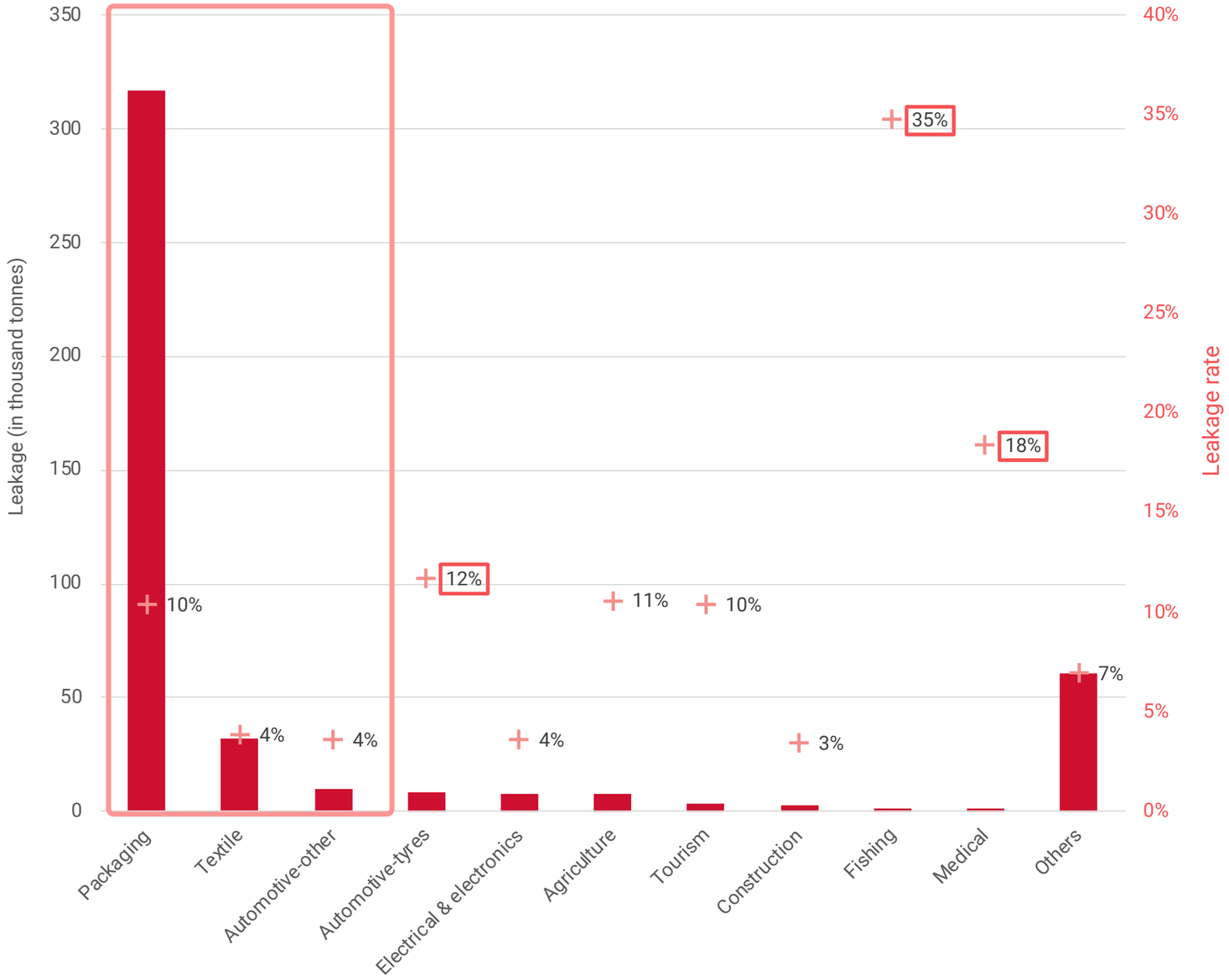
Mismanaged

Leaked

X% | Mismanaged Waste Index (MWI)

X% | Leakage Rate (LR)

SECTOR HOTSPOTS [2018]



Packaging

Textile

Automotive-other

Automotive-tyres

Fishing

Medical

Agriculture

Electrical & electronics

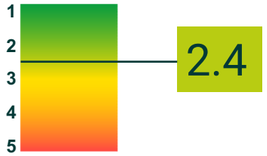
Tourism

Construction

3 highest leakage contributors in absolute OR relative value

Highest leakage contributors in absolute AND relative value

Quality Score



Key take-aways

- **The packaging sector** contributes to 70% of the total plastic leakage with 317 kt of packaging waste leaking into oceans and waterways.
- **The textile sector** is the 2nd highest contributor to plastic leakage in absolute value (32 kt), far behind the packaging sector.
- **Fishing, medical and automotive-tyres sectors** have a low contribution in absolute leakage but have very high leakage rates (respectively 35%, 18% and 12%).

SECTOR HOTSPOTS:
INTERPRETATION AND LIMITATIONS

Packaging

Learnings

Packaging is the sector with the highest absolute leakage, higher than all other sectors combined. This is due to various reasons. Firstly, packaging is the sector with the highest plastic consumption and, unlike other sectors, all the products in the packaging sector become waste within the year (no stock). Secondly, although most of the plastic collected for recycling in Vietnam comes from the packaging sector, this represents only 8% of the entire plastic packaging production. Incidentally, the plastic recycling in Vietnam also contributes to leakage, as the craft-villages where most of the domestic waste is recycled operate without the equipment necessary to prevent environmental pollution. Thirdly, plastic in packaging has one of the highest chances of littering.

Textile

Learnings

Textile is the second sector by absolute leakage, the plastic embedded in textile is not recycled, but the overall relative leakage is smaller because of lower chance of littering and lower release rate with regards to packaging.

Fishing

Learnings

Fishing has the highest relative leakage, due to the widespread practice by fishermen of throwing waste overboard. Loss of fishing gears and improper disposal of fishing gears on land are also considered in our approach, but they do not represent a big share of the absolute plastic leakage of the country.

Limitations

The fishing sector does not include fishing markets. Fishing markets appear to be hubs for waste mismanagement and direct leakage to sea, due to their closeness to the shore. (Lekima Hung photographs).

Tourism

Limitations

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

Medical

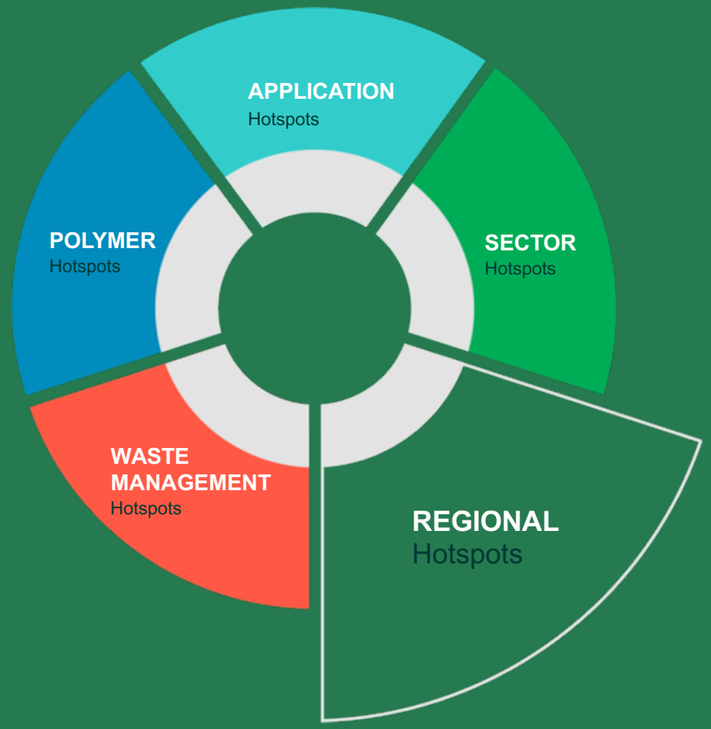
Learnings

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

Limitations

The high relative leakage is most likely not accurate, as we do not assume that there is a special treatment of medical waste, as it 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, with a low value for recyclers since it is contaminated. In fact, we witness that used syringes are recycled in informal villages throughout Vietnam. We are nonetheless confident that the medical plastic waste is orders of magnitude lower than the packaging plastic waste, thus less critical regarding plastic leakage.

D REGIONAL HOTSPOTS

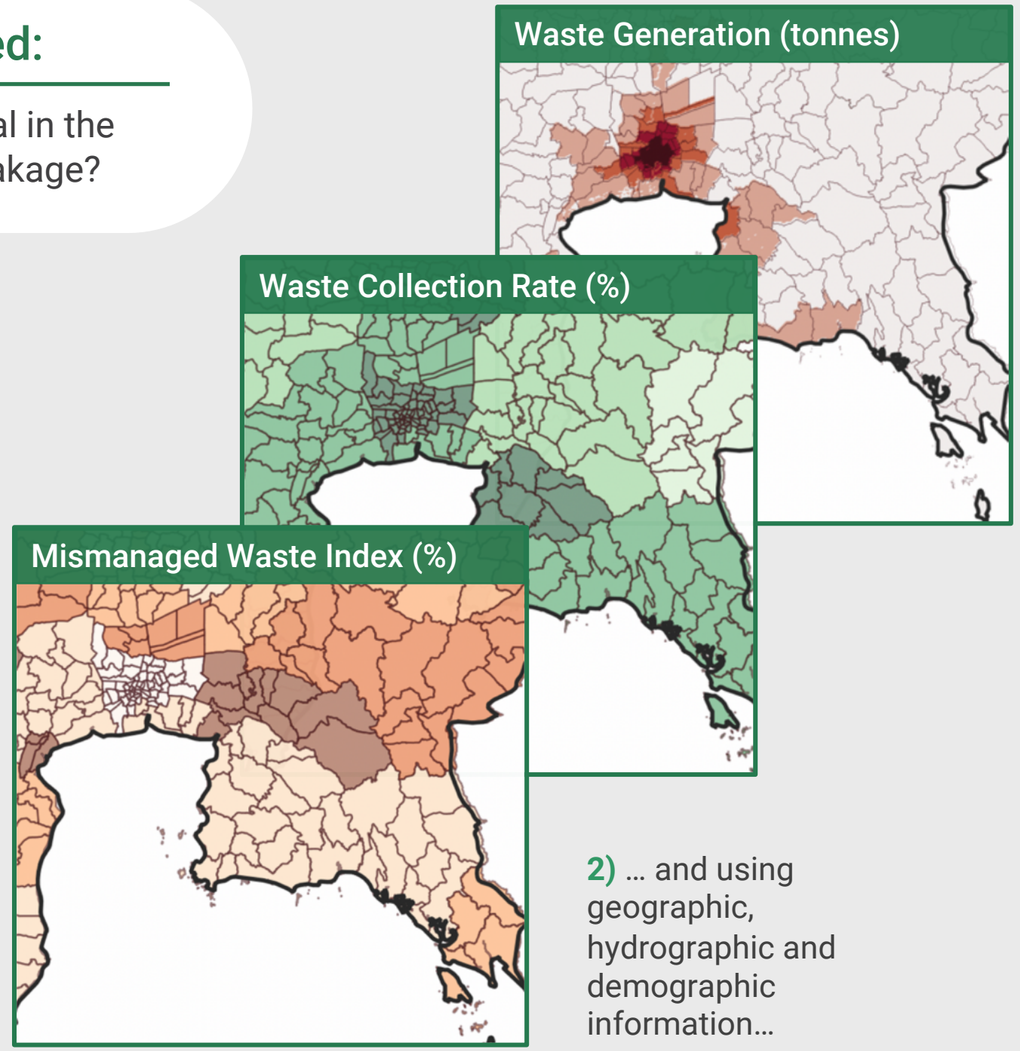


OBJECTIVE AND INSTRUCTIONS

Key question answered:

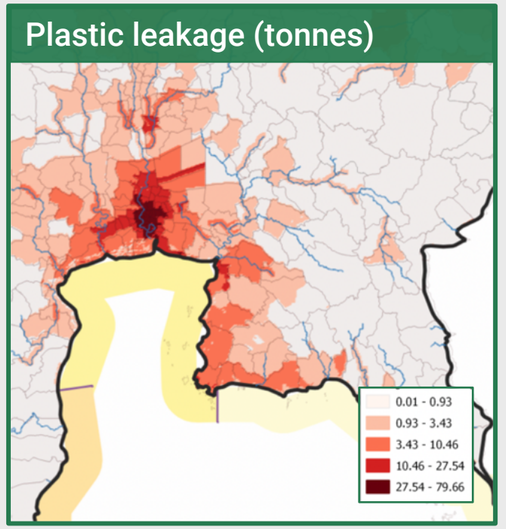
Which areas are most critical in the country regarding plastic leakage?

