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Plastic Pollution Hotspotting and Shaping Action

Regional Results from Eastern and Southern Africa, the Mediterranean, and Southeast Asia

Margherita Pucino, Julien Boucher, Alexandre Bouchet, Paola Paruta, Melissa Zgola

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1 The UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action is available at: https://plastichotspotting.lifecycleinitiative.org/

2 The eight pilot site reports are available at: https://plastichotspotting.lifecycleinitiative.org/pilots

Foreword

Our global ocean, coastlines, and rivers continue to suffer from an immense volume of plastic pollution. This comes as a result of the unsuitable take-make-dispose economy because plastic is such an ideal, inexpensive, versatile, and lightweight material for so many applications. Given the projected annual increase in global plastic production of 4%, the importance of a harmonised methodology to measure plastic waste and leakage, and their associated impacts, is critical.

Plastic leakage is a complex issue. Identifying it and addressing it requires stakeholders from various levels to join forces to understand and benchmark the issue, and to close the data and knowledge gaps that prevent action. As such, a harmonised methodology is needed to understand plastic hotspots – the most relevant plastic polymers, applications, industrial sectors, regions or waste management stages that drive the leakage of plastics into the environment. Once the hotspots have been identified, actions can be taken to address plastic pollution in a holistic, comprehensive manner.

As part of a series of reports from the outcomes of the IUCN Close the Plastic Tap initiative, this Report combines important information from three separate projects: Marine Plastics and Coastal Communities (MARPLASTICCs), Plastic Waste Free Islands – Mediterranean, and PlastiCoCo.

The main goal of this Report is to fill knowledge gaps and inspire actions that will reduce plastic pollution by showing results of the use of the *UNEP/IUCN National Guidance for Plastic Hotspotting and Shaping Action* in the context of pilots in eight locations in Eastern and Southern Africa, the Mediterranean and Southeast Asia. Seven national pilot assessments and one subnational assessment were performed. These assessments, referred to as **pilot sites** in this Report, include national reports from Kenya, Mozambique, South Africa, the United Republic of Tanzania, Thailand, Viet Nam, the Republic of Cyprus, and a provincial assessment of the island of Menorca (Spain).

In order to demonstrate the **intra- and inter-regional similarities and differences** in plastic pollution based on these assessments, this Report provides a comparative overview of plastic leakage; an exploration of regional recycling capacity; a showcase of hotspots by archetype, polymer, application, and sector; and a range of potential instruments and interventions for consideration by decision makers to address plastic pollution. Additionally, the publicly available data for each assessment is shared to illustrate the foundations on which this Regional Report is built.

I hope that this Report and the results of the eight pilot assessments will provide lessons and insights that will lead to actions that meaningfully address plastic pollution in the pilot sites and across the regions. Sharing these results from the application of the *UNEP/IUCN National Guidance for Plastic Hotspotting and Shaping Action* for plastic pollution assessment is important if science-based decision-making on plastic pollution is to be mainstreamed globally to close the plastic tap.

Minna Epps
Director, IUCN Global Marine and Polar Programme

1. Better knowledge and data: keys to solving the plastic pollution crisis

1.1. Core challenges faced in order to mitigate plastic pollution

- *Plastic* is a single word representing a multifaceted reality, encompassing a wide variety of polymers and additives with various chemical and physical properties. Plastics are ubiquitously used in products ranging from single-use plastic bags, food wraps and plastic bottles, to fishing lines, building materials, and synthetic fibres used in the clothing and fishing industries.

- Plastic pollution is as pervasive as the use of plastic itself. An estimated 10 million tonnes of plastic, in all shapes and forms, leak into the ocean each year (Boucher et al. 2020a).

- The plastic crisis is connected not only to littering and waste management, but also human health and loss of biodiversity.[3] Furthermore, plastic production and leakage are highly interconnected with climate change. Current waste management practices contribute to 5% of global GHG emissions; these GHG emissions result from a combination of inadequate waste collection, uncontrolled dumping, and burning of waste, which are the same activities behind plastic leakage (Kaza et al. 2018).

Measuring and forecasting plastic leakage (and impacts) is complex and challenging due to multifaceted aspects of the leakage pathways (leading to a high structural uncertainty), as well as the lack of data to feed the leakage models (leading to a high parametric uncertainty). Adequate metrics, i.e., displaying enough robustness, granularity and actionability, are needed to enable private and public sectors to align on and prioritise action.

Between 2019-2020, IUCN and Quantis EA conducted the measurement of plastic pollution hotspots in eight pilot sites in Africa, Asia and the Mediterranean. The Annexes to this publication provide the plastic pollution overview for each pilot site studied, including data tables used in the modelling of the pilot reports and this publication, in order to provide the supporting data that was used to generate the figures and tables included here.

There are a number of modelling approaches to document and measure plastic pollution and leakage in development or in use. This Report includes results using the guidance and modelling tools that have been developed by UNEP, IUCN, and Quantis EA. The results shown here draw a set of conclusions applicable to the specific regions, but are limited to the eight assessments. It is hoped that additional assessments and data will be generated in the future to fill in the knowledge gaps globally; and

3 For more information, refer to https://www.marilca.org

that the broad use of the *UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action* is taken up by other national and subnational actors.

1.2. A plastics mitigation strategy requires actionable metrics

- As for other science-driven sustainability strategies, a plastics mitigation strategy can be defined in four stages: (1) collecting appropriate data; (2) using the data to generate actionable knowledge (i.e., knowledge with adequate granularity to shape action); (3) monitoring and tracking data; (4) acting on priorities; and (5) disclosing performance to enable continuous improvement.

- In the case of plastic, there is a very strong connection between the private sector (the main supplier of plastic to the market) and the public sector (generally responsible for the infrastructure to handle the plastic waste). For example, extended producer responsibility (EPR) schemes have emerged as a tool to better connect these two dimensions of the plastic value chain.

- The schematic below (Figure 1) represents the components of a proposed plastic mitigation strategy that take into account how the private and public sector components relate to one another . The top half corresponds to data and knowledge aspects of a strategy, while the bottom half corresponds to action and disclosure components of a strategy.

A metrics-based solution pathway approach can address both national needs and business level solutions, gathering the relevant background/ baseline data for the assessment, and generating a list of plastic leakage hotspots along the plastic

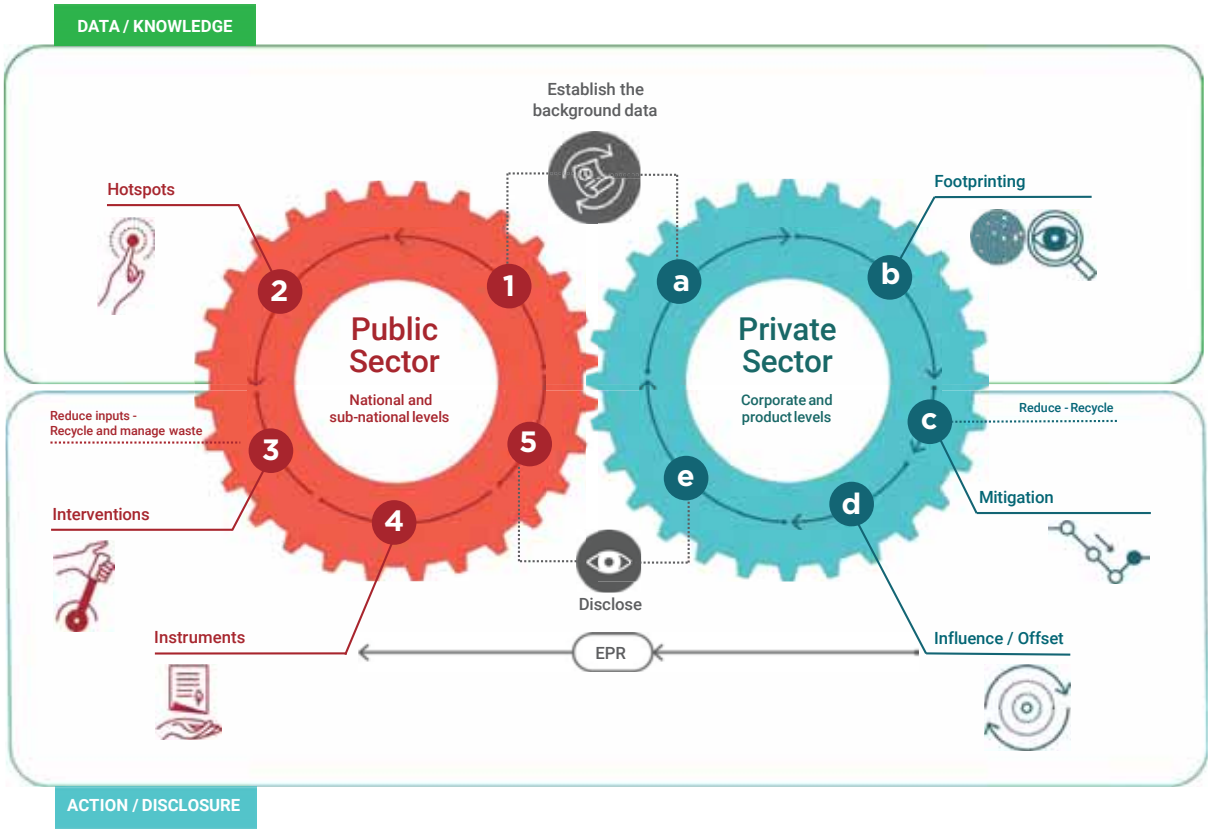


Figure 1 Metrics-based approach to tackling plastic pollution

value chain (Figure 1). These two aspects of addressing plastic pollution are fundamental to a thorough assessment. These two aspects are aligned with the methodology within the *UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action* for this publication.

Step 1/a. Collect background data: Every action plan needs a baseline from which to launch. A *baseline* is a fundamental aspect of a metrics-based *hotspotting* and *footprinting* assessment, both at public or private (corporate/product) levels. The baseline consists of background data which will typically evolve over time. These background data are essential to characterise a country (or a defined area) in terms of its plastics production and consumption level, import and export, waste management strengths and weaknesses, and leakage performance. Such data typically include the collection, recycling and leakage rates for various polymers.

Step 2. Identify hotpots: Hotspots represent sources and conditions of plastic leakage where action to address them will lead to the highest success for plastic pollution reduction. Such causes and conditions will typically be expressed in terms of specific plastic polymers, applications, industrial sectors, regions, or waste management practices. A hotspotting assessment at country level (or another defined area) will inform which polymers or formats leak at which rates and where; which industrial sectors cause the most leakage; and will identify where in the product life cycle those leakages happen. Once hotspots are identified, interventions to address them should be planned.

Step 3. Interventions are the activities chosen to mitigate plastic leakage hotspots. Interventions can be achieved by way of various *instruments*, such as regulations to influence inputs[4], or infrastructure development to improve the fate of outputs. The actions of governments and consumer choices, which influence business responsibility and responsiveness to the market demands, should also be considered when selecting interventions. Consumer behaviours should not be the sole focus to drive change; business practices and governmental regulations should also be considered. **Improve infrastructure:** Infrastructure improvements may include developing capacity or innovating. Typical examples include increasing waste collection rates and improving infrastructure to avoid waste mismanagement.

Step 4. Converge on instruments: Instruments are tactical approaches used to implement interventions. Instruments can take a variety of forms [give the types of instruments] .For example, Extended Producer Responsibility (EPR) by itself is normally not considered a policy or regulatory instrument, but a principle through which provisions of certain policy or regulatory instruments can be exercised. A waste policy or regulation integrating instruments that encourage EPR in a country (or defined area) are example that are part of the broader picture of possible instruments.

Step 4b. Assess organisational footprint: An organisation may assess the plastic footprint of its own activities (direct and indirect) or of its products.

Step 4c. Mitigate: Mitigation includes any action that an organisation might directly undertake, within its value chain or under its control, to reduce its leakage footprint. Mitigation typically includes reduction of plastic use, implementation of re-use schemes, and enabling the recyclability of products.

Step 4d. Invest in Extended Producer Responsibility: According to the OECD definition, extended producer responsibility (EPR), is "an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle"[5].

4 Inputs: In this publication, inputs consist of domestic production and imports while outputs consist of exports, waste generation and increase of stock.

5 OECD definition of EPR available at: https://www.oecd.org/environment/waste/extended-producer-responsibility.htm#:~:text=OECD%20defines%20Extended%20Producer%20Responsibility,of%20a%20product's%20life%20cycle.

Step 5e. Disclose: Disclosure is the gateway to transparency and paves a path for continual improvement. Disclosure topics may include, for example: the amount of plastic product/packaging placed on the market, the amount of waste generated, and the recycling rate.

1.3. Objectives of this report

This Report showcases the use of the guidance presented in the *UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action,* in the context of eight pilot sites[6]. This publication compares the three regions and provides situational analyses in terms of hotspots and interventions to address plastic pollution. The objectives of this report are:

1. To present the results of each pilot test in the context of its region, and benchmark across regions comparing the pilot sites' results in terms of what is leaking, where is it leaking, and why is it leaking;
2. To provide a high-level summary of results for each pilot assessment and map of key similarities and differences by hotspots;
3. To learn from the piloting process and provide recommendations for future updates to the methodology; and
4. To disseminate this information to the regions.

1.4. Navigation of this Report

To help navigate this report, this structure is applied within each section, as follows:

	The primary questions addressed and a figure presenting the supporting data and results
	Results expressed as absolute values
	Results expressed as per-capita values, or as rate values
	Key conclusions and messages

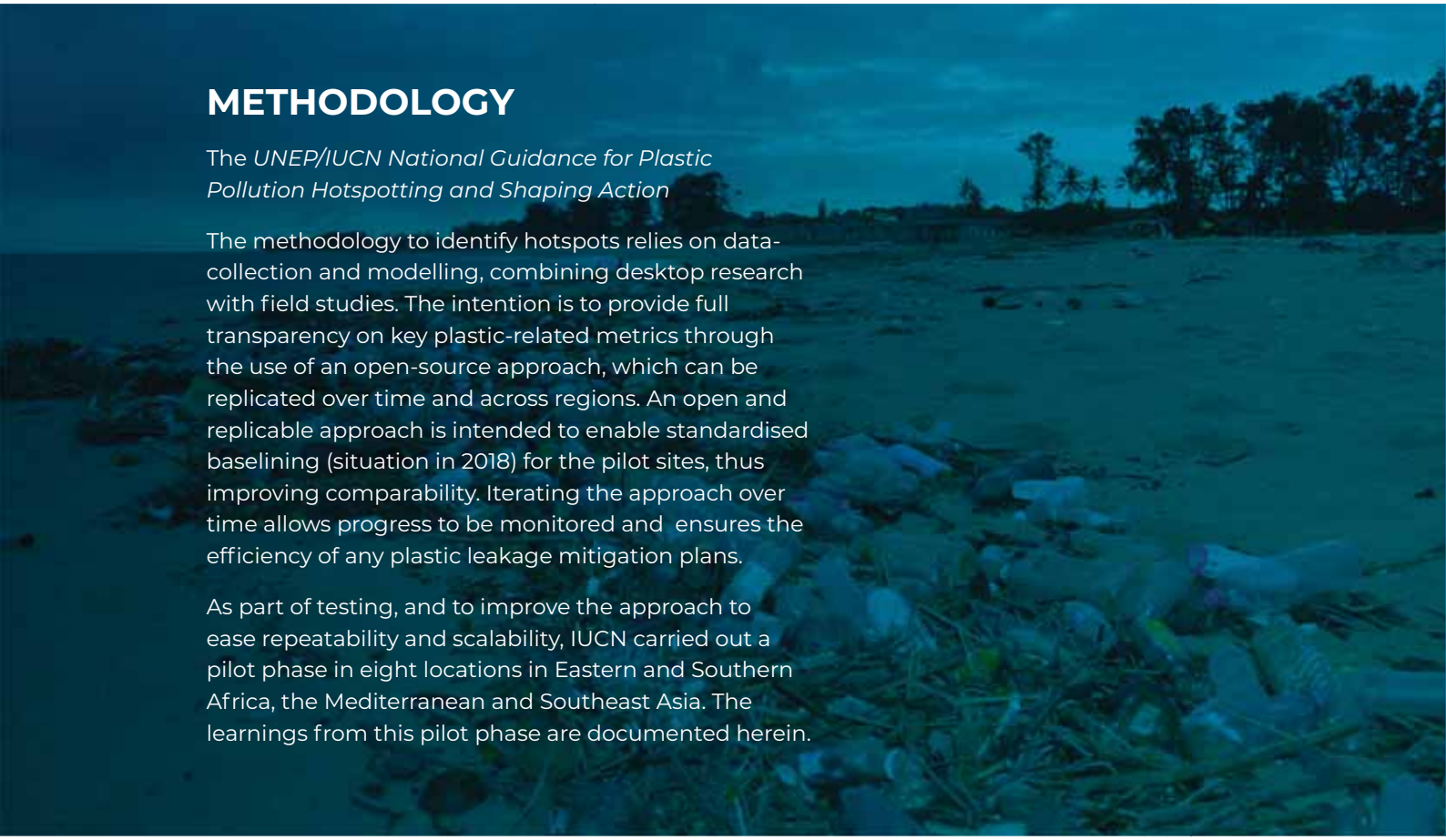
6 Results of plastic leakage hotspots and underlying data were gathered from eight national and subnational locations (Kenya, Mozambique, South Africa, the United Republic of Tanzania, Thailand, Viet Nam, Republic of Cyprus and Menorca, Spain), and throughout three regions (Eastern and Southern Africa, Asia, and the Mediterranean). The reports were reviewed by stakeholders in the countries and territories, and the contents have been shared openly and transparently with all involved parties for validation. All reports are available at https://plastichotspotting.lifecycleinitiative.org/pilots/.

