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REPUBLIC OF SOUTH AFRICA

NATIONAL GUIDANCE FOR PLASTIC POLLUTION HOTSPOTTING AND SHAPING ACTION

FINAL REPORT FOR SOUTH AFRICA

December 2020

Implemented with ea + Quantis

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- University of Cape Town (**UCT**) - Prof. Peter Ryan
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SUMMARY AT A GLANCE

Global view on plastic in South Africa

70%
Collection rate

40%
Mismanaged rate

14% Domestic recycling rate

79 Kt
Leakage

1.4 Kg
Per capita leakage

Hotspots

Most critical polymers

- LDPE
- PET
- 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

2 out of 9 Provinces responsible for **50%** of the plastic leakage

Shaping action from the hotspots

14
Actionable Hotspots

15
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
2
3
4
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

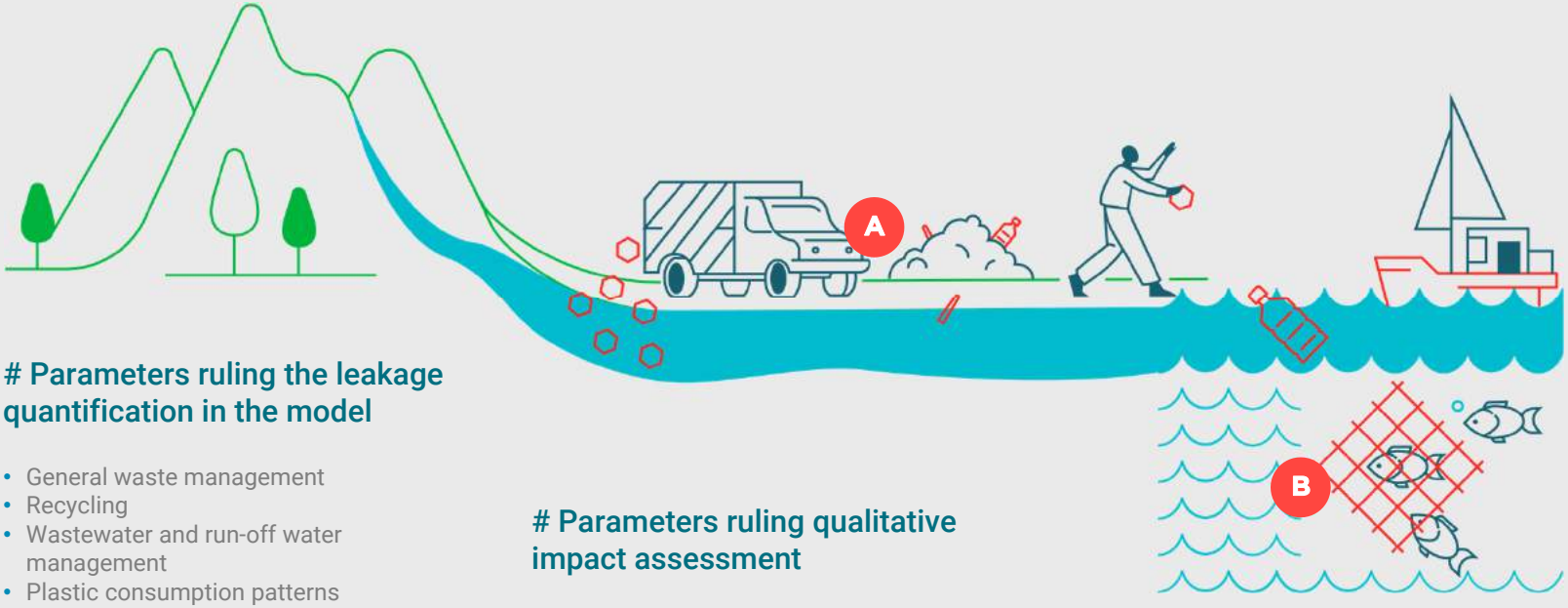
Informal sector: Individuals or a group of individuals who are involved in waste management activities, but are not formally registered or formally responsible for providing waste management services. Newly established formalized organizations of such individuals; for example, cooperatives, social enterprises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

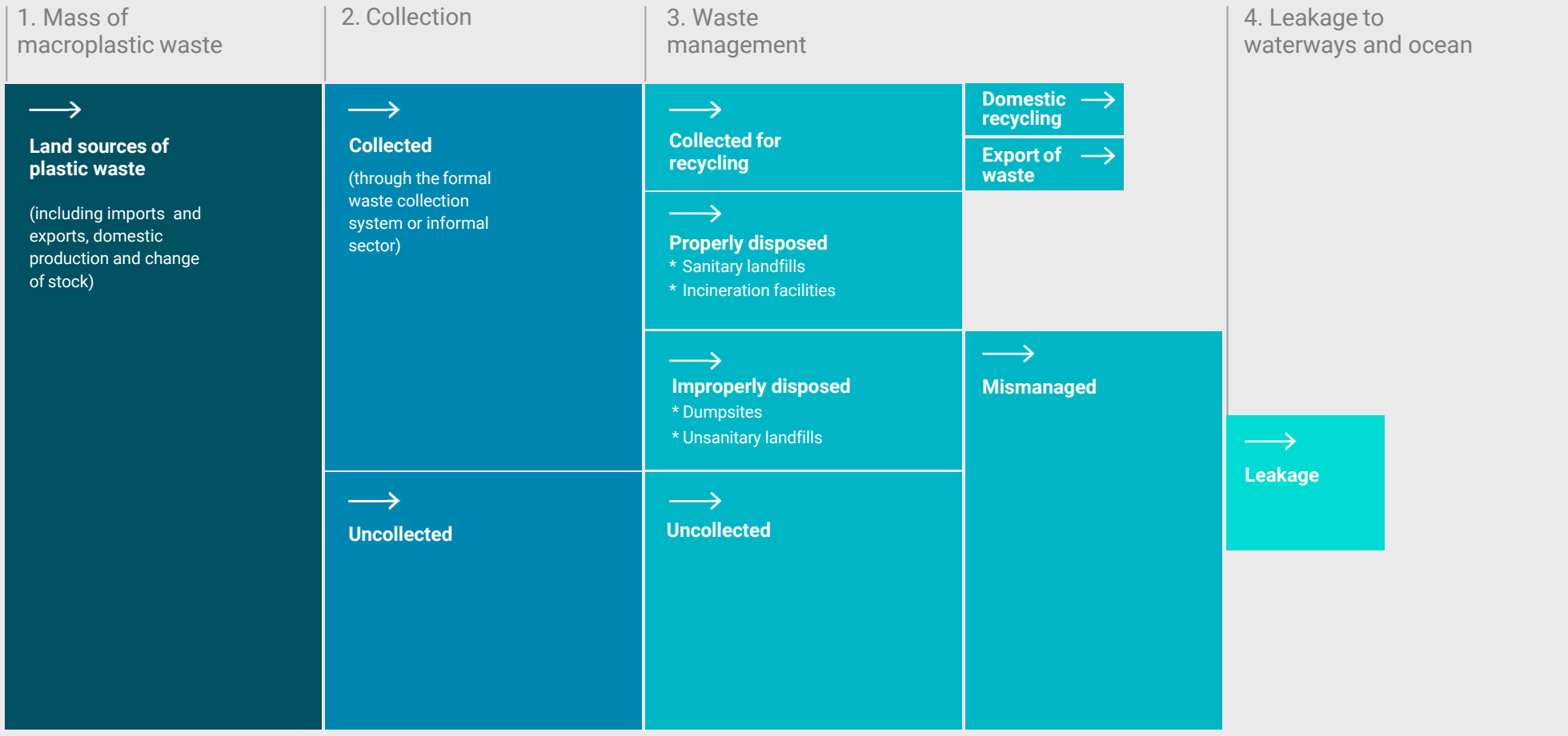
Leaked plastic stems from uncollected and improperly disposed waste.

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	TYPICAL PRODUCTS
Polyethylene Terephthalate	PET*	bottles, food wrappings
Polypropylene	PP	hot food containers, sanitary pad liners
Low-density Polyethylene	LDPE	bags, container lids
High-density Polyethylene	HDPE	milk containers, shampoo bottles
Polystyrene	PS	food containers, disposable cups,
Polyvinyl Chloride	PVC	construction pipes, toys, detergent bottles

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

Key units

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

Calculation variables

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

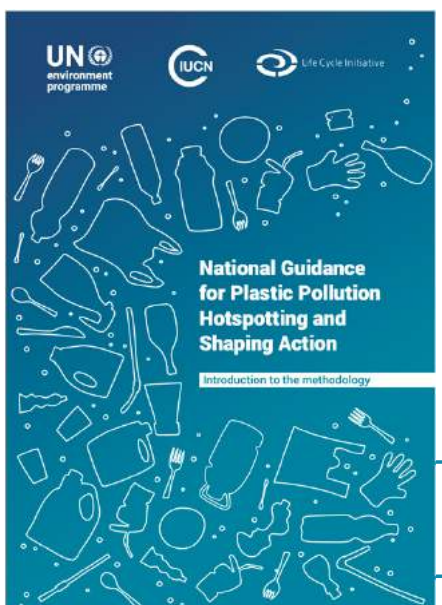
1 INTRODUCTION TO THE GUIDANCE

National guidance for plastic pollution hotspotting and shaping action

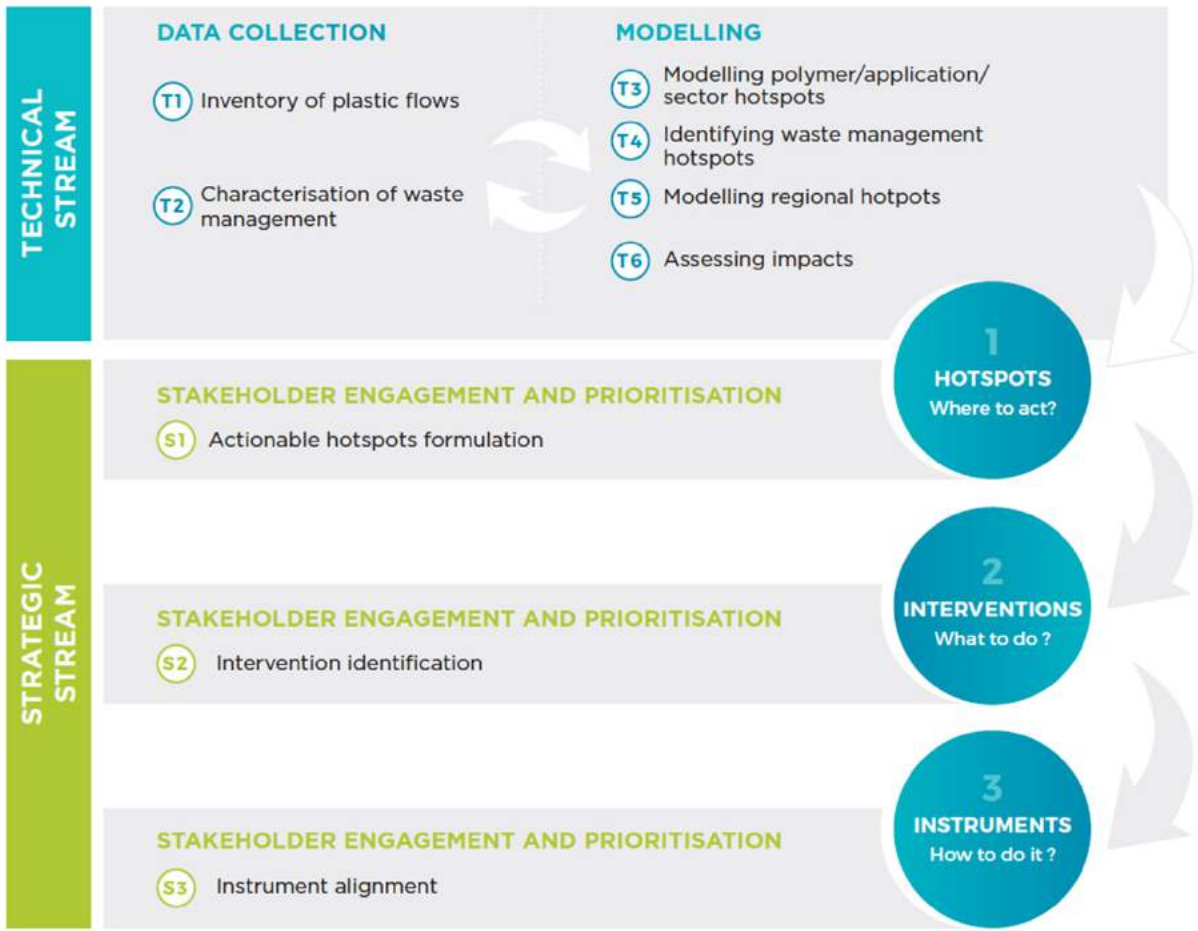
SCHEMATIC OF THE GUIDANCE

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.

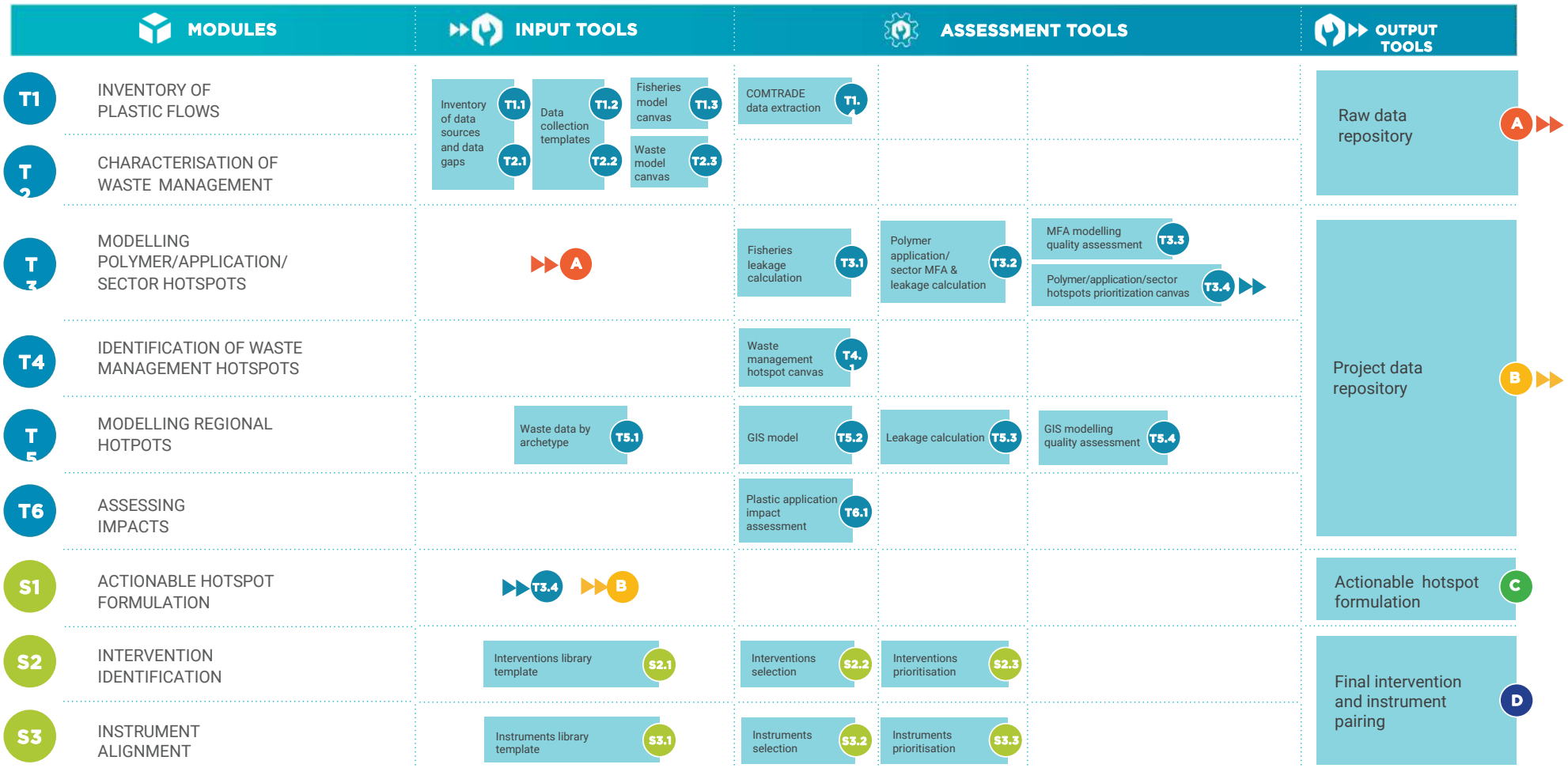
Examples

- 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.

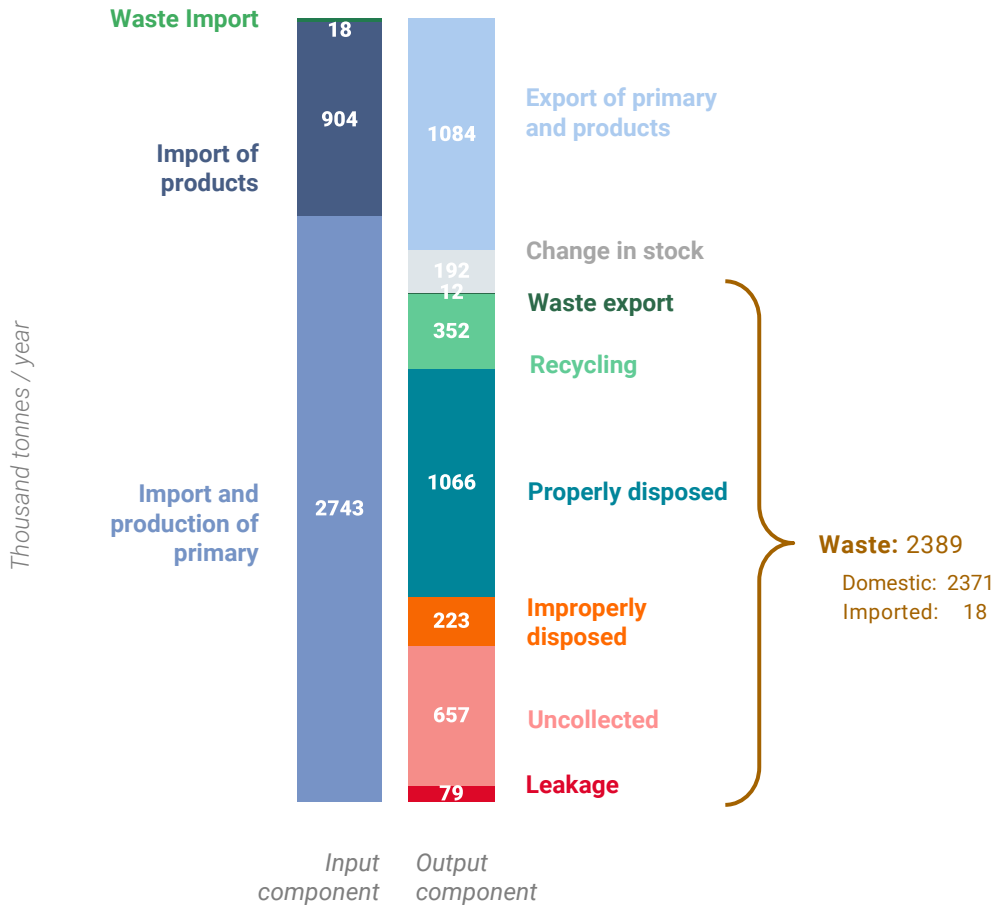
Additional information on the methodology and modelling process can be found directly in the **modules and tools** associated with the guidance and highlighted by this icon.

2 PLASTIC POLLUTION HOTSPOTS

2.1 COUNTRY OVERVIEW

COUNTRY PLASTIC MATERIAL FLOW [2018]

Summary of the results for all plastics in the country



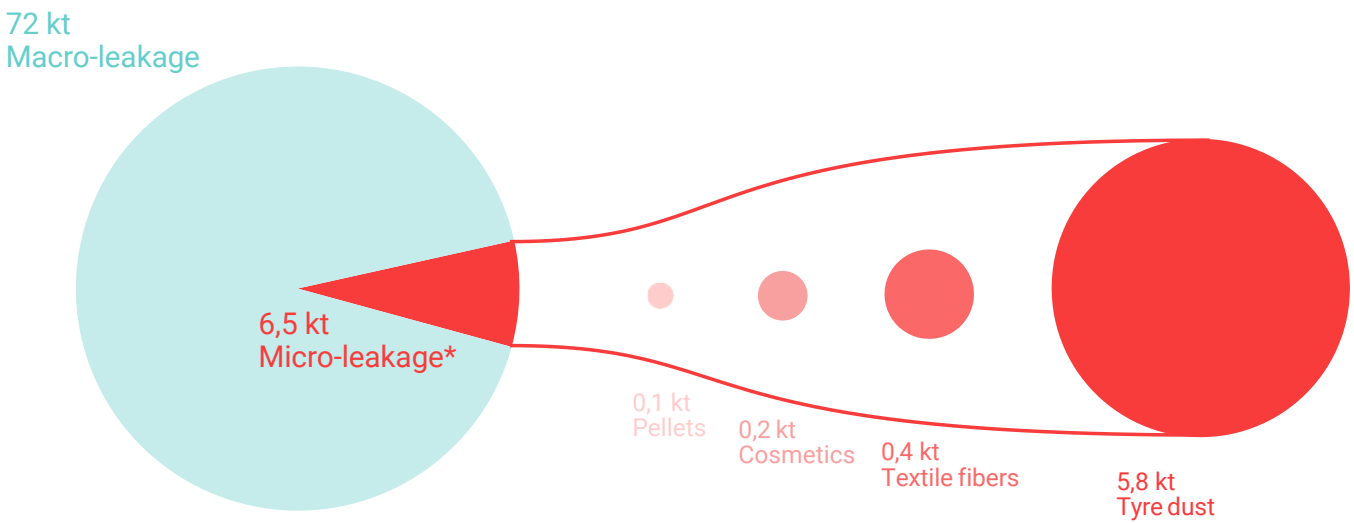
Note: For simplicity, in this figure, we removed a part of the "leakage" from the "improperly disposed" and "uncollected", so that the values displayed for these two metrics correspond to a post-leakage situation.