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

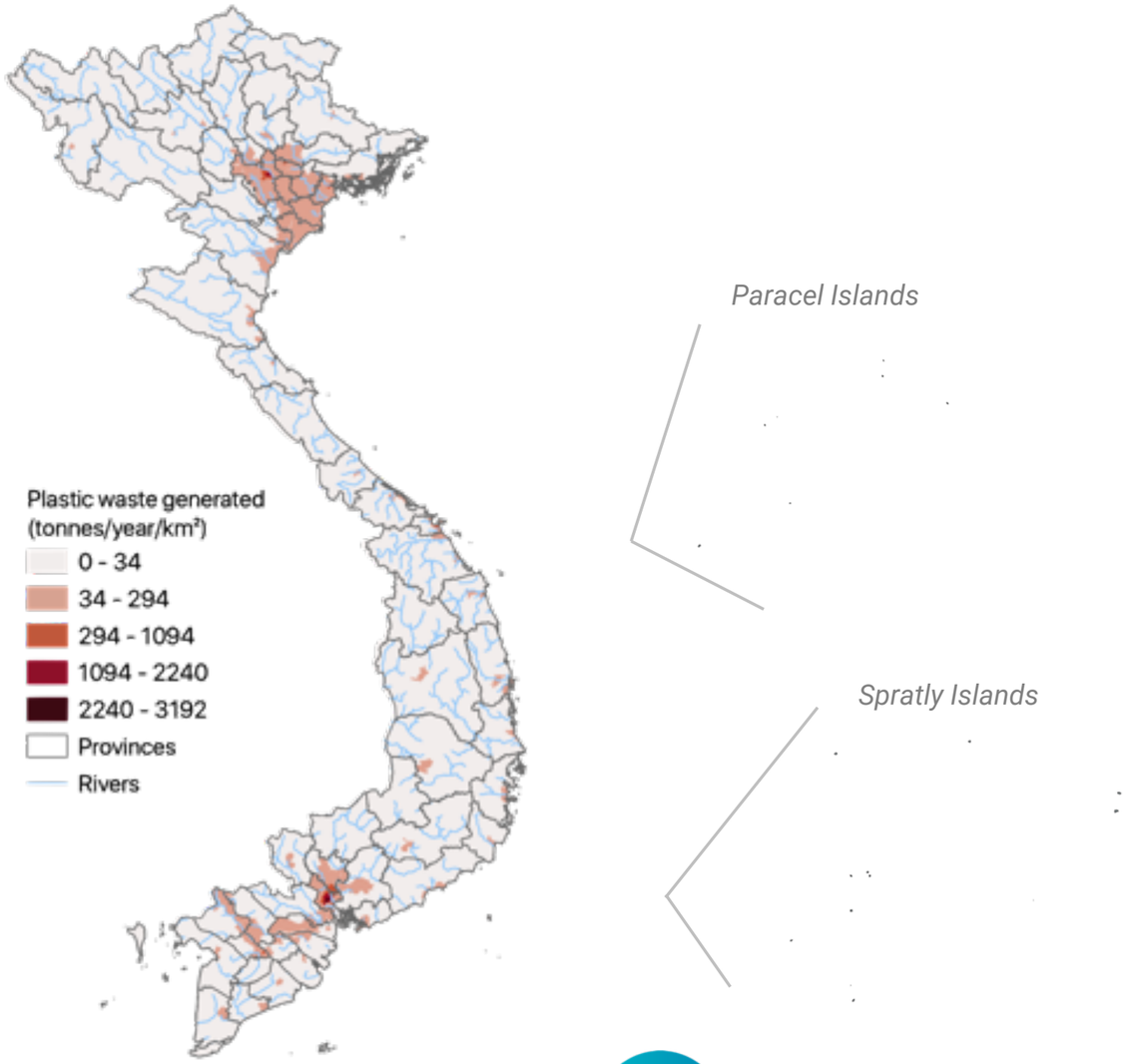


2) … and using geographic, hydrographic and demographic information…

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



WASTE GENERATION:
MAP AND INTERPRETATIONS [2018]



More details available in Appendices

Key take-aways

- Plastic waste generation is concentrated around Ho Chi Minh City and Hanoi areas, where the population density is higher
- 25% of waste generated is plastic (of all kinds)

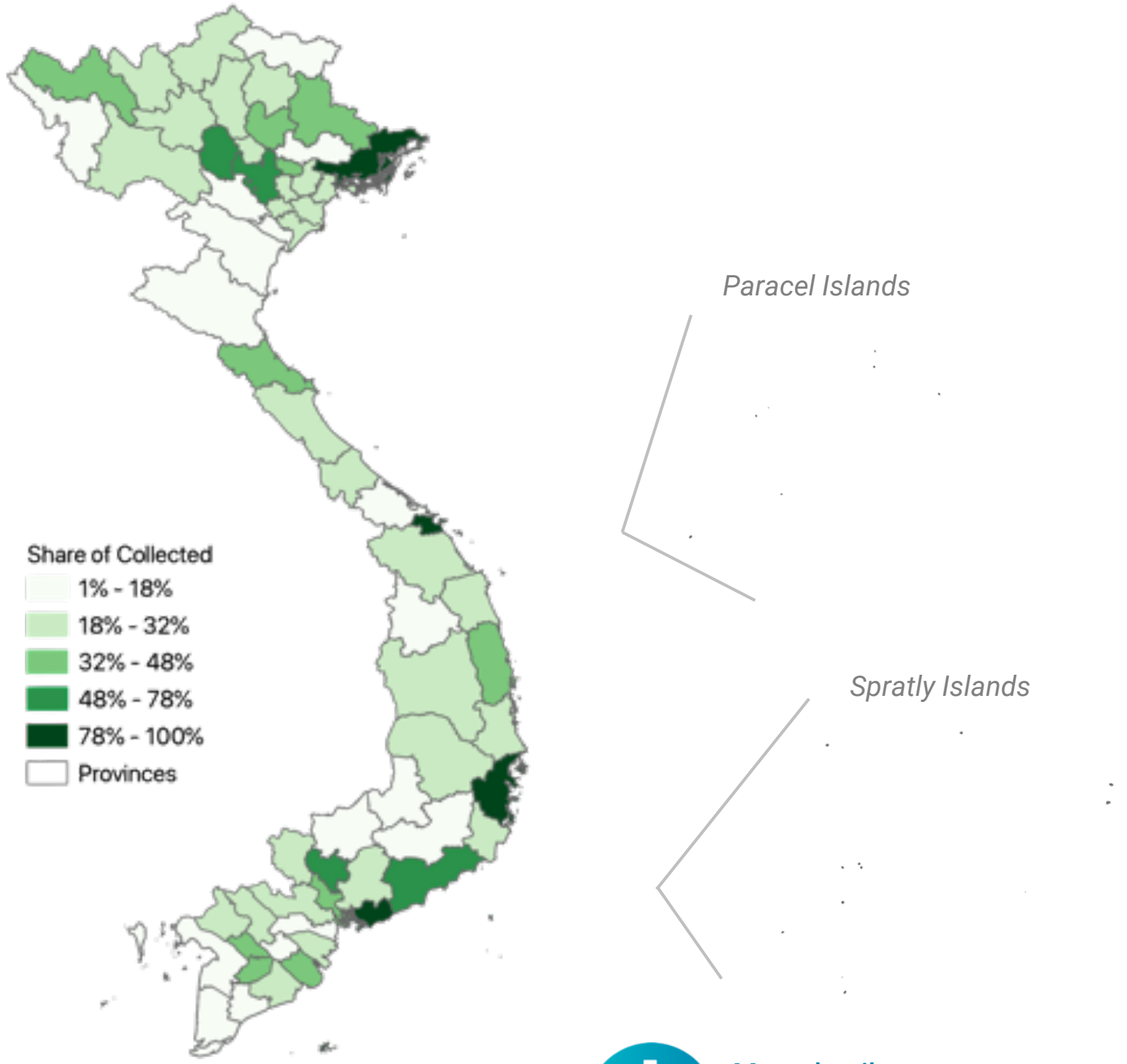
Limitations

- Per capita plastic waste genereation is assumed to be the same across Vietnam (57 kg/cap/year), with no distiction between mega-cities, medium, rural or remote areas (classification based on *GA circular, 2020*). This most likely leads to an over-estimate of plastic consumption in remote and rural areas.
- Tourist population is distributed uniformly across the Vietnamese territory, causing touristic areas to have a lower estimated waste generation than in reality.

Unlocking limitations

Gather information on per capita waste generation and waste characterisation across different archetypes in Vietnam.

WASTE COLLECTION:
MAP AND INTERPRETATIONS [2018]



More details available in Appendices

Key take-aways

- Waste collection effort is focused around main cities where most of the waste is generated.
- Some remote areas have collection rates lower than 15%.

Learnings

Share of waste collected varies greatly across Vietnam. For example, Quảng Ninh and Khánh Hòa provinces have collection rates of 100%, while Cà Mau province has a collection rate of 1%.

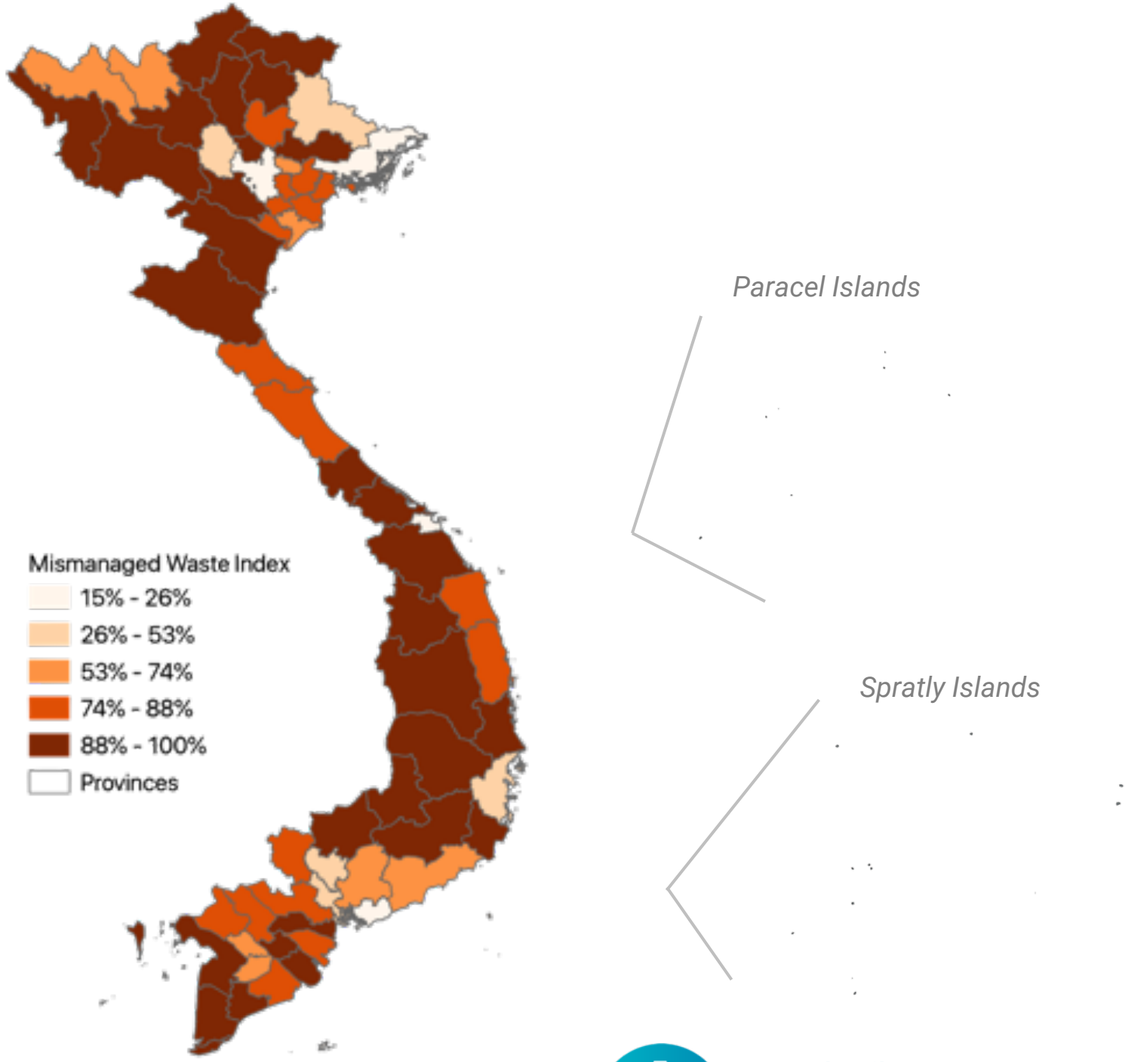
Limitations

We assume that landfills located in a specific province only receive waste from the same province. This might not be the case for mega-cities that might send their waste to neighbouring provinces.

Unlocking limitations

Have detailed information of origin of waste at various landfills and dumpsites.

MISMANAGED WASTE INDEX:
MAP AND INTERPRETATIONS [2018]



More details available in Appendices

Key take-aways

- MWI is lower in mega cities (around 50%) and higher elsewhere (around 90%).

Learnings

Because of the use of unsanitary landfills and dumpsites, a fourth of the waste collected is mismanaged, this together with the uncollected waste leads to high MWI, especially outside urban areas.

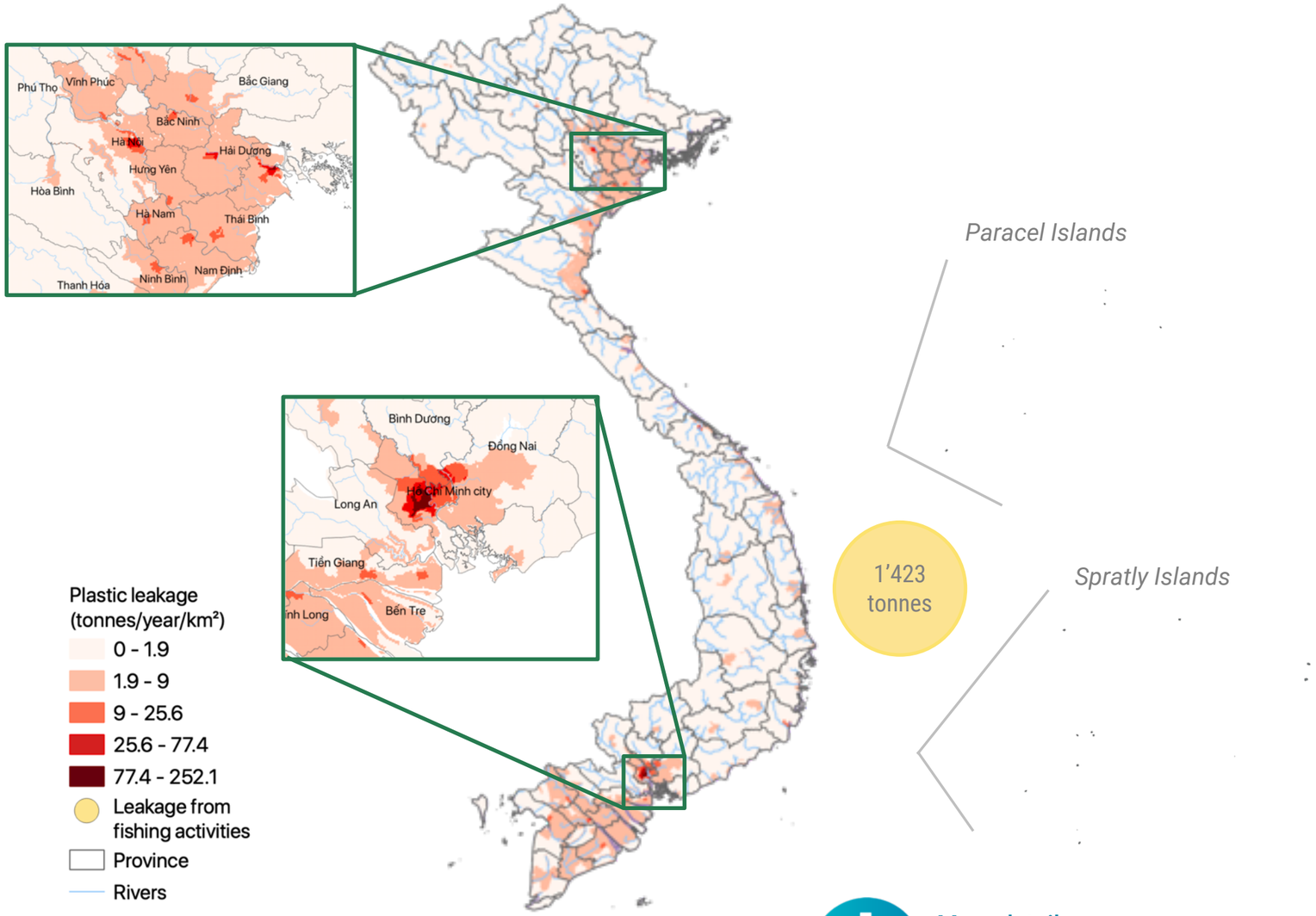
Limitations

- We assume that waste incineration facilities, composting of waste and recycling does not take place in rural and remote areas.
- Due to lack of data, we assumed that within a province, sanitary and unsanitary landfills have the same capacity.