1.5. Methodology of the UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action

- The *UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action* is the product of a joint effort of UNEP and IUCN . This guidance provides a standardised approach and framework to help national and subnational governments identify plastic leakage hotspots along the entire plastic value chain, and to prioritise corresponding actions. (For more information, please refer to the full publication at https://plastichotspotting.lifecycleinitiative.org).

- *Hotspots* refer to the most relevant plastic polymers, applications, industrial sectors, regions and waste management stages that cause plastic leakage into the environment, as well as the associated impacts through the life cycle of plastic products. The process of identifying hotspots requires exploration of what is leaking, where it is leaking, and why it is leaking.

- Emphasis is placed on balancing resources and effort with granularity needed to assess the regional situation. Indeed, given the complex and multifaceted nature of the plastics crisis, there is no one silver bullet that can solve the plastic crisis globally. The guidance provides a systemic framework to help tackle this complexity.



METHODOLOGY

The *UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action*

The methodology to identify hotspots relies on data-collection and modelling, combining desktop research with field studies. The intention is to provide full transparency on key plastic-related metrics through the use of an open-source approach, which can be replicated over time and across regions. An open and replicable approach is intended to enable standardised baselining (situation in 2018) for the pilot sites, thus improving comparability. Iterating the approach over time allows progress to be monitored and ensures the efficiency of any plastic leakage mitigation plans.

As part of testing, and to improve the approach to ease repeatability and scalability, IUCN carried out a pilot phase in eight locations in Eastern and Southern Africa, the Mediterranean and Southeast Asia. The learnings from this pilot phase are documented herein.

2. Overview of Leakage Magnitudes and Hotspots

2.1. Locations of the Pilots

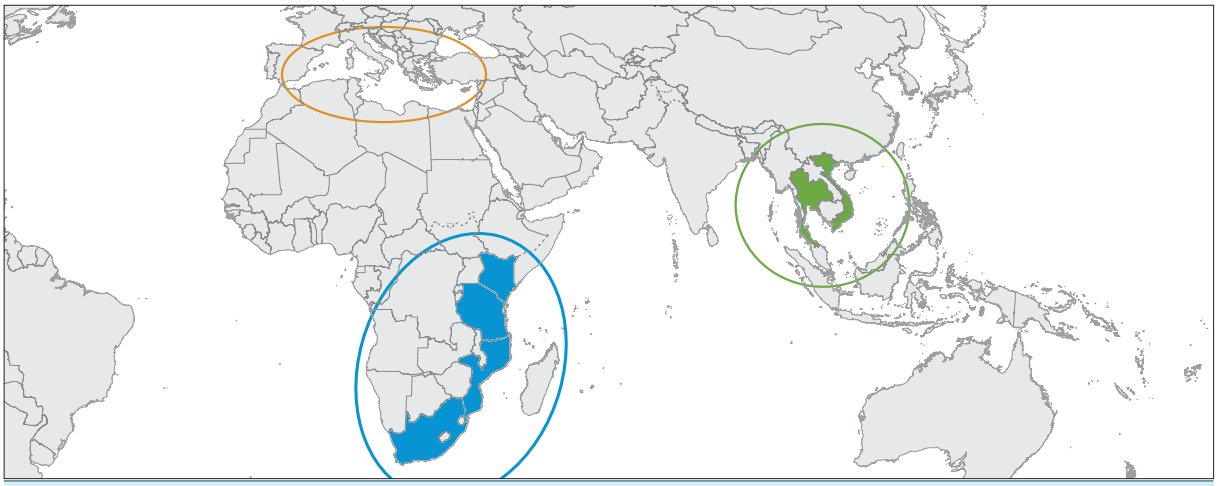


Figure 2. Map of pilot sites.

Global map showing the eight pilot assessments undertaken in Kenya, Mozambique, South Africa, and the United Republic of Tanzania in Eastern and Southern Africa; the Republic of Cyprus and Menorca (Spain) in the Mediterranean, and Thailand and Viet Nam in Southeast Asia. Map courtesy of UNEP.

- The leakage assessment and hotspotting exercise took place in **three regions**:
  - (i) part of **Eastern and Southern Africa**, which includes: Comoros, Kenya, Madagascar, Mauritius, Mozambique, Reunion, Seychelles, Somalia, South Africa and United Republic of Tanzania;
  - (iii) part of the **Mediterranean** region, which includes: Albania, Algeria, Bosnia and Herzegovina, Croatia, Republic of Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Morocco, Montenegro, Slovenia, Spain (Menorca), Syria, Tunisia and Turkey; and
  - part of **Southeast Asia**, which includes: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Viet Nam.
- Within these regions, **eight specific pilot sites** were selected for more detailed analysis and case study: **Kenya, Mozambique, South Africa, United Republic of Tanzania**, **Republic of Cyprus and Menorca** (with Menorca being the only sub-national pilot study), and **Thailand and Viet Nam**.
- The following sections present: 1) each pilot's plastic leakage results, 2) comparisons to other locations in the regions where a pilot was conducted, and 3) comparisons to regional and global results.

2.2. Data Comparison Notes

All **comparisons** are provided against benchmark data, including the What a Waste 2.0 database (Kaza et al., 2018) and Jambeck et al. (2015) (Table 1). These datasets are understood to be the most current and comprehensive available at the country level. More studies will continue to be published, and the reader is invited to view detailed analyses of specific areas of interest (Boucher and Billard 2020b).

Some **limitations of benchmarking** regarding the data from Kaza et al. (2018) and Jambeck et al. (2015) should be noted: 1) these data sources may lack data for the seven national locations and one sub-national location included in this study; and 2) in Jambeck et al. (2015), the reference year is 2010, and the population considered is limited to that within 50 km of the coastline.

The data presented in this publication for the eight pilots are those from the corresponding IUCN reports.[7] Regional and global data are taken from one of the two benchmarks mentioned above, based on data deemed most relevant to the situation. Table 1 presents the key differences between the pilot assessments and the benchmarks.

- One of the **metrics** used to interpret the plastic leakage results is the HDI, Human Development Index (UN, 2020). HDI is an index that measures key dimensions of human development such as Life Expectancy (based on life expectancy at birth), Education Index (based on expected years of schooling and average years of schooling), and Standard of Living GNI (Gross National Income per capita). The authors believe that HDI may be a more representative and interesting indicator for comparison than GNI or GDP, which are more limited as they solely measure economic activity. HDI concentrates on qualitative outcomes and provides a basic indication of social welfare and freedom, which is more relatable to the plastic pollution issue than mere economic growth.
- The HDI is a unitless metric expressed on a scale of 0.0 to 1.0, with 0.0 equating the worst conditions and 1.0 equating the best.

Table 1. Data sources and key differences

Data source	Publication year	Data year of reference	Locations investigated	Population considered	Release rate (RR) for leakage
Plastic waste inputs from land into the ocean, (Jambeck et al.)	2015	2010	Coastal countries	Population living within 50 km of the coast	Range reported 10-40%, 25% is generally used as an average
What a Waste 2.0, (Kaza et al.)	2018	2016	Inland and coastal countries	Entire population of country	10%(a)
IUCN/EA/Quantis 8 Assessment Reports	2020	2018	Sample of eight coastal locations	Entire population of location	7-12%

(a) The Kaza et al. study does not perform a leakage calculation, hence no release rates are provided. The 10% value is instead taken from the Plastic Leak Project report (Quantis, 2020).

7 The eight IUCN assessment reports are available at https://plastichotspotting.lifecycleinitiative.org/pilots/

2.3. Comparative overview of plastic leakage magnitude

The overarching questions to be explored in these sections are:

- Which pilot sites and regions have the highest leakage?
- How do the pilot sites and regional-level leakage rates from this study compare to regional and global averages, as well as to other countries of similar levels of development?
- How do the values from this study compare to those of Jambeck, et al. (2015)?

Data to address these questions are provided in Figures 3 and 4 and Table 2 below.

| Mediterranean region | | Eastern and Southern Africa region | | Southeast Asia region |

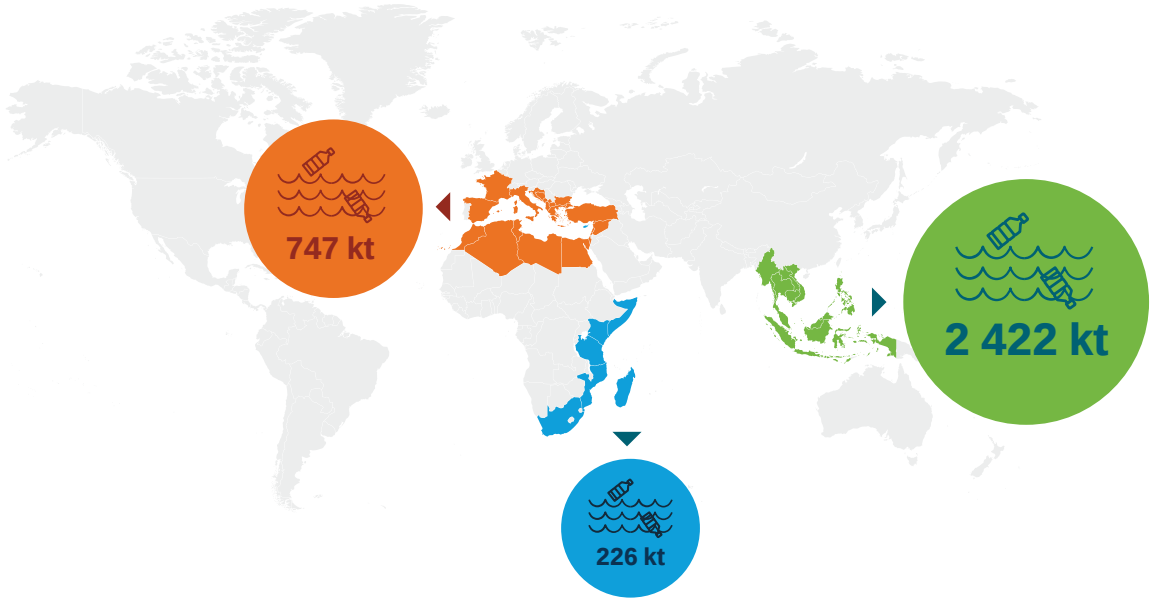


Figure 3. Map of regional totals: values are from IUCN/EA/QUANTIS studies, where available, and supplemented with regional values from Jambeck, et al., 2015.

Figure 4. Map of absolute leakage values, pilot sites

The length of bars and area of circles correspond to the relative magnitudes. Country and subnational values are from IUCN/EA/QUANTIS studies (2020). IUCN/EA/QUANTIS data refer to the year 2018.

Table 2. Total leakage per capita values for each of the pilots compared to benchmark.

Total leakage (kt) and per capita values (kt/capita) for each of the pilots calculated by IUCN/EA/QUANTIS studies (2020), compared with the benchmark, Jambeck et al. (2015). Menorca is not present in the Jambeck study as it is not a country. Leakage per capita benchmark values from Jambeck were re-calculated based on the entire total population of each country in 2010.

	Thailand	Viet Nam	Kenya	Mozambique	South Africa	United Republic of Tanzania	Republic of Cyprus	Menorca
Total leakage *(kt)*	336	452	37	17	79	29	0.8	0.1
Jambeck benchmark	256	458	5	11	157	12	0.5	
Per capita leakage *(kg/capita)*	5.0	4.7	0.8	0.6	1.4	0.5	0.9	0.9
Jambeck benchmark	3.8	5.2	0.1	0.5	3.1	0.3	0.4	

2.3.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, United Republic of Tanzania

- In South Africa, although the estimate of plastic leakage to waterways and the ocean is half of the average estimated by Jambeck et al. (2015), at 79 kt instead of 157 kt, it still contributes 35% of total plastic leakage within the Eastern and Southern Africa region.
- For Kenya, it is quite the opposite as the plastic leakage estimate is six times that from Jambeck et al. (2015), with 37 kt instead of 6 kt.
- For Mozambique, the estimate is one-and-a-half times that of Jambeck et al. (2015), with 17 kt instead of 11 kt.
- For United Republic of Tanzania, the estimate of 29 kt is more than twice that of Jambeck et al. (2015) of 12 kt.
- The estimated cumulative contribution of Kenya, Mozambique, and United Republic of Tanzania is nearly equal to that of South Africa.
- Based on these studies, Kenya, Mozambique and the United Republic of Tanzania contribute 16%, 7.5% and 13%, respectively, to the total plastic leakage in the Eastern and Southern Africa region.

- Leakage per capita in Eastern and Southern Africa varies from 0.5 kg/capita/year in the United Republic of Tanzania, up to 1.4 kg/capita/year in South Africa. Most of the values from these site-specific studies fall below the Eastern and Southern African region average of 1.3 kg/capita/year calculated by Jambeck et al. (2015).

2.3.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- Since the Republic of Cyprus and Menorca are islands with smaller population counts and rather efficient waste management systems, they together contribute to less than 1% of the total leakage arising from all the nations bordering the Mediterranean Sea (0.1% for Republic of Cyprus and 0.01% for Menorca).

- In both the Republic of Cyprus and Menorca, leakage per capita amounts to around 0.9 kg/capita/year, which remains below the average for Mediterranean nations of 1.6 kg/capita/year. Quite surprisingly, this leakage per capita value is close to that of Kenya, where plastic waste is largely mismanaged.
- Considering that waste management systems in Republic of Cyprus and Menorca operate well, it can be inferred that waste generation per capita is much higher on the Mediterranean islands than in Kenya (Table 2).