Key take-aways

- Almost all plastic that is consumed in South Africa is manufactured in the country from locally produced or imported primary or secondary plastic.
- South Africa generates **2'371 thousand tonnes** of plastic waste annually.
- Per capita plastic waste generation is around **41 kg/cap/year** which is above the global average of 29 kg/cap/year*.
- **70%** of the plastic waste generated in South Africa **is collected**, from which 14% is recycled, 45% is disposed in sanitary landfills or incineration facilities, and the remaining 11% disposed in unsanitary landfills or dumpsites.
- Approximately **40%** of plastic waste **is mismanaged.**
- In South Africa**, 79 thousand tonnes** of plastic leak to the ocean and main rivers every year. This leakage corresponds to **3%** the quantity of plastic waste generated in the country per year.
- **Burning of waste** does not appear in the graph but is an existing practice in South Africa, although less widespread than in other African countries.

* 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:

79 kt

Key take-aways

- **Micro-plastic leakage accounts for 8% of the overall country leakage.** This is mostly driven by tyre abrasion.

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.

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

More details available in Appendices

OPEN BURNING: A ROUGH ESTIMATE

959 kt
Total plastic mismanaged

48%
released into the air as noxious chemical substances through open burning

POLLUTION TO THE AIR:
461 kt

Key take-aways

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

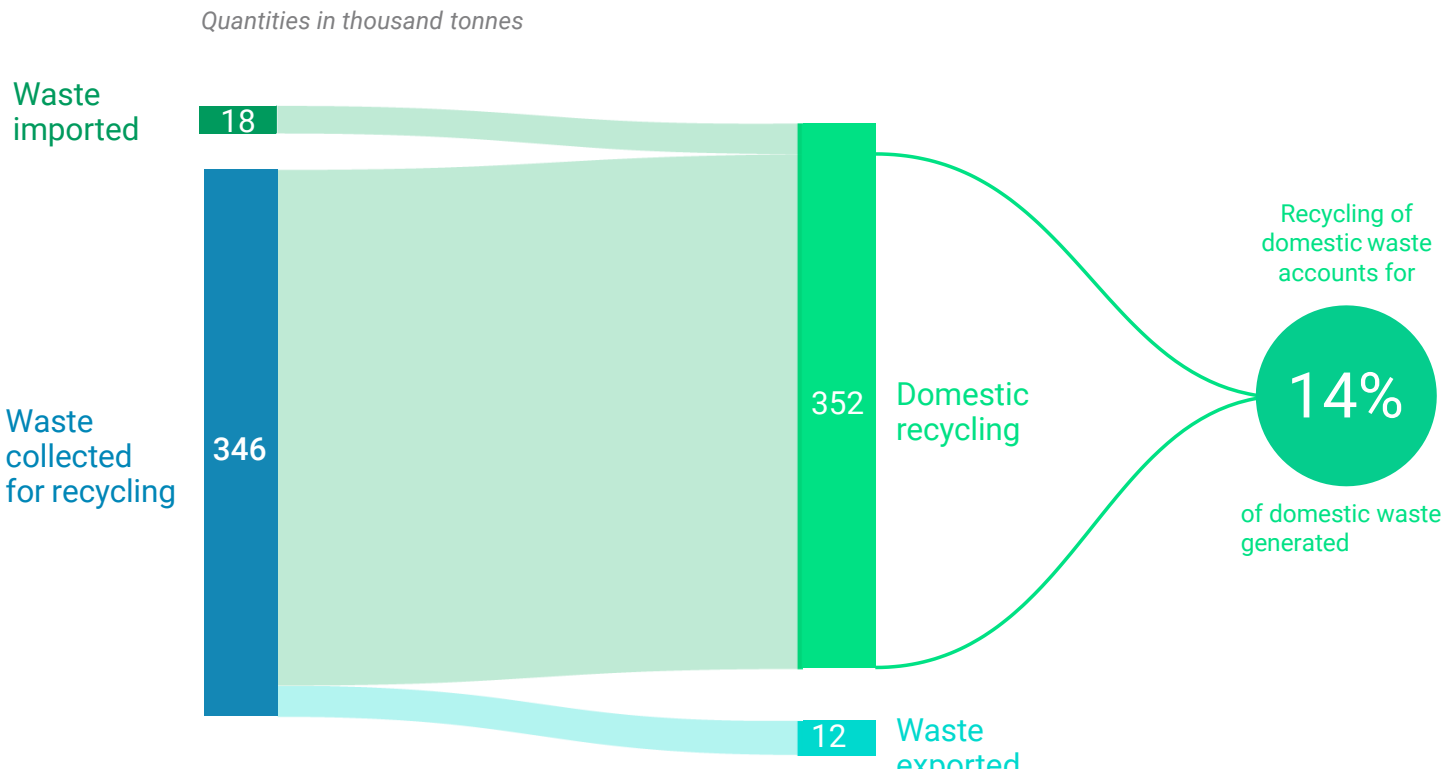
Limitations

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 South Africa, it would translate into having 48% 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.

DOMESTIC RECYCLING AND TRADE OF WASTE



Key take-aways

- Only **14%** of the domestically generated plastic waste is eventually recycled.

Learnings

In 2018, South Africa recycles 352 kt of plastic waste (15% of a total 2389 kt of plastic waste), from which 18 kt come from imported waste. The remaining 334 kt of recycled plastic waste come from domestically generated waste. Consequently, almost all recycled plastic comes from domestically generated plastic waste.

2.2 DETAILED HOTSPOTS RESULTS

5 CATEGORIES OF HOTSPOTS

WHAT

WHAT

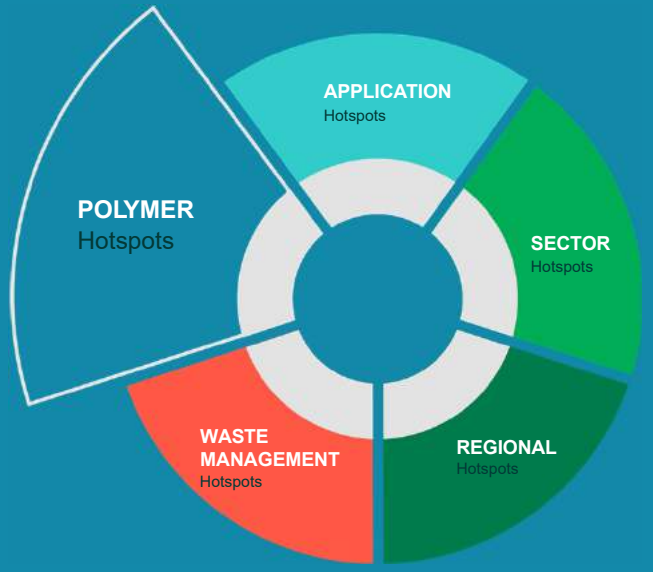
WHERE

WHERE

WHY

ACTIONABLE HOTSPOTS FORMULATION

A POLYMER HOTSPOTS

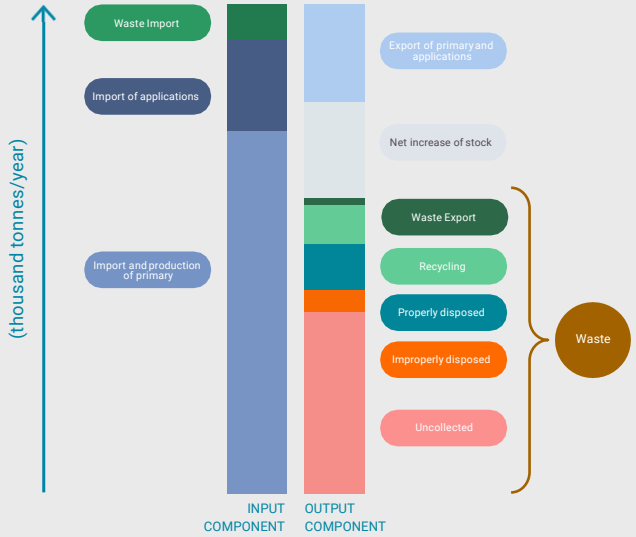


OBJECTIVE AND INSTRUCTIONS

Key question answered:

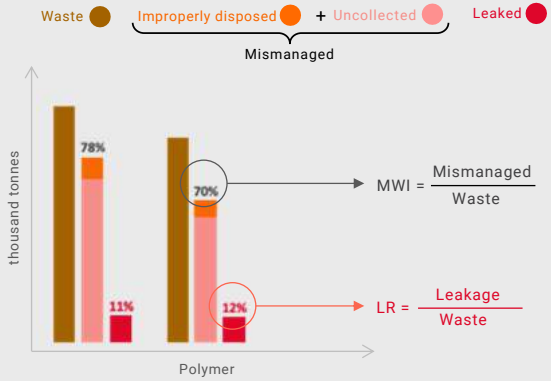
Which polymers are most critical in the country regarding plastic leakage?

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

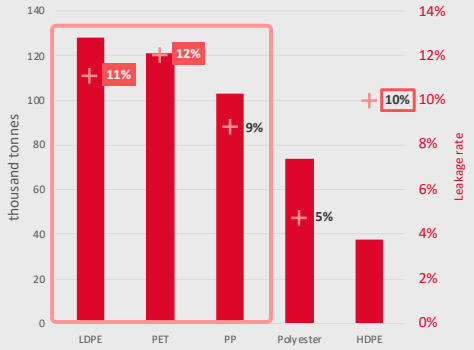


How to read the polymer hotspot graph?

1. Determine leakage from mismanaged waste

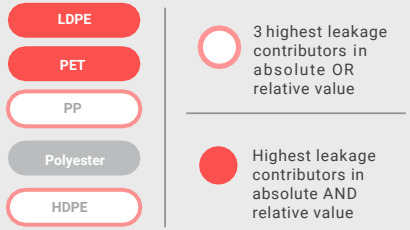


2. Focus on leakage and leakage rate

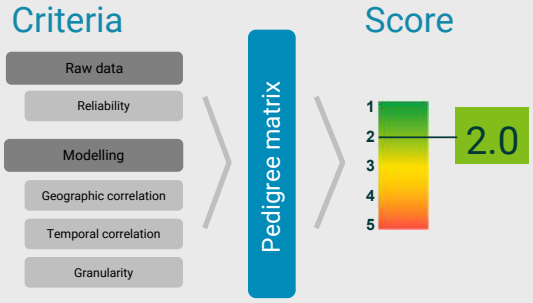


For more details, please read the Methodology

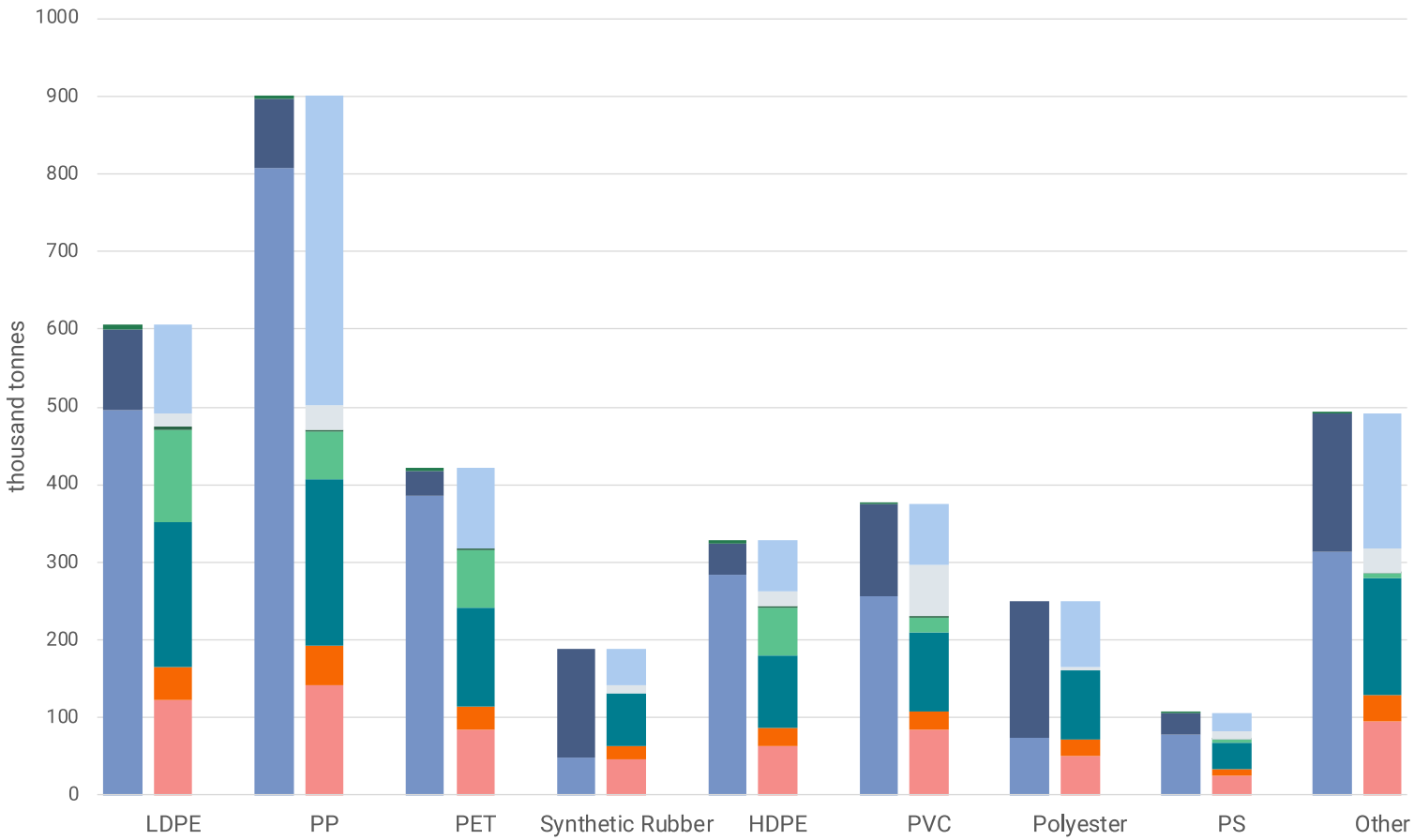
3. Select hotspots based on absolute and relative leakage



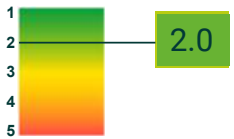
4. Assess the quality score of the results



MASS BALANCE BY POLYMER [2018]



Quality Score



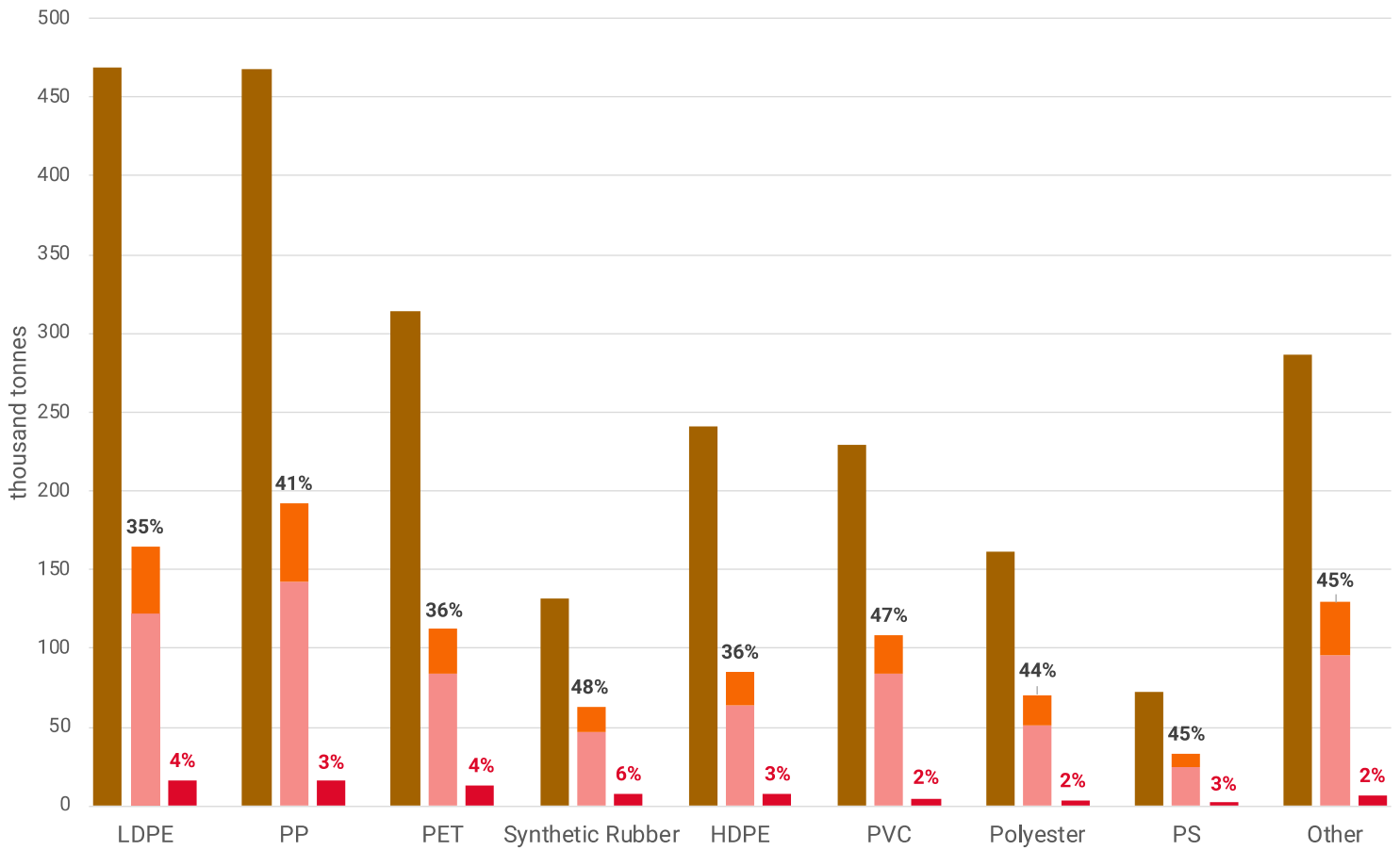
INPUT

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

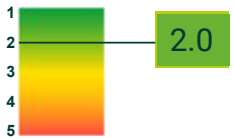
OUTPUT

- 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



Domestic waste

Improperly disposed

+

Uncollected

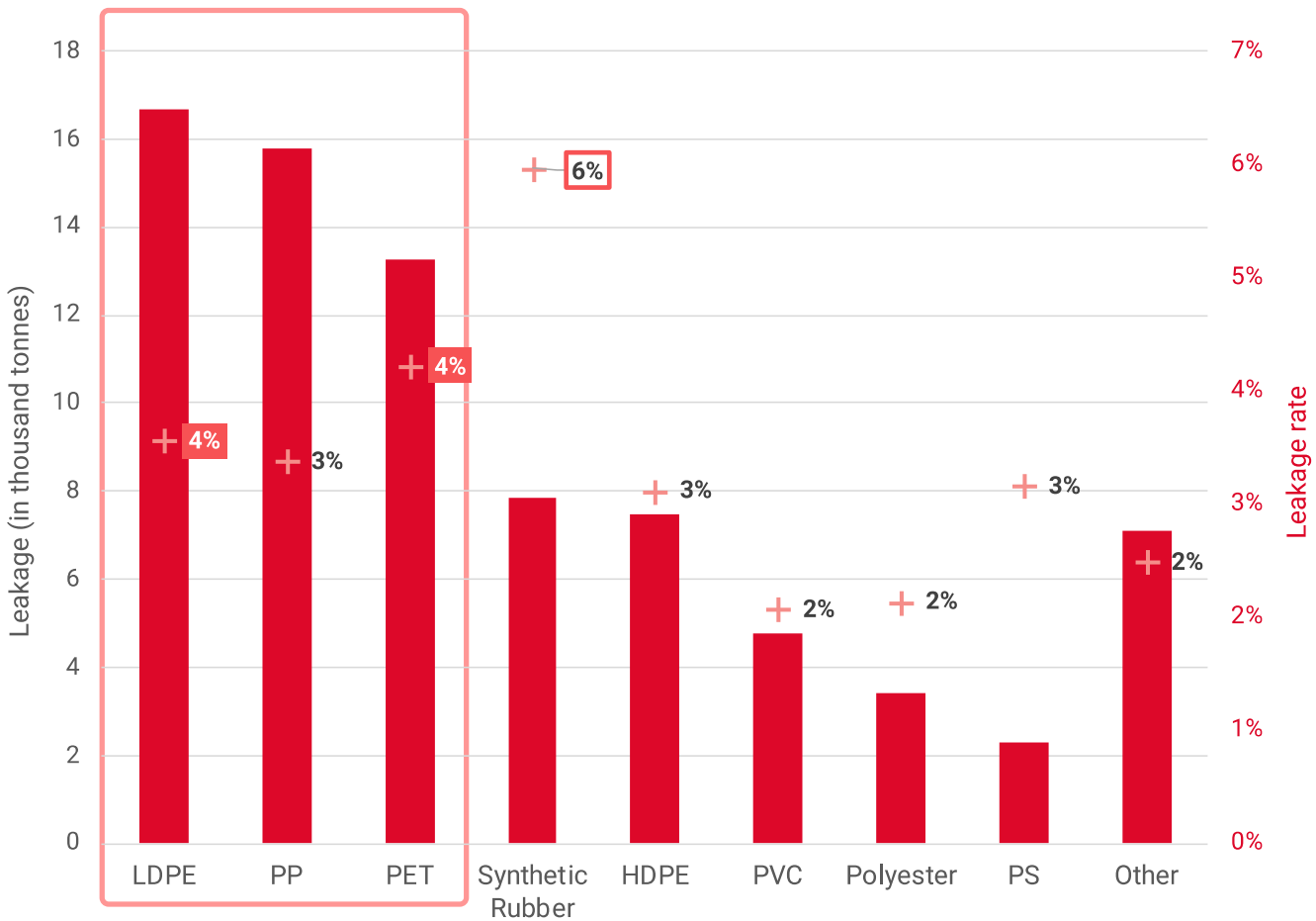
Mismanaged

Leaked

X% | Mismanaged Waste Index (MWI)

X% | Leakage Rate (LR)

POLYMER HOTSPOTS [2018]

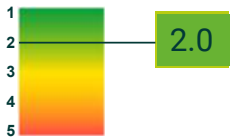


LDPE
PET
PP
Synthetic Rubber
HDPE
PVC
Polyester
PS
Other

3 highest leakage contributors in absolute OR relative value

Highest leakage contributors in absolute AND relative value

Quality Score



Key take-aways:

- **LDPE** is the top contributor in absolute leakage (17 kt), with a leakage rate of 4%.
- **PP** and **PET** follow with 16 kt and 13 kt of leakage respectively. PET has a leakage rate of 4%.
- Although **Synthetic Rubber** ranks lower in absolute leakage (8 kt), it has the highest leakage rate with 6% of its generated waste leaks into the oceans and waterways. Micro-plastics from tyre abrasion are an important driver of leakage for this polymer.