Unlocking limitations

Have access to more granular data , by province on waste quantities entering the sanitary/unsanitary landfills, as well as incineration facilities.

REGIONAL LEAKAGE:
MAP AND INTERPRETATIONS [2018]



More details available in Appendices

Key take-aways

- Annual leakage from mismanaged waste: 443'531 tonnes
- Annual leakage from mismanaged/lost at sea fishing gears and from overboard litter: 1'423 tonnes

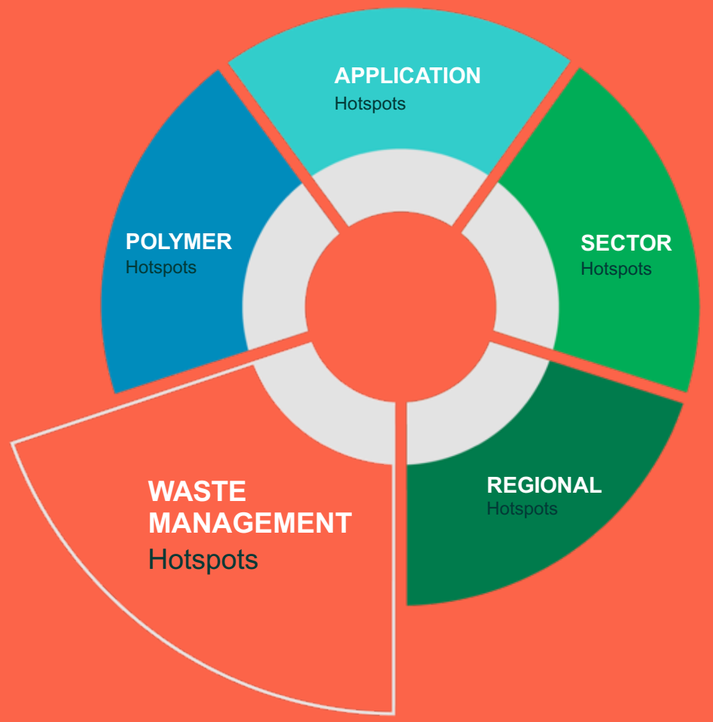
Learnings

Several parameters drive the leakage across Vietnam:

- Populated areas are usually located close to a waterway or the coast (average distance: 6km). This will increase the possibility of transfer to the marine environment
- Surface water runoff peaks at a maximum of 16mm.day-1 in localised watersheds in November.

E

WASTE MANAGEMENT HOTSPOTS



OBJECTIVE AND INSTRUCTIONS

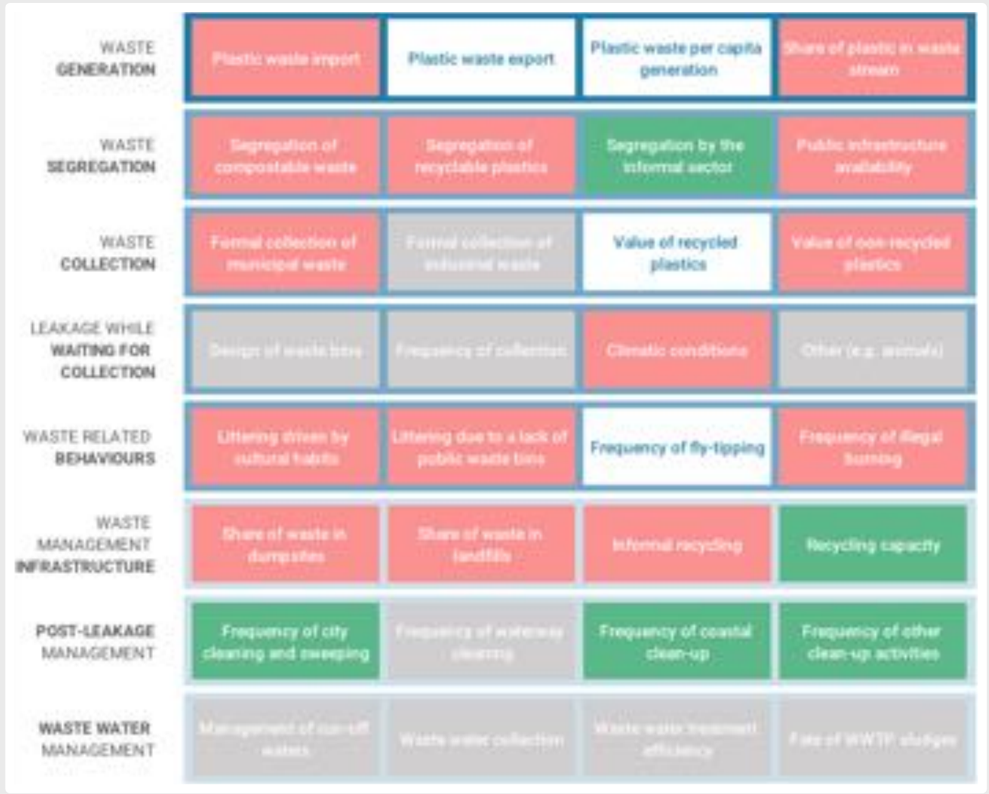
Key question answered:

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

1) We decided 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 hotpsot	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	EA - 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 with this dashboard



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

T4

WASTE MANAGEMENT HOTSPOTS

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
	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
END-OF-LIFE	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 sludges

For more details and justifications, check tool T4.1

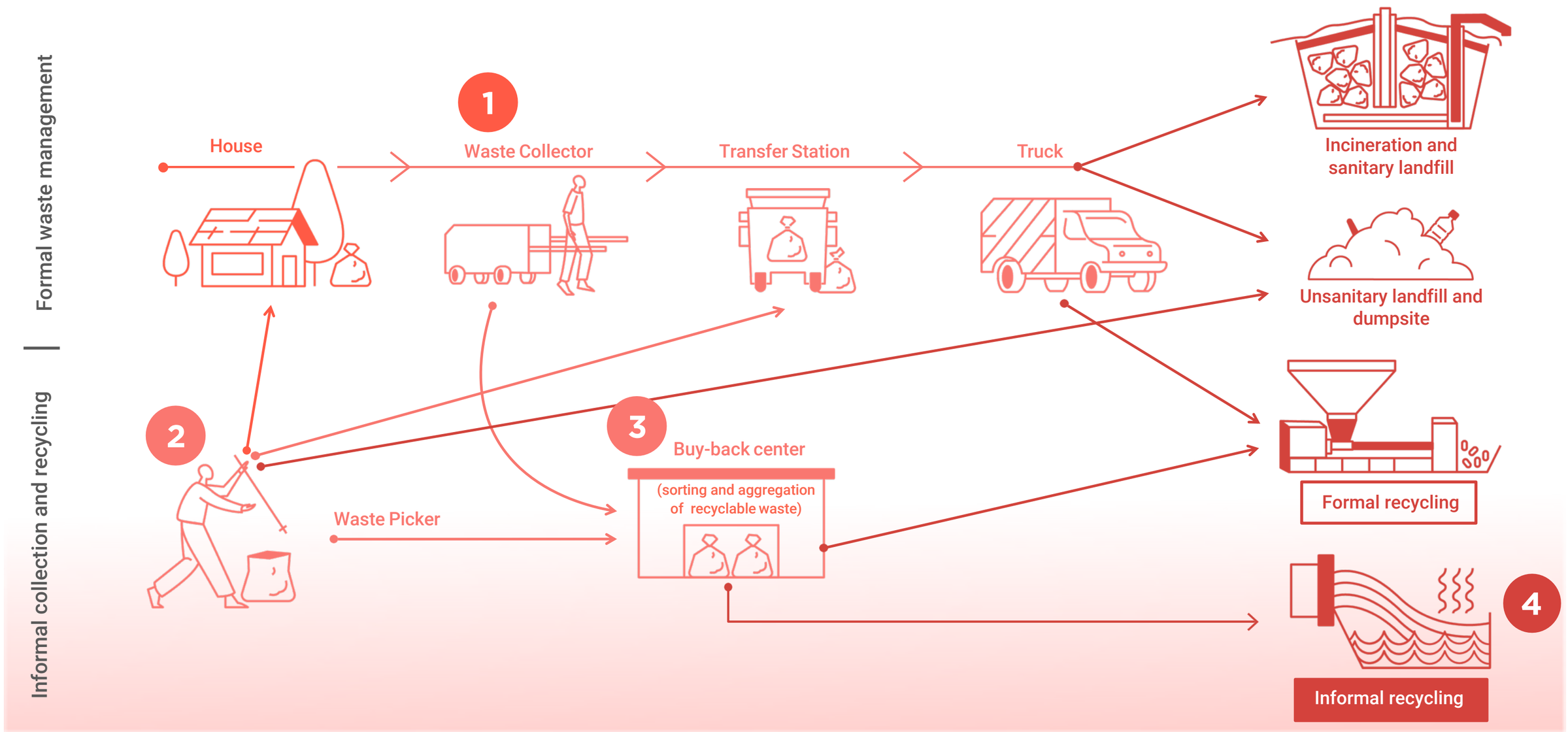
- **Negative contribution to the leakage**
- **Neutral contribution**
- **Positive contribution**
- **Not assessed**

Key take-aways

- Import of plastic waste is jeopardising the recycling infrastructure.
- The per capita plastic waste generation in Vietnam (58 kg/cap/yr) is above the world average* (29 kg/cap/yr).
- Collection of valuable plastics is significant in urban areas.
- Collection of non-valuable plastics is lacking.
- Informally recycled plastics are mismanaged and lead to leakage.
- There is a lack of sanitary landfills.
- Open burning is a dominant practice in rural areas.
- Flooding is recurrent in Vietnam and induces to 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 crew collectors

2

The *Dong Nat* system: door to door collection

3

Transport of plastic for recycling

Transport of plastic for recycling

Informal recycling: the recycling village

4


Storage


Storage


Manual sorting of industrial waste


Waste sorting

4


Recycling

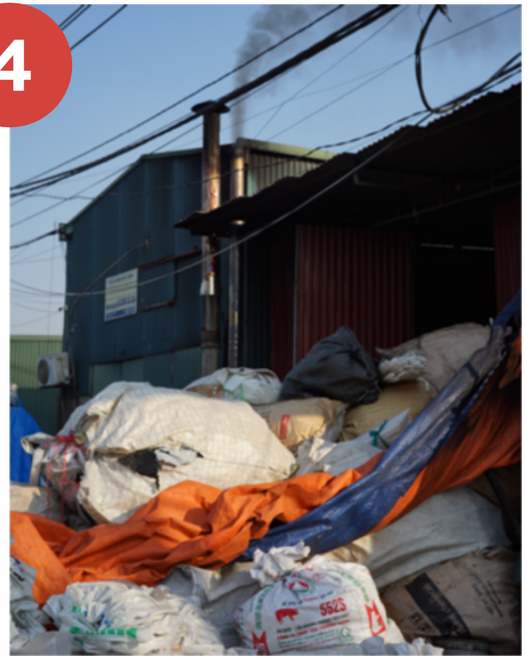

Recycling

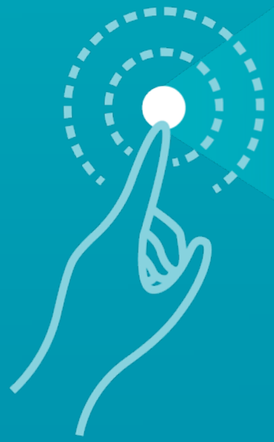

Recycling


Open burning associated with recycling

Leakage from informal recycling

4





2.3 ACTIONABLE HOTSPOTS

HOTSPOTS IN BRIEF

Polymer

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

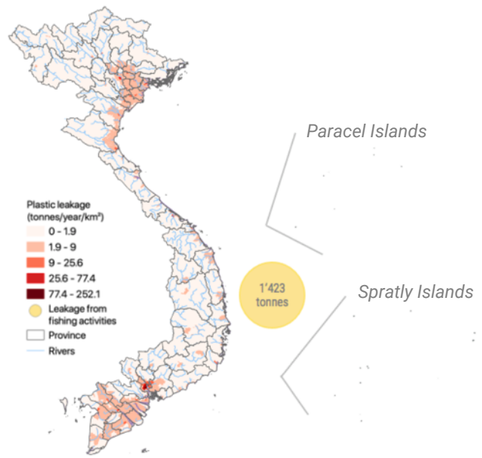
Application

- Bags
- Lids and caps
- Boxes and crates
- Fishing nets
- Cigarette filters
- Drinks bottles
- Other bottles
- Dairy packaging
- Baby diapers
- Sanitary towels

Sector

- Packaging
- Textile
- Automotive-other
- Automotive-tyres
- Fishing
- Medical
- Agriculture
- Electrical & electronics
- Tourism
- Construction