2.3.3. **Southeast Asia:** Thailand and Viet Nam

- Within Southeast Asia, plastic leakage estimates for Viet Nam are similar to averages from Jambeck et al. (2015)[8], while in the case of Thailand a certain difference is visible (452 kt and 336 kt, respectively).
- With these substantial quantities of plastic leaking into waterways and the ocean, Viet Nam and Thailand contribute 19% and 14%, respectively, of the total plastic leakage stemming from the region.

- In Southeast Asia, leakage per capita is high and consistent across the region's pilot areas, with 5.0 kg/capita/year in Thailand and 4.7 kg/capita/year in Viet Nam. This is above the average of 4.0. kg/capita/year for the region as derived from Jambeck et al. (2015).

8 The authors of the Jambeck et al. (2015) study provide a range of values for plastic leakage due to a release rate varying between 15 and 40%. An average estimate of their plastic leakage results based on a 25% release rate are used for comparison in this report.

2.3.4. Plastic leakage rates and HDI

To better understand how the results in the pilot assessments relate to one another and to their regional average, the per capita results have been plotted and are shown relative to their HDI in Figure 5. Key findings are then reported.

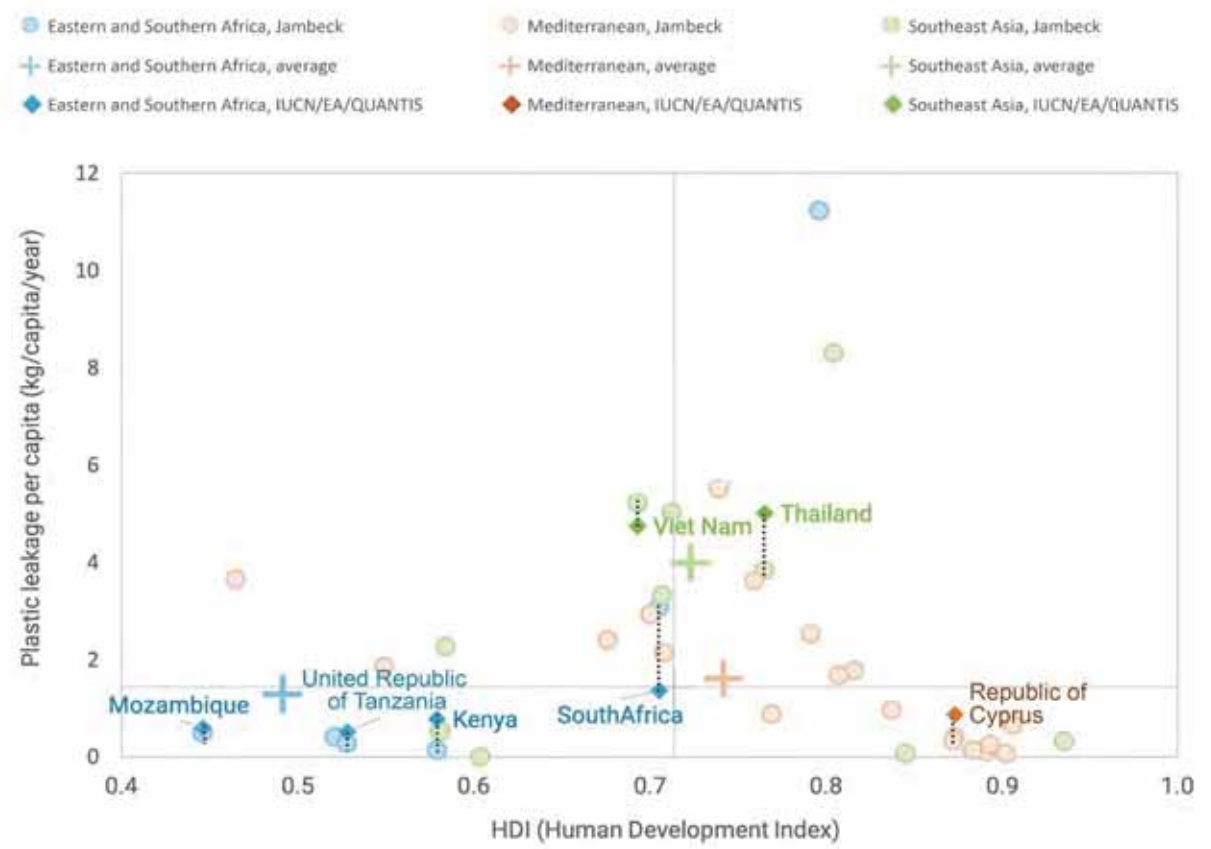


Figure 5. Plastic leakage and HDI

The distribution of leakage per capita as it relates to regional HDI are shown for the pilot sites and regions. The grey lines cross at the world average values. Coloured diamonds represent the IUCN/EA/QUANTIS (2020) pilot sites; light coloured circles represent other pilot sites in the selected regions; crosses represent regional average values from Jambeck et al. (2015); and dotted grey lines represent the difference between IUCN/EA/QUANTIS (2020) values and the Jambeck et al. (2015) benchmark. Leakage per capita benchmark values were calculated based on the entire total population of each country in 2010. Menorca does not appear as it is not a country, and for this reason, it is not included in the Jambeck et al. (2015) study. IUCN/EA/QUANTIS (2020) values refer to 2018 while Jambeck at al. (2015) data refer to 2010.

- The results from each pilot assessment are distributed into three distinct clusters, represented by the three differently coloured circles on the chart: one with low leakage and low HDI; one with higher leakage and higher HDI; and one with low leakage and high HDI. The first group is comprised of the countries in Eastern and Southern Africa, which have low leakage rates–less than 2 kg/capita/year–and an HDI lower than 0.6, with the exception of South Africa which has slightly higher values. In the second group, the two countries in Southeast Asia are comparable in terms of both leakage and quality of life. In the third group, Republic of Cyprus stands alone with a high HDI and low leakage.
- Comparing the values obtained in this study to the benchmarks from Jambeck et al. (2015), it appears that all values are similar with the exceptions of South Africa and Thailand. For South Africa, Jambeck et al. (2015) report per-capita leakage, which is twice as high as that estimated here; and 1.3 times less for Thailand than what is estimated here.
- Looking more broadly at the placement of individual pilot areas with respect to others in their region, it appears that the countries in Africa remain a cluster with low HDI and low leakage values (with the exception of South Africa and Mauritius), while the Mediterranean and Asian pilot areas are more evenly distributed across a wider range of values.

2.3.5. Plastic leakage – key messages

Where is plastic leakage highest?

- On average, Thailand and Viet Nam produce ten times more plastic leakage than Kenya, and five times more than South Africa. Kenya and South Africa are the two largest contributors to plastic leakage among the pilot sites in Africa.
- Absolute plastic leakage from the Mediterranean islands is 100 to 1000 times less than that of countries in Africa and Asia. The low leakage of these small islands can be explained not only by their low populations but also by their more efficient waste management systems.

How do the plastic leakage rates in this Report compare to regional and global rates, as well as to pilot sites of similar income level?

- Thailand and Viet Nam are slightly above the average per-capita leakage of their region (regional average is 4 kg/capita/year) and almost three times higher the world average of 1.4 kg (Jambeck et al., 2015).
- Mozambique, Kenya and the United Republic of Tanzania have lower per-capita leakage than the regional average of 1.3 kg, but South Africa is in line with it.
- Republic of Cyprus is below the Mediterranean per-capita regional average of 1.6 kg.
- The discrepancies in values between IUCN/EA/QUANTIS (2020) data and the benchmarks that appear in this report are explained by the intrinsic differences in the methodologies.

2.4. What is driving plastic leakage in the pilot sites?

The overarching questions explored throughout the following sections are:

- What are the key drivers of plastic leakage in the pilot sites?
- How do plastic waste management practices compare?

Data to address to these questions are provided in Figure 6 and the questions are further discussed below.

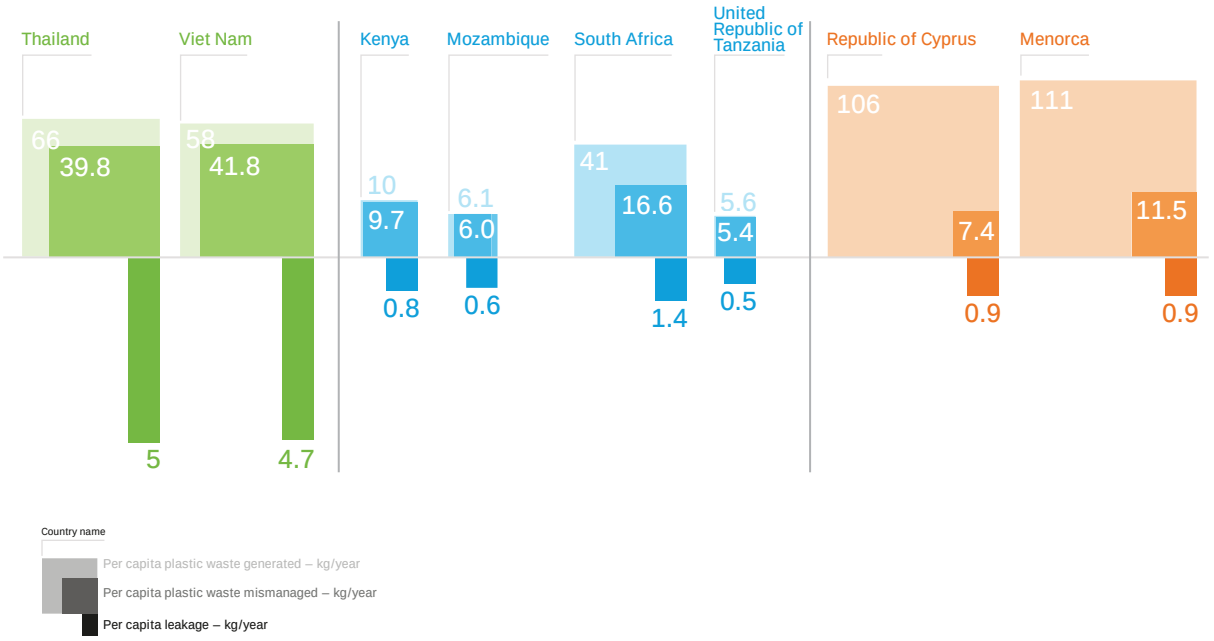


Figure 6. Magnitudes of plastic waste generation, mismanagement and leakage

The yellow boxes and their size represent relative per capita plastic waste generation for each of the pilot sites; the orange boxes and their size represent the relative magnitude of mismanaged plastic, from which the leakage (shown here in red) is derived. All data refer to the year 2018.

2.4.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, United Republic of Tanzania

- In general, African countries consume and waste less plastic per capita as compared to Asian countries. Plastic waste generation in Africa spans from 6 to 41 kg/capita/year compared to 58 or 74 kg/capita/year in Asia.
- Leakage per capita is also lower than in Asia (ca. 1 kg per person vs ca. 5 kg in Asia), but is quite similar to the leakage seen in Mediterranean countries.
- However, in South Africa, leakage tends to be higher due higher plastic consumption.

- Waste management is generally not very developed in African countries; there tend to be low collection rates and few sanitary landfills and incinerators.
- In Mozambique, Kenya and the United Republic of Tanzania, the waste generated is almost entirely subject to mismanagement. The high mismanagement values are mainly related to low collection rates. For instance, in Kenya, almost all plastic waste is mismanaged of which almost three quarters is due to uncollected plastic waste.

2.4.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- In absolute terms, the Mediterranean islands do not leak large quantities of plastic, as compared to the other two regions studied in this Report. It is noteworthy that the per capita amount of waste generated in the islands (values above 100 kg/year) surpass the ones of all other pilot sites. Calculations estimate that up to 11 and 23% of the waste generated is due to tourism in the Republic of Cyprus and Menorca, respectively.

- When it comes to plastic mismanagement, it appears that the absolute numbers for the Mediterranean islands are quite low. However, these numbers still lead to high per capita leakage (around 1 kg/person/year), which is of the same order of magnitude as that of Kenya and Mozambique. This leakage, which only stems from uncollected plastic waste, is driven by very high plastic waste generation per capita.

2.4.3. **Southeast Asia:** Thailand and Viet Nam

- Plastic consumption levels in Thailand and Viet Nam are high. Plastic is heavily present in all sectors (packaging, textile and construction); and on-the-go plastic products are ubiquitous in everyday life.

- Leakage per capita is five times higher in Thailand and Viet Nam than in the other six pilot sites. This is due to a combination of high plastic consumption and rather poor waste management practices.
- In Viet Nam, more than half of the plastic waste generated remains uncollected, while in Thailand it is slightly more than a quarter. Uncollected plastic is a large driver of the significantly high mismanagement values. It is important to note that what is reported for Viet Nam for collected and improperly disposed waste could have been underestimated because it was not possible to properly quantify the amount of plastic disposed at landfills. Nevertheless, this limitation does not affect the leakage estimate in any significant manner.

2.4.4. Plastic waste generation rates and HDI

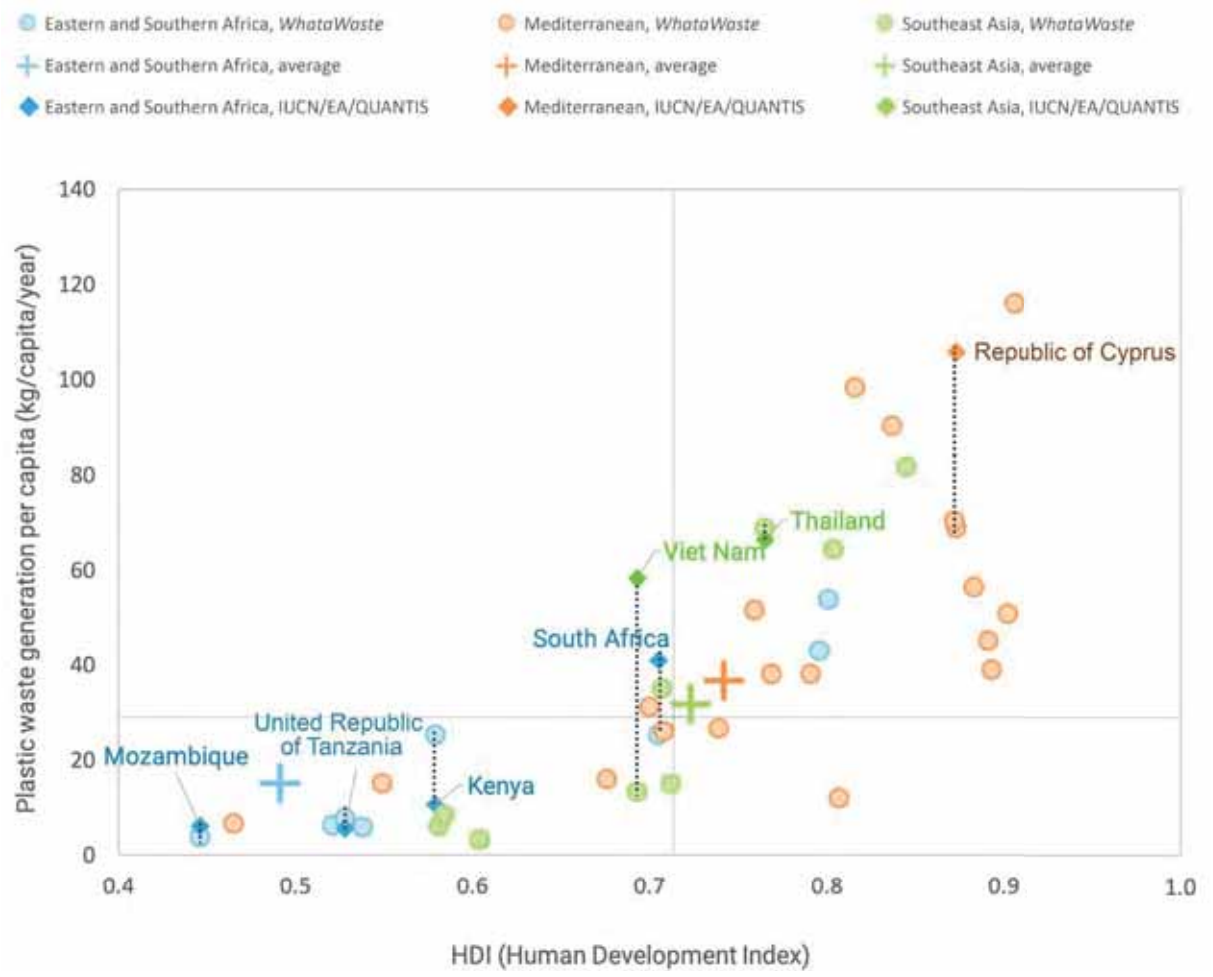


Figure 7. Waste generation and HDI

The chart shows the distribution of pilot sites with respect to their per capita waste generation and HDI. The grey lines cross at the world average values. Coloured diamonds represent the IUCN/EA/QUANTIS (2020) pilot sites; light coloured circles represent other pilot sites in the selected regions; crosses represent the regional average values from Kaza et al. (2018); and dotted grey lines represent the difference between IUCN/EA/QUANTIS (2020) values and the Kaza et al. (2018) benchmark. Menorca does not appear as it is not a country; for this reason, it is not considered in the WhataWaste 2.0 database (Kaza et al., 2018). All data refer to the year 2018.