POLYMER HOTSPOTS:
INTERPRETATION AND LIMITATIONS

LDPE

Learnings

LDPE is the top leaking polymer by absolute and relative leakage because almost 70% is used in Packaging sector where products have a higher chance of leakage (release rate is 15% for packaging items in South Africa). 17 thousand tonnes of LDPE leaked into oceans and main rivers in 2018.

PP

Learnings

PP has a lower relative leakage rate than LDPE, but is very close in terms of absolute leakage with 16 thousand tonnes / year leaking into the marine environment. The main factor contributing to PP ranking second is that although PP waste generation is the same as LDPE (468 thousand tonnes), only half of this PP waste comes from the Packaging sector which has a higher release rate than most other sectors.

PET

Learnings

PET ranks third in absolute leakage but has second highest relative leakage (4%) with LDPE.

Limitations

PETCO announced 98'649 tonnes of PET bottles recycled in 2018 while Plastics SA announced only 74'328 tonnes of PET bottles recycled this same year. For data consistency across all polymers, we used values from *Plastics SA (2019)*.

Unlocking limitations

Ensure alignment in recycling values reported or check if the difference between *PETCO (2019)* and *Plastics SA (2019)* values of PET bottles recycled is actually exported abroad for recycling.

POLYMER HOTSPOTS:
INTERPRETATION AND LIMITATIONS

Synthetic rubber

Learnings

From 8 kt of synthetic rubber leaked, 6 kt are due to micro-plastics from tyre abrasion leaking into waterways and only 2 kt come from mismanaged tyres.

Limitations

- No production data was found for synthetic rubber. Thus we have set production to 0 by default but this most probably underestimates input quantities as well as waste generated for this polymer.
- We lack insights on how discarded tyres are managed throughout the country. According to *DEA (2017)*, tyres are stockpiled over years at private depots or tyre retailers and do not really end up in landfills. By default, we distributed the overall waste management value (properly and improperly managed) proportionally to the share of tyre waste out of the total waste (after having discounted recycling and littering). Moreover, it is unclear whether some discarded tyres are recovered either through rethreading or incineration as it is the case in Kenya. As a result, reuse and circular practices are not captured in our analysis.

Unlocking limitations

Gain insight on both primary production of synthetic rubber and waste management from the automotive tyre sector.

All polymers

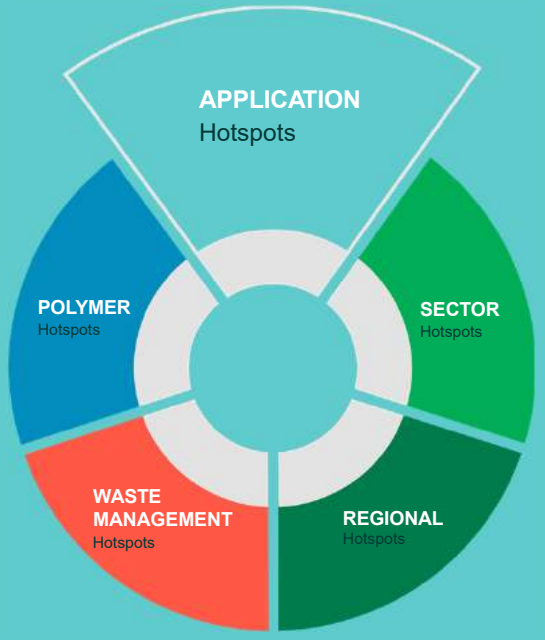
Limitations

- Sanitary landfills might not reach the standards we are expecting in South Africa, so the number of sanitary landfills used from *SAWIC database* might be too high, leading us to underestimate the share of waste mismanaged and leaked for all polymers.
- 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

- Improve *SAWIC database* consistency by aligning data reporting practices across the country as well as setting clear sanitary management standards to distinguish between fully and partially complying landfills.
- Building a sector to polymer mapping based on the South African market would improve the quality of the analysis.

B APPLICATION HOTSPOTS

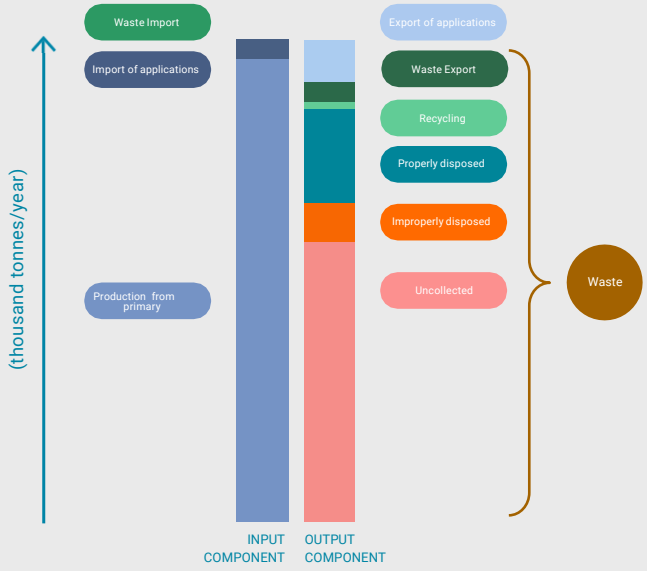


OBJECTIVE AND INSTRUCTIONS

Key question answered:

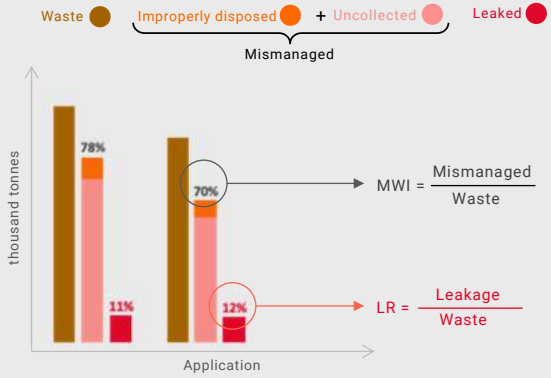
Which applications are most critical in the country regarding plastic leakage?

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

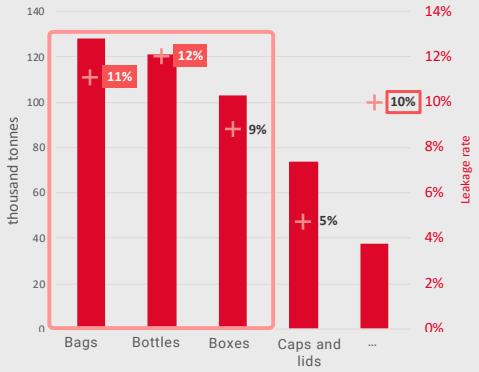


How to read the application hotspot graph?

1. Determine leakage from mismanaged waste



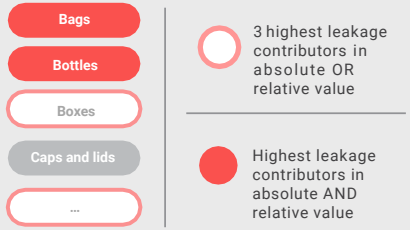
2. Focus on leakage and leakage rate



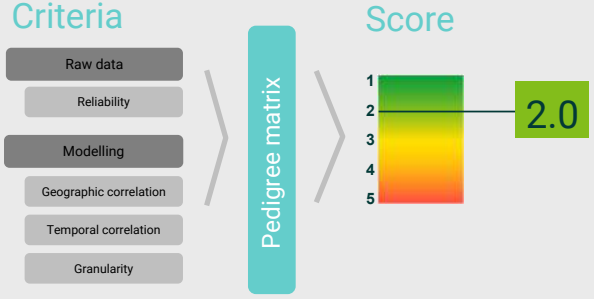
For more details, please read the Methodology

T3

3. Select hotspots based on absolute and relative leakage

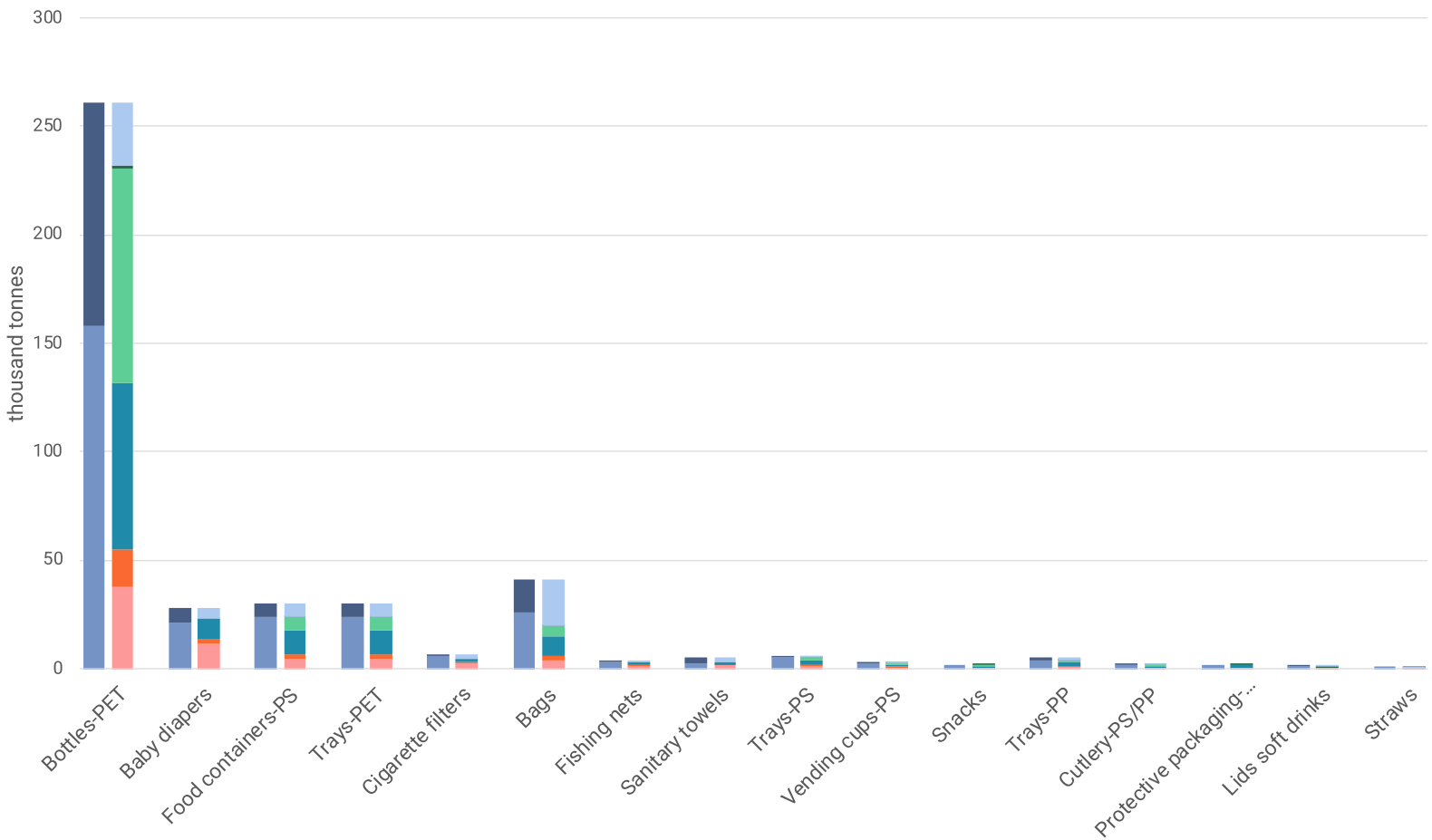


4. Assess the quality score of the results

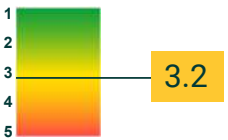


MASS BALANCE BY APPLICATION [2018]

The application analysis covers **15%** of total plastic waste (including 29% of waste from the packaging sector).



Quality Score



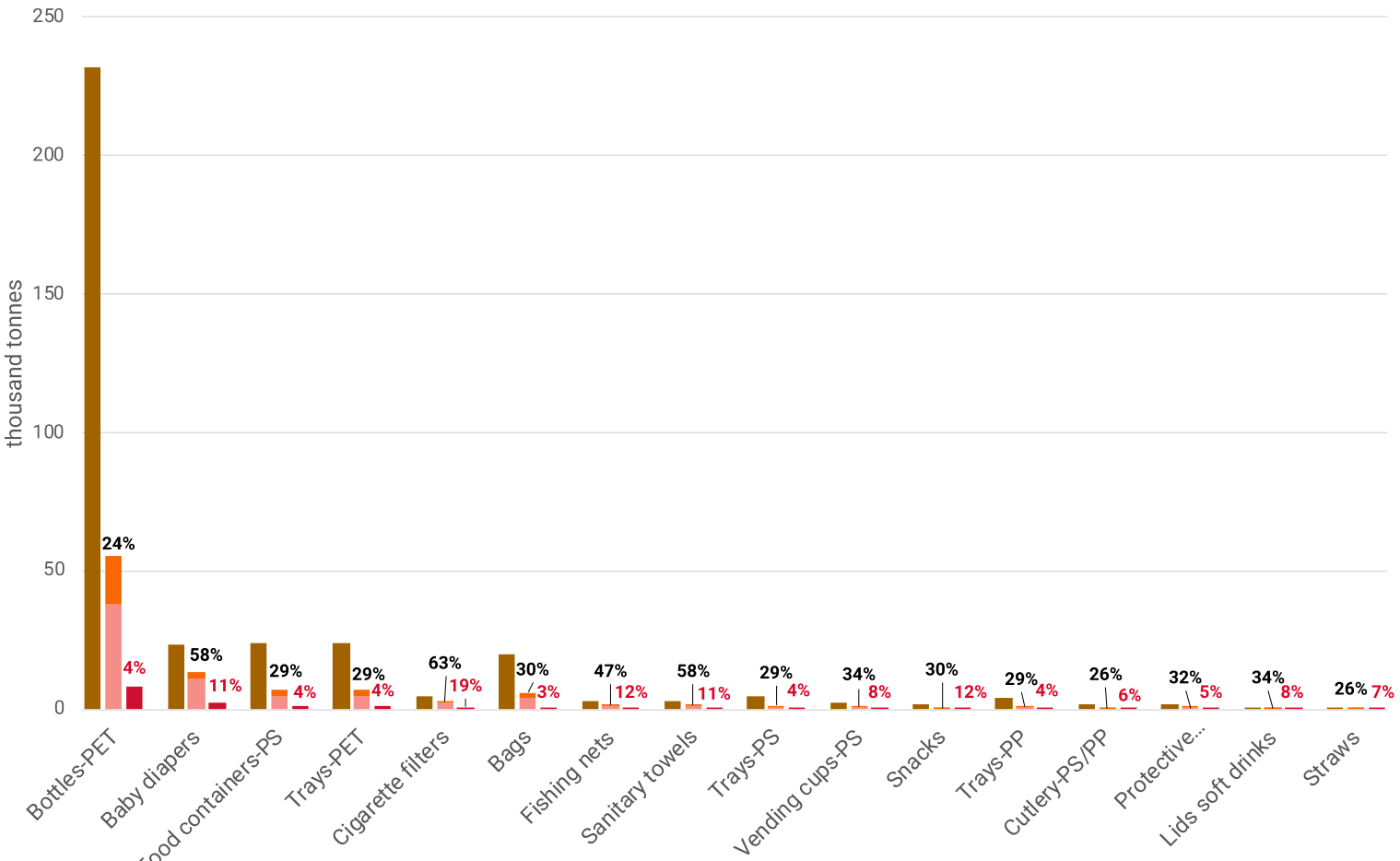
INPUT

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

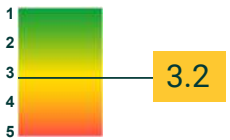
OUTPUT

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

MISMANAGED WASTE AND LEAKAGE BY APPLICATION [2018]



Quality Score



Domestic waste

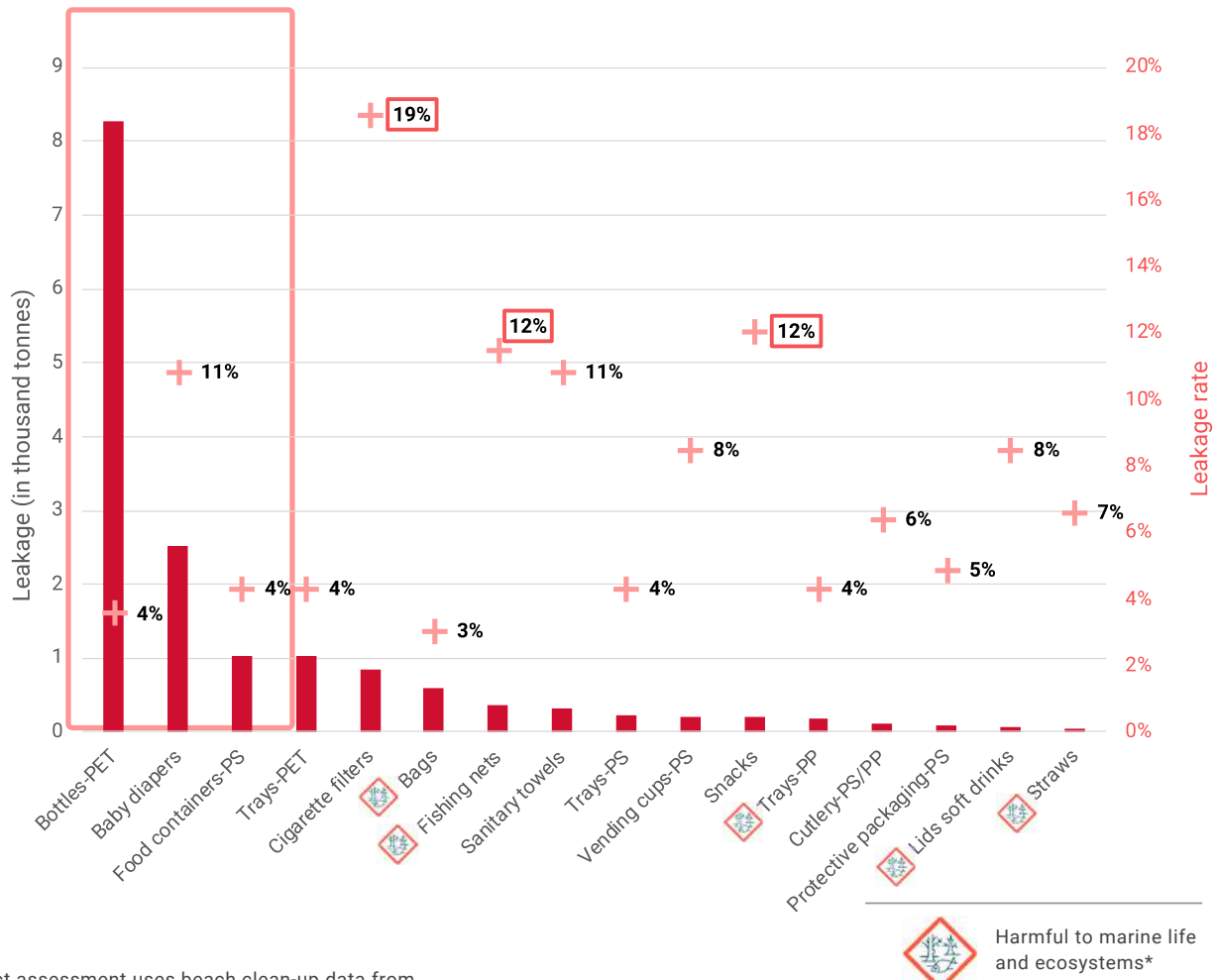
Improperly disposed + Uncollected = Mismanaged

Leaked

X% | Mismanaged Waste Index (MWI)

X% | Leakage Rate (LR)

APPLICATION HOTSPOTS [2018]



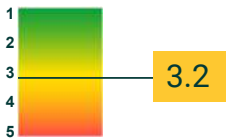
* The impact assessment uses beach clean-up data from *Ryan, P.G. (2020)* and *Ocean Conservancy (2019)*

Bottles - PET
Baby diapers
Food containers - PS
Cigarette filters
Fishing nets
Snacks
Bags
Sanitary towels
Trays - PS
Vending cups - PS

3 highest leakage contributors in absolute OR relative value

Highest leakage contributors in absolute AND relative value

Quality Score



Key take-aways

- Within known products, **PET bottles** are the top contributor in absolute leakage (8 kt), although it has one of the lowest leakage rate (4%).
- **Baby diapers** and **PS food containers** rank respectively 2nd (2,5 kt) and 3rd (1 kt) in absolute leakage.
- Although **cigarette filters** rank lower in absolute leakage (1 kt), almost 1/5th of its waste generated tends to leak into the oceans.
- **Fishing nets** and **snacks** have a relatively high leakage rate (12% for both).