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 sludges

3 highest leakage contributors in absolute OR relative value

Highest leakage contributors in absolute AND relative value

Negative contribution to the leakage

Positive contribution

Neutral contribution

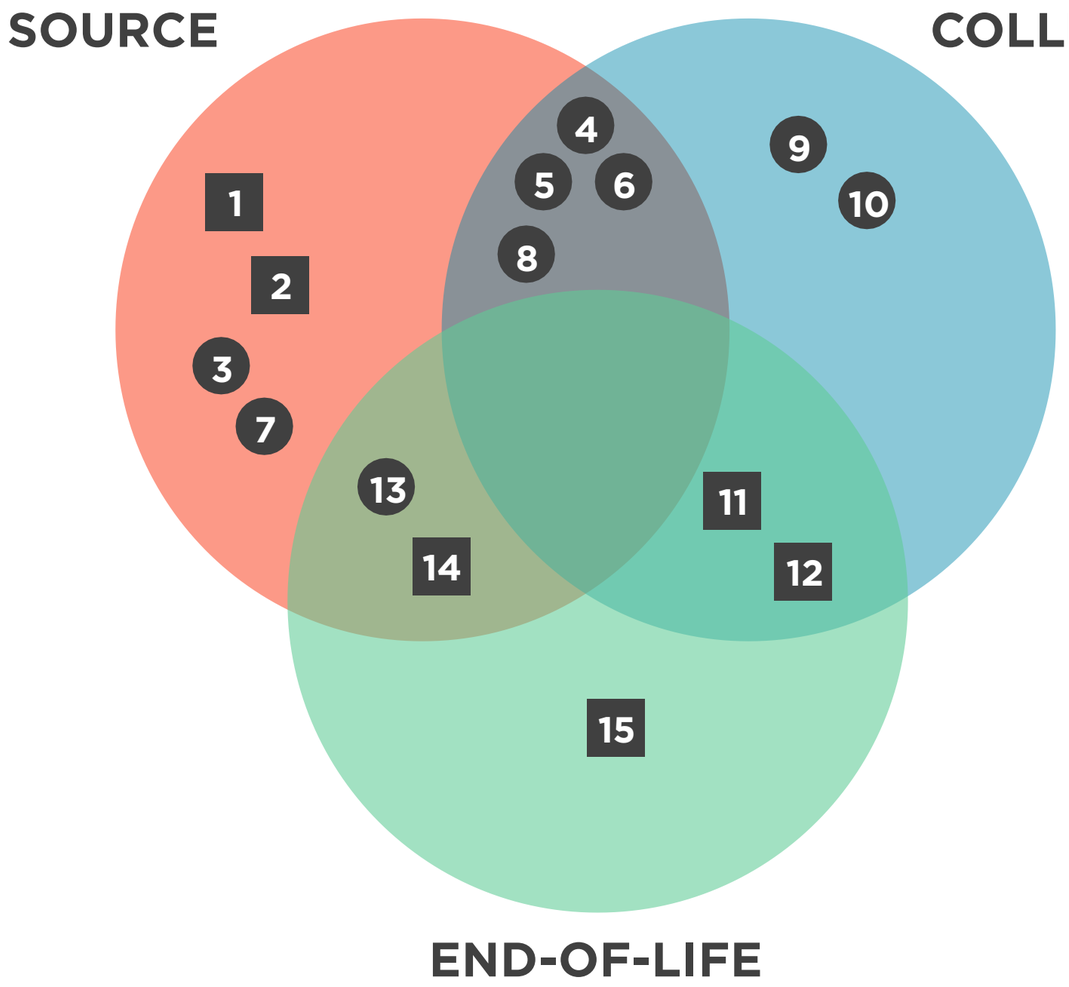
Not assessed

ACTIONABLE HOTSPOTS LIST

[#]	[ACTIONABLE HOTSPOT]	[■/●]
1	Plastic is leaking in Vietnam because of high amount of waste being imported for recycling , that prevents local waste from being recycled.	■
2	Percentage of plastic in the waste stream is high in Vietnam and the waste generation rate drastically increases due to important economic growth in the country.	■
3	Plastic leaks from Ho Chi Minh and Hanoi regions because they are densely populated areas with high plastic waste generation levels, close to waterways.	●
4	PET leaks in Vietnam due to high consumption of PET in single use packaging and low collection rate (46%).	●
5	LDPE leaks in Vietnam due to high consumption and low collection rate (36%).	●
6	PP leaks in Vietnam due to high consumption and low collection rate (34%).	●
7	Plastic leaks from the Packaging sector due to high consumption of plastic single-use packaging in Vietnam.	●
8	Plastic embedded in textile and footwear leaks in Vietnam due to high consumption and low collection rate (36%).	●
9	Plastic leaks especially in rural and remote areas because of low collection rates where waste pickers cannot make a living on it.	●
10	Plastic leaks in in urban areas as the collection of recyclable plastics is still too low in spite of a well implemented Dong Nat system (door-to-door collection).	●
11	Widespread littering reduces the amount of waste collected.	■
12	Burning of waste reduces the amount of waste being collected and properly managed.	■
13	The presence of water canals in densely populated areas combined with littering behaviour increases the direct leakage into the environment.	●
14	Waste leaks in Vietnam because capacity of sanitary landfills is low with respect to waste generation.	■
15	In Vietnam, domestically generated waste is recycled by the informal sector, which is performed improperly and increases the plastic leakage.	■

■ **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 Vietnam calls for a well-balanced set of actions across the value chain, yet with an emphasis on the source (plastic production and imports).

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

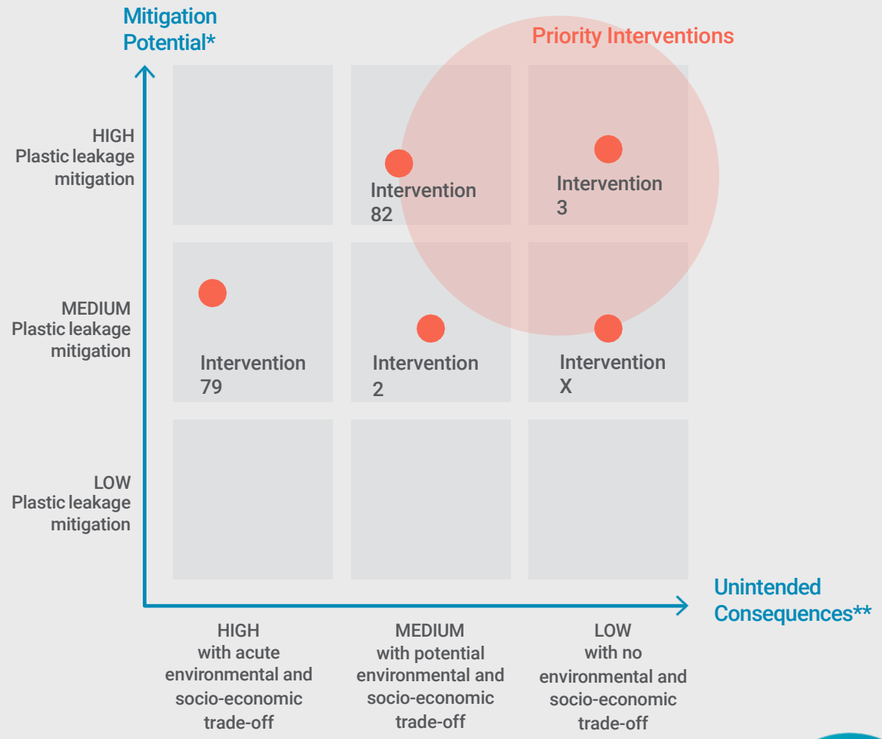
STEP 1: choose up to 3 interventions for each actionable hotspot

STEP 2: assess criteria levels for each chosen intervention

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

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

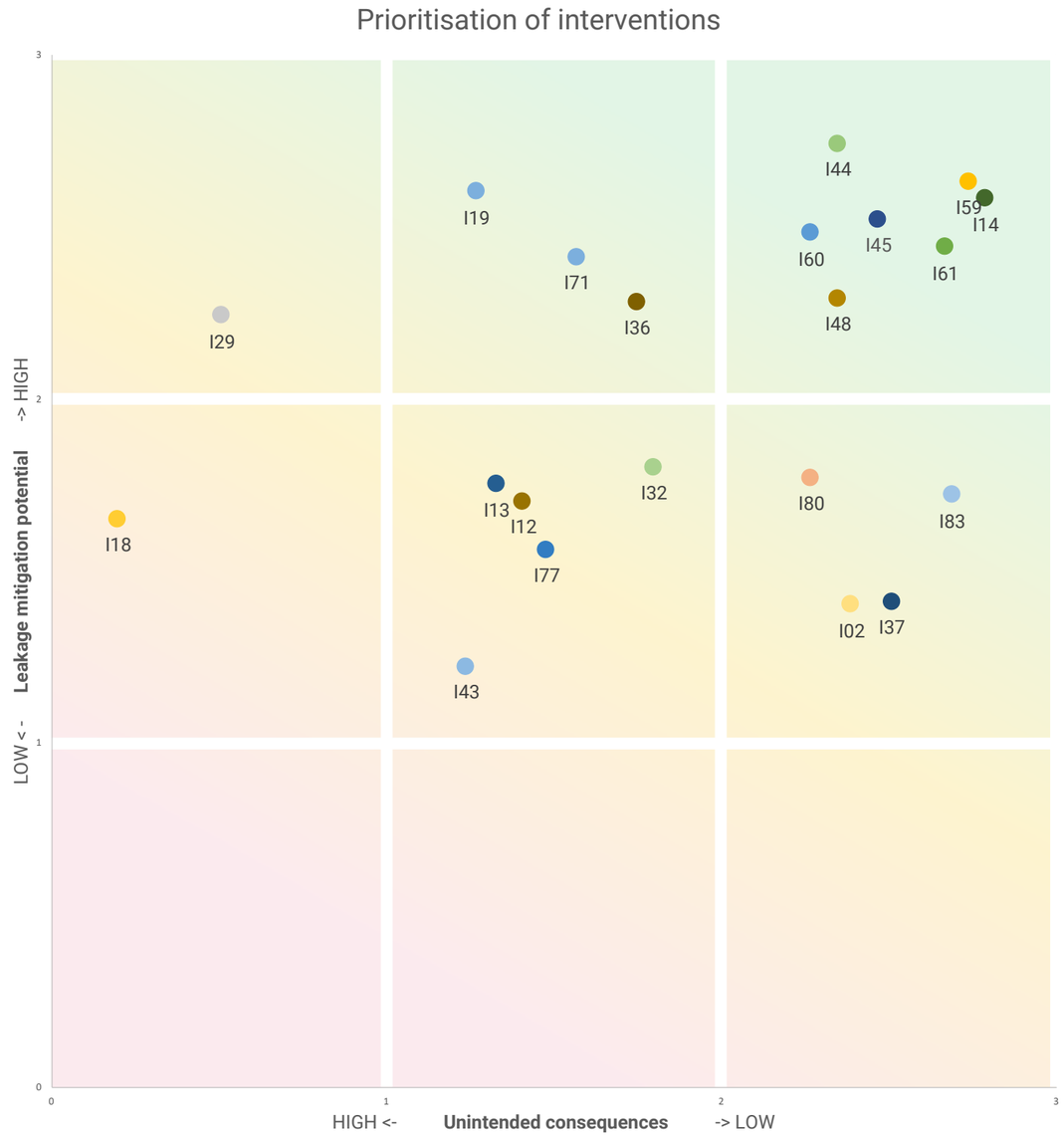
Interventions (I)	Leakage mitigation potential*	Unintended consequences**
I1		
I2	medium	medium
I3	high	low
I4		
I5		
...		
I79	medium	high
I80		
I81		
I82	high	medium
I83		



* **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



- I02: Clean beaches and/or polluted areas
- I12: Ensure constant plastic feedstock to the recycling industry
- I13: Ensure proper functioning of existing recycling facilities
- I14: Reduce littering in urban 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
- 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
- I36: Promote design of material or process that substitute plastic by other material based on life cycle assessment
- I37: Promote design of material or process that favour reuse of plastic objects (e.g. deposit scheme)
- I43: Reduce open burning of plastic waste
- I44: Prevent street sweeping services from discharging plastic into sewers or water bodies
- I45: Plan more frequent waste collection prior to the rainy events
- I48: Increase plastic segregation at household level
- I59: Ensure plastic waste has a enough value to cover collection costs (for all polymers)
- I60: Ensure plastic waste has a enough value to cover collection costs (PP)
- I61: Ensure plastic waste has a enough value to cover collection costs (LDPE)
- I71: Increase capacity for proper waste disposal (sanitary landfills if other upstream solutions cannot be applied)
- I77: Reduce leakage associated with informal recycling activities
- I80: Increase density of waste bins in urban 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.

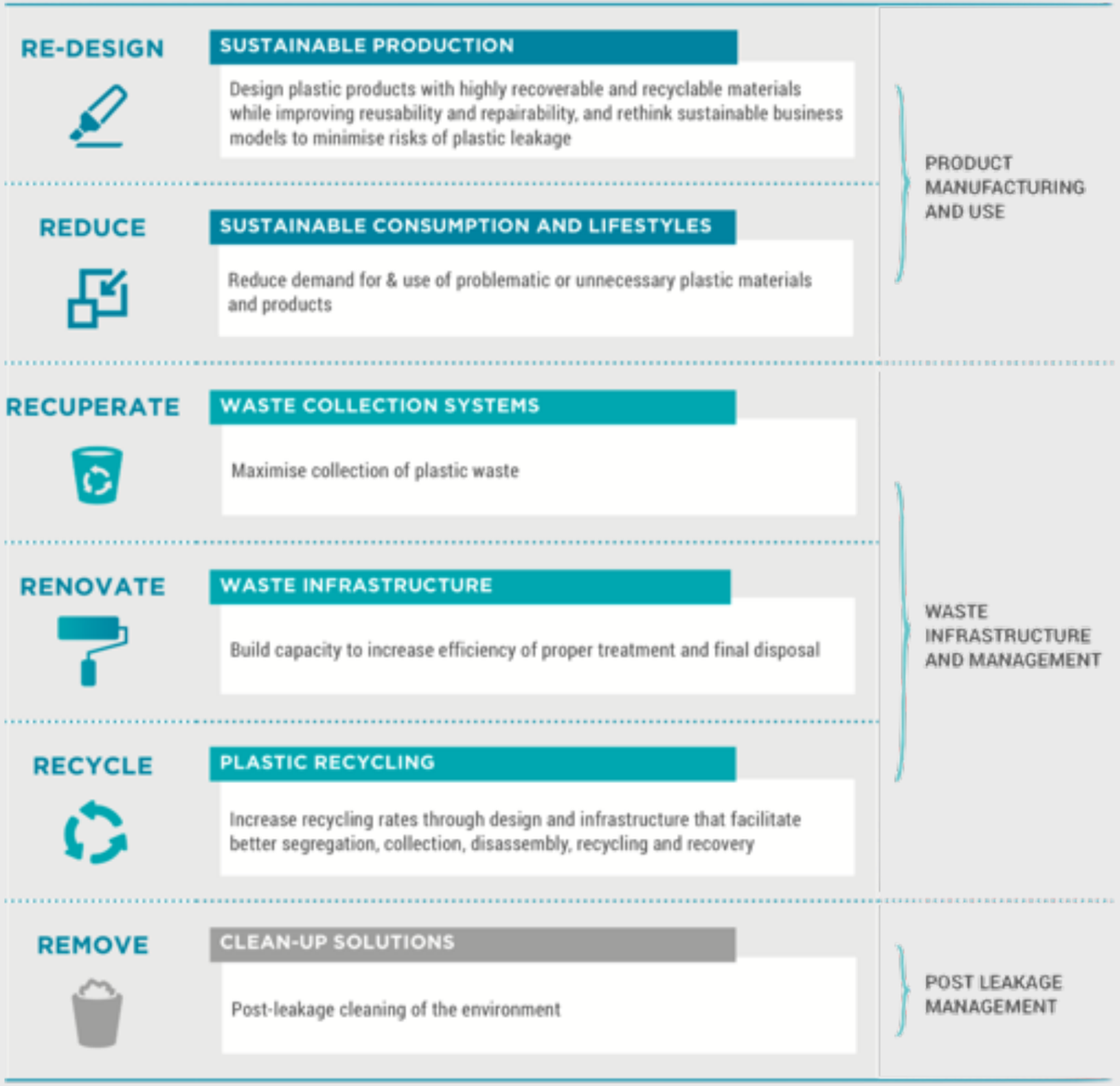
Unlock button

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.