- By observing where the pilot sites fall in terms of their waste generation and their HDI, Asian pilot sites and South Africa represent a cluster of high waste generation and similar HDI.
- Other Eastern and Southern African pilot sites, except South Africa, cluster more closely together and constitute a much larger cluster if combined with those in the Southeast Asia. This cluster can be characterised with a lower HDI than the global average and low plastic waste generation.
- Republic of Cyprus differentiates itself with both high HDI and high waste generation.
- The data obtained from these studies does not differ substantially from those of Kaza et al. (2018), except for Viet Nam and Republic of Cyprus. The discrepancy in the case of Viet Nam is due to a misinterpretation of the values in the source report, Kaza et al. (2018), which is in fact aligned with this study's results. In the case of the Republic of Cyprus, the data source of the What a Waste 2.0 database (Kaza et al., 2018) is Eurostat (2017), but it only accounts for household waste (Nguyen, H. et al., 2014).

2.4.5. Plastic waste mismanagement – key messages

What are the key drivers of the plastic leakage?

- Across the eight assessments, there are three drivers of the mismanagement of plastic waste.
- High waste generation values and/or a high degree of mismanagement result(s) in high plastic leakage values.
- Usually, high mismanagement rates are related to low collection rates. Even in cases where some waste is collected, a portion of it is improperly managed by ending up in open dumps or unsanitary landfills. This suggests that simply increasing collection rates is not sufficient on its own and governments should ensure that collected waste is eventually properly disposed in sanitary landfills or incinerated in strictly controlled conditions.
- Even in cases where some waste is collected, a portion of it is improperly managed by ending up in open dumps or unsanitary landfills. This suggests that simply increasing collection rates is not a sufficient action if implemented on its own. Governments should also ensure that collected waste is eventually properly disposed of in sanitary landfills or incinerated in strictly controlled conditions.
- The interventions shared in Table 3 illustrate different means in each pilot context to address the issue of mismanaged waste.

How do these pilot sites compare in terms of plastic waste management practices?

- The two Asian countries presented in this study – especially Thailand, and to a lesser degree Viet Nam – have higher waste generation than their regional average, 32 kg/capita/year, and almost three times higher than the world's average of 29 kg/capita/year.
- Thailand and Viet Nam are certainly the most polluting in terms of plastic leakage per capita. The Eastern and Southern African and Mediterranean pilot sites present similar values albeit with different waste management pathways. This observation highlights the need to tackle the plastic leakage issue from a wide perspective by looking at the whole value chain, from plastic production and consumption down to waste disposal management. Even though in Viet Nam waste management is transitioning to proper management and focuses on high collection rates in urban areas, there are still large quantities of plastics, which remain uncollected. This is due to a combination of extremely high plastic consumption, littering behaviour and open waste burning. The opportunity for plastic to end up in waterways is very high, as the country is rich in rivers and canals, and precipitation can be intense.
- Waste generation per capita among the four pilot Eastern and Southern African sites is below the region's average of 15 kg/year. This is below the global average.
- South Africa is anomalous in the Eastern and Southern Africa region with its high waste generation.
- Republic of Cyprus is largely above the Mediterranean average of 36 kg, which is already higher than the global average.

2.5. Overview of plastic recycling capacity

Ensuring adequate domestic recycling capacity is a key component of any leakage mitigation strategy. This chapter explores the status of recycling, and answers the following questions:

The overarching questions explored throughout this section are:

- What is the plastic recycling rate of each pilot site and how do they compare?
- How much of the current recycling capacity is used to treat imported waste versus domestic waste?w
- How much of the domestic waste is exported for recycling?

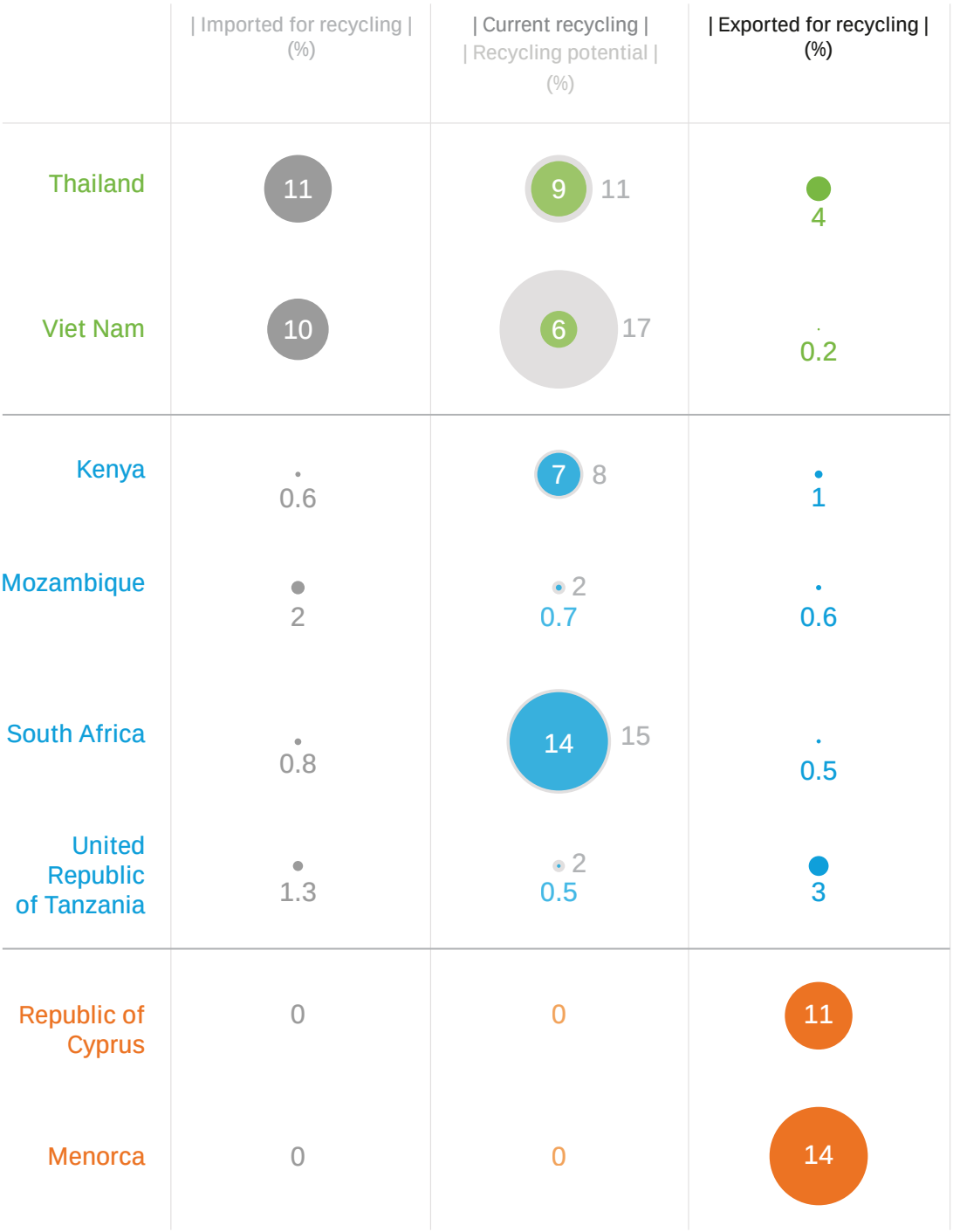


Figure 8. State of plastic recycling in each pilot site

The first column denotes the share of total plastic waste derived from imports (dark grey). The second column shows the actual recycling rates that are currently operating in each site (light green) with respect to recycling potential (light grey). The third column (dark green) provides the amount of waste, which is exported for recycling purposes. 'Imported for recycling (%)' is defined as: import of plastic waste/ (domestic + imported plastic waste). 'Current recycling' is defined as: recycling of domestic plastic waste / (domestic + imported plastic waste). 'Recycling potential' is defined as: recycling capacity / domestic plastic waste. 'Exported for recycling' is defined as: export of plastic waste / (domestic +imported plastic waste). All data refer to the year 2018.

2.5.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, United Republic of Tanzania

- Among Eastern and Southern African countries, the recycling rates are higher for South Africa and Kenya, with 14% and 7%, respectively; and are much lower for Mozambique and United Republic of Tanzania, only 1% and 0.5%, respectively.
- The waste import is relatively small for both South Africa and Kenya, with both pilot sites using most of their recycling potential to recycle domestic waste.
- In Mozambique, the waste that is imported for recycling, although small in relation to the country's overall waste volume, is actually four times higher than the domestic recycling collection (4 kt vs 1 kt). Local authorities have little insight on the fate of this imported waste.[9]
- All pilots included in this Report export only a small portion of their recycling waste.

2.5.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- Republic of Cyprus and Menorca do not have any recycling facilities[10] and for this reason, they export all collected plastic waste. Republic of Cyprus exports 11% of its plastic waste, while Menorca exports 14%. Half of the Republic of Cyprus plastic exports are directed to Greece and 44% are exported to Asian countries.
- Despite the difficulty to understand the precise fate of Menorca's plastic waste exports, it is reported that Spain's top four partners in waste trade are Malaysia, Viet Nam, China, and Thailand (United Nations, 2020).

9 Some limitations should be considered when interpreting these data. This study assumes that in Mozambique, a fraction of the imported waste is dealt with by exporting it, and the remainder is possibly recycled domestically by recycling actors that are not known to waste management authorities (who it was not possible to be in contact with).

10 Data refers to the year 2018.

2.5.3. **Southeast Asia:** Thailand and Viet Nam

- In Viet Nam, imported waste amounts to 10% of the pilot site's total waste. A considerable portion of Viet Nam's recycling capacity is diverted from recycling domestic waste to treat this imported waste. While Viet Nam has the potential to recycle 17% of its domestic plastic waste, it currently only recycles 6%. Moreover, the imported waste is recycled by the formal recycling sector, while domestic waste is recycled mainly in craft-villages where appropriate environmental protection practices are lacking. If Viet Nam were to stop importing plastic and were to divert the formal recycling capacity to recycle domestic waste, this would reduce the pilot site's plastic leakage by 11%.
- In Thailand, current recycling rates for domestic waste are very close to the potential recycling capacity. Nonetheless, much like in Viet Nam, Thailand imports large quantities of plastic waste from all over the world. After China banned plastic waste imports in 2018, Thailand experienced a 360% increase in waste imports relative to 2017. As a result, the imported waste quantity is almost as high as the domestic waste collected for recycling, 556 kt and 635 kt, respectively. But, unlike for Viet Nam, Thailand's recycling capacity (500 kt (Pollution Control Department, Ministry of Natural Resources and Environment, 2018)) is not enough to handle both domestic and imported waste (GAIA, 2019).[11] If Thailand were to stop importing plastic, this would reduce plastic leakage by 11%. Moreover, imported waste allows domestic recyclers to make more profit than with domestic waste alone. If the practice of importing waste continues, the value of recyclable waste for waste pickers would continue to fall, reducing the incentive for this informal waste management sector. If waste pickers were to stop collecting waste, domestic collection and recycling would come to a halt and plastic leakage would increase by 9%.

2.5.4. Recycling capacity – key messages

What is the plastic recycling capacity of each pilot site and to what extent is it used to manage domestic and imported plastic waste?

- Among the eight pilot sites, South Africa has the highest domestic recycling rate[12] (14%); Thailand has the next highest at 9%, and Kenya is in third place at 7%. It is important to note that South Africa receives plastic waste from neighbouring countries.
- In the Southeast Asian and Eastern and Southern African pilot sites, the recycling capacity is not sufficient to handle the total waste volume when considering both domestically generated and imported recycling waste.
- Mediterranean islands currently export most of their waste as they do not have recycling facilities.

11 Some limitations should be considered when interpreting these data. Exports of waste appear to be minimal, but a wide discrepancy in data concerning export of waste from Viet Nam has been found in the COMTRADE database (United Nations, 2020). For example, export data as reported by Viet Nam is 197 kt, with import data from Viet Nam as reported by other countries is 20 kt. The value used for this report comes from BACI database that aims to reconcile COMTRADE data, based on country reporting reliability, and it corresponds to 14 kt. (BACI, sourced via CEPII, Research and Expertise on the World Economy, available at: http://www.cepii.fr/cepii/en/bdd_modele/presentation.asp?id=37#:~:text=BACI%20provides%20disaggregated%20data%20on,Nations%20Statistical%20Division%20(Comtrade).&text=Products%20are%20defined%20as%20items,at%20the%206%2Ddigit%20level.)

12 Amount of plastic waste that is recycled of the total plastic waste generated within each national and subnational study.

2.6. Where is the plastic leaking? Hotpots by geographic archetype.

The overarching questions explored throughout this section are:

- Where is leakage occurring?
- Are there common geographic archetypes where leakage is prevailing?

Where most of the leakage is coming from in each country?

	Thailand	Viet Nam	Kenya	Mozam-bique	South Africa	United Republic of Tanzania	Republic of Cyprus	Menorca
	Total leakage 322 kt	Total leakage 443 kt	Total leakage 35 kt	Total leakage 16 kt	Total leakage 72 kt	Total leakage 27 kt	Total leakage 0.07 kt	Total leakage 0.47 kt
Main Cities Inland	2%	10%	40%	27%	21%	71%	N/A	N/A
Main Cities Waterside	1%	5%	1%	7%	2%	10%	N/A	N/A
Urban Inland	13%	5%	22%	5%	22%	5%	48%	26%
Urban Waterside	7%	4%	4%	2%	3%	1%	18%	62%
Rural Inland	63%	56%	30%	49%	45%	11%	32%	2%
Rual Waterside	13%	21%	3%	9%	6%	2%	3%	9%

Where is leakage most concentrated in each country?