APPLICATION HOTSPOTS:
INTERPRETATION AND LIMITATIONS

All applications

Limitations

- From various sources (*PETCO, Plastix911, The Moss Group, SARS*), we were able to derive a mass balance for only some detailed products (including food trays, snacks or straws), representing 15% of all plastic waste. Almost all plastic applications outlined in the graph are from the packaging sector, except for sanitary towels, baby diapers and cigarette filters categorised as “Other” sector and fishing nets included in the fishing sector. However, the packaging applications in the graph sum up to around 30% of the total plastic waste generated in the packaging sector, the remaining 70% being labelled as “other packaging” and including unknown products.
- The “other packaging” category of applications was not displayed to avoid important discrepancies in bar heights. However, the category of applications “other packaging” might include some critical applications that we are not aware of, and that could change our current perception of application hotspots.

Unlocking limitations

Engage collaborative research projects to close the gap on unknown products, especially from the Packaging sector. Collaboration with general and industrial retailers is advisable.

Bottles (PET)

Learnings

On the basis of known products, PET bottles are the biggest hotspot in terms of absolute leakage. This can be explained by their large plastic waste input, representing 9% of all plastic waste on their own.

Limitations

Bottles made from other polymers do not appear in the analysis but is by default been included in “other packaging” that is not displayed as it would flatten all other applications on the bar chart.

Unlocking limitations

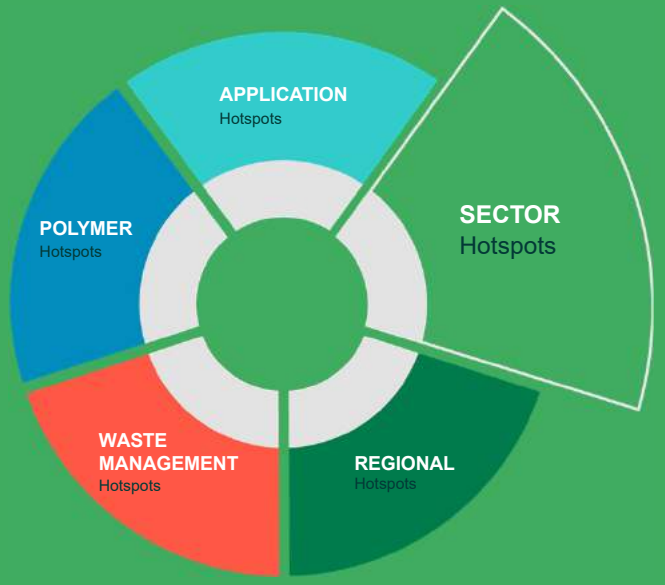
More detailed data on production of bottles made of other polymers than PET would allow to reach a complete picture for plastic bottles in South Africa.

Plastic bags

Learnings

Plastic bags are not regarded as a hotspot in our analysis, which supports the fact that continuous efforts on plastic bags regulations paid off. However, plastic bags are regarded as especially harmful to marine wildlife and should still be monitored.

C SECTOR HOTSPOTS

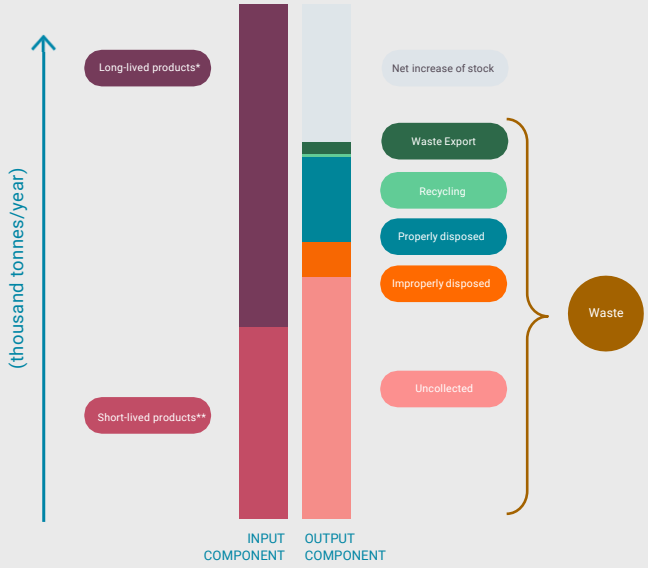


OBJECTIVE AND INSTRUCTIONS

Key question answered:

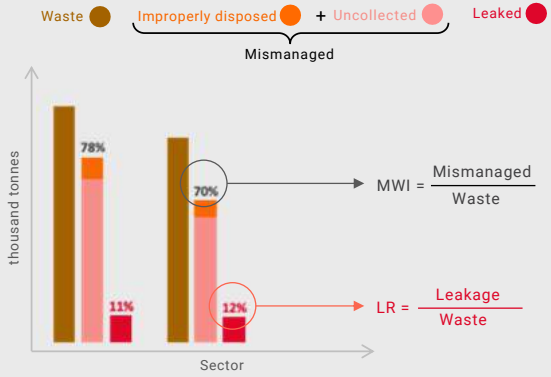
Which sectors are most critical in the country regarding plastic leakage?

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

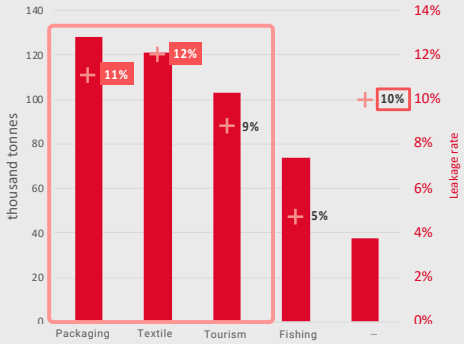


How to read the sector hotspot graph?

1. Determine leakage from mismanaged waste

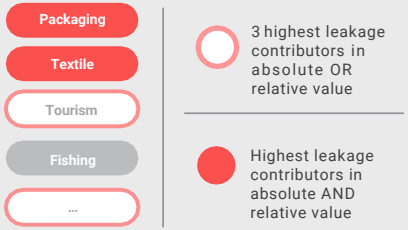


2. Focus on leakage and leakage rate

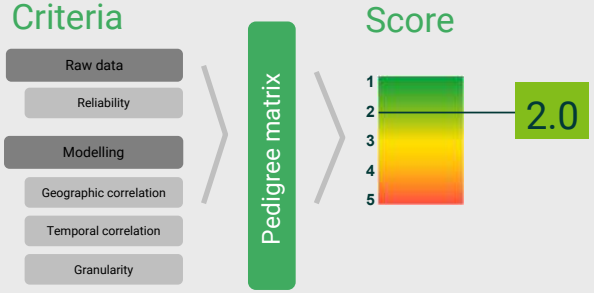


For more details, please read the Methodology

3. Select hotspots based on absolute and relative leakage

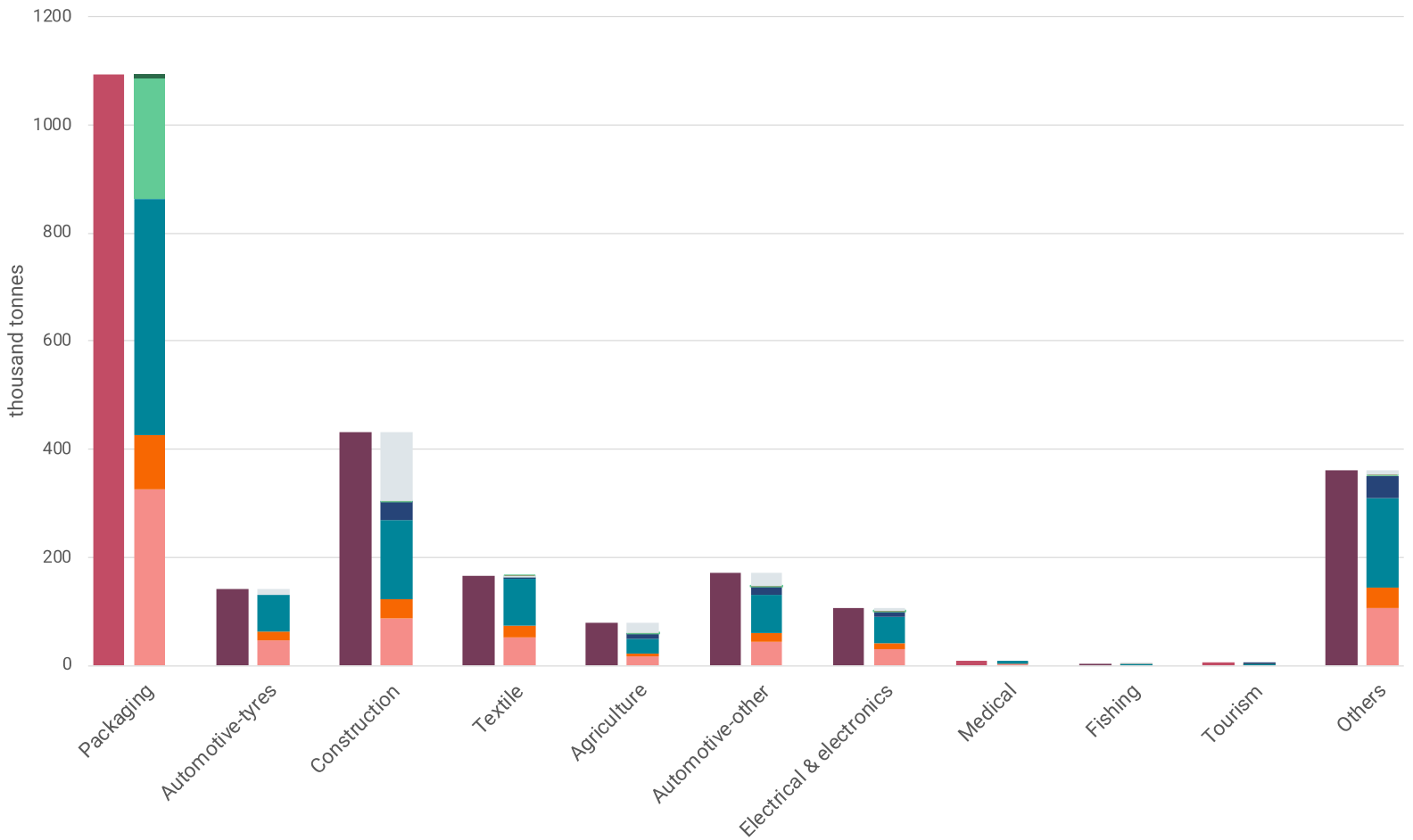


4. Assess the quality score of the results

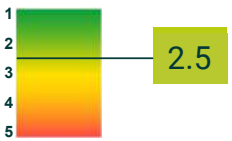


* **Short-lived products:** products that are disposed within the year of study (Life-time < 1 year)
** **Long-lived products:** products that are disposed after the year of study (Life-time > 1 year)

MASS BALANCE BY SECTOR [2018]



Quality Score



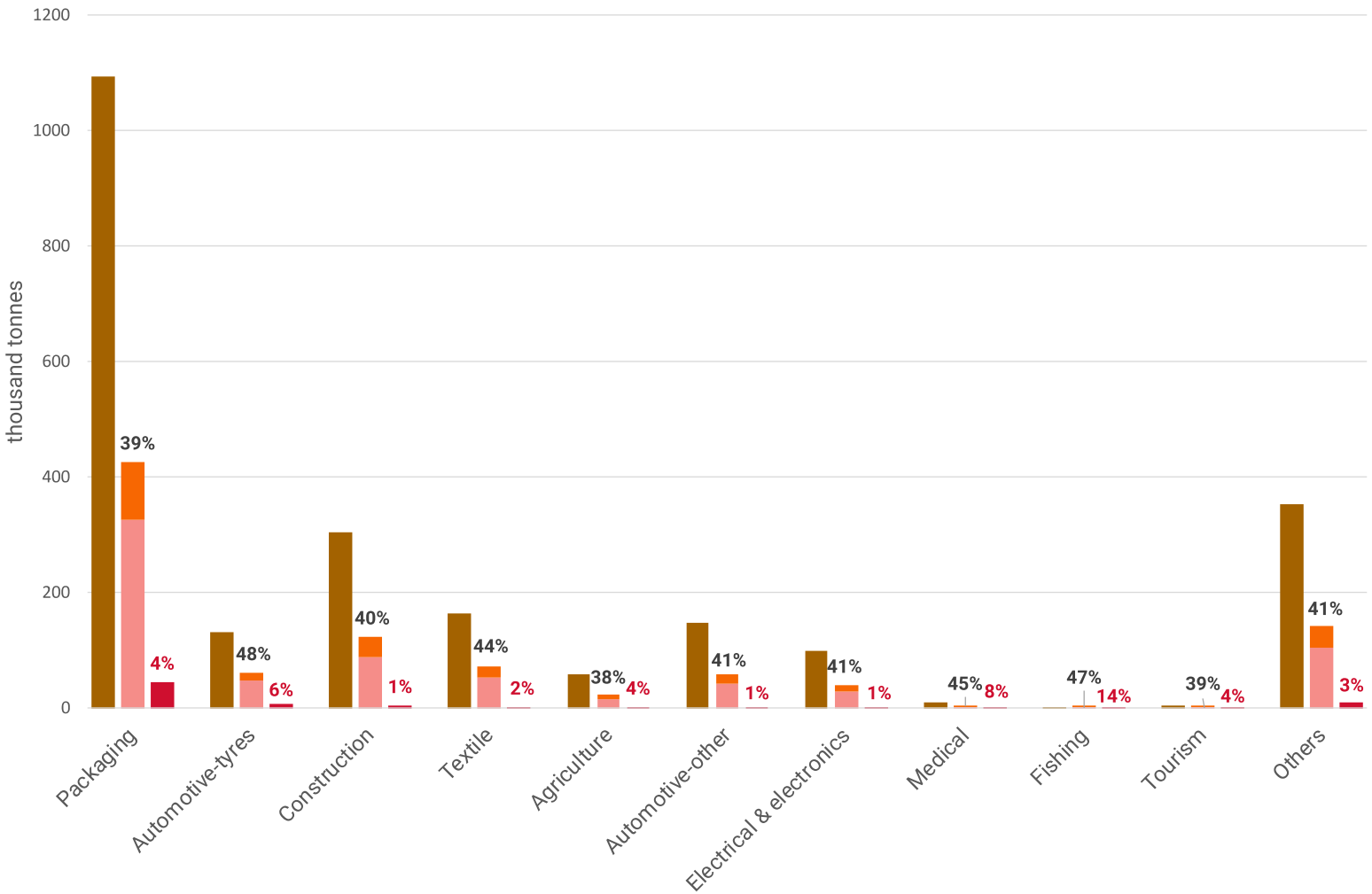
INPUT

- Short-lived products
- Long-lived products

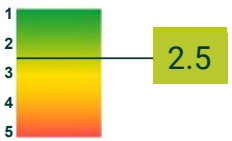
OUTPUT

- 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



Domestic waste

Improperly disposed

+

Uncollected

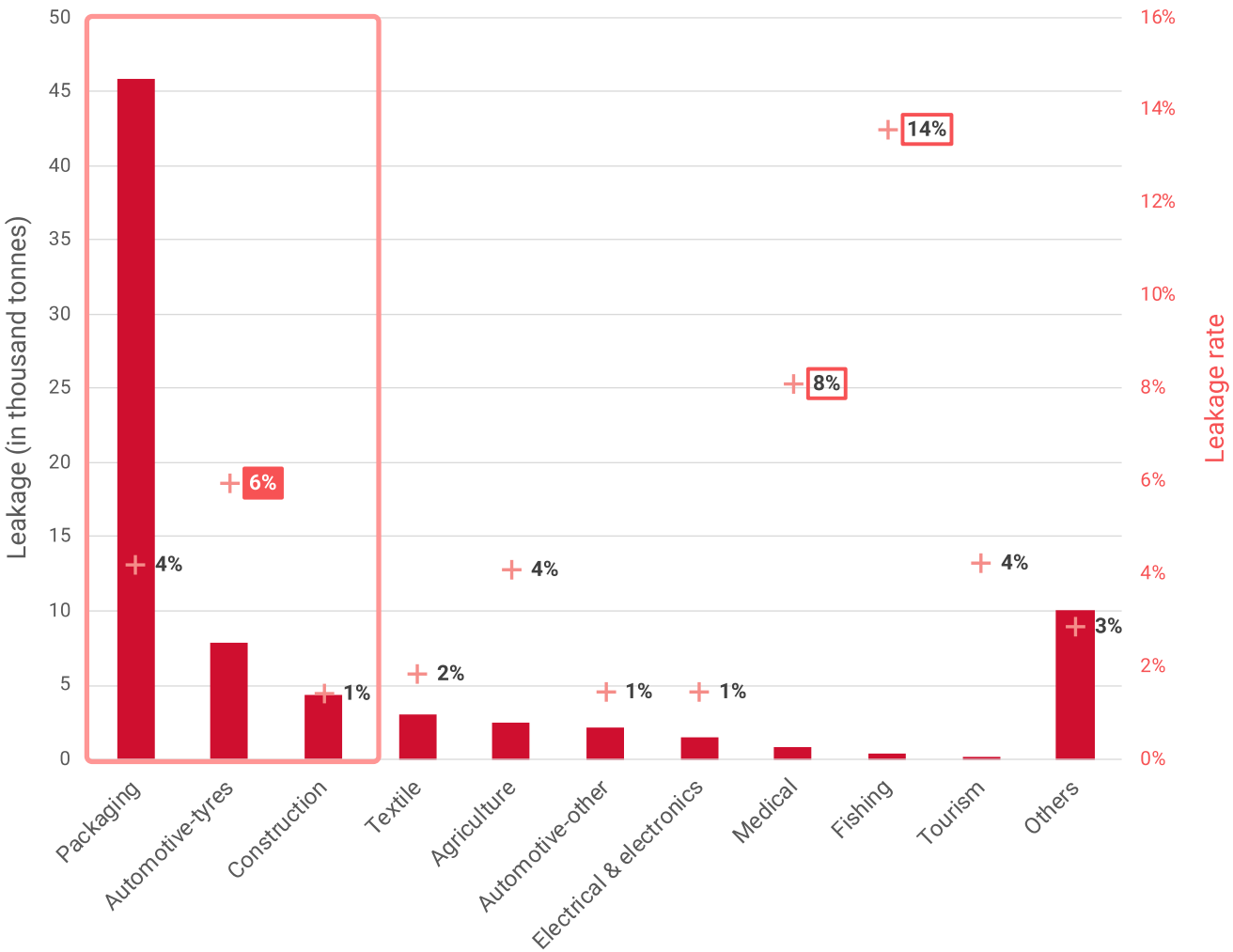
Mismanaged

Leaked

X% | Mismanaged Waste Index (MWI)

X% | Leakage Rate (LR)

SECTOR HOTSPOTS [2018]



Automotive-tyres

Packaging

Construction

Fishing

Medical

Tourism

Agriculture

Electrical & electronics

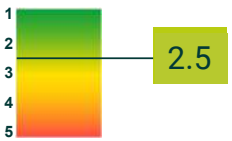
Automotive-other

Textile

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 almost 60% of the total plastic leakage with 46 kt of packaging waste leaking into oceans and waterways.
- **Automotive tyres** are the 2nd highest contributor to plastic leakage in absolute value (8kt), especially due to microplastics from tyre abrasion.
- **Fishing and medical sectors** have a low contribution in absolute leakage but have high leakage rates (respectively 14% and 8%).

SECTOR HOTSPOTS:
INTERPRETATION AND LIMITATIONS

Packaging

Learnings

Packaging is the sector with the highest absolute leakage, higher than all other sectors combined, since packaging is the sector with the highest plastic consumption and, unlike other sectors, all of the products in the packaging sector are assumed to become waste within a year (no stock).

Automotive tyres

Learnings

Tyres are responsible for 8 kt of plastic leakage, from which 6 kt are microplastics from tyre abrasion in use and 2 kt are released tyres from mismanaged waste.

Limitations

As mentioned in the polymer hotspots for synthetic rubber, we lack insights on how discarded tyres are managed throughout the country.

Unlocking limitations

Gain insight on waste management from the automotive tyre sector.

Construction

Learnings

Construction is the third sector by absolute leakage (4 kt). Although plastic waste generated is lower than for automotive-tyres, overall relative leakage is smaller because of a lower release rate with respect to packaging as well as a high share of plastic waste being stocked in buildings (thus not being discarded the same year).

Fishing

Learnings

Fishing has a high relative leakage (14%), but a very low absolute leakage. The number of fishing vessels reported is low *(Cefas, 2020)* compared to other countries, although they are larger in size as fisheries in South Africa is mainly commercial. Gear loss and leakage is minor in the country and does not represent a critical sector hotspot. Some advanced measures are already taken to retrieve lost gears such as voluntary gear marking, but many recommendations from *Cefas (2020)* still need to be enforced in order to lower this high leakage rate.

Medical

Learnings

Medical waste also has a high relative leakage and low absolute leakage.