S2

PRELIMINARY PRIORITY INTERVENTIONS LIST

[INTERVENTION CLASS]	[PRIORITY INTERVENTION]	[CODE]
SUSTAINABLE PRODUCTION	Promote design of material or process that substitute plastic by other material based on life cycle assessment	I36
	Promote design of material or process that favour reuse of plastic objects (e.g. deposit scheme)	I37
SUSTAINABLE CONSUMPTION AND LIFESTYLES	Reduce littering in urban areas	I14
	Reduce demand for, and use of, single-use, especially on-the-go, plastics	I19
WASTE COLLECTION SYSTEMS	Prevent street sweeping services from discharging plastic into sewers or water bodies	I44
	Plan more frequent waste collection prior to the rainy events	I45
	Increase plastic segregation at household level	I48
	Ensure plastic waste has a enough value to cover collection costs (for all polymers)	I59
	Ensure plastic waste has a enough value to cover collection costs (PP)	I60
	Ensure plastic waste has a enough value to cover collection costs (LDPE)	I61
WASTE INFRASTRUCTURE	Increase capacity for proper waste disposal (sanitary landfills if other upstream solutions cannot be applied)	I71
	Increase density of waste bins in urban areas	I80
	Increase density of waste bins in specific areas prone to leakage	I83
CLEAN-UP SOLUTIONS	Clean beaches and/or polluted areas	I02

3.2 INSTRUMENTS

METHODOLOGY FOR IDENTIFYING INSTRUMENTS

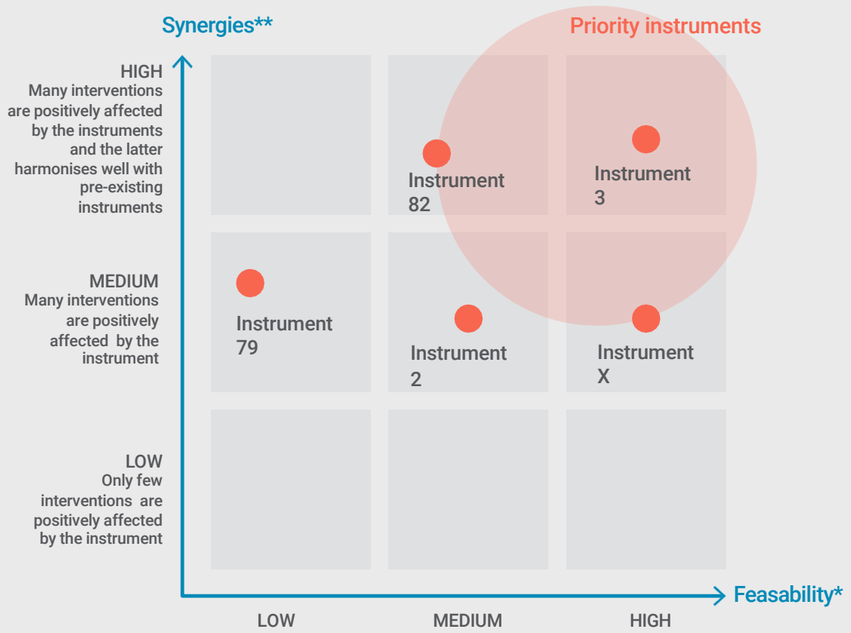
STEP 1: choose up to 3 instruments for each intervention selected in S2

STEP 2: assess criteria levels for each chosen instrument

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

Intervention (I)
I2
I3
…
I79
I82

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

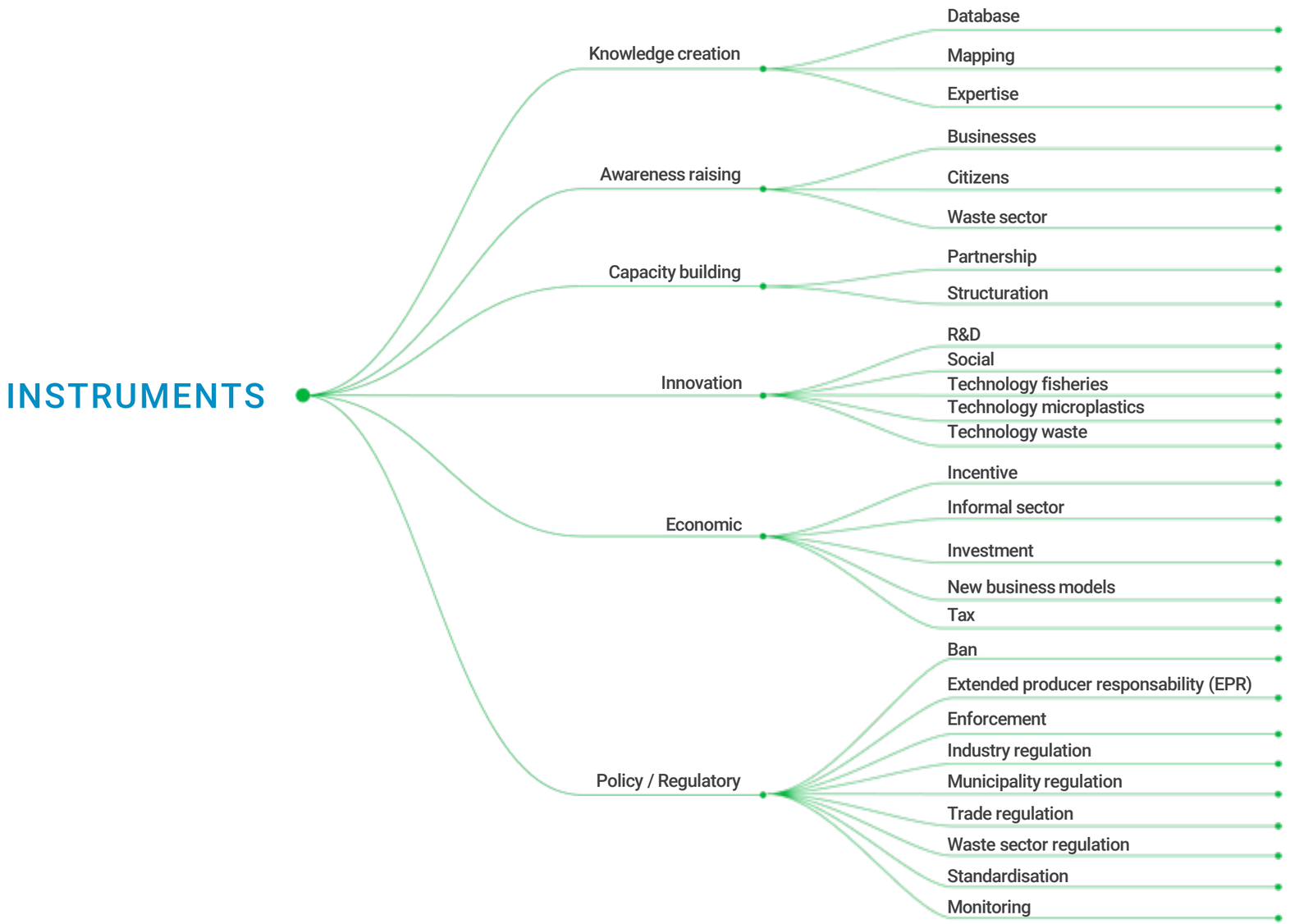


* **Feasability:** technical and socio-economic assessment of each instrument should be performed. We do not assert a method to perform the assessment as this is beyond the scope of the Guidance. The user can decide on the method to use based on resources available. A by default qualitative assessment 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 country	Domestic recycling of collected	Export of collected	Properly disposed	Improperly disposed	Uncollected	*Tot*	Collected	Mismanaged	Leaked	Waste produced and imported	Domestic recycling incl imported
PET	*1003*	13%	1%	24%	8%	54%	*100%*	46%	62%	11%	*1049*	17%
PP	*1135*	4%	0%	22%	8%	66%	*100%*	34%	74%	8%	*1147*	5%
Polyester	*922*	0%	0%	27%	9%	64%	*100%*	36%	73%	5%	*922*	0%
LDPE	*972*	3%	0%	24%	8%	64%	*100%*	36%	72%	11%	*1526*	38%
HDPE	*434*	16%	1%	18%	6%	59%	*100%*	41%	65%	8%	*434*	16%
PS	*245*	5%	0%	17%	6%	72%	*100%*	28%	78%	7%	*246*	6%
Other	*618*	0%	0%	20%	7%	73%	*100%*	27%	80%	5%	*618*	0%
Synthetic Rubber	*71*	0%	0%	23%	8%	69%	*100%*	31%	77%	12%	*71*	0%
PVC	*169*	11%	1%	8%	3%	77%	*100%*	23%	80%	3%	*170*	12%
All	*5569*	*6%*	*0%*	*23%*	*8%*	*64%*	*100%*	*36%*	*72%*	*8%*	*6184*	*15%*

- **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	Population	Generated t	Collected t	Collected for recycling t	Properly disposed t	Improperly disposed t	Uncollected t	Leaked t	Generated kg/hab	Collected for recycling kg/hab	Mismanaged kg/hab	Share of collected	Share of mismanaged	Leakage rate
An Giang	2 225 334	127 648	31 180	14 623	1 183	15 374	96 468	13 589	57	7	50	24%	88%	11%
Bà Rịa - Vũng Tàu	1 016 454	58 305	55 910	21 206	25 099	9 605	2 395	1 231	57	21	12	96%	21%	2%
Bình Dương	3 260 681	187 037	137 739	48 511	89 229	-	49 298	5 492	57	15	15	74%	26%	3%
Bình Phước	1 194 238	68 503	5 208	2 443	461	2 305	63 295	7 240	57	2	55	8%	96%	11%
Bình Thuận	1 296 882	74 391	41 654	19 535	5 104	17 015	32 737	4 880	57	15	38	56%	67%	7%
Bình Định	1 459 829	83 738	27 102	-	20 326	6 775	56 636	6 731	57	0	43	32%	76%	8%
Bạc Liêu	1 000 852	57 410	10 053	-	1 676	8 378	47 357	8 201	57	0	56	18%	97%	14%
Bắc Giang	1 629 144	93 450	2 245	1 053	149	1 043	91 205	10 536	57	1	57	2%	99%	11%
Bắc Kạn	316 537	18 157	4 386	-	1 097	3 290	13 771	1 804	57	0	54	24%	94%	10%
Bắc Ninh	1 121 413	64 326	22 239	4 897	17 342	-	42 087	4 566	57	4	38	35%	65%	7%
Bến Tre	1 135 787	65 150	14 963	7 017	993	6 952	50 187	6 225	57	6	50	23%	88%	10%
Cao Bằng	488 162	28 002	4 789	-	1 596	3 193	23 213	2 914	57	0	54	17%	94%	10%
Cà Mau	1 284 554	73 684	426	-	77	348	73 258	11 658	57	0	57	1%	100%	16%
Cần Thơ	1 495 979	85 811	37 499	-	31 499	6 000	48 312	7 055	57	0	36	44%	63%	8%
Gia Lai	1 725 064	98 952	24 905	-	7 325	17 580	74 047	9 834	57	0	53	25%	93%	10%
Hà Giang	849 106	48 706	8 852	-	2 529	6 323	39 853	5 049	57	0	54	18%	95%	10%
Hà Nam	772 881	44 333	14 174	2 835	7 145	4 195	30 159	4 006	57	4	44	32%	77%	9%
Hà Nội	8 338 394	478 301	375 281	-	375 281	-	103 020	11 548	57	0	12	78%	22%	2%
Hà Tĩnh	1 169 958	67 110	28 867	-	13 121	15 746	38 243	5 511	57	0	46	43%	80%	8%
Hòa Bình	781 491	44 827	6 849	-	1 522	5 327	37 978	4 651	57	0	55	15%	97%	10%
Hưng Yên	1 199 004	68 776	18 775	2 890	13 973	1 912	50 001	5 633	57	2	43	27%	75%	8%
Hải Dương	1 775 991	101 873	21 002	1 088	19 915	-	80 871	9 144	57	1	46	21%	79%	9%
Hải Phòng	1 827 514	104 828	22 509	-	21 158	1 351	82 320	9 523	57	0	46	21%	80%	9%
Hậu Giang	671 586	38 523	13 944	6 540	7 405	-	24 579	3 893	57	10	37	36%	64%	10%
Hồ Chí Minh city	10 515 034	603 155	285 485	-	285 485	-	317 670	34 978	57	0	30	47%	53%	6%
Khánh Hòa	1 227 104	70 388	70 388	37 423	7 704	25 261	-	1 936	57	30	21	100%	36%	3%
Kiên Giang	1 743 951	100 035	17 576	8 243	1 556	7 778	82 459	13 184	57	5	52	18%	90%	13%
Kon Tum	603 759	34 632	4 540	-	649	3 892	30 092	3 785	57	0	56	13%	98%	11%
Lai Châu	688 030	39 466	14 497	-	14 497	-	24 970	2 716	57	0	36	37%	63%	7%
Long An	1 557 826	89 359	19 285	1 358	14 882	3 044	70 074	4 613	57	1	47	22%	82%	5%
Lào Cai	631 133	36 203	11 526	-	11 526	-	24 677	2 724	57	0	39	32%	68%	8%
Lâm Đồng	1 438 995	82 543	11 036	-	2 547	8 489	71 506	8 642	57	0	56	13%	97%	10%