* Average leakage per km²

	Thailand	Viet Nam	Kenya	Mozam-bique	South Africa	United Republic of Tanzania	Republic of Cyprus	Menorca
	(t/km²) 0.5*	(t/km²) 1.1*	(t/km²) 0.06*	(t/km²) 0.03*	(t/km²) 0.1*	(t/km²) 0.03*	(t/km²) 0.01*	(t/km²) 0.06*
Main Cities Inland	4.9	5.7	7.5	2.8	0.7	3.6	N/A	N/A
Main Cities Waterside	10.6	6.4	6.5	4.3	0.9	5.7	N/A	N/A
Urban Inland	1.1	5.3	2.5	0.34	0.3	0.2	0.15	2.26
Urban Waterside	1.9	6.2	3.2	0.48	0.5	0.4	0.30	1.57
Rural Inland	0.4	0.8	0.02	0.01	0.07	0.003	0.03	0.004
Rual Waterside	0.7	1.3	0.05	0.02	0.11	0.006	0.05	0.02

Figure 9. Pilot site leakage distribution by geographic archetype.

The graphic shows the magnitude of leakage stemming from waste mismanagement in terms of several archetypes: main cities, urban areas, and rural areas; and for each of these, inland versus waterside sites. The colour intensity is a function of leakage density (quantity per area (km2)) while values in cells represent the share of the total leakage per archetype. To be noted that: i) The main cities are: 1 – Viet Nam: Ha Noi, Ho Chi Minh City, Can Tho, Hai Phong, Da Nang; 2 – Thailand: Bangkok Metropolis; 3 – South Africa: Johannesburg, Cape Town, Durban, Pretoria, Soweto; 4 – Kenya: Mombasa, Nairobi, Kisumu, Nakuru; and 5 – Mozambique: Maputo, Matola, Beira, Nampula. Densely populated peri-urban areas and townships happen to occur under main cities/urban areas (as those become important in the context of Eastern and Southern Africa). ii) Values for urban areas are taken from the NASA database except for those included in the "Main cities" category (CIESIN, 2018). iii) All other areas are tagged as rural areas. iv) For all archetypes, "waterside" is defined as the national area within 2 km of the ocean coast/ seaside or a river. v) All data refer to the year 2018.

2.6.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, United Republic of Tanzania

- In the Eastern and Southern African pilot sites, it appears that the total plastic leakage is similar between rural areas and urban areas.
- In South Africa, as is the case for the Asian pilot sites, proper disposal of waste is more developed in urban areas. Nonetheless, 49% of plastic leakage comes from urban areas and main cities. This is mainly because 75% of the population is concentrated there.
- In Kenya, Mozambique and the United Republic of Tanzania, where there is inadequate waste management, the per capita plastic leakage in urban areas is not better than in rural areas. The higher urban leakage also has to do with higher plastic consumption overall. In Kenya, most of the leakage comes from the main cities.

2.6.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- In the two Mediterranean islands, the "Main cities" category is not covered, as there are no large cities on these islands. The "Urban" category is used to account for all towns and cities. For both islands, most of the plastic leakage comes from urban areas. In Menorca, only 11% of the leakage comes from rural areas. Interestingly, in Menorca more than 70% of the leakage comes from the 2 km buffer on the coast, which is labelled as waterside, a result not seen in the other reports used herein.

2.6.3. **Southeast Asia:** Thailand and Viet Nam

- Most of the leakage in the two Asian countries comes from rural areas; waste collection and disposal tend to be better organised in urban areas.
- Proper disposal of waste is also more developed in urban areas than in rural areas.

2.6.4. Geographic archetype hotspots – key messages

Where is plastic leakage occurring? Are there common geographic archetypes where leakage is prevailing?

- The density of leakage (reported in Figure 9 as leakage per km^2) is much higher in urban areas than in rural ones, and even more so in main cities.
- Rural areas are as responsible, if not more than urban areas, for plastic pollution of waterways.
- Except Menorca, the seven other pilot reports showed that leakage from waterside areas (within 2 km from the coast) account for only a small portion of the total leakage. This share is the highest in Menorca at 71%, but then spans from 30% in Viet Nam down to a low of 8% in Kenya. This reflects the population distribution within those pilot sites: only a small portion of the population lives along the waterside: 23% for Viet Nam and 6% for Kenya.
- On the other hand, for all pilot sites, leakage density (leakage per km^2) in waterside communities is higher than for inland areas, for each of the three categories (main cities, urban areas, rural). Leakage density is higher along the waterside because of the physical proximity to water. The issue of poor waste management in both waterside and inland areas needs to be addressed.
- Actions to reduce leakage will have a greater positive impact in urban areas than in rural areas. In Eastern and Southern Africa, especially Kenya and Mozambique, urban areas should be a priority to improve the waste management system.
- In Thailand, Viet Nam and South Africa, governments should more seriously address the problems present in rural areas. This includes the low collection rates, burning of waste and general waste mismanagement (especially those closer to urban centres, where plastic consumption and waste generation are likely to be higher).

2.7. What is leaking? Hotpots by polymer, application, and sector

2.7.1. Polymer hotspots

The overarching questions explored throughout this section are:

- What types of polymers are leaking the most?
- Are there commonalities in polymer leakage shown in the results from each study location?

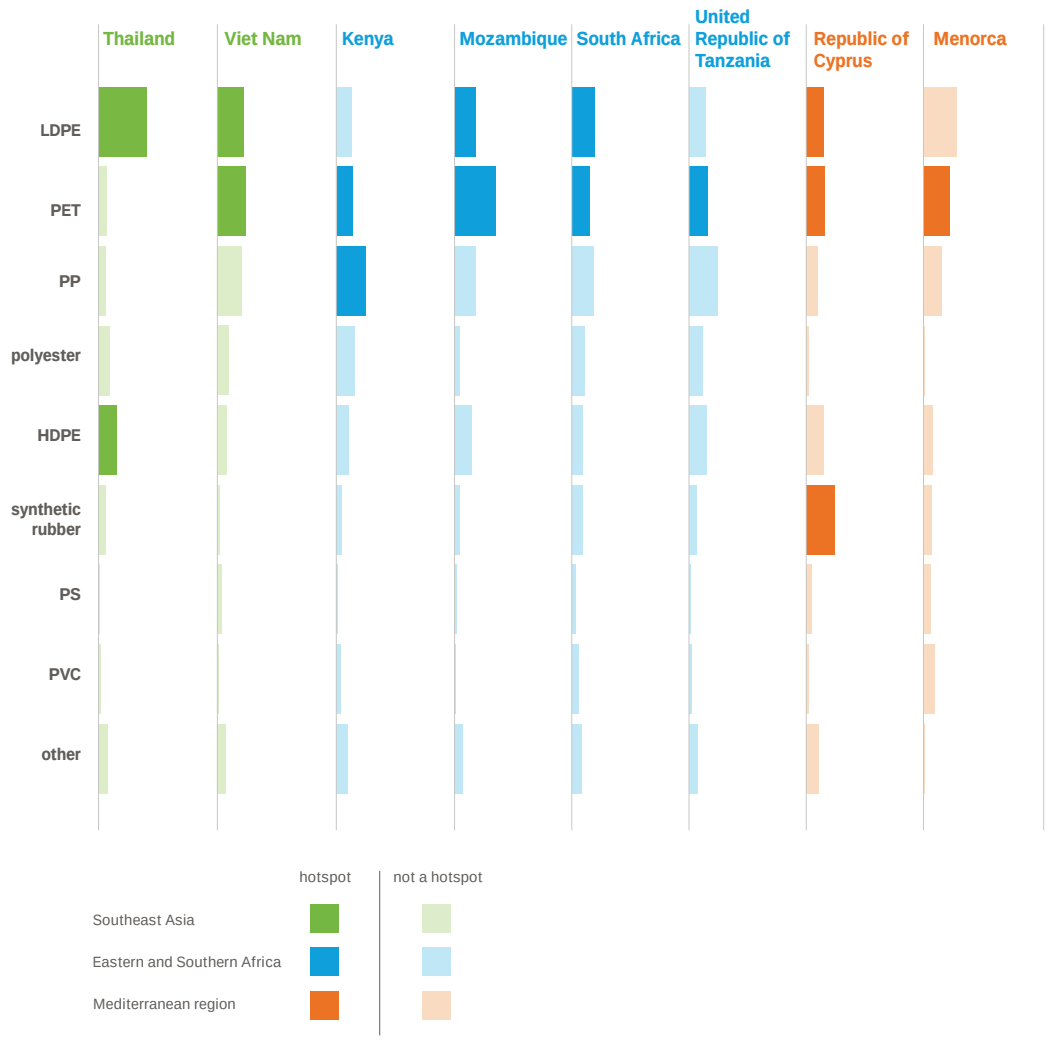


Figure 10. Plastic leakage by polymer.

For each polymer type in the national or subnational pilot site reports, the polymer share of plastic leakage is shown. The darker shades highlight hotspots for each pilot site, which are defined as being among the top three in both absolute (i.e., total amount of leaked plastic) and relative (i.e., amount of leaked plastic divided by amount of waste generated) values. The category "Other" is excluded from the ranking. All data refer to the year 2018.

2.7.1.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, United Republic of Tanzania

- PET is an issue in all the pilot countries in Eastern and Southern Africa, both in absolute and relative terms.
- Another concerning polymer in the region is LDPE, with the exception of Kenya. The main application of LDPE tends to be plastic bags, and LDPE bags were banned in the country in 2017. However, PP is the top leaking polymer by absolute leakage in Kenya, likely because PP bags were not banned and have largely taken the place of banned LDPE plastic bags (Lange et al., 2018). In United Republic of Tanzania, the LDPE share of the total leakage is also low compared to other African countries. This may also be due to the plastic bag ban that came into effect in 2019 and might have already impacted the 2018 trade and production. This may be linked to domestic policy moves due to the signal sent by the East African Community Polythene Materials Control Bill from 2016[13], and the overall projected decline in demand.
- The two polymers, which are hotspots by absolute leakage in all countries, are PET and PP. PET is widely used in containers, packaging material and in saturated polyesters; generally, PET and PP are commonly used in many commodity plastics.
- PS and PVC account for a smaller portion of the absolute leakage for all Eastern and Southern African countries.

2.7.1.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- In the Republic of Cyprus, LDPE and PET are problematic polymers in absolute and relative terms, and PP in absolute terms.
- On both islands, synthetic rubber largely contributes to leakage.

2.7.1.3. **Southeast Asia:** Thailand and Viet Nam

- LDPE leakage is an issue for Thailand and Viet Nam, both in absolute and relative terms, while PS and PVC constitute a smaller portion of the absolute leakage.
- Regarding PET, it is a concern especially in Viet Nam (both in absolute and relative terms). In Thailand, the PET waste generated in the country is recycled domestically (37%) or exported for recycling (19%).
- In Viet Nam, PP absolute leakage is very high, while in Thailand PP is extensively recycled (22%) or exported for recycling (11%).

13 The East African Community Polythene Materials Control Bill (2016). East African Legislative Assembly. No.10 (18 November, 2016), Uganda Printing and Publishing Corporation. Available at: https://www.eala.org/index.php/documents/view/the-east-african-community-polythene-materials-control-bill2016.

2.7.1.4. Polymer hotspots – key messages

Which polymers are leaking the most? Are there commonalities in terms of polymer leakage?

- LDPE, PET and PP are extensively used in the packaging sector, making up 70% of the plastic used in packaging applications (Geyer et al. 2017). As such, they are consumed in large quantities across every region, with packaging making up 45% of total plastic consumption worldwide (Geyer et al., 2017). Due to their ubiquitous use in packaging applications, these polymers are more likely than others to be littered or mismanaged. They eventually leak into waterways and the ocean due to their low density and the on-the-go consumer culture.
- PVC constitutes a smaller portion of the absolute leakage for all pilot sites. This is mainly due to PVC being used in construction in the rapidly growing African and Asian economies under evaluation. Given that there is more construction than demolition of buildings, much of the PVC on the market goes to increase the stock and does not become waste in the short to medium time frame.
- Synthetic rubber is often a hotspot in terms of relative leakage because there are two leakage pathways for synthetic rubber: macro-leakage from waste mismanagement and micro-leakage from tyre abrasion.
- For PS, leakage is mostly linked to its specific weight: high or low depending on the form. An analysis of various types and applications of PS might result in different hotspots.

2.7.2. Application hotspots

The overarching questions explored throughout this section are:

- Which applications are leaking the most?
- Are there commonalities in terms of application leakage?

APPLICATION HOTSPOT

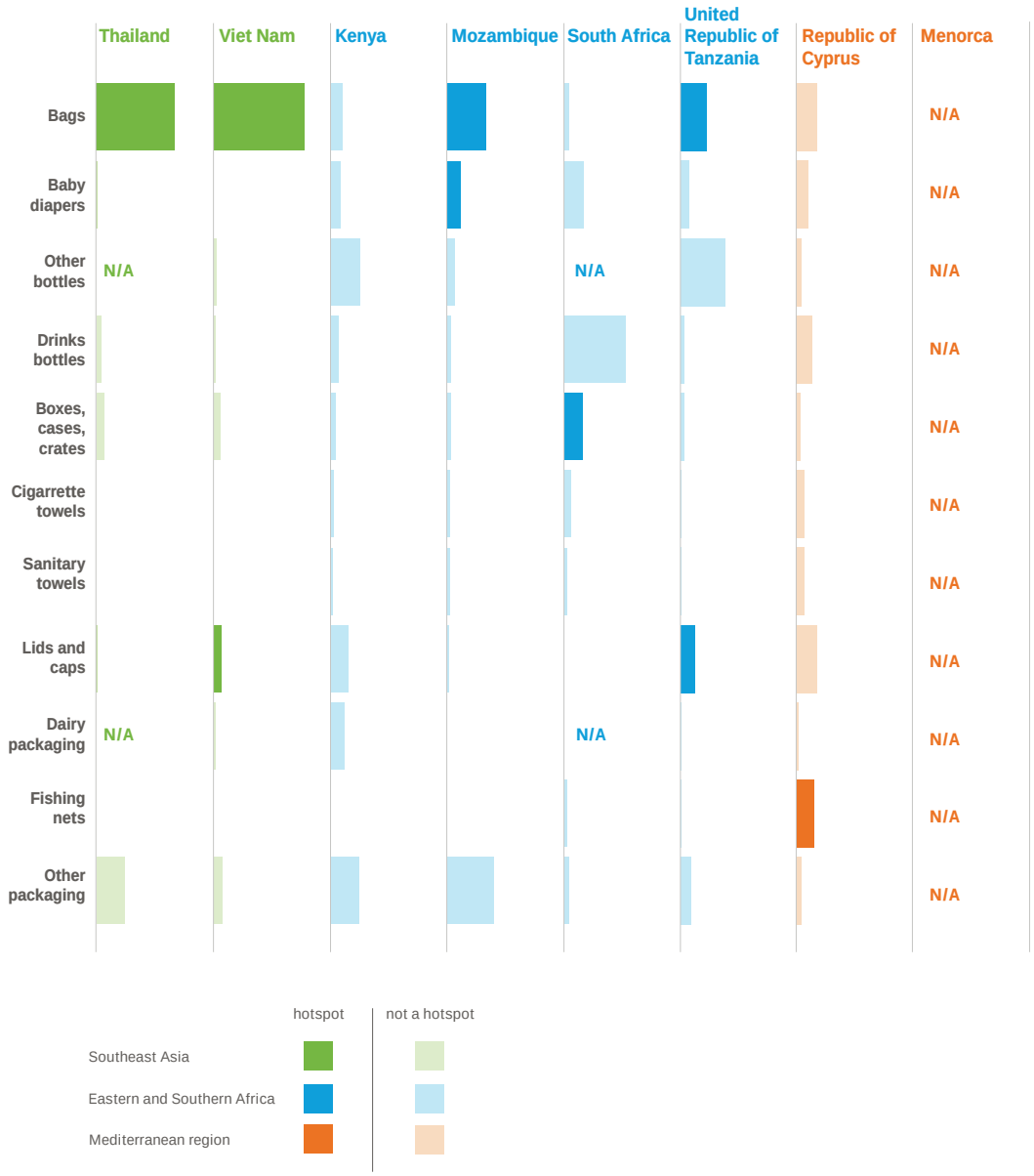


Figure 11. Plastic leakage per application.