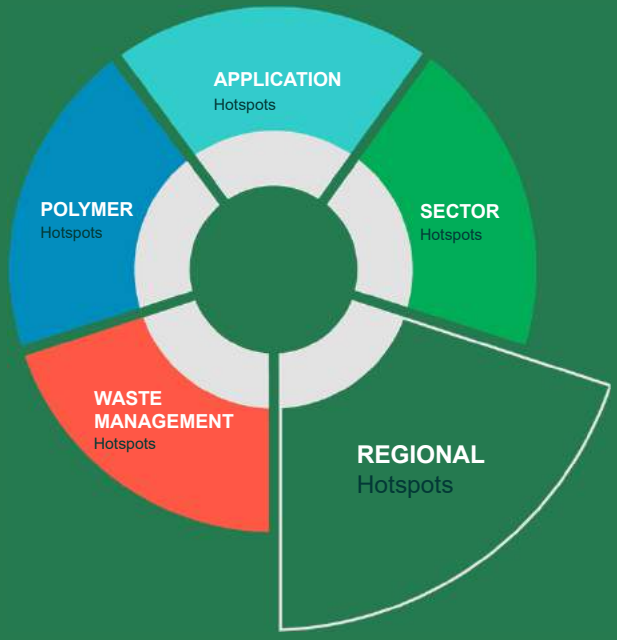
Limitations

The high relative leakage is most likely not accurate, as we do not assume that there is a special treatment of medical waste, as should be the case in most countries, with the majority of the medical waste being incinerated. We instead assume that medical waste is managed as normal waste, and we assume that because it is contaminated it has low value for recyclers. Despite our assumptions, a high relative leakage for medical waste could actually be possible due to poor medical waste management practices in all provinces of South Africa (*Olaniyi et al., 2018*). We are nonetheless confident that plastic medical waste is orders of magnitude lower than plastic packaging waste for instance, and as such less critical for what concerns plastic leakage.

Unlocking limitations

Gain insight on waste management from the medical sector.

D REGIONAL HOTSPOTS

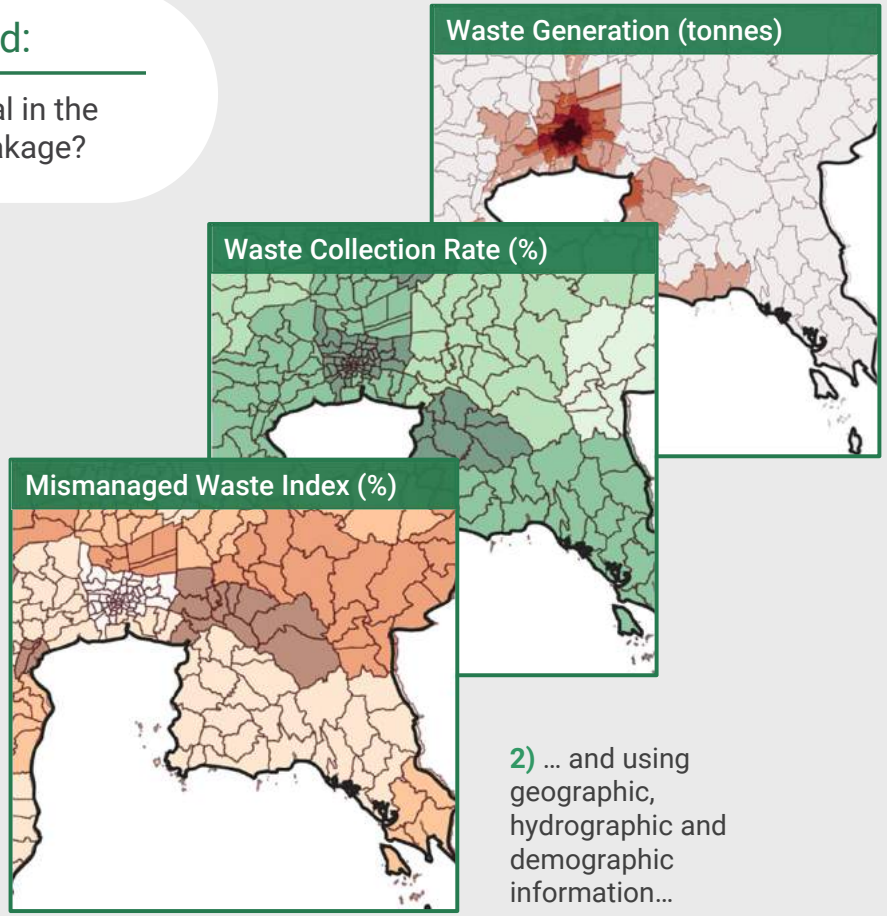


OBJECTIVE AND INSTRUCTIONS

Key question answered:

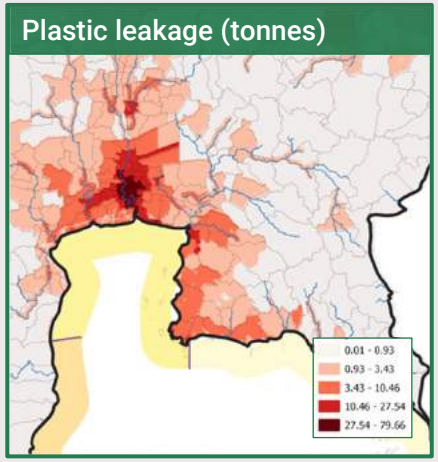
Which areas are most critical in the country regarding plastic leakage?

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

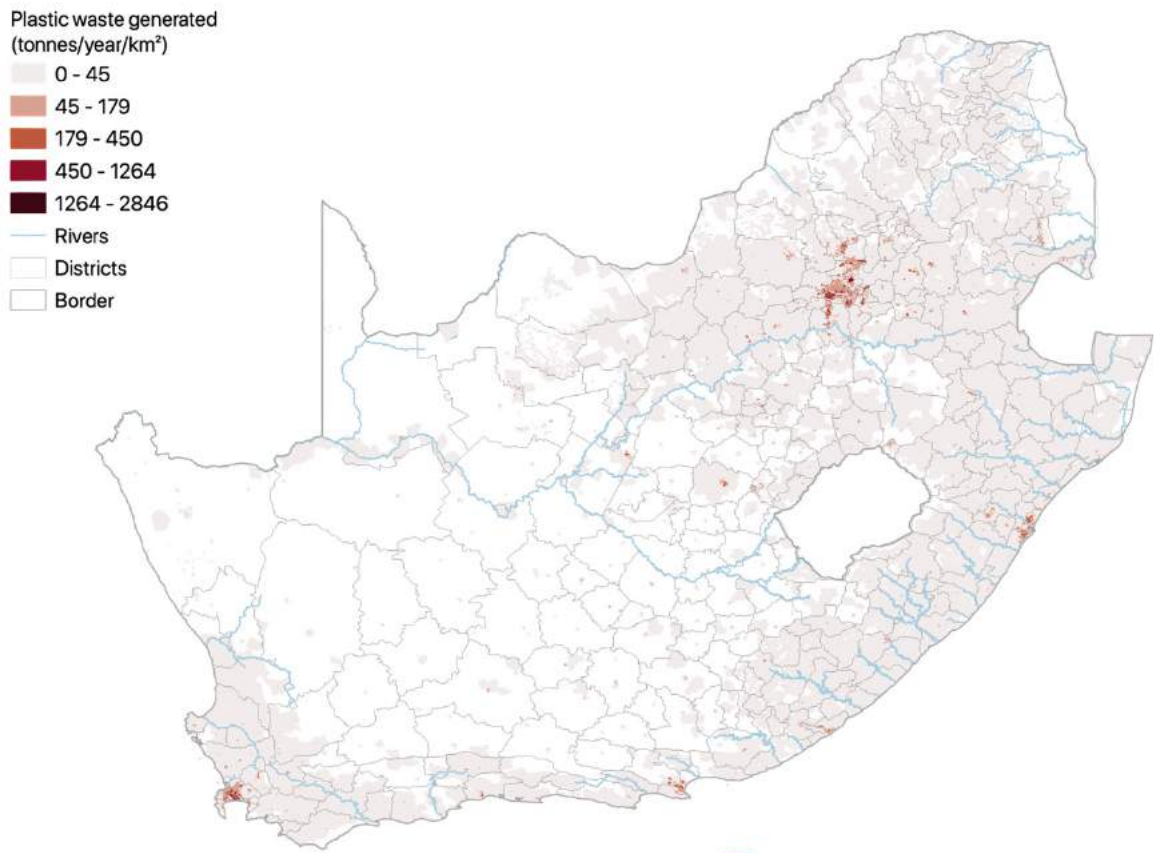


2) … and using geographic, hydrographic and demographic information…

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



WASTE GENERATION:
MAP AND INTERPRETATIONS



More details available in Appendices

Key take-aways

- Plastic waste generation is concentrated around Pretoria, Johannesburg, Durban and Cape Town areas where the population density is higher.
- On average, 18% of generated waste is plastic.

Learnings

Waste generation is distributed according to the shares of population by income level in each province. This increases the quality of the results.

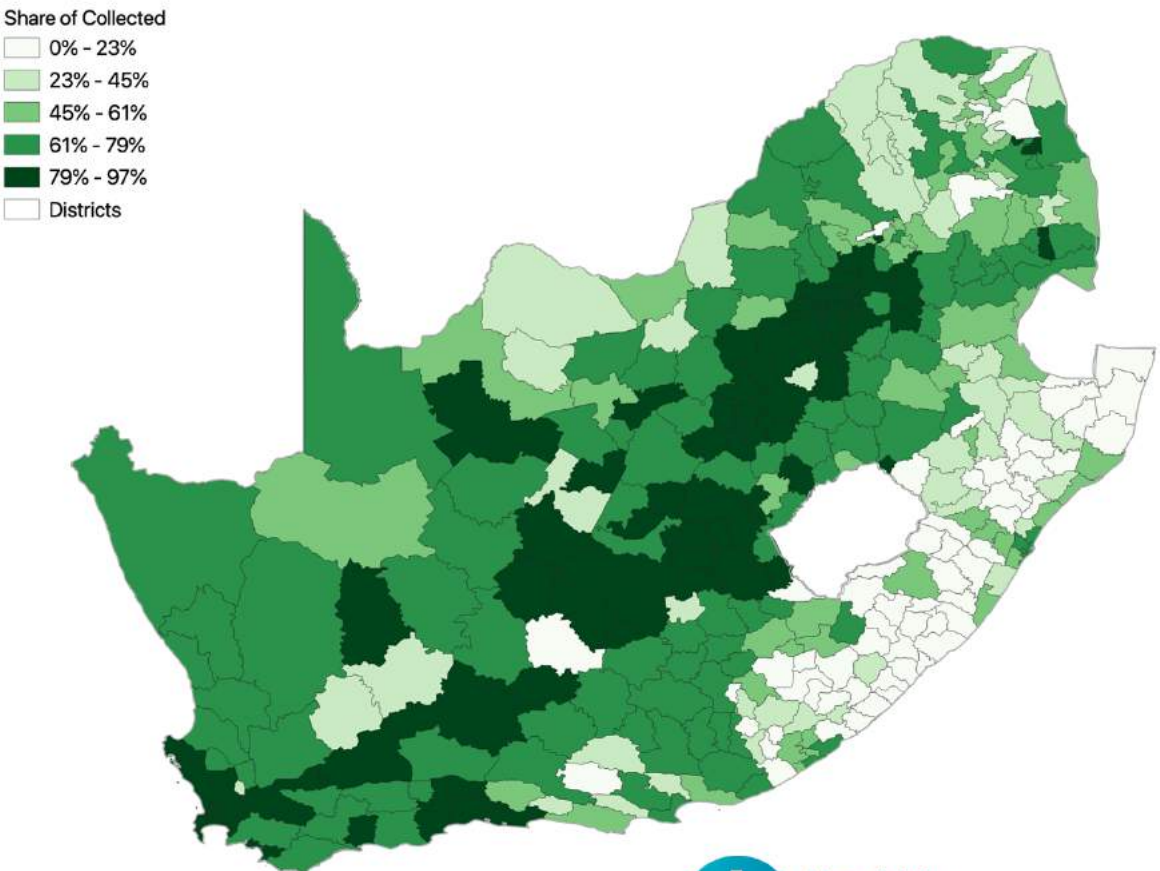
Limitations

Per capita waste generation and plastic share are estimated at a province level based on severeal studies. For some provinces, these values were only known for one or two municipalities. In that case, these values were used as a proxy for the other areas within the province. This most likely leads to an over estimate of plastic consumption in remote and rural areas.

Unlocking limitations

Gather information on per capita waste generation and waste characterisation for additional areas and archetypes in South Africa.

WASTE COLLECTION:
MAP AND INTERPRETATIONS



More details available in Appendices

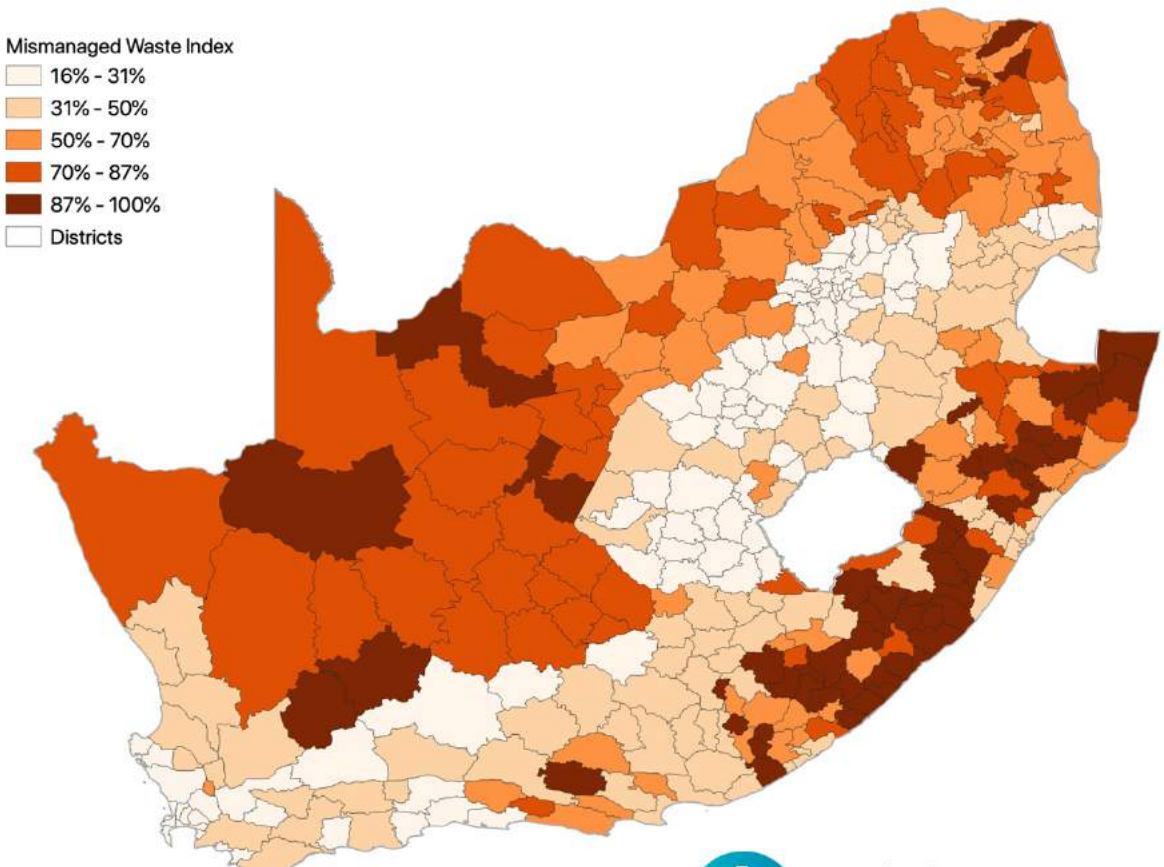
Key take-aways

- Waste collection effort is very effective in Gauteng and Western Cape provinces.
- Eastern cape has the lowest collection rate with 36%.

Learnings

Although some provinces have high overall collection rates, there are significant discrepancies between rural and urban areas. On average in South Africa, less than 20% of waste is collected in rural areas while this share exceeds 80% in urban areas.

MISMANAGED WASTE INDEX:
MAP AND INTERPRETATIONS



More details available in Appendices

Key take-aways

- MWI is usually lower around big cities (around 20%) and can reach 70 to 80% in other areas.

Learnings

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

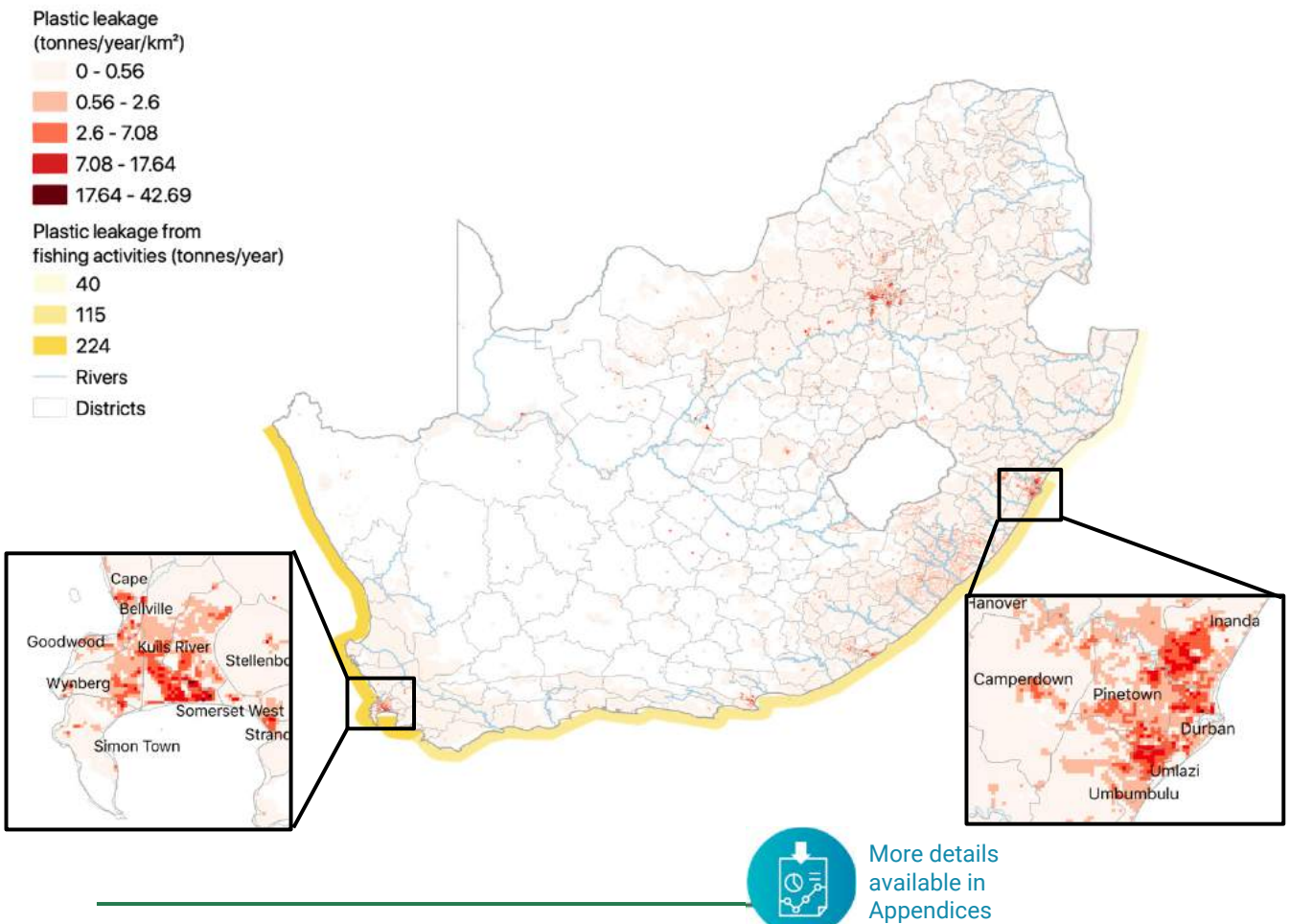
Limitations

The distinction between sanitary and unsanitary landfills is based on the figures given by the SAWIC database. However, sanitary landfills in South Africa might not reach the standards we are expecting.

Unlocking limitations

Improve SAWIC database consistency by aligning data reporting practices across the country as well as setting clear sanitary management standards to distinguish between fully and partially complying landfills.

REGIONAL LEAKAGE:
MAP AND INTERPRETATIONS



More details available in Appendices

Key take-aways

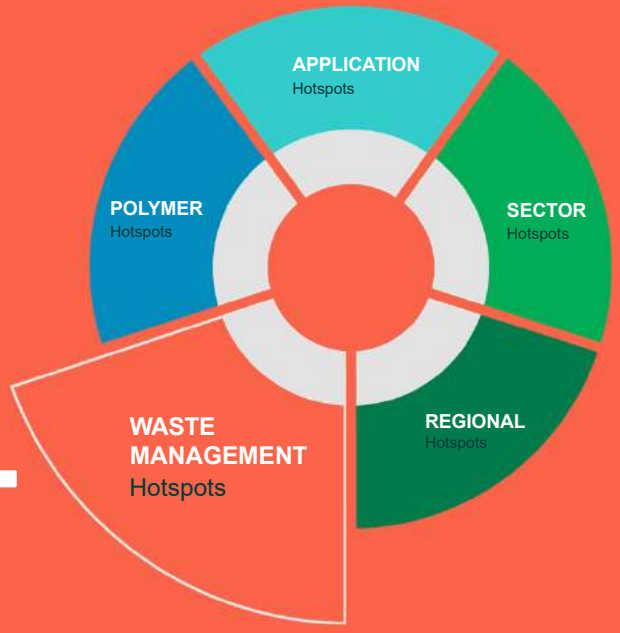
- Annual leakage of mismanaged waste: 71'801 tonnes.
- Annual leakage from mismanaged/lost at sea fishing gears and from overboard litter: 379 tonnes.

Learning

- Except for Gauteng, populated areas are usually located close to a waterway or the coast. This will increase the possibility of transfer to the marine environment
- There is a leakage hotspot due to mismanaged/lost at sea fishing gear and overboard litter located on the west coast (234 tonnes/year), hosting 54% of the ports identified in the analysis.