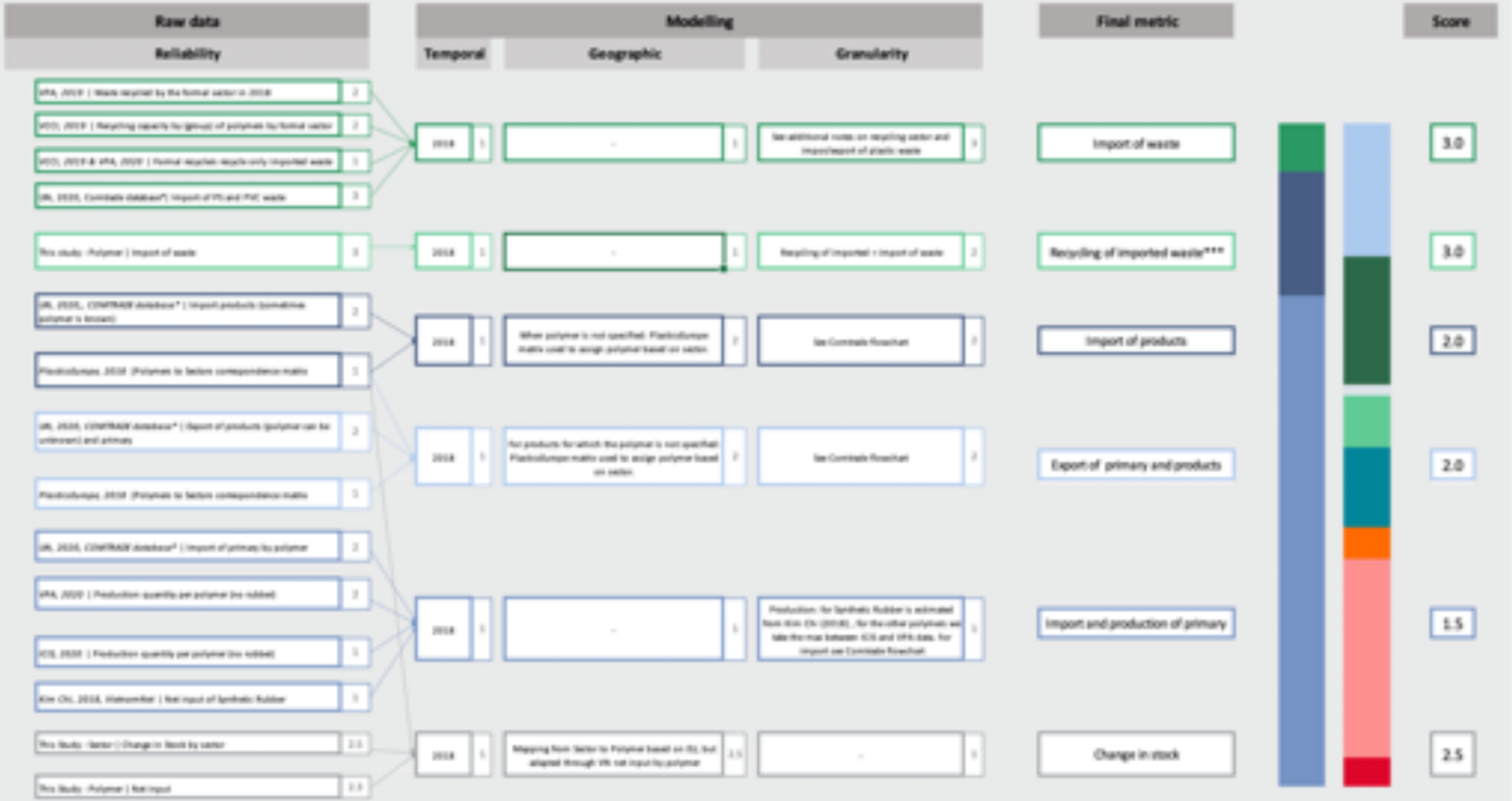
Per capita values are calculated by dividing total values by the 2020 population forecasted by NASA in 2015.

WASTE MANAGEMENT BY PROVINCE (2/2)

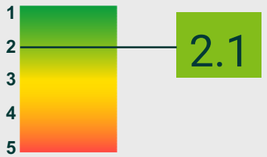
Province	Population	Generated t	Collected t	Collected for recycling t	Properly disposed t	Improperly disposed t	Uncollected t	Leaked t	Generated kg/hab	Collected for recycling kg/hab	Mismanaged kg/hab	Share of collected	Share of mismanaged	Leakage rate
Lạng Sơn	736 054	42 221	20 126	-	20 126	-	22 095	2 407	57	0	30	48%	52%	6%
Nam Định	1 705 356	97 821	27 711	4 582	21 340	1 788	70 111	7 467	57	3	42	28%	74%	8%
Nghệ An	2 937 567	168 502	28 445	-	15 171	13 275	140 057	16 666	57	0	52	17%	91%	10%
Ninh Bình	873 062	50 080	9 019	4 230	2 395	2 395	41 061	4 943	57	5	50	18%	87%	10%
Ninh Thuận	632 195	36 263	8 266	-	870	7 396	27 998	3 738	57	0	56	23%	98%	10%
Phú Thọ	632 687	36 292	22 190	10 407	8 837	2 946	14 102	1 968	57	16	27	61%	47%	5%
Phú Yên	933 402	53 541	16 243	-	1 805	14 439	37 298	4 886	57	0	55	30%	97%	9%
Quảng Bình	884 456	50 734	11 808	-	9 184	2 624	38 926	5 287	57	0	47	23%	82%	10%
Quảng Nam	1 439 191	82 554	17 876	-	6 384	11 491	64 678	8 915	57	0	53	22%	92%	11%
Quảng Ngãi	1 209 357	69 370	20 368	-	11 881	8 487	49 002	7 201	57	0	48	29%	83%	10%
Quảng Ninh	1 048 043	60 117	60 117	34 050	14 828	11 239	-	1 091	57	32	11	100%	19%	2%
Quảng Trị	621 134	35 629	7 979	-	3 627	4 352	27 650	3 579	57	0	52	22%	90%	10%
Sóc Trăng	1 385 370	79 467	24 070	11 288	-	12 782	55 397	9 537	57	8	49	30%	86%	12%
Sơn La	1 333 745	76 505	19 896	-	-	19 896	56 609	8 114	57	0	57	26%	100%	11%
Thanh Hóa	3 276 720	187 957	18 995	8 908	917	9 170	168 962	19 842	57	3	54	10%	95%	11%
Thái Bình	1 721 923	98 772	22 431	2 025	20 407	-	76 340	8 389	57	1	44	23%	77%	8%
Thái Nguyên	1 214 475	69 664	27 629	12 958	4 891	9 781	42 034	5 825	57	11	43	40%	74%	8%
Thừa Thiên - Huế	1 057 026	60 632	7 943	3 725	2 531	1 687	52 689	6 550	57	4	51	13%	90%	11%
Tiền Giang	1 713 735	98 302	4 692	2 200	712	1 779	93 610	7 829	57	1	56	5%	97%	8%
Trà Vinh	992 740	56 945	23 083	-	5 771	17 312	33 862	5 568	57	0	52	41%	90%	10%
Tuyên Quang	785 162	45 038	9 539	-	1 908	7 631	35 499	4 948	57	0	55	21%	96%	11%
Tây Ninh	1 178 873	67 622	14 615	6 854	3 880	3 880	53 006	3 783	57	6	48	22%	84%	6%
Vĩnh Long	1 001 174	57 429	7 985	-	1 996	5 989	49 444	6 206	57	0	55	14%	97%	11%
Vĩnh Phúc	1 029 904	59 077	13 529	6 345	189	6 995	45 548	6 036	57	6	51	23%	89%	10%
Yên Bái	813 745	46 677	13 057	-	1 306	11 751	33 621	4 963	57	0	56	28%	97%	11%
Điện Biên	638 472	36 624	6 524	-	1 450	5 074	30 100	3 746	57	0	55	18%	96%	10%
Đà Nẵng	1 059 935	60 799	51 792	-	51 792	-	9 007	927	57	0	8	85%	15%	2%
Đăk Nông	749 587	42 997	6 107	-	1 357	4 750	36 890	4 527	57	0	56	14%	97%	11%
Đắk Lắk	2 109 870	121 025	34 318	-	4 576	29 742	86 707	12 412	57	0	55	28%	96%	10%
Đồng Nai	3 175 144	182 130	53 923	25 289	28 634	-	128 207	14 015	57	8	40	30%	70%	8%
Đồng Tháp	1 753 691	100 594	22 341	10 478	2 373	9 491	78 253	8 674	57	6	50	22%	87%	9%

4.2 DATA QUALITY ASSESSMENT

POLYMER HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)



Quality Score

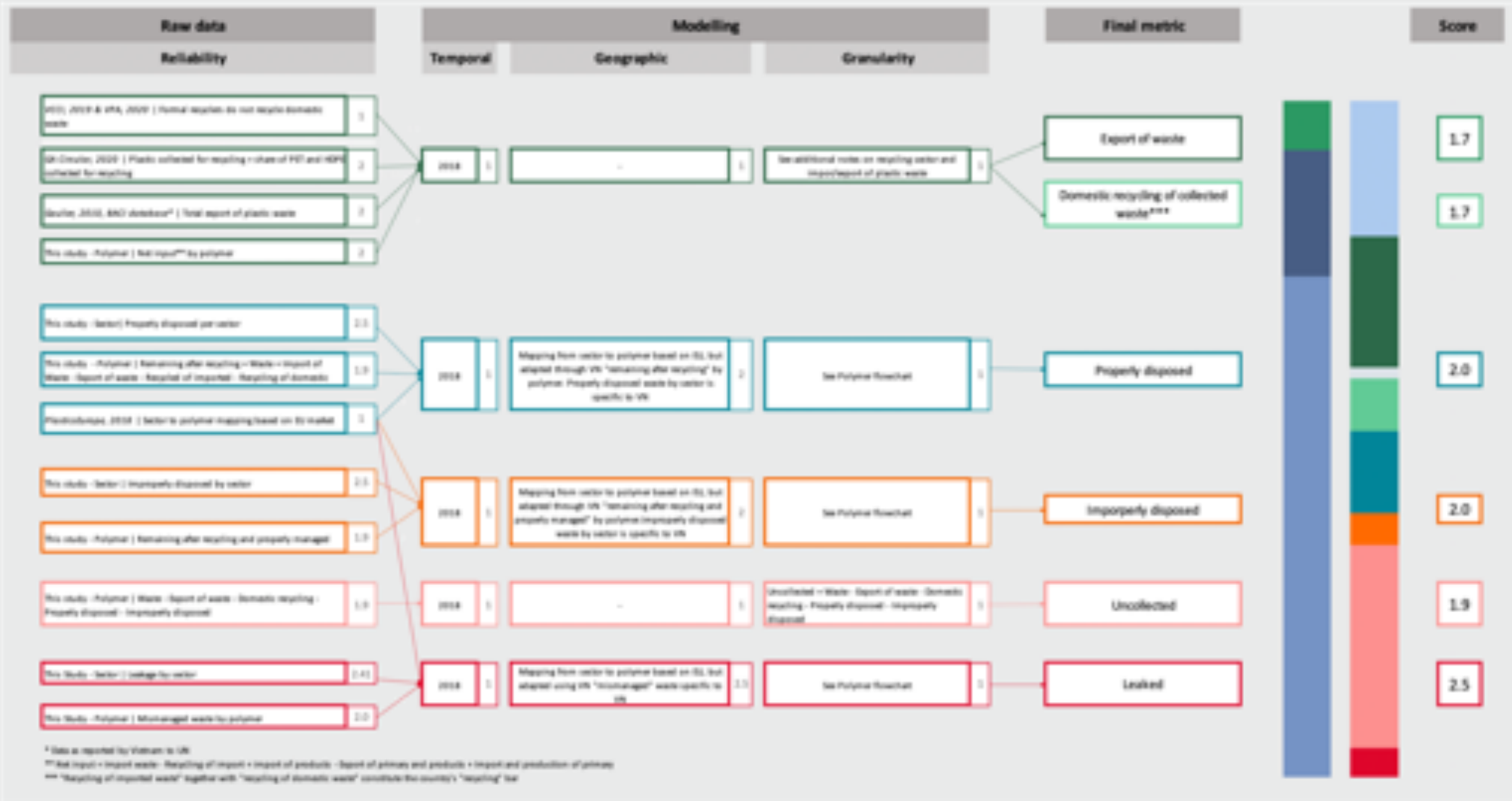


* Data as reported by Vietnam to UN

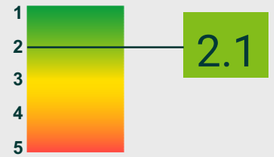
** Net input = Import waste - Recycling of import + import of products - Export of primary and products + Import and production of primary

*** "Recycling of imported waste" together with "recycling of domestic waste" constitute the country's "recycling" bar

POLYMER HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)



Quality Score



POLYMER HOTSPOTS MODELLING NOTES (1/2)

Formal recycling and import of waste

Vietnam recycles both imported waste and domestic waste. Import of waste is regulated by the government which distributes licences to companies that meet environmental standards. We call these "formal" recyclers. According to VPA and VCCI (2019) formal recyclers only recycle imported plastic waste, they do not recycle waste generated within the country. This is motivated, between other things, by the need to have a continuous source of recyclable waste (logistic) and high quality of waste. On the other hand, the waste generated within the country is collected for recycling mostly by a widespread networks of self-organised waste pickers and it is recycled by "informal" recyclers that operate at household level in craft-villages (see following section).

Polymer groups	Formal sector recycling capacity (kt)
PE, PS, PVC	561
PE	132
PE, PS	78
PE, PP	36
PET	65

Concerning formal recycling, we have two main sources of data VCCI (2019) and VPA. VCCI (2019) provides a list of recycling companies together with the recycling capacity and the types of polymer that they recycle, for a total of 872kt.

Polymer	Fromal recycling capacity (kt)	Formal recycling of imported waste (kt)
PET	65	46
PS	2	1
PVC	1	1
LDPE	785	554
PP	18	13

From which we know that formally recycled PET is 65 kt/year. VPA assessed during an interview that the formal sector only recycled LDPE, and that there was no recycling of PVC and PS. From UN Comtrade we have 2 kt of PS import and 1 kt of PVC. We are left with having to assessed how the 36 kt of PE (LDPE) and PP split. Since we have no other information we assume a 50-50 split. VPA estimated that the actual quantity of plastic recycled in 2018 was 615 kt. Assuming that the recycling quantity by polymer to be proportional to the recycling capacity we obtain:

Let us point out that, in reality, it is difficult to assess exactly the amount of waste recycled by the formal sector, as different sources report different quantities, especially for what concerns trade of waste.

What is clear though is that Vietnam imports a lot of plastic waste. In the best case scenario this waste is 100% recycled by companies that are licenced and respect environmental standards causing no direct leakage of plastic waste (as assumed for simplicity in our analysis). But even under this optimistic scenario, the import of waste diverts a considerable part of the country recycling capacity away from recycling domestic, therefore it indirectly contribute to plastic leakage.