The share of plastic leakage is presented for each application and pilot site. The darker shades highlight the hotspot applications for each pilot site which are the top three in both absolute (i.e., total amount of leaked plastic) and relative (i.e., amount of leaked plastic divided by amount of waste generated) values. The category "Other" is excluded from the ranking. All data refer to the year 2018.

2.7.2.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, United Republic of Tanzania

- Bottles, in general, represent an issue for both Kenya and South Africa. In South Africa, bottles alone represent 9% of all plastic waste.
- Plastic bags are not a hotspot for South Africa, which is likely due to continuous updates to the plastic bag regulations.
- Although plastic bags were banned in Kenya in 2017 and subjected to heavy fines, import and export of plastic bags continued to occur in 2018, as declared by Kenyan customs to the UN trading body (United Nations, 2020)[14]. Nonetheless, the trade of plastic bags fell from 16 kt in 2016, before the ban, to 3 kt in 2018, after the ban (United Nations, 2020), a drop of 80%.

2.7.2.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- In the Republic of Cyprus, bags, lids and caps are the main application according to absolute leakage. Although a specific collection scheme for bottle caps is in place on the island, this still does not prevent the plastic caps from being a hotspot. Fishing nets are considered as a hotspot; due to their length in use in the fishing sector, there is a greater likelihood of leakage.
- In Menorca, the application hotspot analysis could not be performed due to the absence of trade data that would allow the researchers to track down product quantities being used on the island.

2.7.2.3. **Southeast Asia:** Thailand and Viet Nam

- For Thailand, bags are the main application hotspot.
- Bags are followed in the ranking by the category of “boxes, cases, crates”, which is another set of short-lived, single-use applications.
- Snack bags and pouches, are included in the “Others” category for the purposes of this Report. These products tend to be comprised of multiple layers of various materials that are difficult to separate and recycle, and tend to be a large source of leakage.
- Bottles are the second most common plastic packaging application on the market, according to WWF estimates (WWF, 2020); 70% of all bottles going to waste are collected for recycling.

14 COMTRADE database, HS codes 392321 and 392322, Available at: https://comtrade.un.org/.

2.7.2.4. Application hotspots – key messages

What types of applications are leaking the most? Are there commonalities in terms of application leakage?

From the analysis performed in seven of the eight pilots (data from Menorca was not available), it appears that bags and bottles are hotspot applications. The category, "Other packaging", often makes an important contribution to total leakage. As such, efforts should be made to better identify, which applications within this category are most responsible for the leakage.

2.7.3. Sector hotspots

The overarching questions explored throughout this section are:

- Which sectors are responsible for the most leakage?
- Are there commonalities in sectors? If so which ones?

SECTOR HOTSPOT

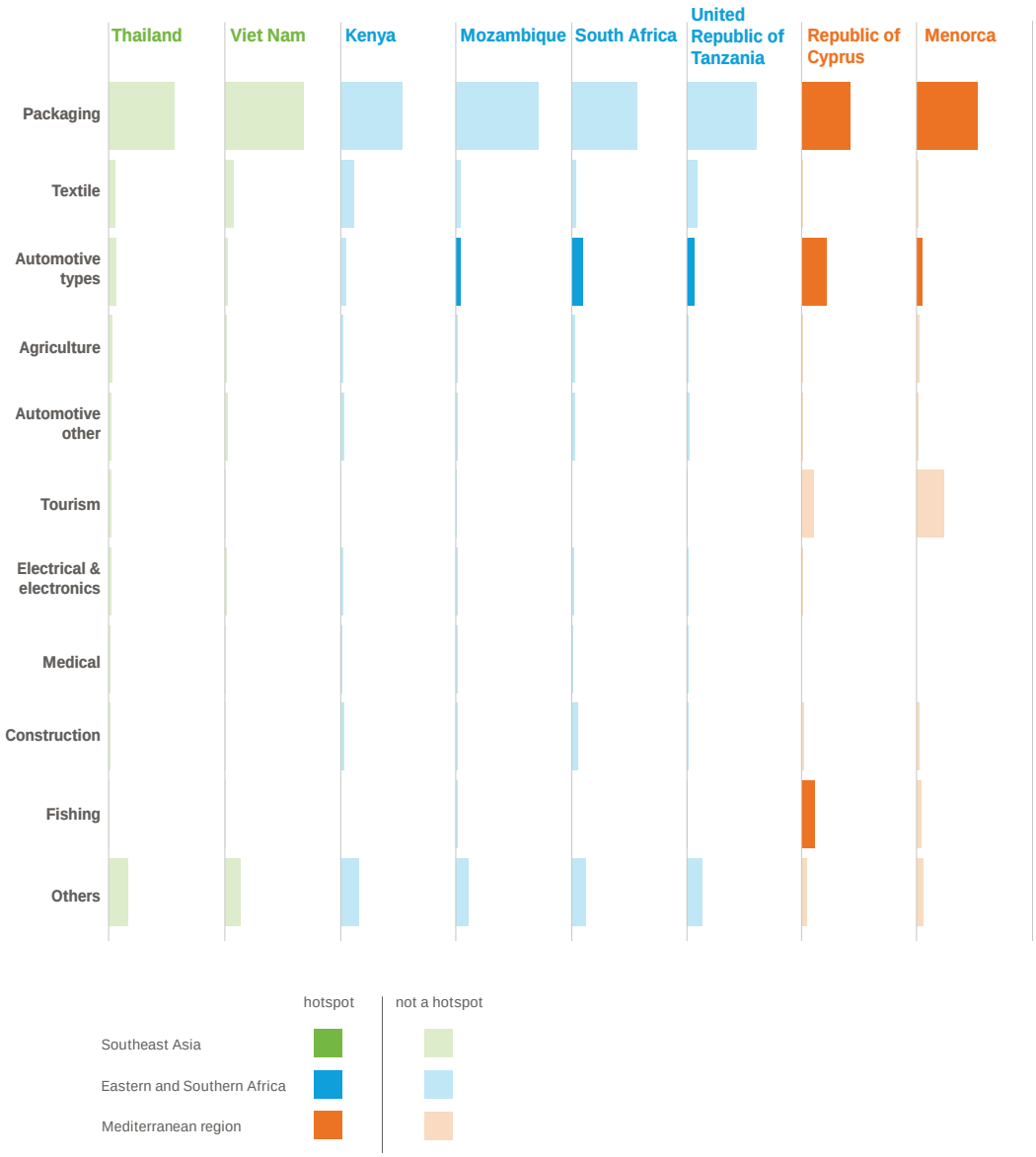


Figure 12. Pilot site plastic leakage per sector.

The share of plastic leakage is shown for each sector and pilot site. The darker shades highlight the hotspot sectors for each pilot site which are the top three in both absolute (i.e., total amount of leaked plastic) and relative (i.e., amount of leaked plastic divided by amount of waste generated) values. The category "Other" is excluded from the ranking. All data refer to the year 2018.

2.7.3.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, and United Republic of Tanzania

- Sector hotspots are similar between Eastern and Southern African and Southeast Asian pilot sites, with packaging contributing to most of the plastic leakage, followed by the textile and automotive-tyres sectors.
- The exception is South Africa, for which the textile sector is not a hotspot by absolute leakage. In South Africa, the construction sector has the highest share of plastic net input on the market (17%) after the packing sector (43%).

2.7.3.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- Main sector hotspots in the Republic of Cyprus are similar to those of other regions, with the packaging sector responsible for most of the plastic leakage, followed by automotive-tyres. The fishing and tourism sectors closely follow, even though they often only contribute minimally in other locations in the region.
- In Menorca, the tourism sector is as much a critical hotspot as the packaging industry, each contributing more than one-fifth of the total plastic leakage. The automotive-tyre sector follows as a leakage hotspot.

2.7.3.3. **Southeast Asia:** Thailand and Viet Nam

- Sector hotspots are similar between the Southeast Asian and Eastern and Southern African pilot sites, with packaging contributing to the majority of plastic leakage, followed by the textile and automotive-tyres sectors.
- The exception is Viet Nam, where the automotive-tyres sector is not a hotspot. This is because there is a lack of visibility regarding the production of synthetic rubber in Viet Nam. This likely leads to an underestimation of the production of synthetic rubber and the plastic leakage contributed by the automotive-tyres sector, by extension.

2.7.3.4. Sector hotspots – key messages

Which sectors create the most leakage? Are there commonalities?

- As a general trend, packaging contributes to most of the absolute leakage across the eight pilot sites, followed by the textile and automotive-tyres sectors. A detailed analysis of the fishing sector shows that between 12% and 36% of the plastic used in fishing activities – from fishing nets, to packaging used by fishermen during their time spent at sea – leaks to the ocean. This being said, the absolute leakage from fishing activities usually only contributes less than 1% of the total plastic leakage, and seldom to more than 10%, as is the case in the Republic of Cyprus.
- In terms of relative leakage, the most problematic sectors are fishing and medical, followed by either agriculture or automotive-tyre. The high relative leakage of the medical sector is due to a data gap on specific waste disposal practices for medical waste: waste that is currently treated as hazardous waste and incinerated.
- Data on the disposal of industrial waste from certain sectors (construction, automotive-tyres, automotive-others, electrical, electronics, agriculture and medical) were not available. This is probably due to the fact that the waste management of these sectors follows a different pattern than the waste management of municipal solid waste, for which data are usually available. If industrial waste were to be taken into consideration, this might affect the results from the packaging, tourism, textile and possibly fishing sectors.

3. Data Quality and Availability Assessment

3.1. Benchmark of the quality of the final hotspots in the pilots

The overarching questions explored throughout this section are:

- Which of the hotspot category results are robust enough to use as the basis for targeted interventions?
- How can the quality and robustness of hotspot results be improved?

- Based on a pedigree matrix[15], each hotspot dimension is assigned a quality score between 1 and 5, 1 signifying high quality for the criterion, and 5 signifying very poor quality. In this study, a score of less than 3 is used to signal that the hotspot results are reliable enough to use as the basis to derive meaningful interventions towards plastic leakage abatement. Otherwise, a hotspot score that is equal to, or above 3, signals the need to improve the hotspot model either by collecting better data or by using a different modelling approach.
- In general, the resulting quality scores have been interpreted to suggest that all hotspot categories across pilot sites are robust enough to use for decision-making, with the exception of application hotspots for which data are scarce and often score above 3. Thailand is the only pilot site for which data were reliable enough for plastic applications; hence a score below 3. Otherwise, all scores by hotspot category across the sites are quite similar, reflecting a similar trend in the modelling assumptions used for each pilot site.

15 The pedigree matrix describes several criteria that are used to evaluate not only the quality of source data but also the robustness of the modelling applied to this data. The criteria assessed in this project are the following:
- Reliability – relates to the level of trust one can have in the data source, based on acquisition methods and verification procedures used to obtain the data.
- Temporal correlation – represents the difference between the year of study and the year of obtained data.
- Geographic correlation – represents the geographical discrepancies between area of study and the obtained data.
- Granularity – relates to differences in granularity between data needed and the obtained data.

For more information, please refer to the methodology developed for this project (UNEP, IUCN, 2020) found at https://plastichotspotting.lifecycleinitiative.org/

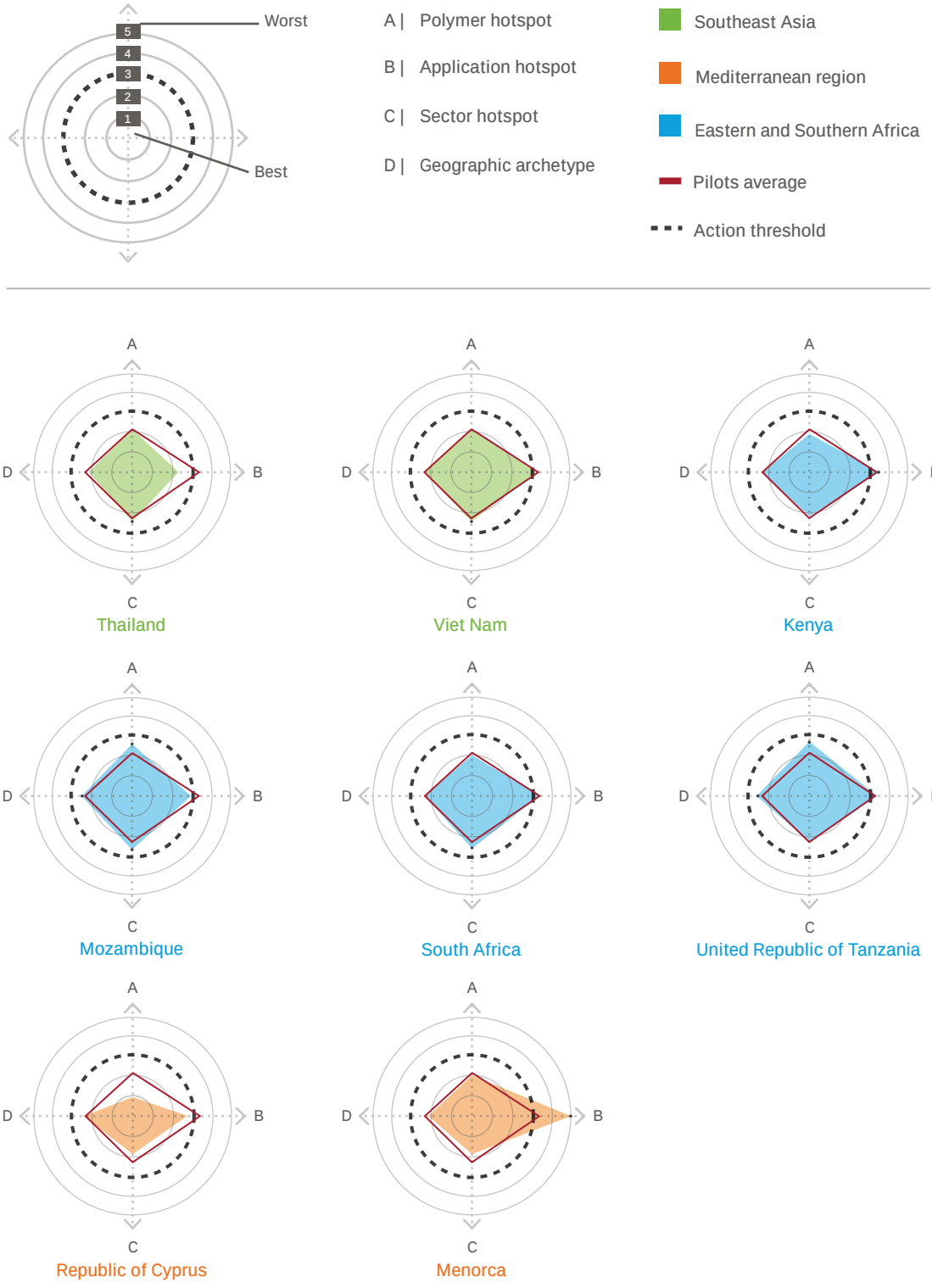


Figure 13. Quality score by hotspot category for all pilot sites.