E

WASTE MANAGEMENT HOTSPOTS



OBJECTIVE AND INSTRUCTIONS

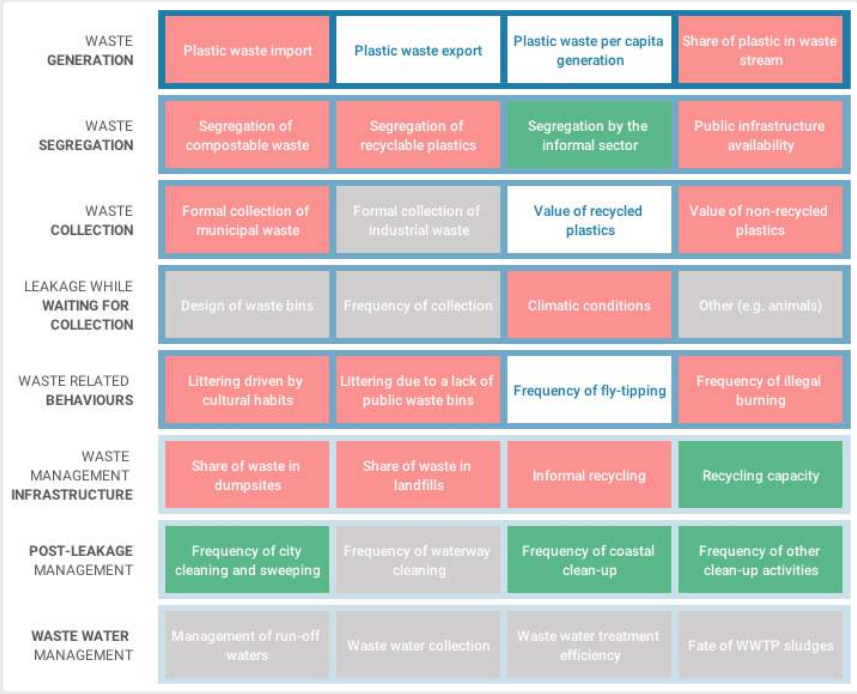
Key question answered:

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% is 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

WASTE MANAGEMENT HOTSPOTS

SOURCE	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
COLLECTION	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 unsanitary 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

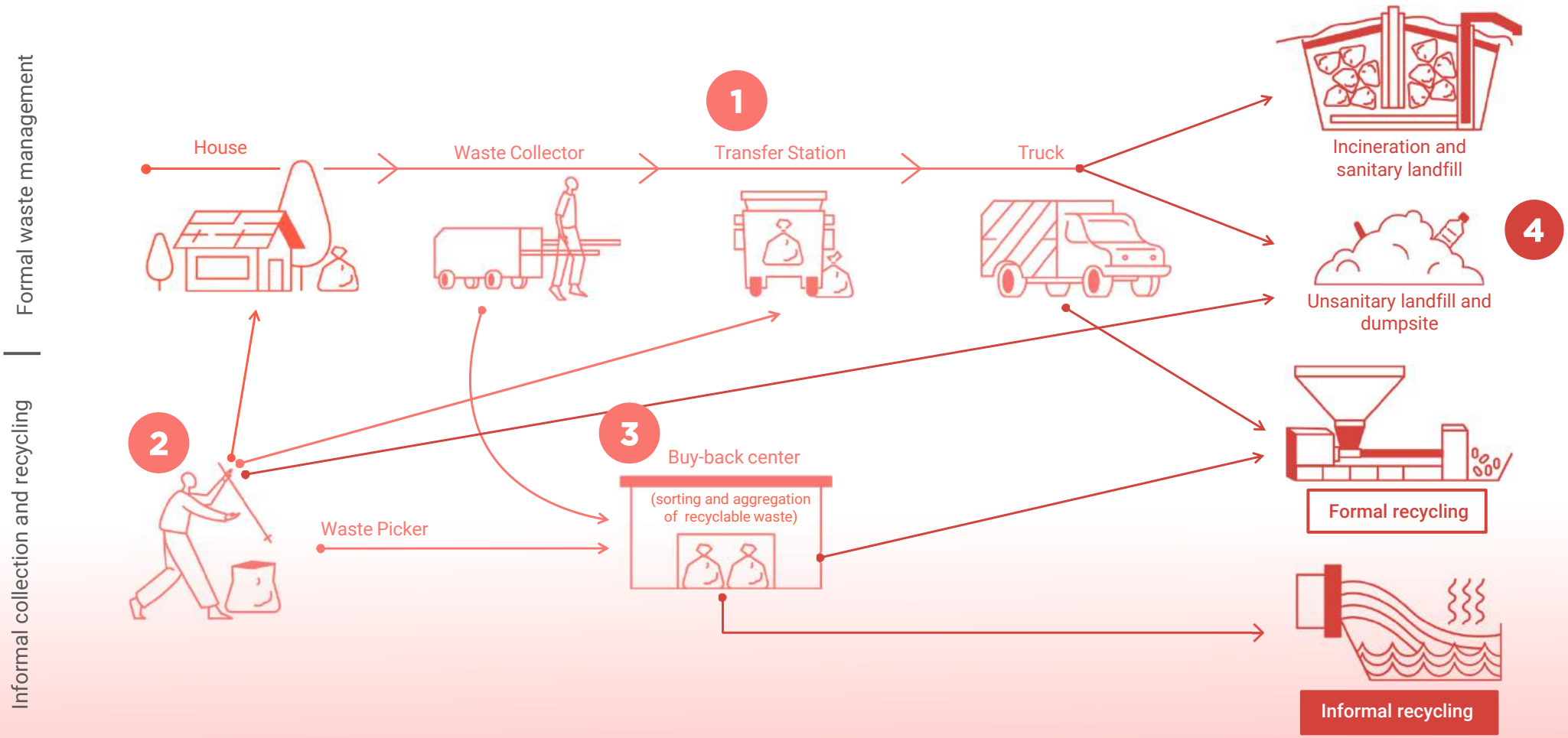
- **Negative contribution to the leakage**
- **Neutral contribution**
- **Positive contribution**
- **Not assessed**

*For more details and justifications, check tool T4.1

Key take-aways

- Share of plastic in waste stream is high (18%).
- Waste separation at household level is low in many provinces.
- Slumping growth and international secondary market context drive recyclable plastic prices down, while plastics are still flooding the South African market.
- Lack of public waste bins, especially in low income areas (including informal settlements) drives littering behaviours.
- Extreme meteorological events are common in South Africa and drive plastic leakage.
- Some municipal sweeping teams push waste into drainage systems and waterways for the sake of simplicity. This increases the leakage and can lead to clogging and floods during extreme rain events.

PLASTIC WASTE JOURNEY IN PICTURES

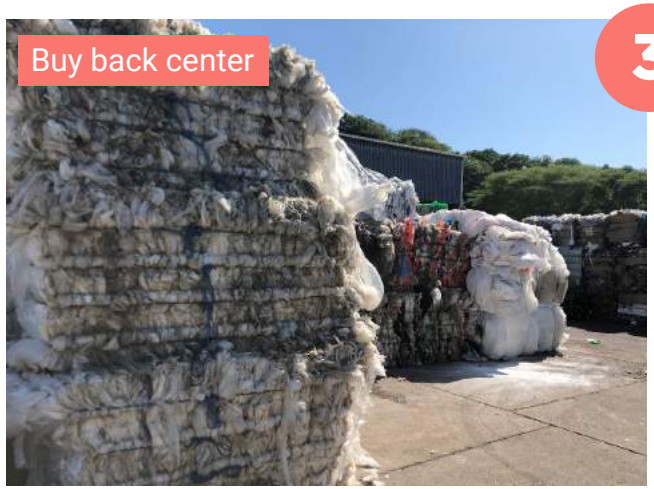


1

Transfer stations

3

Buy back center



2

Waste pickers on landfills

4

Unsanitary landfill

2.3 ACTIONABLE HOTSPOTS

HOTSPOTS IN BRIEF

Polymer

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

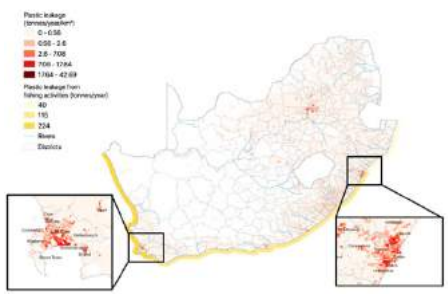
Application

- Bottles - PET
- Baby diapers
- Food containers - PS
- Fishing nets
- Snacks
- Cigarette filters
- Bags
- Sanitary towels
- Trays - PS
- Vending cups - PS

Sector

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

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 unsanitary 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

Neutral contribution

Positive contribution

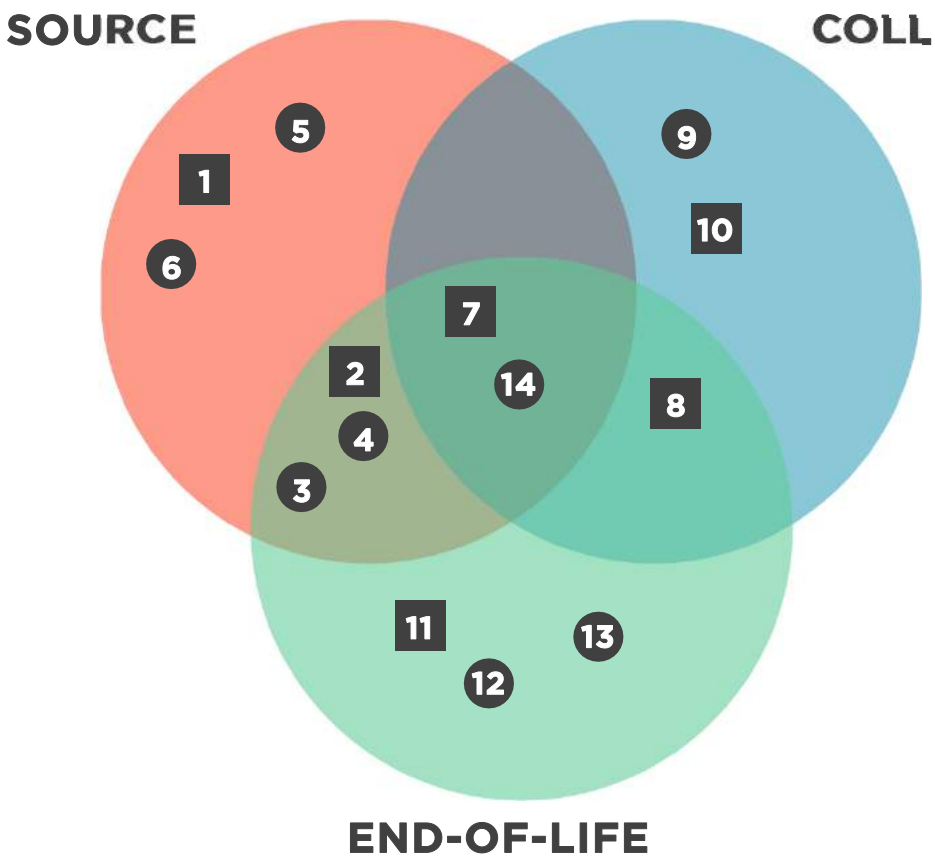
Not assessed

ACTIONABLE HOTSPOTS LIST

[#]	[ACTIONABLE HOTSPOT]	[■/●]
1	Plastic per capita waste generation in South Africa is above the world average and shows an increase in recent years.	■
2	The lack of re-use schemes or deposit scheme in South Africa contribute to a high consumption of single-use and on the go packaging.	■
3	PP is leaking because of high consumption in South Africa and lower recycling rate compared to other polymers such as LDPE or PET.	●
4	LDPE and PET are widely consumed polymers and could benefit from even higher recycling rate to reduce leakage.	●
5	Many different plastic packaging applications (including PET bottles) leak throughout the country due to very high use of plastic in the packaging sector.	●
6	Packaging is a key sector in South Africa that consumes important quantities of plastic.	●
7	The low demand for recycled material on the domestic market does not create enough incentive (market price) for the informal sector to increase collection.	■
8	Lack of waste segregation at source reduces the quality and quantity of recyclable waste.	■
9	All plastic leak in rural and peri-urban areas because of low collection rates (especially in informal settlements).	●
10	All plastic waste is prone to leakage while waiting for collection because of extreme meteorological events (wind / flooding).	■
11	A possibly higher proportion of dumpsites and unsanitary landfills than what officially recorded could increase waste mismanagement and eventually contribute to higher leakage rates in South Africa.	■
12	Tyres remain mismanaged in South Africa because of inefficacy of current regulations.	●
13	Absorbent hygiene products (including nappies and sanitary towels) have important relative leakage since no specific regulation on their proper disposal is in place.	●
14	Some applications, such as fishing nets, straws, lids and caps, trays and plastic bags, can have serious impact on marine wildlife, despite having a relatively small absolute 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 South Africa calls for a well-balanced set of actions across the value chain, yet with an emphasis on the source (plastic production and imports) and 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

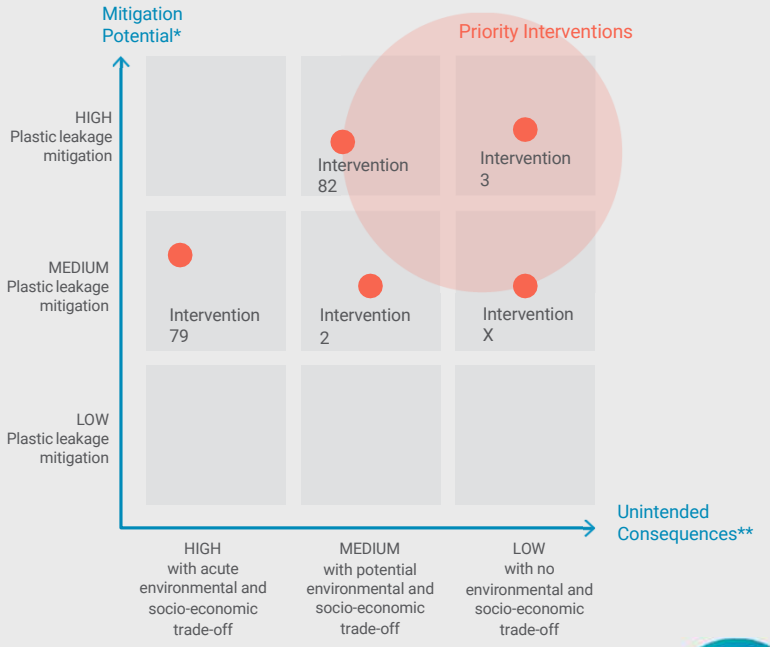
STEP 1: choose up to 3 interventions for each actionable hotspot

STEP 2: assess criteria levels for each chosen intervention

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		

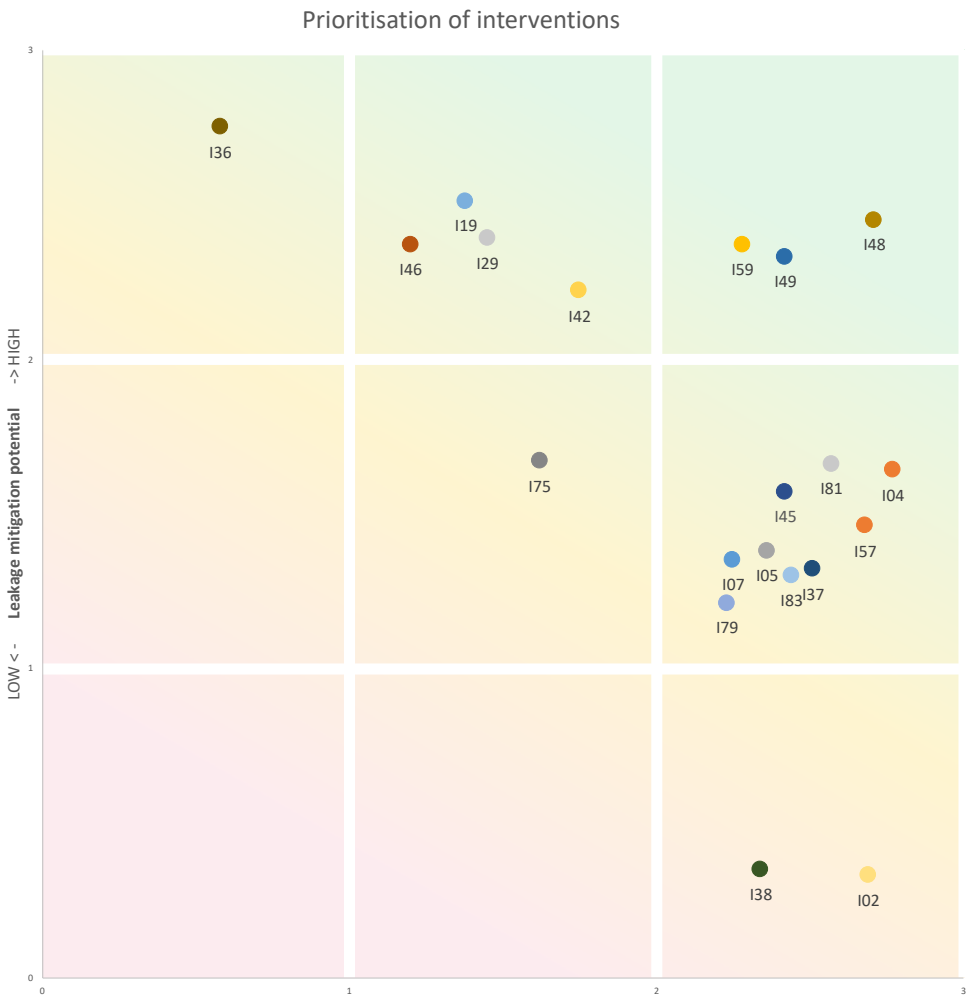
STEP 3: visualise priority interventions in the top right corner of the chart



* **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



- I02: Clean beaches and/or polluted areas
- I04: Increase recycling capacity for domestic plastic waste (PP)
- I05: Increase recycling capacity for domestic plastic waste (LDPE)
- I07: Increase recycling capacity for domestic plastic waste (PET)
- 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
- 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)
- I38: Promote design of products to be less harmful if leaked to the environment
- I42: Reduce the number of dumpsites and unsanitary landfills
- I45: Plan more frequent waste collection prior to the rainy events
- I46: Plan more frequent waste collection in areas prone to plastic leakage (taxi stations, informal settlements, ...)
- I48: Increase plastic segregation at household level
- I49: Increase plastic segregation in public space (sorting waste bins)
- I57: Ensure collection of discarded tyres
- I59: Ensure plastic waste has enough value to cover collection costs (for all polymers)
- I75: Reduce losses from non-sanitary landfills and dumpsites (from wind and flooding)
- I79: Ensure proper use of existing sorting infrastructure
- 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

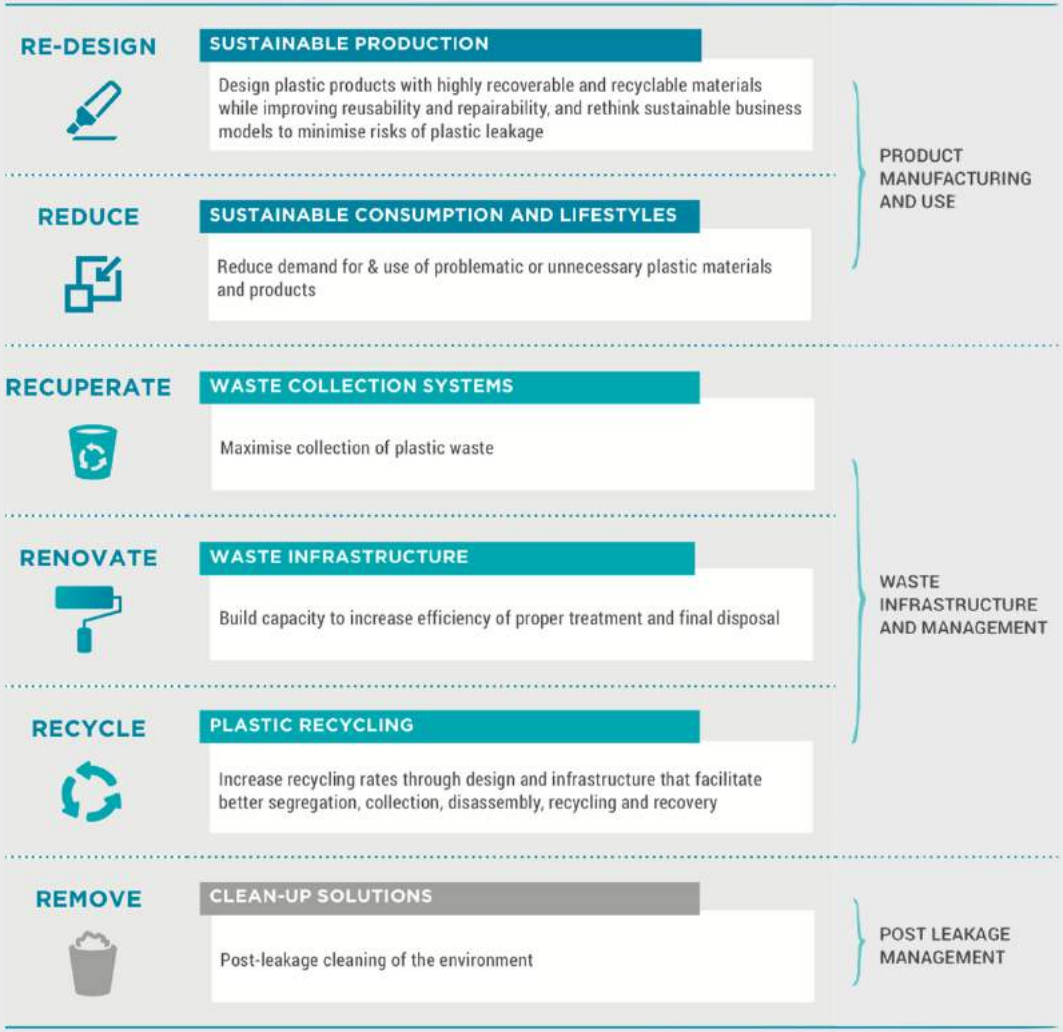
The list of interventions results from the hotspot analysis and it is currently based on the author perception. A final version of the interventions should be elaborated through a multi-stakeholder consultation process.