POLYMER HOTSPOTS MODELLING NOTES (2/2)

Informal recycling and export of waste

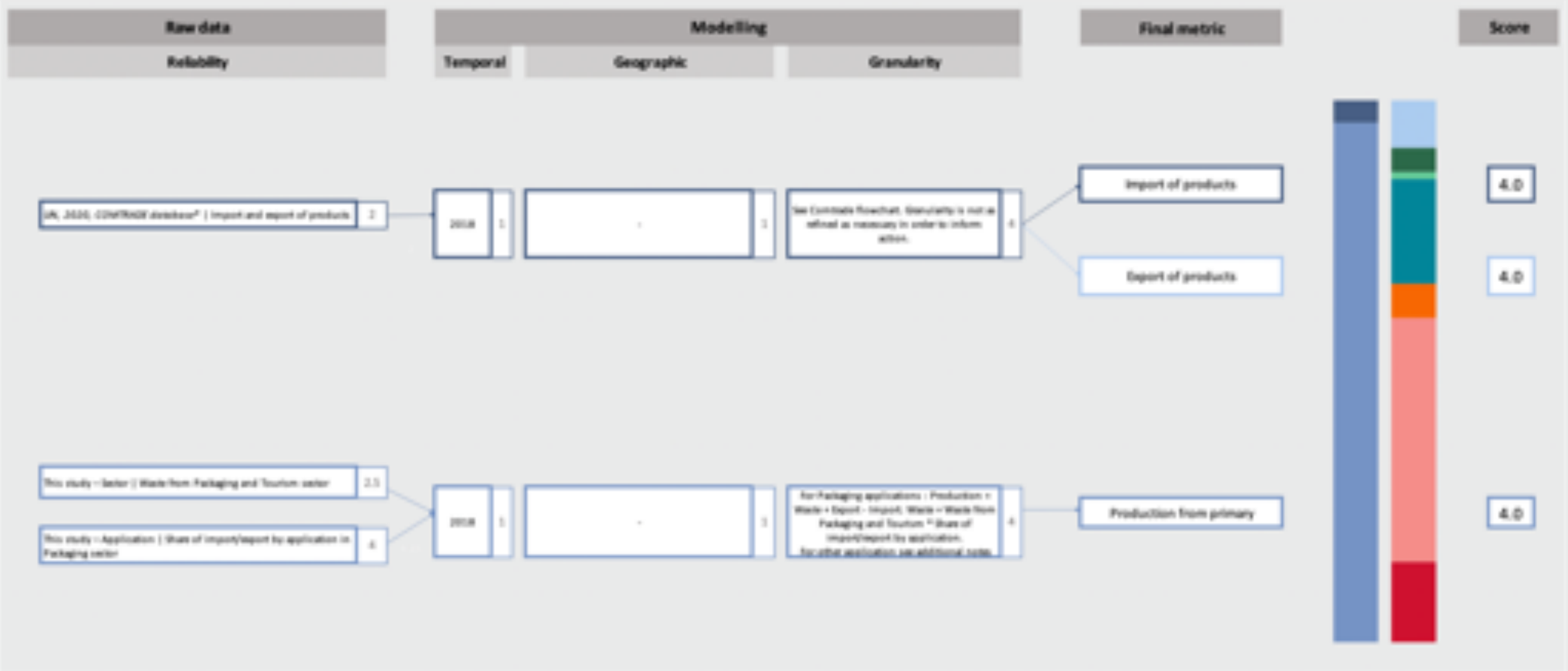
In Vietnam there is also a vibrant informal community of waste pickers who collect and sort waste for recycling and then deliver it to the informal recycling sector that operates in craft villages in the outskirts of Ho-Chi-Minh and Hanoi mega-cities. A study by *GA Circular (2020)* estimates that there are 323 kt of plastic collected by Recycling Collectors (Dang Nat), Waste Collectors and scavengers at landfills. It also estimates the PET and HDPE share of waste collected for recycling (43% and 23% respectively). For the remaining part, we assign the share by polymer based on the quantity available on the market, for those polymers that we consider recyclable. We obtain:

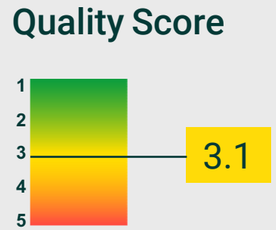
Polymer	Collected for recycling by the informal sector(kt)
PET	137
HDPE	73
PVC	20
LDPE	34
PP	45
PS	13
Other	0
Polyester	0
Synthetic Rubber	0

We considered that Polyester is not recyclable because it is embedded in textile, Other is not recyclable, and Synthetic Rubber is not in the category considered by *GA circular (2020)*.

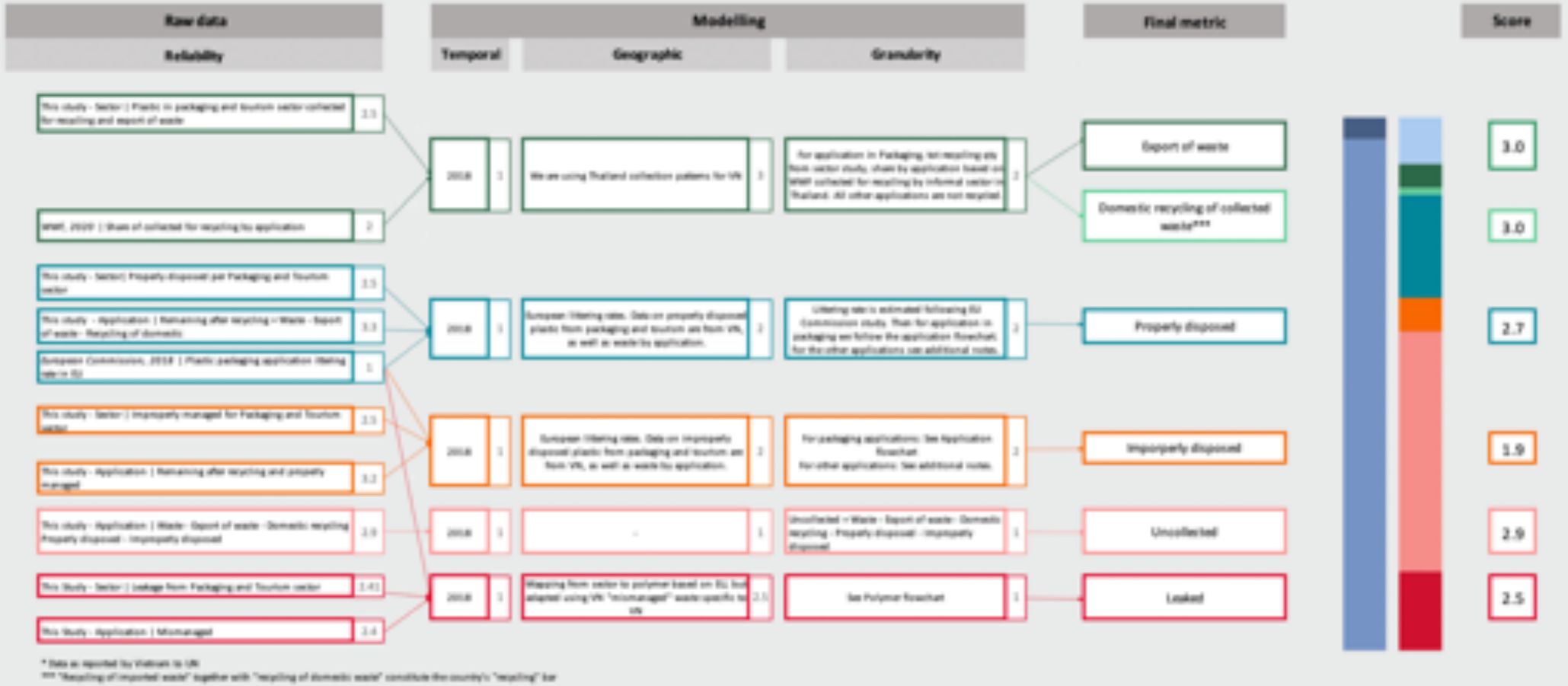
Some of this waste collected for recycling is exported, and some is informally recycled. The total quantity of export is taken from Gaulier (2010) BACI database 2018 (code HS3915) and the share by polymer is the same at that of ”Collected for recycling”. What is left is recycled in Vietnam by the informal sector. To have a glance into recycling of waste in recycling villages in Vietnam see pictures in the "Waste Management Hotspots" section.

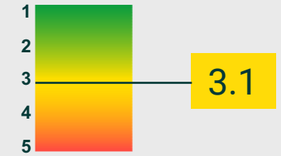
APPLICATION HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)





APPLICATION HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)





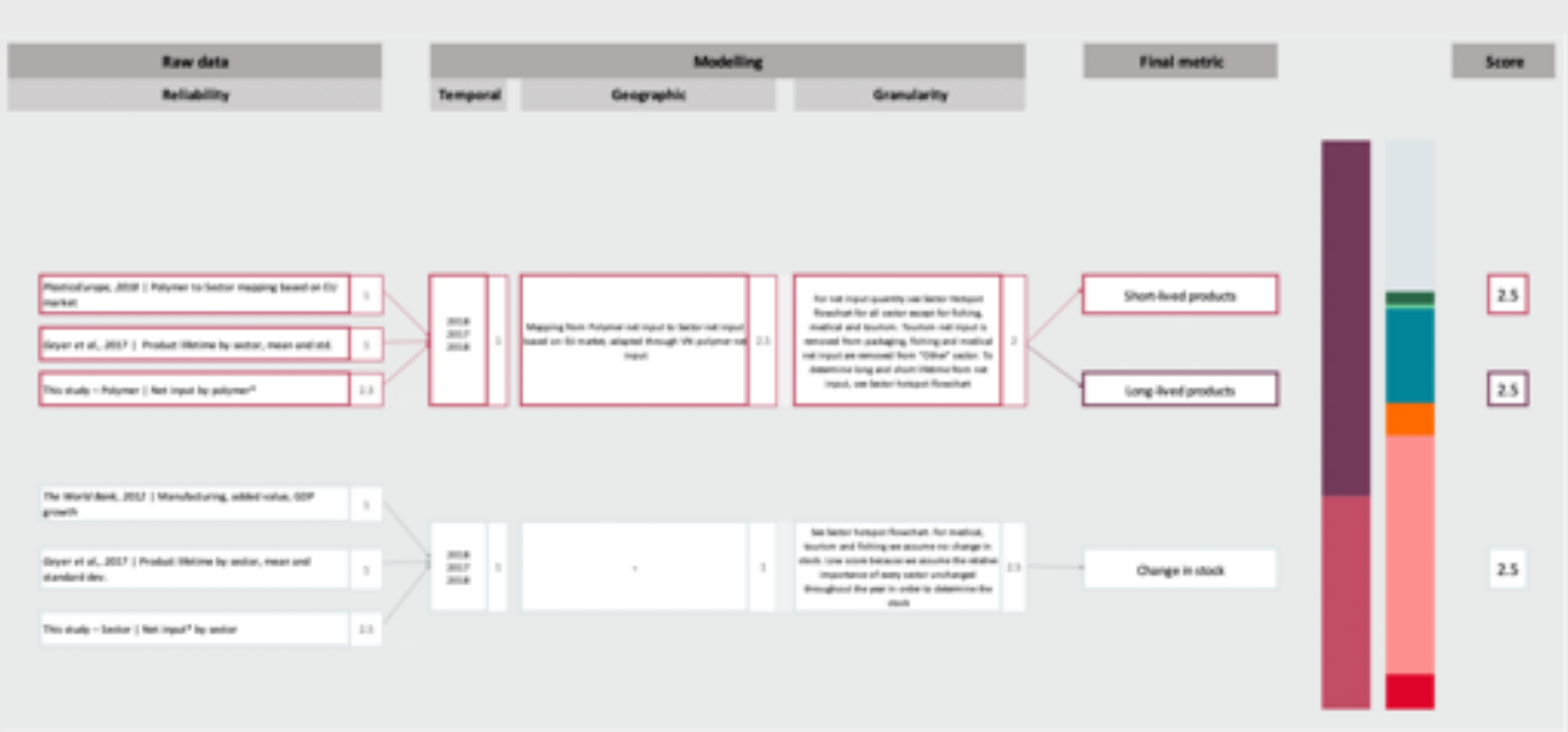
APPLICATION HOTSPOTS MODELLING NOTES

Cigarette filters: We estimate the number of cigarette filters from cigarette consumption data from Kostova et al. (2014) combined with population data of Vietnam. The plastic weight of a cigarette filter is 0.17gr. From these data we obtain the waste generated. Trade data on import and export are determined through UN 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%, based on European Commission littering report (2018). The improperly managed is based on the average share of improperly managed (sector hotspot), applied to cigarette filters not littered or properly managed. The leakage rate is taken from PLP (25%) and applied to uncollected and improperly managed to determine de total leakage.