The quality scores for all hotspot categories, except waste management hotspots for which the researchers did not assign a score, are displayed for pilot sites in a polar plot where each dimension assesses a specific hotspot category. The average quality score profile across all pilot sites is represented by the red line. The reliability threshold, defined by a quality score of 3, is marked by the black dotted line. The latter means that no action can be taken based on the results from a specific hotspot category in a pilot site if the score of the corresponding dimension crosses this line and is above 3. When quality scores are the same between countries, they relate to very comparable aspects (see the Pedigree Matrix in the UPE/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action, page 25). All of the score categories are decided with the same process for every country.

3.2. Quality of the final hotspots – key messages

Across the eight pilot sites, the results from the different categories of hotspots can be used to determine relevant interventions, except for the application category of hotspots for which data are either too scarce or are unavailable. To address this weakness in the applications category, it is important to collect information at the level of consumption quantity by product, either by contacting manufacturers and retailers or by conducting a consumer survey.

3.3. Key data-sources by pilot site

- Which datasets provide useful granularity to enable generating actionable results?
- Which datasets are already useful, and which may be improved?

Figure 14. Raw data availability and main data source by metric type.

This figure shows the status of data availability for different metrics along the plastic value chain, be it at the plastic production and trade stage or at the end-of-life phase (recycling and disposal). For each metric, data availability is assessed for different granularity levels as listed in the "data type" column. The last column mentions the stakeholder usually holding data for each metric. The definition of "in primary form" is based on the COMTRADE code no.39, which can be found here: https://www.gov.uk/guidance/classifying-plastics#classifying-polymers-in-primary-forms

3.3.1. **Eastern and Southern Africa:** Kenya, Mozambique, South Africa, and United Republic of Tanzania

- For Eastern and Southern Africa, as shown in Figure 14, data are scarce compared to other regions. In the eight studies from the three regions, data lacks granularity regarding polymer, application, or sector type.
- In Kenya, Mozambique and United Republic of Tanzania, spatial differences in waste management are not well captured in the waste studies, which tend to be available only for specific municipalities (often where main cities are located).
- South Africa stands out as an exception on this topic, as waste management data are available for each province and across different geographical archetypes. Despite an abundance of data sources for South Africa, the information is not always coherent; this is a challenge, which prejudices the reliability of raw waste management data.
- Recycling data are only partial in Mozambique and the United Republic of Tanzania as no database that gathers data from all recyclers exists yet.

3.3.2. **Mediterranean:** Menorca (Spain) and Republic of Cyprus

- In Menorca, data on waste management, especially waste collection and recycling, are available by province and are better categorised than for other regions. The plastic waste data are at times detailed for some polymers or product types, such as packaging or tyres. The data can also be derived from the total waste quantities available for some sectors. However, for the Republic of Cyprus, data are scarcer and are not available by province but rather by landfill site. Therefore, it is difficult to know the origin of the plastic waste, and consequently, how much plastic waste is collected in each province.
- As neither the Republic of Cyprus nor Menorca are primary plastic producers, the availability and granularity of plastic production data could not be assessed.
- Although Menorca shows the strongest set of waste management data among the sites studied, it is missing trade data as this island is not captured by any national trade database in Spain. This shortcoming limits the scope of the results for Menorca, especially when it comes to application hotspot assessment.

3.3.3. **Southeast Asia:** Thailand and Viet Nam

- For Thailand, many of the data required to compute the metrics for this study were available in reports or scientific literature, and were quite coherent with one another. Data were available at the granularity of specific sectors as well as import/export shares by product type, which is not the case for other studies in Asia or Africa.
- In Viet Nam, data were rather scattered and were not always aligned across various sources, thus requiring adjustments and additional modelling layers. While there are adequate data available to support a plastic leakage analysis for Viet Nam, data on recycling still needs to be completed to recover quantitative values from the informal waste sector.

3.3.4. Data availability and resources – key messages

- For the eight studies, data on primary plastic production are available and can be obtained either from national plastic associations or private data platforms.
- Trade data, on the other hand, are only available for countries and not for regions of countries such as Menorca. Data on imports and exports can be found in national and international trade databases, but access may be limited, and trade quantities can vary for the same country depending on the data source.
- Waste management data are more readily available for the pilot regions in Southeast Asia and the Mediterranean than in most African countries where these data are still scarce or less accurate. Even though data can easily be found on national data platforms for South Africa, its accuracy is still questionable due to problematic measurements and reporting methods. Regarding sources, waste management data can often be found on national data platforms, in reports by NGOs or consulting groups, and even in scientific literature.
- For the eight pilot sites evaluated, it was not possible to obtain or access data on the disposal of industrial waste from sectors, including construction, automotive-tyre, automotive-other, electrical and electronics, agriculture and medical. This limitation is likely due to the fact that waste management for these sectors follows a different pattern than that of municipal solid waste, for which data is usually available. If industrial waste had been available for this study, this might have affected the results from packaging, tourism, textile and possibly fishing. The impact of this approximation is marginal in countries such as Kenya and Mozambique because of the absence of proper disposal in the waste management system. One exception might be the automotive-tyre sector in Kenya, for which re-threading and reuse is common, as well as the burning of tyres in kilns (cement factories). For other pilot sites, the impact depends on the share of waste that is categorised as industrial waste. The higher contribution to waste from industry, the less accurate the model is when compared to reality.

4. Conclusion and Outlook

By piloting the *UNEP/IUCN National Guidance for Plastic Hotspotting and Shaping Action* in eight seven national and one subnational setting across three different regions, the authors explored the strengths and weaknesses of its methodology. This piloting process elucidated the crucial importance of using science-based metrics to prioritise actions and monitor progress while aiming to close the plastic tap. The analysis in this Report clearly demonstrates that marine plastic pollution continues to present challenges to the integrity of coastal livelihoods and marine biodiversity globally.

A set of five concluding remarks are provided, which may be used as recommendations to continue to expand the plastic pollution hotspotting data collection effort and apply the plastic leakage approach shared in this Report to additional sites:

- **Robust data** lead to high quality metrics, which lead to actions that results in measurable change (with high confidence in the science behind the action).
- **Proposed priority interventions**, are provided to generate ideas for national and subnational actors to add to policies and implement for real on-the-ground-change to mitigate plastic pollution.
- **There is no one "silver bullet"** to solve plastic pollution.
- When confronted with a lack of data, all hope is not lost! The **precautionary principle** is necessary here, until more data is generated.
- There is a strong need for **improved access to data and knowledge.** It is more than just the need for open, global databases for plastic pollution, there is a need to empower the right actors to take the best, science-based actions.

4.1. From data to action

While the first stage of the journey has been completed for eight pilots, generating knowledge and shaping action should now be the next milestone. Indeed, knowing *where* to act is key, but knowing *what* to do is better. This next stage should involve a wider group of stakeholders in order to brainstorm on relevant interventions and instruments to mitigate plastic leakage in light of the plastic hotspotting results in each pilot site. Interventions can be taken at any stage of the plastic value chain, from reducing plastic input at the source, to improving waste management. More details on identifying interventions and instruments are available from modules S2 and S3 of the *UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action*.[16]

Once interventions and instruments are identified, the leakage model should be used in conjunction with other tools, to assess the costs and benefits of various potential solution

16 See the UNEP/IUCN Modules – *UNEP/IUCN National Guidance for Plastic Pollution Hotspotting and Shaping Action*, available at; https://plastichotspotting.lifecycleinitiative.org/modules/.

pathways. This assessment should be done by considering social, economic as well as a wide range of environmental impacts, such as climate change and biodiversity. A leakage cost abatement curve could be established to help policy makers decide upon the most appropriate solutions pathways for their given context and jurisdiction.

4.2. Proposed Priority Interventions

Table 3. Proposed priority interventions: by class, pilot site, and region.

INTERVENTION CLASS	PRIORITY INTERVENTIONS BY PILOT SITE	PRIORITY REGIONAL RECOMMENDATIONS
SUSTAINABLE PRODUCTION + SUSTAINABLE CONSUMPTION AND LIFESTYLES	**Kenya**: Avoid producing or importing plastic objects that do not benefit from a national recycling solution.	**Eastern and Southern Africa region** Encourage governments to implement measures that discourage the production and import of plastic objects that do not benefit from a recycling solution within national jurisdiction. Consider a product substitution strategy for these items and support innovation for the alternate solutions that can be produced nationally or regionally. Urge governments and the private sector in the WIO region to develop and support measures that increase the value of after-use plastics, and encourage the redesign of products and materials for End-of-Life value and circularity.
	Mozambique: Reduce demand for, and use of, single-use plastics, especially on-the-go plastics.	
	South Africa: Avoid producing / importing plastic objects that do not benefit from a national recycling solution. Promote material designs or processes that favour reuse of plastic objects (e.g. deposit schemes). Reduce demand for, and use of, single-use plastics, especially on-the-go plastics.	
	United Republic of Tanzania: Reduce littering in urban areas and reduce demand for, and use of, single-use plastics, especially on-the-go plastics.	
	Republic of Cyprus: Increase demand for recycled material in the country (LDPE, PET). Promote material designs or processes that substitute plastic with other material based on life cycle assessment. Promote material designs or processes that favour the reuse of plastic objects (e.g. deposit schemes). Reduce littering in urban areas. Reduce demand for, and use of, single-use plastics, especially on-the-go plastics. Reduce tyre abrasion.	**Mediterranean region** Consider plastic bans in the region, working within EU regulations. Develop and support measures that increase the value of after-use plastics and encourage the redesign of products and materials for End-of-Life value and circularity. Consider implementing regional campaigns to reduce littering.
	Menorca: Promote material designs or processes that favour reuse of plastic objects (e.g. deposit schemes). Reduce littering in urban areas. Reduce demand for, and use of, single-use plastics, especially on-the-go plastics.	
	Thailand: Reduce import and export of plastic waste. Avoid producing or importing plastic objects that do not benefit from a recycling solution in the country. Reduce the demand for new synthetic fibres in textiles and recycle synthetic textiles back to raw materials. Reduce demand for, and use of, single-use plastics, especially on-the-go plastics.	**Southeast Asia region** Urge governments to reduce import and export of plastic waste. Review current import of plastic regulations and procedures, and revise as appropriate. Consider campaigns to reduce the demand for, and use of, single-use plastics, especially on-the-go plastics. Consider implementing regional campaigns to reduce littering.
	Viet Nam: Promote material designs or processes that substitute plastic by other material based on life cycle assessment. Promote material designs or processes that favour reuse of plastic objects (e.g. deposit schemes). Reduce littering in urban areas, Reduce demand for, and use of, single-use plastics, especially on-the-go plastics.	

WASTE COLLECTION SYSTEMS	**Kenya**: Plan more frequent waste collection in areas prone to plastic leakage. Increase door-to-door waste collection. Ensure proper disposal of waste at landfill by private collectors.	**Eastern and Southern Africa region** Facilitate the strengthening of tools, capacities and knowledge for municipalities and local governments to address plastic pollution in major cities, towns and peri-urban areas. Urge municipalities and local governments to scale measures to address widespread littering and open burning of plastics through increased waste collection efforts. Consider sustainable financing models to improve municipal waste collection. Call for scaling up of measures for plastic waste collection and recovery; improved integration of the informal sector in the waste economy; and increased funding for local initiatives that enhance community livelihood options, and address the socio-equity gap via circular economy.
	Mozambique: Reduce the number of dumpsites and unsanitary landfills. Plan more frequent waste collection prior to rainy events. Increase plastic segregation at household level. Increase plastic segregation in public spaces (sorting waste bins), Ensure plastic waste has enough value to cover collection costs (for all polymers).	
	South Africa: Reduce the number of dumpsites and unsanitary landfills, Plan more frequent waste collection prior to rainy events, Plan more frequent waste collection in areas prone to plastic leakage (e.g. taxi stations, informal settlements), Ensure plastic waste has enough value to cover collection costs (for all polymers). Increase plastic segregation at the household level. Increase plastic segregation in public spaces (e.g. sorting waste bins). Ensure collection of discarded tyres.	
	United Republic of Tanzania: Reduce the open burning of plastic waste. Ensure recuperation of used fishing gear. Ensure plastic waste has enough value to cover collection costs (for all polymers).	
	Republic of Cyprus: Plan more frequent waste collection in areas prone to plastic leakage (e.g. taxi stations, informal settlements). Increase plastic segregation at the household level. Increase plastic segregation in public spaces (e.g. sorting waste bins).	**Mediterranean region** Improve waste collection and management by 10%. Improve waste collection and management in 100 key cities. Improve wastewater collection and treatment.
	Menorca: Plan more frequent waste collection in areas prone to plastic leakage. Ensure recuperation of used fishing gear.	
	Thailand: Plan more frequent waste collection prior to the rainy events. Increase plastic segregation in businesses. Ensure plastic waste has enough value to cover collection costs (for all polymers).	**Southeast Asia region** Improve waste collection methods and coverage. Call for scaling up of measures for plastic waste collection and recovery; improved integration of the informal sector in the waste economy; and increased funding for local initiatives to enhance community livelihood options, and address the socio-equity gap via circular economy.
	Viet Nam: Prevent street sweeping services from discharging plastic into sewers or water bodies. Plan more frequent waste collection prior to rainy events. Increase plastic segregation at the household level. Ensure plastic waste has enough value to cover collection costs (for all polymers, PP and LDPE).	

WASTE INFRASTRUCTURE	**Kenya**: Increase capacity for proper waste disposal (e.g. sanitary landfills if other upstream solutions cannot be applied). Ensure proper maintenance of waste management equipment (e.g. vehicles, assets).	**Eastern and Southern Africa region** The short-term solution to minimising marine plastic pollution inputs to the region is through improved waste collection and management—a prerequisite and first step towards more circularity. Facilitate the strengthening of tools, capacities and knowledge for municipalities and local governments to address plastic pollution in major cities, towns, and peri-urban areas. Urge municipalities and local governments to scale measures to address widespread littering and open burning of plastics through increased waste collection efforts.
	Mozambique: Increase density of waste bins in urban areas and in specific areas prone to leakage.	
	South Africa: Ensure proper use of existing sorting infrastructure. Increase density of waste bins in rural areas and in specific areas prone to leakage.	
	United Republic of Tanzania: Increase capacity for proper waste disposal (e.g. sanitary landfills if other upstream solutions cannot be applied).	
	Republic of Cyprus: Reduce losses from waste management equipment (e.g. bins, transport). Increase density of waste bins in specific areas prone to leakage.	**Mediterranean region** Improving waste management, starting with waste collection, should be the priority as this is the intervention showing the greatest leakage abatement over time.
	Menorca: Reduce losses from waste management equipment (e.g. bins, transport). Increase density of waste bins in specific areas prone to leakage.	
	Thailand: Increase capacity for proper waste disposal (e.g. sanitary landfills if other upstream solutions cannot be applied). Reduce losses from non-sanitary landfills and dumpsites (from wind and flooding). Increase density of waste bins in rural areas and areas prone to leakage.	**Southeast Asia region:** Improving waste management infrastructure, starting with waste collection, should be the priority as this is the intervention showing the greatest leakage abatement over time.
	Viet Nam: Increase capacity for proper waste disposal (e.g. sanitary landfills if other upstream solutions cannot be applied). Increase density of waste bins in urban areas. Increase density of waste bins in specific areas prone to leakage.	
RECYCLING	**Mozambique**: Increase recycling capacity for domestic plastic waste (all polymers).	**Eastern and Southern Africa region:** Urge governments to undertake measures to strengthen plastic recycling capacity; lessen the burden of entry and scaling for informal and formal actors; and adhere to established norms, standards, and licensing requirements, as applicable.
	South Africa: Increase recycling capacity for domestic plastic waste (PP). Increase recycling capacity for domestic plastic waste (PET, LDPE).	
	Republic of Cyprus: Increase recycling capacity for domestic plastic waste (all polymers).	**Mediterranean region** Urge governments to undertake measures to strengthen plastic recycling capacity.
	Thailand: Increase recycling capacity for domestic plastic waste (all polymers).	**Southeast Asia region** Urge governments to undertake measures to strengthen plastic recycling capacity.
CLEAN UP	**Menorca**: Clean beaches and/or polluted areas. Retrieve lost fishing gear from the marine environment.	**Mediterranean region:** Post-leakage management in rivers can be an efficient intervention.
	Viet Nam: Clean beaches and/or polluted areas	**Southeast Asia region:** Post-leakage management in rivers can be an efficient intervention.