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	Avoid producing / importing plastic objects that do not benefit from a recycling solution in the country	I29
	Promote design of material or process that favour reuse of plastic objects (e.g. deposit scheme)	I37
SUSTAINABLE CONSUMPTION	Reduce demand for, and use of, single-use, especially on-the-go, plastics	I19
WASTE COLLECTION SYSTEMS	Reduce the number of dumpsites and unsanitary landfills	I42
	Plan more frequent waste collection prior to the rainy events	I45
	Plan more frequent waste collection in areas prone to plastic leakage (taxi stations, informal settlements, …)	I46
	Ensure plastic waste has a enough value to cover collection costs (for all polymers)	I59
	Increase plastic segregation at household level	I48
	Increase plastic segregation in public space (sorting waste bins)	I49
	Ensure collection of discarded tyres	I57
WASTE INFRASTRUCTURE	Ensure proper use of existing sorting infrastructure	I79
	Increase density of waste bins in rural areas	I81
	Increase density of waste bins in specific areas prone to leakage	I83
RECYCLING	Increase recycling capacity for domestic plastic waste (PP)	I04
	Increase recycling capacity for domestic plastic waste (PET, LDPE)	I05, I07

3.2 INSTRUMENTS

METHODOLOGY FOR IDENTIFYING INSTRUMENTS

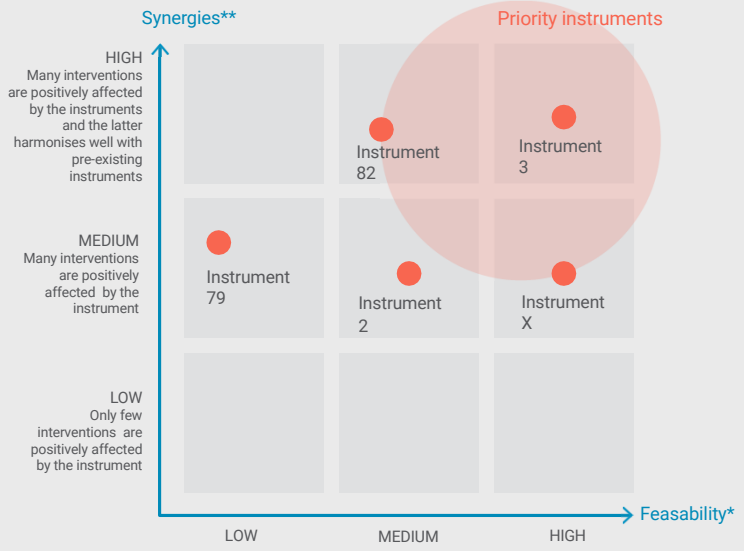
STEP 1: choose up to 3 instruments for each intervention selected in S2

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		

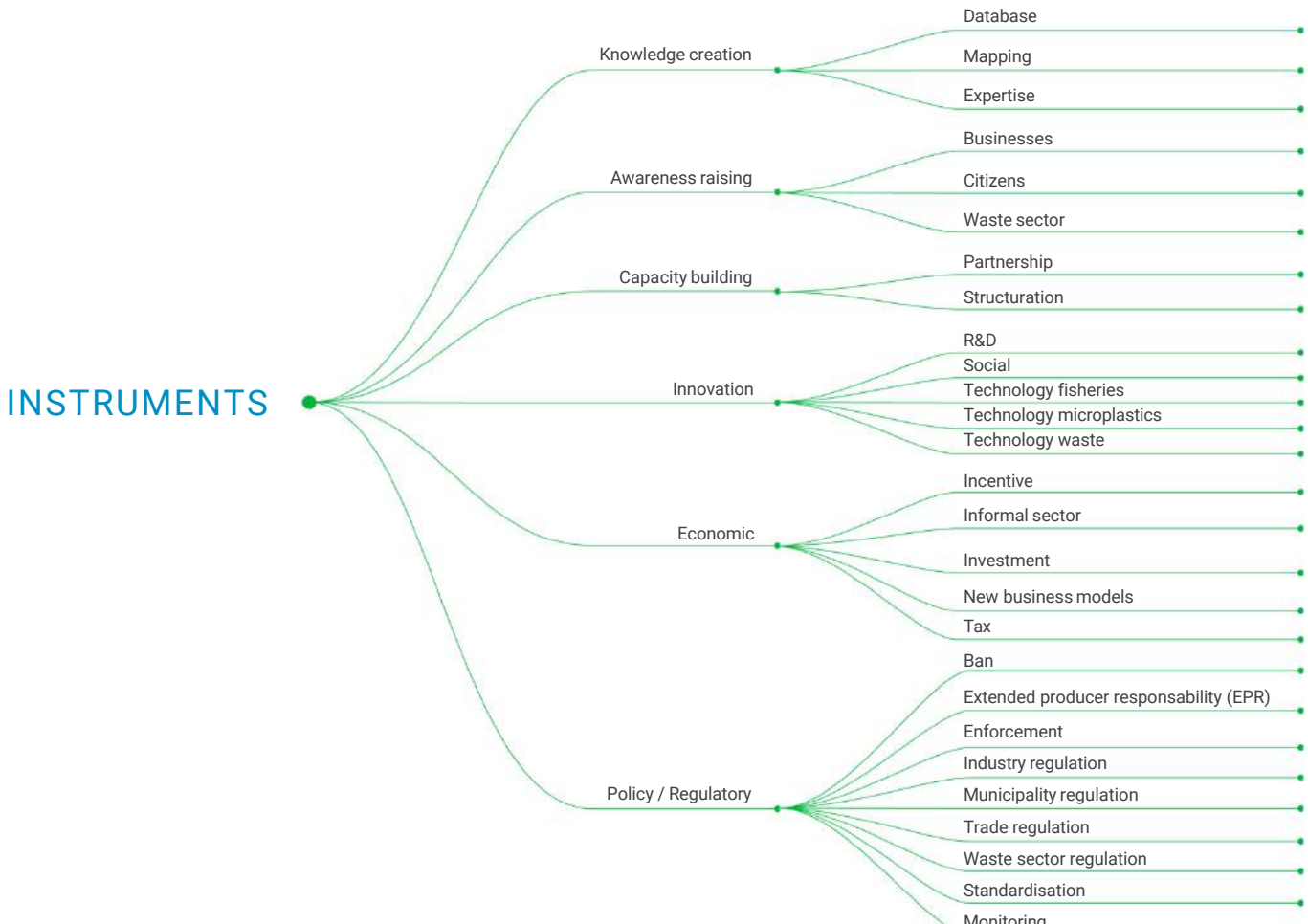


* **Feasability:** technical and socio-economic assessment of each instrument should be performed. We do not assert a method to perform the assessment as this is beyond the scope of the Guidance. The user can decide on the method to use based on resources available. A by default qualitative assessment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

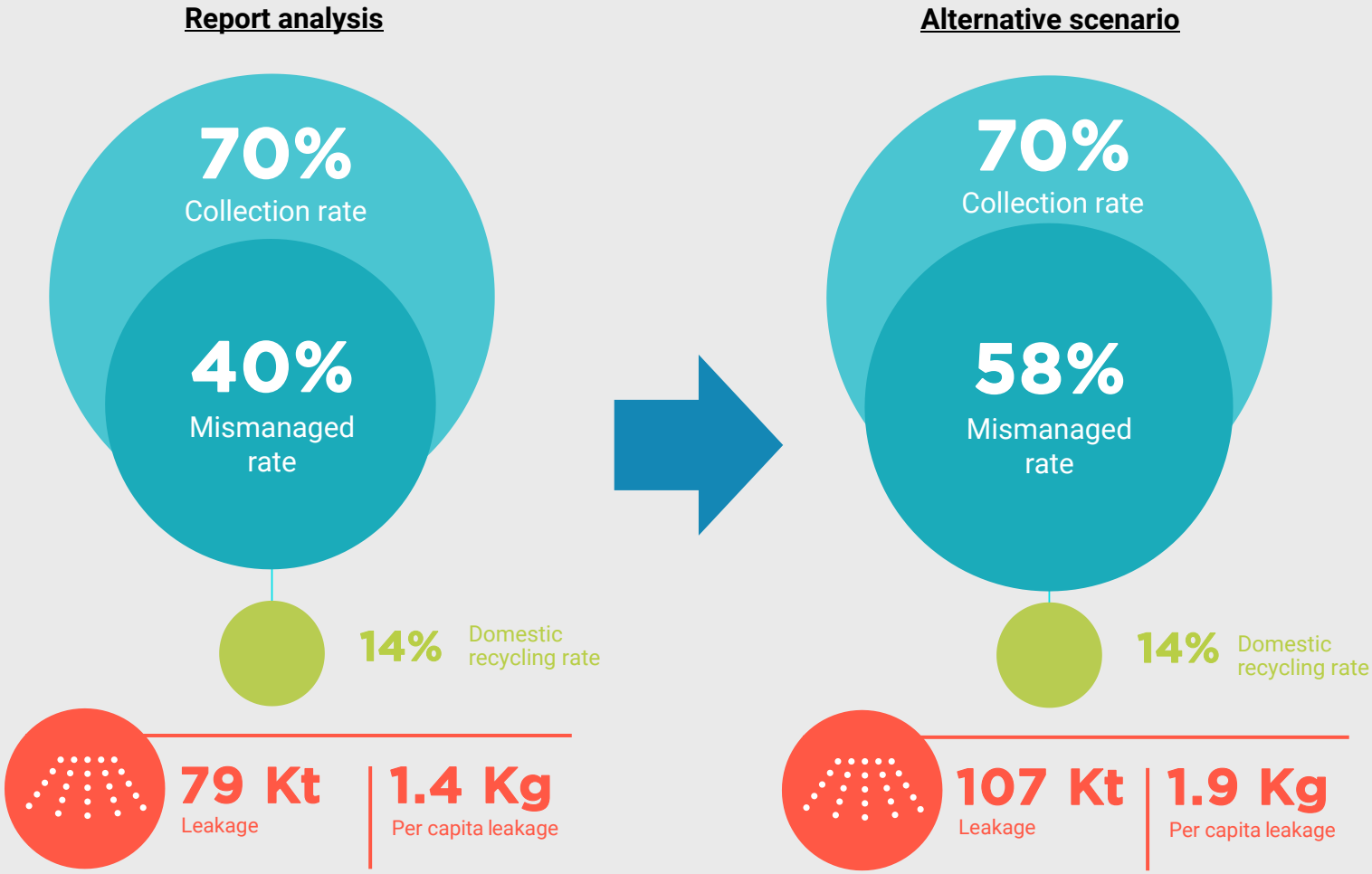
4 APPENDICES

COMPARISON WITH OTHER STUDIES

	Production and trade		Waste generation		Waste management		Leakage	
Reports	Data	Explaining the differences	Data	Explaining the differences	Data	Explaining the differences	Data	Explaining the differences
IUCN *National guidance for plastic pollution and shaping action*	Production + Import = 3'637 kt Export = 1'084 kt --- Net input: 2'563 kt	**year = 2018**	Waste = 2'371 kt Imported waste = 18 kt		Recycled = 352 kt (+12 kt exported) [14%] Properly disposed = 1066 kt [45%] Improperly disposed = 243 kt [11%] Uncollected = 716 kt [30%]		Leakage = 79 kt	
H. von Blottnitz et al. 2019 *South Africa beats Europe at plastics recycling, but also is a top 20 ocean polluter. Really?*	Production = 840 kt + 296 kt (recyclates) Import = 961 kt Export = 157 kt --- Net input: 1'940 kt	**year = 2017** Production: no details provided on the data sources Import/export: no details provided on the data sources	Waste = 1'533 kt		Recycled + Exported = 333 kt [21%] Properly disposed = 352 kt [23%] Improperly disposed = 457 kt [30%] Uncollected = 381 kt [25%] Littered = 11 kt [1%]	**Uncollected**: based on the same source (Household survey, 2018) **Properly disposed:** lower than that of IUCN analysis. We estimate 45% properly disposed while here it is only 23%.	Leakage = ? kt	not assessed
Verster et al. 2020 *Land-based sources and pathways of marine plastics in a South African context*	Net input: unknown	**year = 2017**	Waste = 1'100 kt Import of waste : unknown	Source : DEA (2017)	mismanaged = 440 kt [40%]	the share of mismanaged waste is identical to IUCN study but the absolute is twice as low. Calculation is a rough top-down approach.	Leakage = 15 - 30 kt	Takes only the population near the coast (50 km buffer) as a source of leakage, which yields around 100 kt mismanaged plastic waste liable to leak. Then applies a 15-40% release rate from Jambeck 2015.
Jambeck et al. 2015 *Plastic waste inputs from land into the ocean.*					mismanaged = 630 kt	takes only the population near the coast (50 km buffer)	Leakage = 90 - 250 kt	Uses between 15-40% release rate for coastal population while our release rate is at 8% for the whole country.

ALTERNATIVE SCENARIO

The SAWIC database was suggesting that on average in 2018, 85% of collected waste (except recycled and exported) was properly disposed in engineered landfills or incinerated while only 15% were improperly disposed in non-engineered landfills. These shares seem very optimistic and stakeholders in South Africa suggested to complement the analysis with data from Von Blottnitz et al. (2019). Consequently, our results are adapted here by considering that 43% of collected waste (except recycled and exported) was properly disposed in engineered landfills or incinerated while 57% were improperly disposed in non-engineered landfills. This results in an alternative scenario where the mismanaged waste quantity increases as well the total plastic leakage. However, the alternative total plastic leakage value is in the same order of magnitude as the one from the report, and the hotspots by category in the detailed results remain unchanged.



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	*314*	22%	1%	41%	9%	27%	*100%*	73%	36%	4%	*318*	23%
PP	*467*	13%	0%	46%	10%	31%	*100%*	69%	41%	3%	*471*	13%
Polyester	*161*	0%	0%	56%	12%	31%	*100%*	69%	44%	2%	*161*	0%
LDPE	*469*	24%	1%	40%	9%	26%	*100%*	74%	35%	4%	*475*	25%
HDPE	*241*	25%	1%	39%	9%	27%	*100%*	73%	36%	3%	*244*	26%
PS	*72*	7%	0%	47%	11%	34%	*100%*	66%	45%	3%	*73*	8%
Other	*286*	2%	0%	53%	12%	33%	*100%*	67%	45%	2%	*286*	2%
Synthetic Rubber	*131*	0%	0%	52%	12%	36%	*100%*	64%	48%	6%	*131*	0%
PVC	*229*	9%	0%	44%	11%	37%	*100%*	63%	47%	2%	*230*	9%
Average	-	*14%*	*0%*	*45%*	*10%*	*30%*	*100%*	*70%*	*40%*	*3%*	*265*	*15%*

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

WASTE MANAGEMENT BY PROVINCE

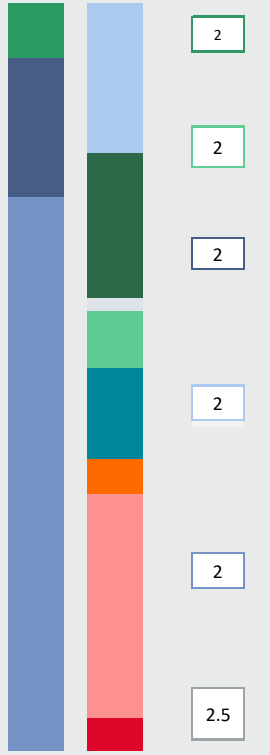
Province	Population 2020	Generated t	Collected t	Properly disposed & collected for recycling t	Improperly disposed t	Uncollected t	Mismanaged t	Leaked t	Generated kg/cap	Collected kg/cap	Mismanaged kg/cap	Share of Collected	Share of Mismanaged	Leakage rate
Eastern Cape (rural)	3 433 703	167 286	836	686	151	166 449	166 600	15 268	49	0	49	1%	100%	9%
Eastern Cape (urban)	3 319 103	161 703	117 720	101 954	15 765	43 983	59 748	4 254	49	35	18	73%	37%	3%
Free State (rural)	235 814	7 872	394	366	27	7 478	7 506	733	33	2	32	5%	95%	9%
Free State (urban)	2 530 121	84 461	76 353	71 172	5 181	8 108	13 289	1 310	33	30	5	90%	16%	2%
Gauteng (rural)	386 278	19 411	6 134	5 303	831	13 277	14 108	843	50	16	37	32%	73%	4%
Gauteng (urban)	14 336 163	720 402	664 931	599 912	65 019	55 471	120 490	8 850	50	46	8	92%	17%	1%
KwaZulu-Natal (rural)	4 305 262	138 482	5 539	5 197	342	132 943	133 285	11 437	32	1	31	4%	96%	8%
KwaZulu-Natal (urban)	6 677 966	214 802	152 509	147 490	5 019	62 292	67 311	6 364	32	23	10	71%	31%	3%
Limpopo (rural)	3 237 780	60 379	3 744	2 319	1 425	56 636	58 060	2 927	19	1	18	6%	96%	5%
Limpopo (urban)	2 807 396	52 353	44 134	28 855	15 279	8 219	23 498	1 181	19	16	8	84%	45%	2%
Mpumalanga (rural)	1 103 118	47 582	6 424	6 165	259	41 158	41 417	2 686	43	6	38	14%	87%	6%
Mpumalanga (urban)	3 643 454	157 156	131 540	126 368	5 172	25 616	30 788	1 893	43	36	8	84%	20%	1%
North West (rural)	1 805 540	60 782	16 776	7 745	9 031	44 006	53 037	2 918	34	9	29	28%	87%	5%
North West (urban)	3 264 468	109 895	96 488	49 754	46 734	13 407	60 142	3 272	34	30	18	88%	55%	3%
Northern Cape (rural)	187 612	7 601	2 022	370	1 651	5 579	7 230	694	41	11	39	27%	95%	9%
Northern Cape (urban)	932 333	37 771	33 087	6 663	26 425	4 684	31 109	2 790	41	35	33	88%	82%	7%
Western Cape (rural)	600 494	26 827	9 068	7 483	1 585	17 759	19 344	1 048	45	15	32	34%	72%	4%
Western Cape (urban)	6 621 041	295 794	287 512	244 234	43 278	8 282	51 560	3 334	45	43	8	97%	17%	1%

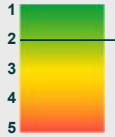
Per capita values are calculated by dividing total values by the 2020 population forecasted by NASA in 2015.