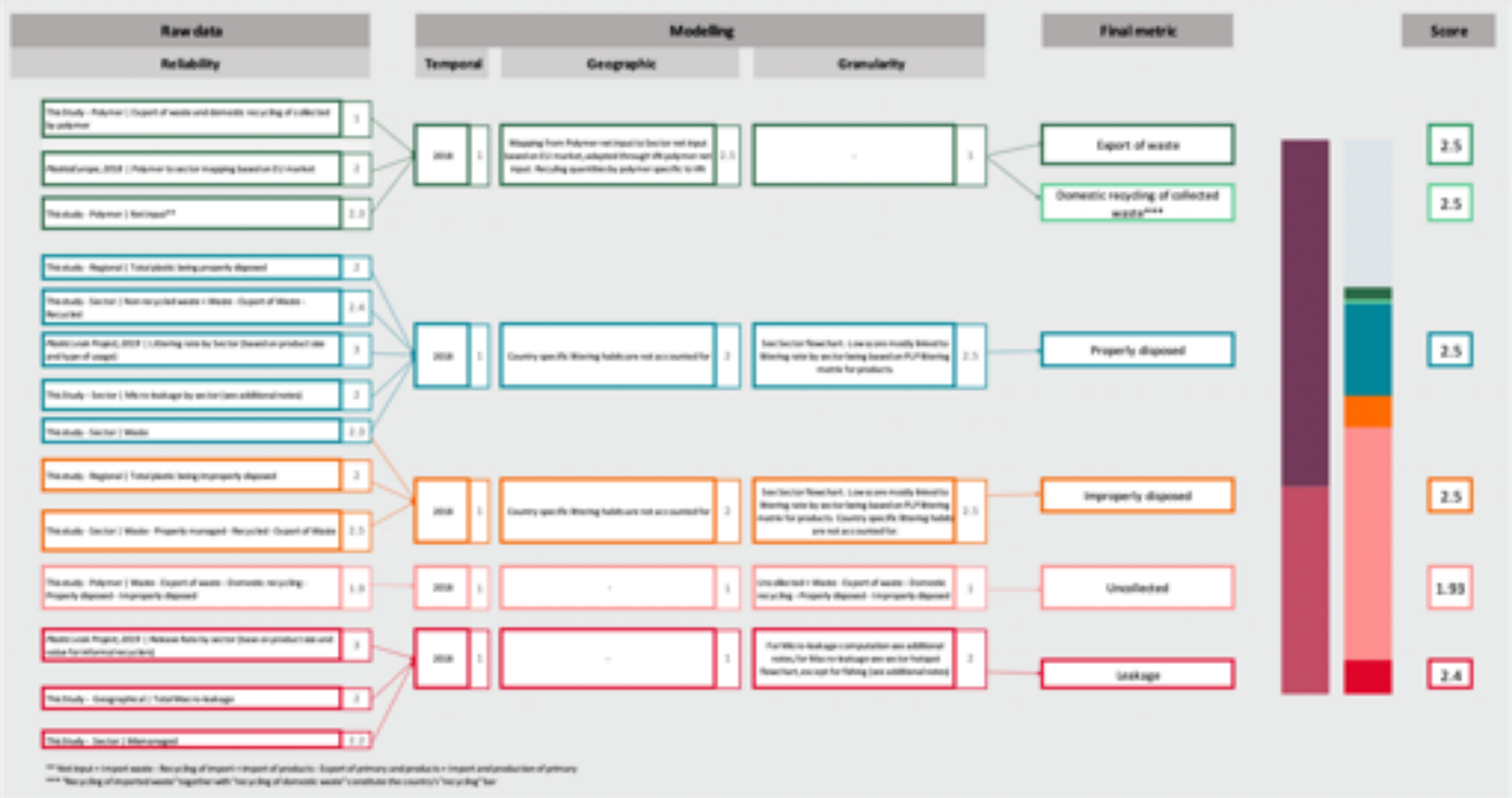
Sanitary towels: import and export are determined through UN COMTRADE (code: 961900). Waste generation is estimated to be 3 sanitary towels/ day, 4 days/month, 12 month/year for all the female population from 15 to 55 years old, with one sanitary towel weighting 2gr. Recycling is set to zero. The share 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%, based on European Commission littering report (2018). The improperly managed is based on the average share of improperly managed (sector hotspot), applied to sanitary towels not littered or properly managed. The leakage rate is taken from PLP (15%) and applied to uncollected and improperly managed to determine de total leakage.

Baby diapers: import and export are determined through UN COMTRADE (2020). To determine de waste generation we consider that the urban population (36%) 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 gr, from which 33% 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 towels that are not littered. Littering rate is set to 21% (using sanitary towels as a proxy), based on the European Commission littering report (2018) The improperly managed is based on the average share of improperly managed (sector hotspot), applied to baby diapers not littered or properly managed .The leakage rate is taken from PLP (15%) and applied to uncollected and improperly managed to determine de total leakage.

SECTOR HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)



SECTOR HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)



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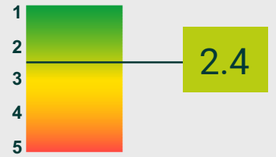


SECTOR HOTSPOTS
MODELLING NOTES (1/2)

Fishing: Data on number of fishing boats comes from the Fisheries Economic and Planning Institute (2019), which is a projection of fleet size by 2029. Number of fishing gears by boat is derived from the Marine management plan of Thailand 2015-2019 published by FAO (2015), and used as a proxy to come up with numbers of fishing gears in Vietnam. By default plastic weights by fishing gear type were derived from technical designs found in multiple publications (including Nédélec et al., 1990). Combining these two pieces of information yields the net plastic input from fishing gears. (Quality Score = 3, as we are taking some data from Thailand)

Medical: Total plastic waste generated by the medical sector is computed by combining the number of hospital beds (WHO statistics 2014, 2.6 beds per 1000 inhabitants), the average bed occupancy rate (Abhicharttibutra et al., 2018), the total waste generated by bed and the average plastic share in medical waste (Nguyen et al. 2014). No distinction was made infectious and non-infectious medical waste.
(Quality Score = 1.5, as the average occupancy rate is from a study on Thailand)

Tourism: Data on number of tourists and average length of stay comes from the WTO Compendium of Tourism Statistics (2020). 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 Vietnamese citizen. (Quality score = 3, as tourist could generate more plastic waste than the average citizen)

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 contribution

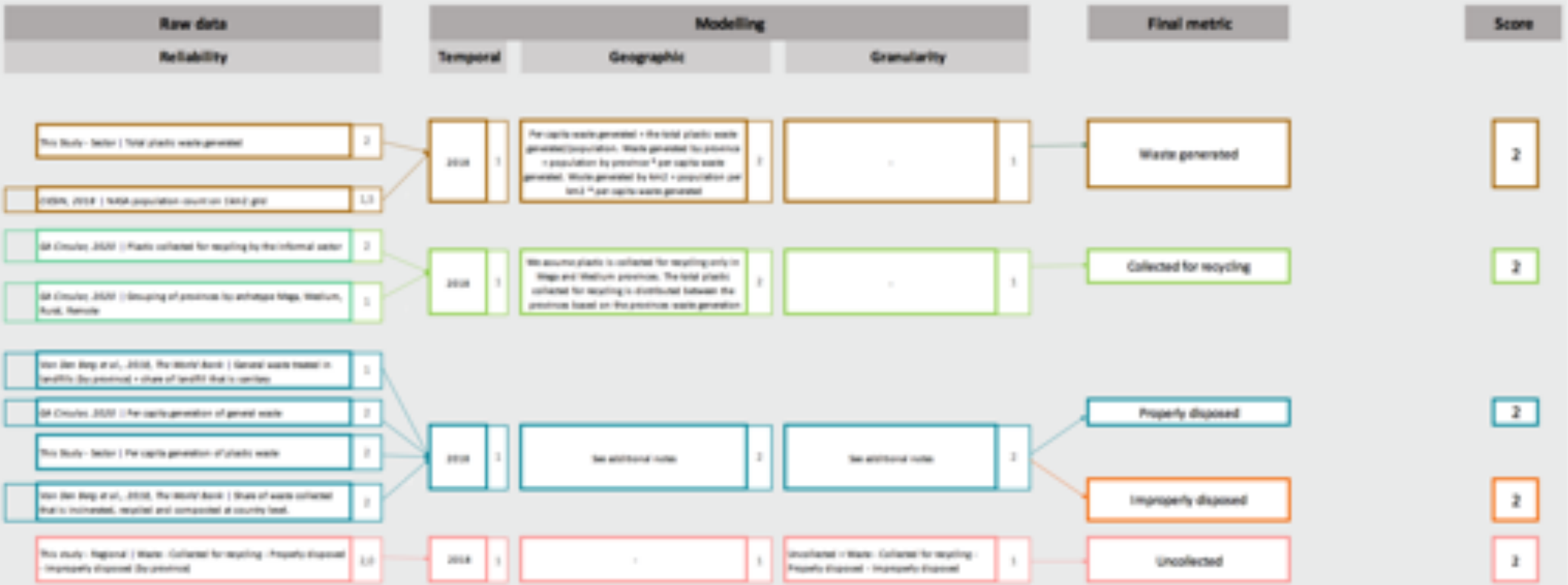
- **tyre dust:** loss and leakage of synthetic rubbers particles from tyres to the marine environment is calculated based on the methodology described in PLP (2019). Its contribution to leakage is included in “Automotive-tyres”.

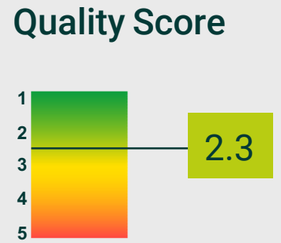
- **Textile fibres:** loss and leakage of textile fibres to the marine environment is calculated based on the methodology described in PLP (2019). Its contribution to leakage is included in “Textiles”.

- **Cosmetics:** loss and leakage of plastic micro-particles from cosmetics to the marine environment is calculated based on the methodology described in PLP (2019). Its contribution to leakage is included in “Others”.

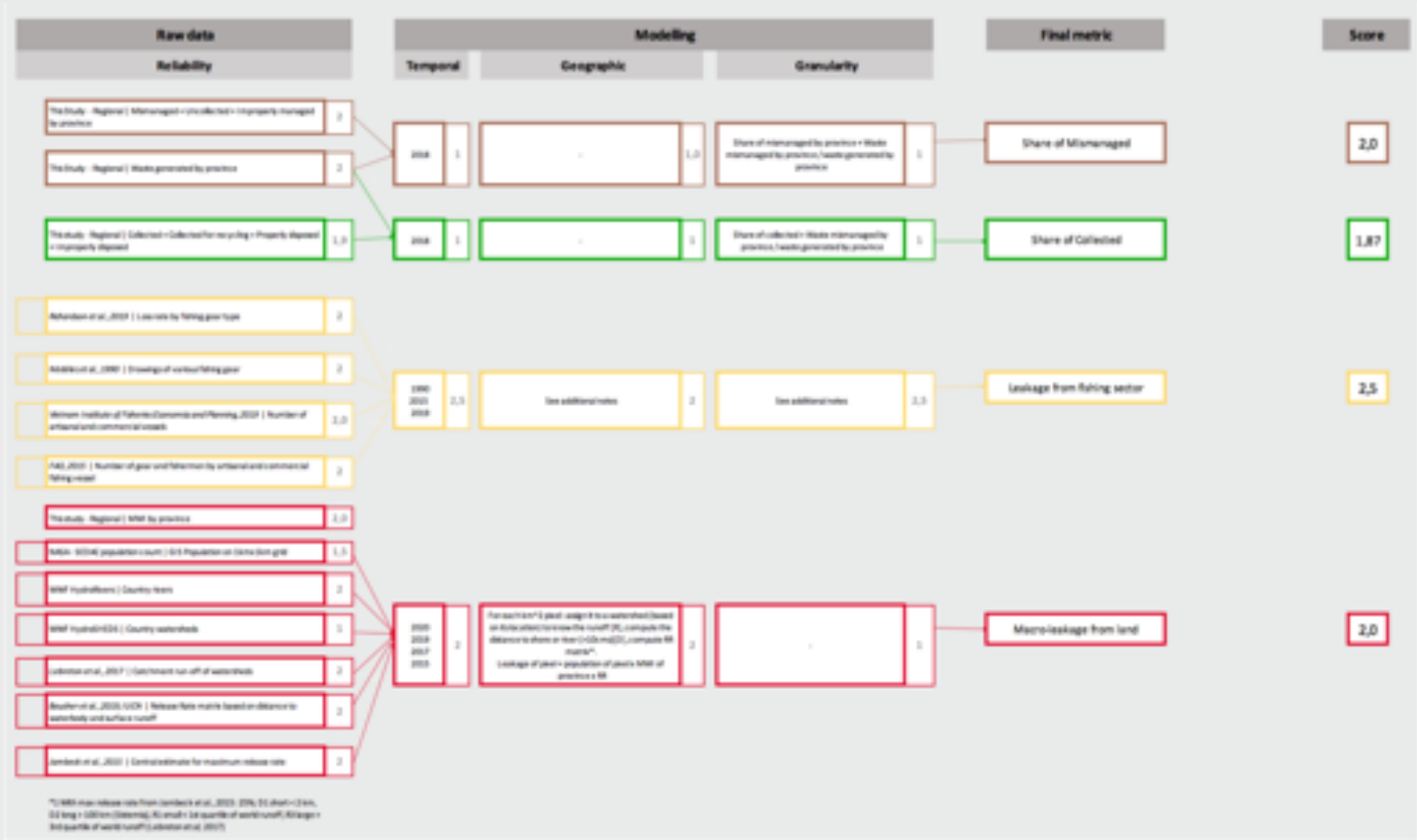
- **Pellets:** loss and leakage the marine environment of plastic pellets during transportation and production stages is calculated based on the methodology described in PLP (2019). Its contribution to leakage is included in “Others”.

REGIONAL HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)





REGIONAL HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)



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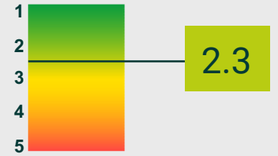

REGIONAL HOTSPOTS MODELLING NOTES (1/2)

Properly and improperly disposed

Waste in Vietnam is either incinerated, composted, collected for recycling or sent to sanitary or unsanitary landfill. The World Bank report "Solid and Industrial hazardous waste management assessment" (*Van Den Berg et al., 2018*) is the main source on data for Vietnam waste management. According to this report 14% of collected waste is incinerated, 4% is composted and 10% is recycled. Moreover, for the remaining 72% disposed at landfill, the report indicates that there are 7.4 Mt of waste sent to landfills every year.

We assume that only Municipalities and Mega provinces (see *GA circular (2020)* for archetype classification) have composting and incineration facilities, processing a total of 1.8 Mt of waste. This waste is distributed by province based on the province population. Similarly we distribute the 10% of collected for recycling between Municipalities, Mega and Medium provinces, based on their population. Additionally, the report details the tons of waste disposed at landfill by province. This gives us a complete picture of waste collected by province (composted, incinerated, collected for recycling and disposed at landfill).

These data are not specific to plastics, rather, they include all the general waste. In order to know how much plastic is collected in the country, we need to determine the plastic share in the waste stream. *GA Circular (2020)* estimates 0.75 kg of waste generation per capita; dividing the plastic waste generation obtained from the Sector hotspot analysis by the total waste generated estimated by *GA Circular (2020*), we obtain that the plastic share in the waste stream is 25%.

We obtain the plastic waste collected by province by multipling the general waste collected by province by the share of plastic in the waste stream.

To know how much plastic goes to landfill and incineration, we subtract from the plastic waste collected by province, the plastic waste collected for recycling by province (This Study - Regional | Cllected for recycling). We assume that the split of plastic waste between landfill and incineration reflects the general waste split between landfill and incineration, by province. Finally to know how much waste goes to unsanitary or sanitary landfill, we use the share of sanitary vs non-sanitary landfills by province (*Van Den Berg et al., 2018*). We consider properly disposed the plastic waste that is incinerated or treted in sanitary landfill. We consider improperly disposed the plastic waste that goes to unsanitary landfill.

REGIONAL HOTSPOTS MODELLING NOTES (2/2)

Fishing: 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, multiply it by two (assumption: 120 days per year at sea for full time fishermen). The number of fishermen is obtained from number of boats multiplied by the average number of fishermen on a fishing boat in Thailand (the Marine management plan of Thailand 2015-2019, FAO.) (Quality score 2.5)

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