4.2 DATA QUALITY ASSESSMENT

POLYMER HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)

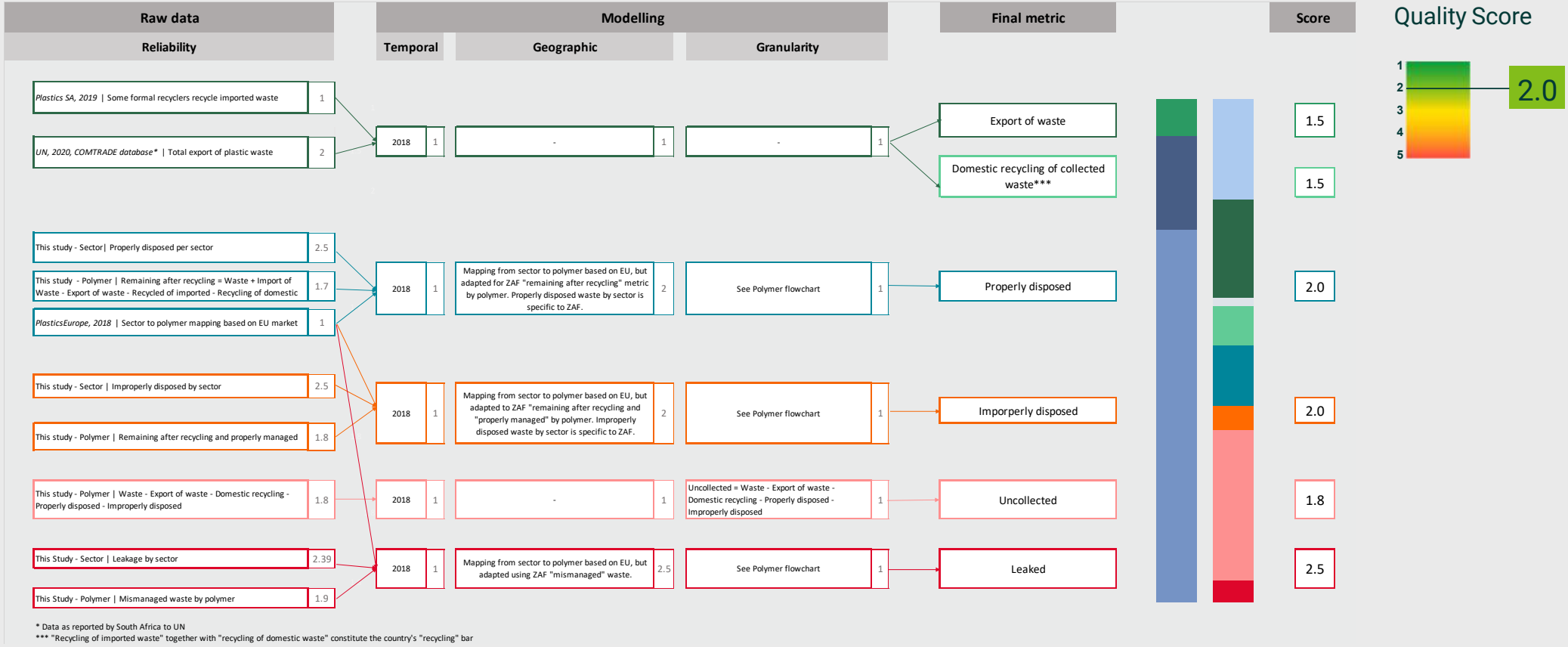
Raw data		Modelling			Final metric	Score
Reliability		Temporal	Geographic	Granularity		
*UN, 2020, COMTRADE database** | Import of waste (sometimes polymer is unknown)	2	2018 1	- 1	We assume that waste is imported to be recycled. Hence the share by polymer of waste traded are set to be the shares by polymer of collected for recycling 2	Import of waste	2
Plastics SA, 2019 | Some formal recyclers recycle imported waste	1					
This study - Polymer | Import of waste	2	2018 1	- 1	Recycling of imported waste = import of waste 2	Recycling of imported waste***	2
*UN, 2020, COMTRADE database** | Import products (sometimes polymer is known)	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	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
PlasticsEurope, 2018 |Polymers to Sectors correspondence matrix	1					
*UN, 2020, COMTRADE database** | Import of primary by polymer	2	2018 1	- 1	Production for synthetic rubber is missing and was arbitrarily set to 0. 2	Import and production of primary	2
ICIS, 2020 | Production quantity per polymer (no rubber)	1					
This Study - Sector | Change in Stock by sector	2.5	2018 1	Mapping from Sector to Polymer based on EU, but adapted to the South Africa net input by polymer 2.5	- 1	Change in stock	2.5
This Study - Polymer | Net input	2					





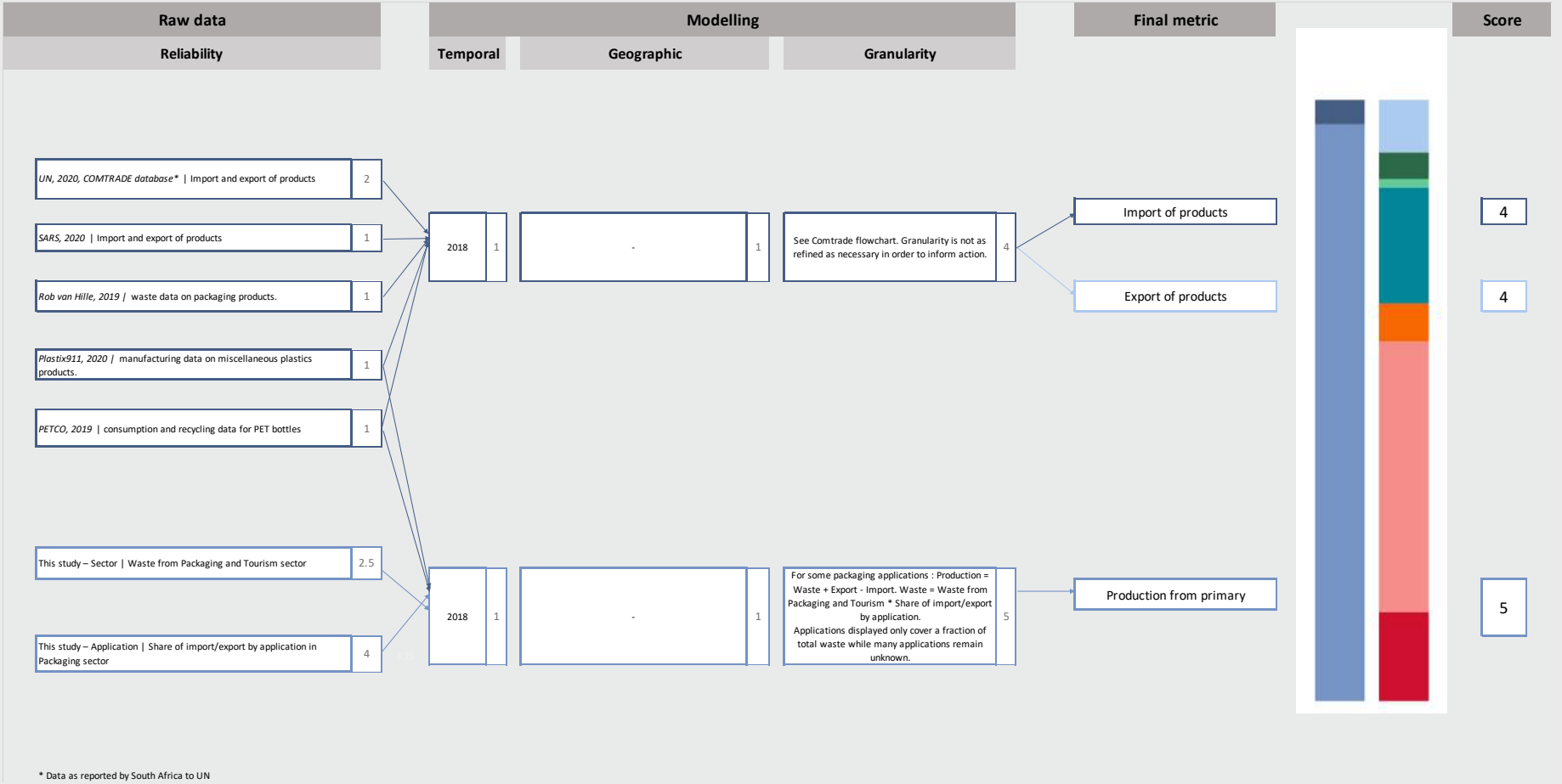
* Data as reported by South Africa to UN
** Net input = Import waste - Recycling of import + import of products - Export of primary and products + Import and production of primary
*** "Recycling of imported waste" together with "recycling of domestic waste" constitute the country's "recycling" bar

POLYMER HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)



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

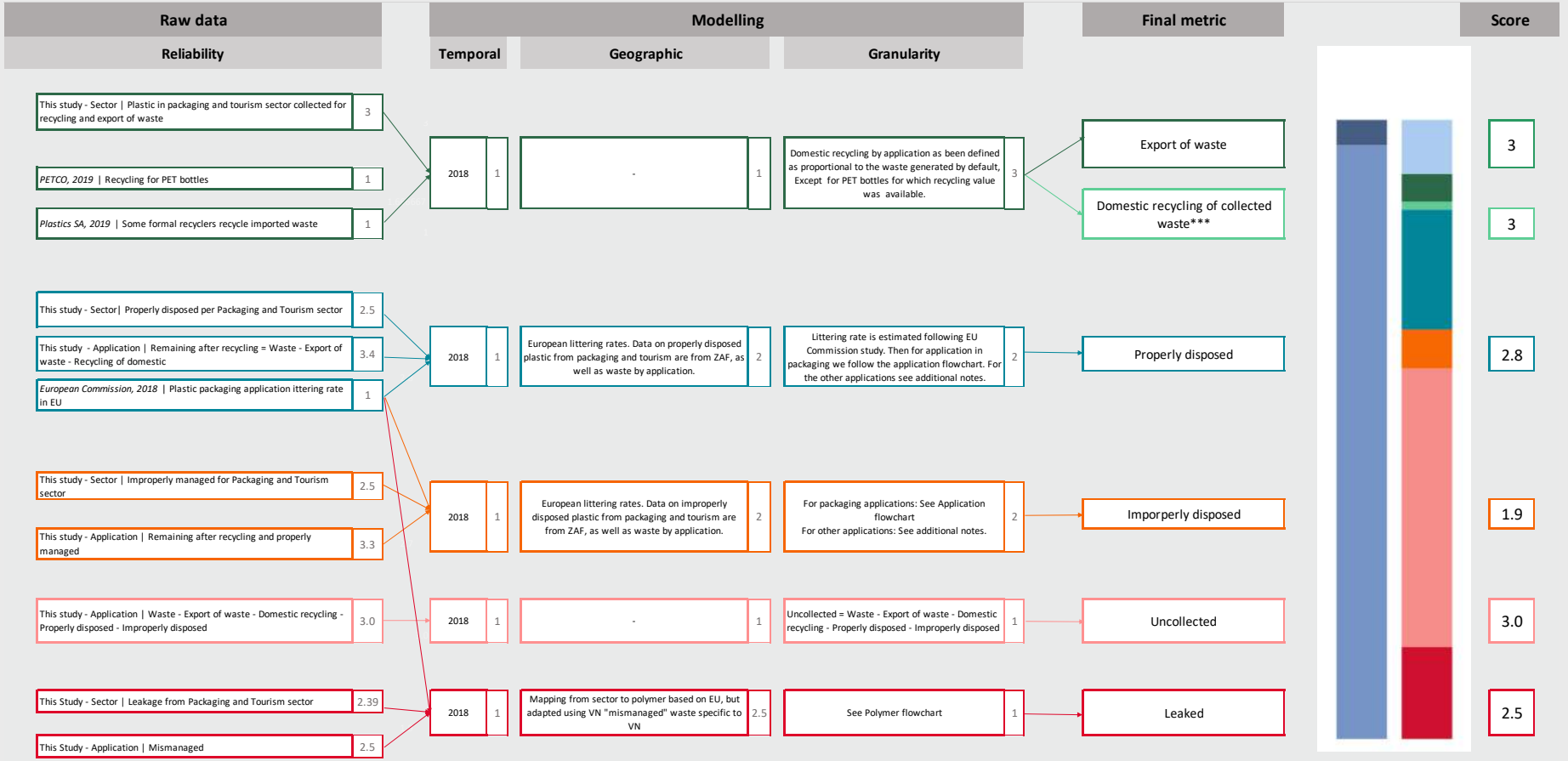
APPLICATION HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)



Quality Score

* Data as reported by South Africa to UN

APPLICATION HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)



Quality Score

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

APPLICATION HOTSPOTS
MODELLING NOTES

Cigarette filters: Cigarette filters: We estimate the number of cigarette filters from cigarette consumption data (https://www.iol.co.za/the-star/about-8-million-adults-in-sa-smoke-27-billion-cigarettes-a-year-9429417). 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 Comtrade (code: 240220). Recycling is set to zero. The share of properly managed is taken from the average share of properly managed (see sector hotspots calculation sheets), applied to the cigarette filters that are not littered. Littering rate is set to 29%, based on EU littering report. The improperly managed is based on the average share of improperly managed (see ibid), applied to cigarette filters not littered or properly managed. The release rate for cigarette filters (small low value item) is 31%, we reduce it for South Africa to 19% based on the average reduction of release rate due to geographical conditions. Release rate is applied to uncollected and improperly managed to determine de total leakage.

Sanitary towels: Sanitary towels: Waste generation is estimated to be 3 sanitary towels/ day, 5 days/month, 12 month/year for the female population from 15 to 55 years old with a middle or high income level. One sanitary towel weighs 2 grams. Recycling is set to zero. The share of properly managed is taken from the average share of properly managed (see sector hotspots calculation sheets), applied to the sanitary towels that are not littered. Littering rate is set to 21%, based on EU littering report. The improperly managed is based on the average share of improperly managed (see ibid), applied to sanitary towels not littered or properly managed. The release rate for sanitary towels (medium low value item) from PLP is 25%, we reduce it for South Africa to 19% based on the average reduction of release rate due to geographical conditions. Release rate is applied to uncollected and improperly managed to determine de total leakage.

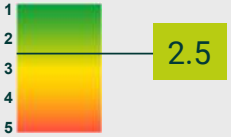
Baby diapers: Baby diapers: To determine de waste generation we consider that the middle and high income population (55%) from 0-2 years old (half of the 0-4 pop in UN statistics database), uses 4.16 unit of diapers/day (Mendosa et al., 2018). Average weight of a baby diaper is 29,1 grams, from which 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		Modelling			Final metric	Score
Reliability		Temporal	Geographic	Granularity		
PlasticsEurope, 2018 | Polymer to Sector mapping based on EU market	1	2018 2017 2018	Mapping from Polymer net input to Sector net input based on EU market, adapted to ZAF polymer net input	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	Short-lived products	2.5
Geyer et al., 2017 | Product lifetime by sector, mean and std.	1					
This study – Polymer | Net input by polymer*	2	1	2.5	2	Long-lived products	2.5
The World Bank, 2012 | Manufacturing, added value, GDP growth	1	2018 2017 2018	-	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 year in order to determine the stock	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	1	1	2.5		

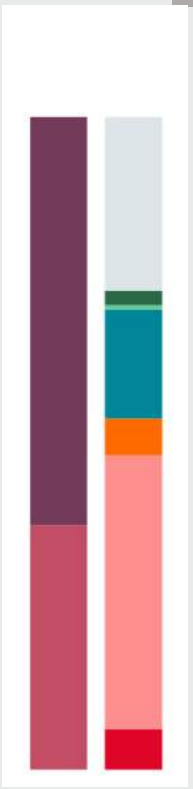
* sources : *GCIS (2014); Cefas (2020)*
** sources : *Nemathaga, F. et al. (2008); Olaniyi, F. et al. (2018)*
*** source : *Statistics South Africa (2019). Tourism 2018.*

Quality Score

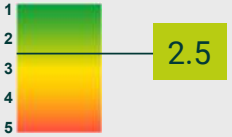


SECTOR HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)

Raw data – Reliability		Modelling – Temporal		Modelling – Geographic		Modelling – Granularity		Final metric	Score
This Study - Polymer | Export of waste and domestic recycling of collected by polymer	1	2018	1	Mapping from Polymer net input to Sector net input based on EU market, adapted to ZAF polymer net input. Recyling quantities by polymer specific to ZAF.	3.0	-	1	Export of waste	3
PlasticsEurope, 2018 | Polymer to sector mapping based on EU market	2								
This study - Polymer | Net input**	2							Domestic recycling of collected waste***	3
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	2.7								
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	2.1								
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	2.7								
This study - Polymer | Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	1.82	2018	1	-	1	Uncollected = Waste - Export of waste - Domestic recycling - Properly disposed - Improperly disposed	1	Uncollected	1.82
Plastic Leak Project, 2019 | Release Rate by sector (base on product size and value for informal recyclers)	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
This Study - Geographical | Total Macro-leakage	2								
This Study - Sector | Mismanaged	2.16								



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: See details in regional hotspots modelling notes.

Medical: Total plastic waste generated by the medical sector is computed by combining the number of hospital beds (*Nemathaga et al. 2008*, 2.8 beds per 1'000 capita), the average bed occupancy rate, the total waste generated by bed and the average plastic share in medical waste (*Nemathaga et al. 2008*). No distinction was made infectious and non-infectious medical waste. In South Africa there is informal medical sector that operates outside of hospitals which we do not capture. Nonetheless, plastic waste from the medical sector significantly smaller than plastic waste from the packaging sector, thus not a hotspot in the country. (Quality Score = 2.5, as the average occupancy rate is from a default value and insight into informal sector is missing)

Tourism: Data on number of tourists and average length of stay comes from the *Tourism report 2018, STATS SA*. We combine this information with the average country plastic waste generation per capita per day derived from our calculations, in order to estimate the plastic waste generated by the tourism sector. We make the assumption that a tourist will generate as much plastic waste as an average South African 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". Data on vehicles numbers are taken from *eNATIS (2017)* and average distance travelled are based on *Stone et al. (2018)*.

- **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".

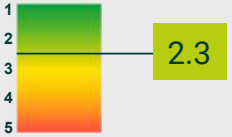
- **Cosmetics:** loss and leakage of plastic micro-particles from cosmetics to the marine environment is calculated based on the methodology described in PLP (2019). Its contribution to leakage is included in "Others".

- **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".

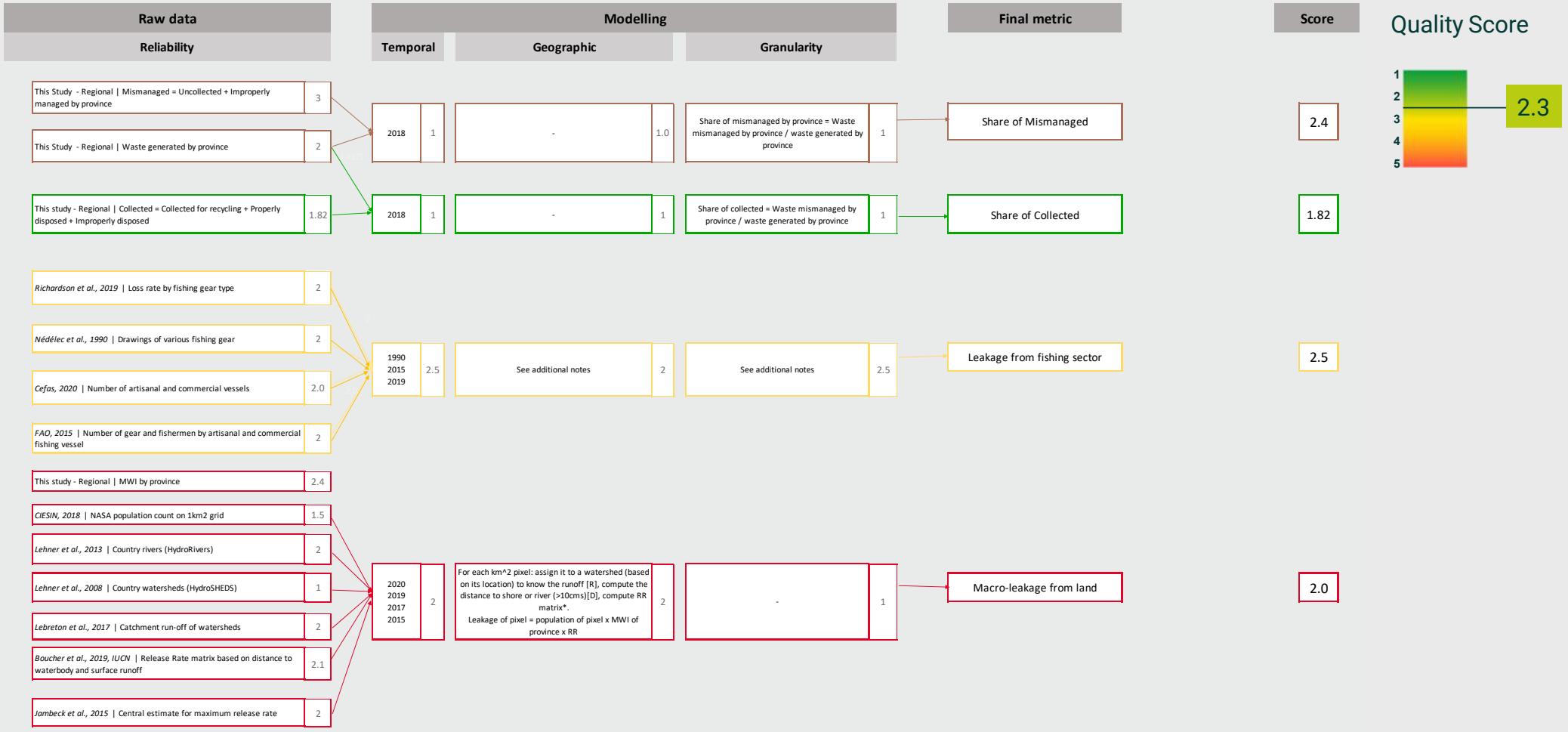
REGIONAL HOTSPOTS
DATA QUALITY ASSESSMENT (1/2)

Raw data		Modelling				Final metric	Score
Reliability		Temporal		Geographic		Granularity			
This Study - Sector | Total plastic waste generated	2	2018	1	Per capita waste generated = the total plastic waste generated/population. Waste generated by province = population by province * per capita waste generated. Waste generated by km2 = population per km2 * per capita waste generated	2	-	1	Waste generated	2
CIESIN, 2018 | NASA population count on 1km2 grid	1.5								
Green Cape, 2020 | Plastic recyclers by province	2	2018	1	The number of recyclers in each province is used as a proxy to allocate the quantity of plastic recycled in the province.	3	-	1	Collected for recycling	3
Plastics SA, 2019 | Total plastic recycled in South Africa	1								
Rodesth et al., 2020 | Per capita generation of general waste by income level	1	2015- 2018	1	For provinces where no specific waste generation rate was available, we used a national estimate. Same applies to share of plastic in the waste stream.	3	Share between "properly" and "imporperly disposed" is based on the split between tonnages sanitary and unsanitary landfil from SAWIC database.	3	Properly disposed	3
Association Jeffares & Green & RWA Resources & Waste Advisory Group (2016) | Waste composition in various municipalities	1								
Stats SA, 2018 | Collection rate by province	1								
SAWIC, 2020 | Share between sanitary and unsanitary landfills	4							Improperly disposed	3
This study - Regional | Waste - Collected for recycling - Properly disposed - Improperly disposed (by province)	2.8	2015 - 2018	1	-	1	Uncollected = Waste - Collected for recycling - Properly disposed - Improperly disposed	1	Uncollected	3

Quality Score



REGIONAL HOTSPOTS
DATA QUALITY ASSESSMENT (2/2)



*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 (2/2)

Fishing:

Leakage from lost/mismanaged fishing gear & overboard litter is estimated in three distinct zones of the South African coastline (west, south and east coasts) and includes three parameters:

1) Direct loss of fishing gear at sea: based on the number of vessels per fishing gear (e.g. demersal trawl), registered in each port of each zone (*Cefas, 2020*). The raw unit loss per type of gear is derived from *Richardson et al., (2019)*. By default plastic weights by fishing gear type were derived from technical designs found in multiple publications: *Nédélec et al. (1990), Prado (1990), Boopendranath, M. (2012) and Kishan, W. et al. (2018) and Queirolo, D. et al. (2009*). Combining these pieces of information yields the net plastic input from fishing gears as well their plastic leakage.

2) Leakage from overboard littering by fishermen: is calculated based on the number of fishermen in the country, their average number of days spent at sea (120 days) and the amount of packaging littered in the country based on Tool T3 and doubled for fishermen.

3) Leakage from mismanaged fishing gear on land: results from the application of Tool T3 to total plastic in fishing gears in use, defined as 10 times higher than direct loss at sea (based on average ratio between direct loss at sea and fishing gear net input found for other pilot countries).

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