4.3. There is no “silver bullet” to solve the plastic pollution crisis

The hotspotting approach shows that there is no silver bullet to solve the global crisis of plastic pollution. Indeed, the drivers of leakage vary across regions in terms of polymers, applications and geographical archetypes. This is the consequence of different patterns of plastic use, as well as the different implementation of waste collection, management, and recycling practices within regions.

An understanding of these hotpots is essential and must be fed with granular datasets with specific collection rates and recycling rates for different polymers and applications. Viewing this information in a very structured and transparent way has been an eye opener for many stakeholders involved in this work. It is hoped that this effort will contribute to improving the plastic leakage situation within the eight pilot sites.

As compared to previous work inspired by the Jambeck et al. (2015) study, in which all plastics were considered equal with respect to their leakage risk, this study proposes a more granular and polymer/application/sector-specific view, valid for the 2018 situation. However, the total plastic leakage per pilot site still remains in the same order of magnitude, with some countries slightly above or below the Jambeck et al. (2015) estimates. It should be noted that while the mismanaged waste index (MWI) reflects an actual plastic mass balance, the leakage value reflects the release rate model that currently lacks ground truthing.

4.4. Lack of data, all is not lost!

While metrics to characterise plastic leakage for different polymers, applications, industry sectors, geographies and waste management stages are key to setting justified priorities, these metrics rely on data that may not exist or cannot be collected. Collecting data for so many parameters across very large areas is neither feasible on the practical side nor allows for sufficient coherence across multiple data sources. Modelling and mass balancing are thus key to fill gaps and generate robust / coherent metrics. The data reconciling process developed within the *UNEP/IUCN National Guidance for Plastic Hotspotting and Shaping Action* has proven useful to achieve the right level of information to inform the hotspotting process, balanced with resource limits for data-collection campaigns.

A thought provoking question to consider: if modelling is a solution to address data gaps, there needs to be a recognised mechanism of global validation of models in use – through peer reviewed literature, application and validation, a certification process, or other format.

These pilot projects demonstrate the benefit of the chosen approach and provide the most consistent dataset to date, with best-in-class information on domestic plastic inputs, waste management, and plastic leakage.

Obtaining this information and knowledge and using it, as the basis to justify chosen priorities to mitigate plastic pollution for the public and private stakeholders, is essential for success. Based on these pilot reports and the data shared in this Report, the private sector is encouraged to replicate the leakage hotspotting approach at their value chain level by using the complimentary Plastic Leak Project guidance (Quantis, 2020) fed with the data shared herein.

Until more data is generated, the precautionary principle is necessary. Taking a particular course of action, such as generating a policy to remediate plastic pollution (when conclusive evidence is not available) may help improve the situation, but the responsibility to protect the public, and our ocean, from harm remains.

In reference to the proposed interventions outlined above (Table 3), the application of the precautionary principle has been made a statutory requirement in some areas of law. This must be considered when applying information from this Report.

4.5. The need for improved access to data and knowledge

While action is being taken, knowledge must also be updated as the plastic flows and underlying economic drivers rapidly change. The 2018 situation that was modelled in these studies may have already changed, especially in light of the plastic waste import ban implemented by China (Staub, 2019), which has had tremendous effects on the entire plastic and recycling economy.

The development of a platform to make plastic information – for example, data on plastic collection rates and recycling per polymer – should be made available and open for the public good. There are many organisations working on databases, platforms, cross-organisation data clearinghouses, for example. This effort should be inclusive of the many organisations working on this topic, be independent, and be based on sound governance to ensure transparency and scientific excellence. Such a platform would not only allow for updates to the work included in this Report, but would also stimulate a scale-up of the hotspotting approach in additional countries and subnational areas, including island states.

5. Appendix: Glossary

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

HPDE: High-density polyethylene (e.g. milk containers, shampoo bottles).

Hotspots: The most relevant plastic polymers, applications, industrial sectors, regions or waste management stages driving the leakage of plastics into the environment (including land, air, fresh water and marine environment), as well as the associated impacts, through the life cycle of products. These are counted and ranked.

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 unsanitary when waste management quality standards are not met, thus entailing a potential for leakage. Improper waste disposal is the disposal of waste in a way that has negative consequences for the environment.

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. Informal waste workers (often referred to as 'waste pickers' or 'waste reclaimers') remain largely invisible, unrecognised in the waste sector but are an integral part of solving the plastic pollution crisis. Newly established formalised organisations of such individuals (such as, cooperatives, social enterprises and programs led by non-governmental organisations) can also be considered part of the informal sector for the purpose of this methodology.

Instrument: The ways an intervention may be practically implemented through specific regulatory, financial or informative measures, in light of contextual factors such as political dynamics and existing measures. As an example, a pilot site may identify 'mismanaged polyethylene bottles' as one of its hotspots. A relevant instrument may be to instate a bottle return deposit scheme.

Intervention: Tangible action that can be taken to mitigate hotspots. A relevant intervention may be an increase in the bottle collection rate. Interventions are to be prioritised and designed to address the most problematic hotspots in the plastic value chain.

KT (kt): kilotons, or a thousand tonnes

Leakage: Plastic that is released to the environment, specifically to waterways and the ocean. The leakage rate is the ratio between leakage and total waste generated, and its value is expressed as a percentage.

LDPE: Low-density polyethylene (e.g. bags, container lids).

Littering: Incorrect disposal of small, one-off items, such as: throwing a cigarette on the ground, dropping a crisp packet or a drinking cup, and damaging the environment. These items may or may not be collected by municipal street cleaning and formal waste management schemes.

Macro-plastic: Relatively large plastic waste that is readily visible and with dimensions larger than 5 mm, typically in the form of plastic packaging, plastic infrastructure or fishing nets.

Mass balance: Mass balancing is a mathematical process to equalise inputs

and outputs of a given material flow across a system boundary. In this Report, inputs consist of domestic production and imports; outputs consist of exports, waste generation and increase of stock. A mass balance enables checking data consistency and helps to reconcile different datasets when needed.

Micro-plastic: Relatively small plastic particles below 5 mm in size and above 1 mm. Two types of micro-plastics are contaminating the world's ocean: primary and secondary micro-plastics. This study focuses on primary micro-plastics, which are plastics directly released into the environment in the form of small particles.

Mismanaged waste index (MWI): 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 is given as a percentage.

On-the-Go Plastics: Single-use plastics, used in a culture of 'on-the-go' rapid consumption with little thought as to the waste generated.

Pedigree matrix (PM): Describes several criteria used to evaluate the quality and robustness of the modelling applied to the data. The criteria assessed in this study are: reliability, completeness, temporal correlation, geographic correlation and granularity.

PET: Polyethylene terephthalate (e.g. bottles, food wrapping).

PP: Polypropylene (e.g. hot food containers, sanitary pad liners).

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.

PS: Polystyrene (e.g. food containers, disposable cups).

PVC: Polyvinyl chloride (e.g. construction pipes, toys, detergent bottles).

Release rate: The ratio between leakage and total mismanaged waste; its value is expressed as a percentage.

Sanitary landfill: A particular area where large quantities of waste are deliberately disposed in a controlled manner (e.g. waste being covered on a daily basis, 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.

Sustainable waste management: The collection, transportation, valorisation and disposal of waste to avoid harming the environment, human health or future generations in order to reduce the amount of natural resources consumed. The sustainable management of waste is key to meet the Sustainable Development Goals (SDGs), as the effects of waste touch all of the SDGs.

Uncollected waste: Waste fraction, including littering, that is not collected by the formal sector.

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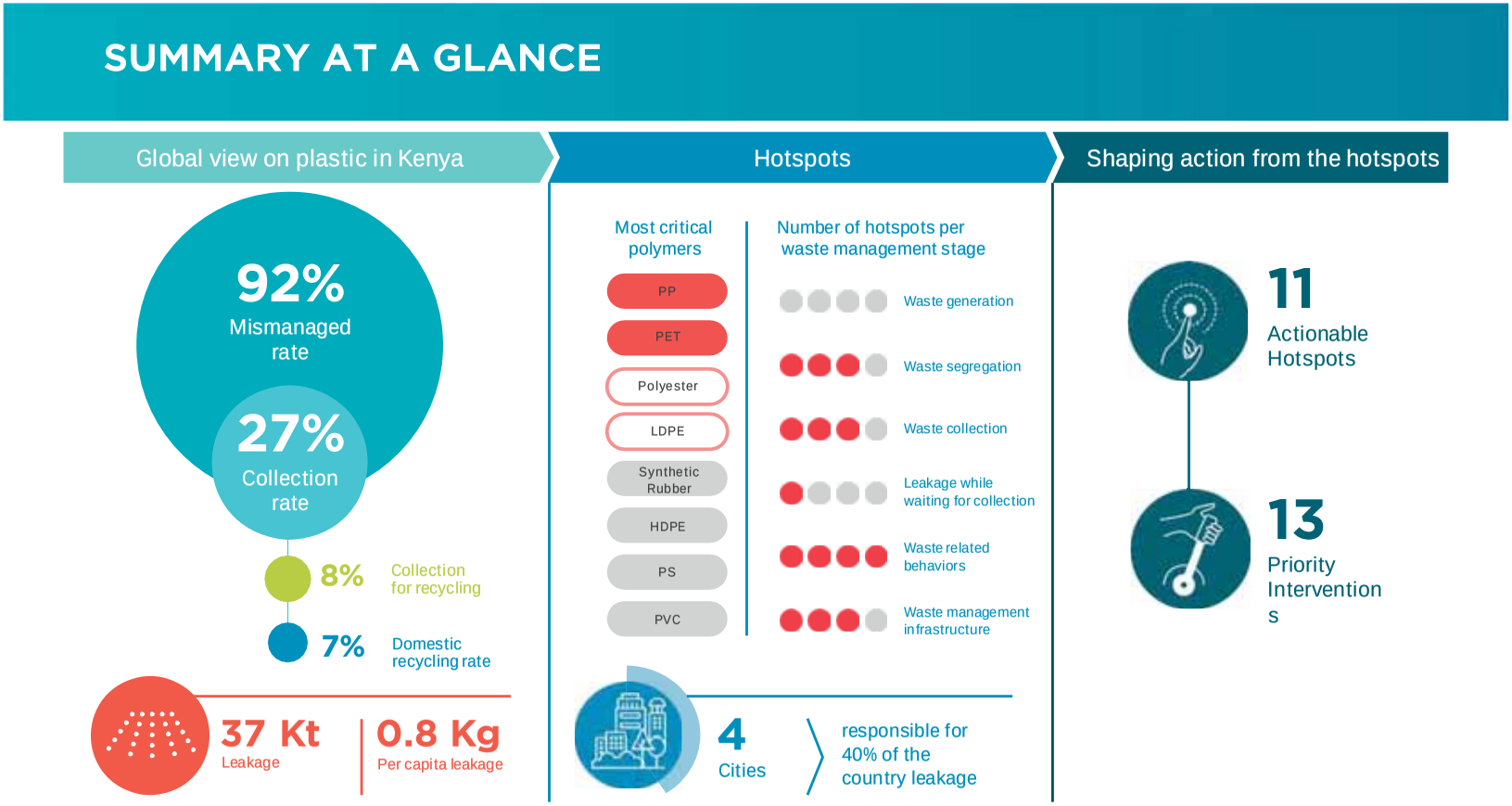
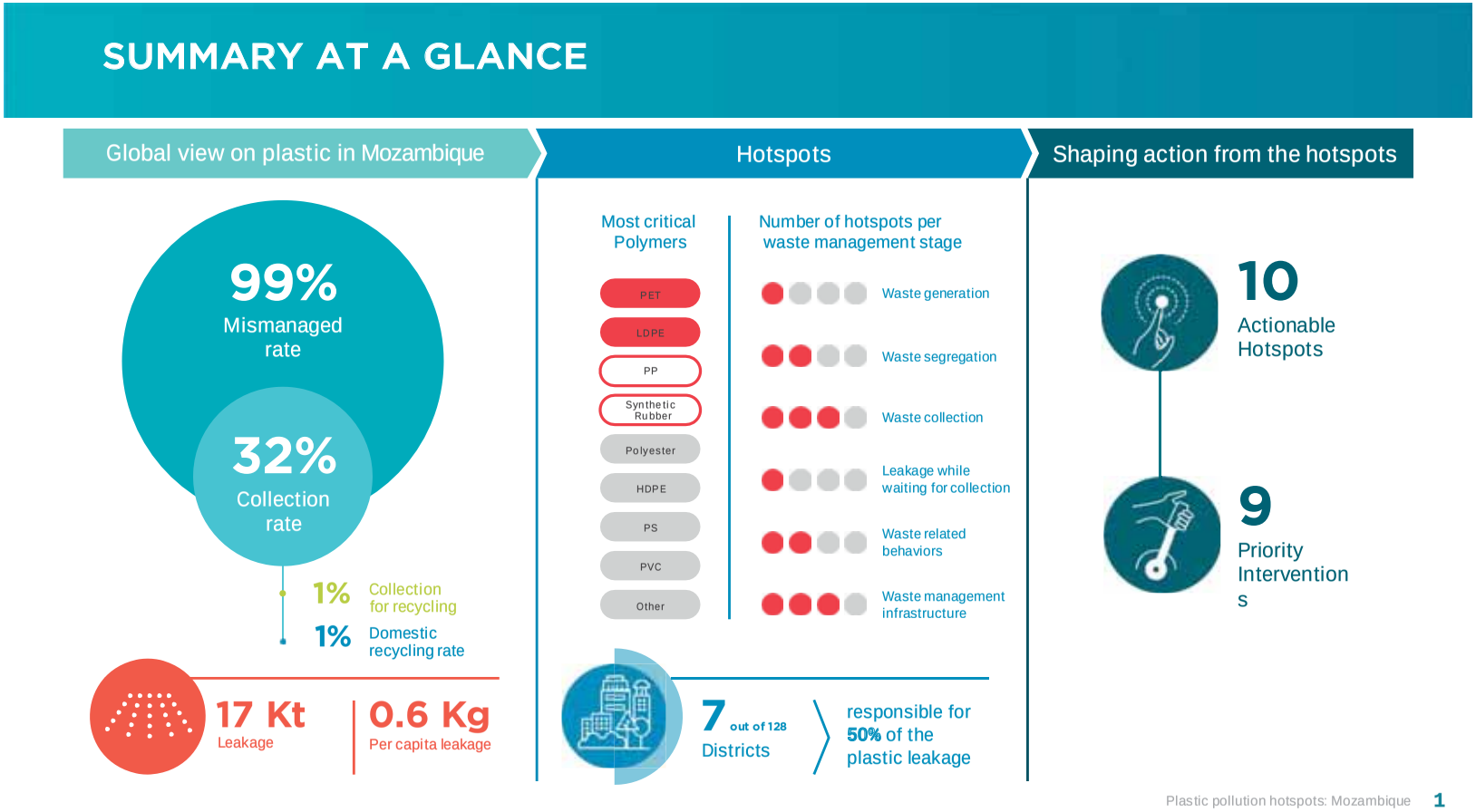
Annex 1 Data Overview: Kenya

Summary



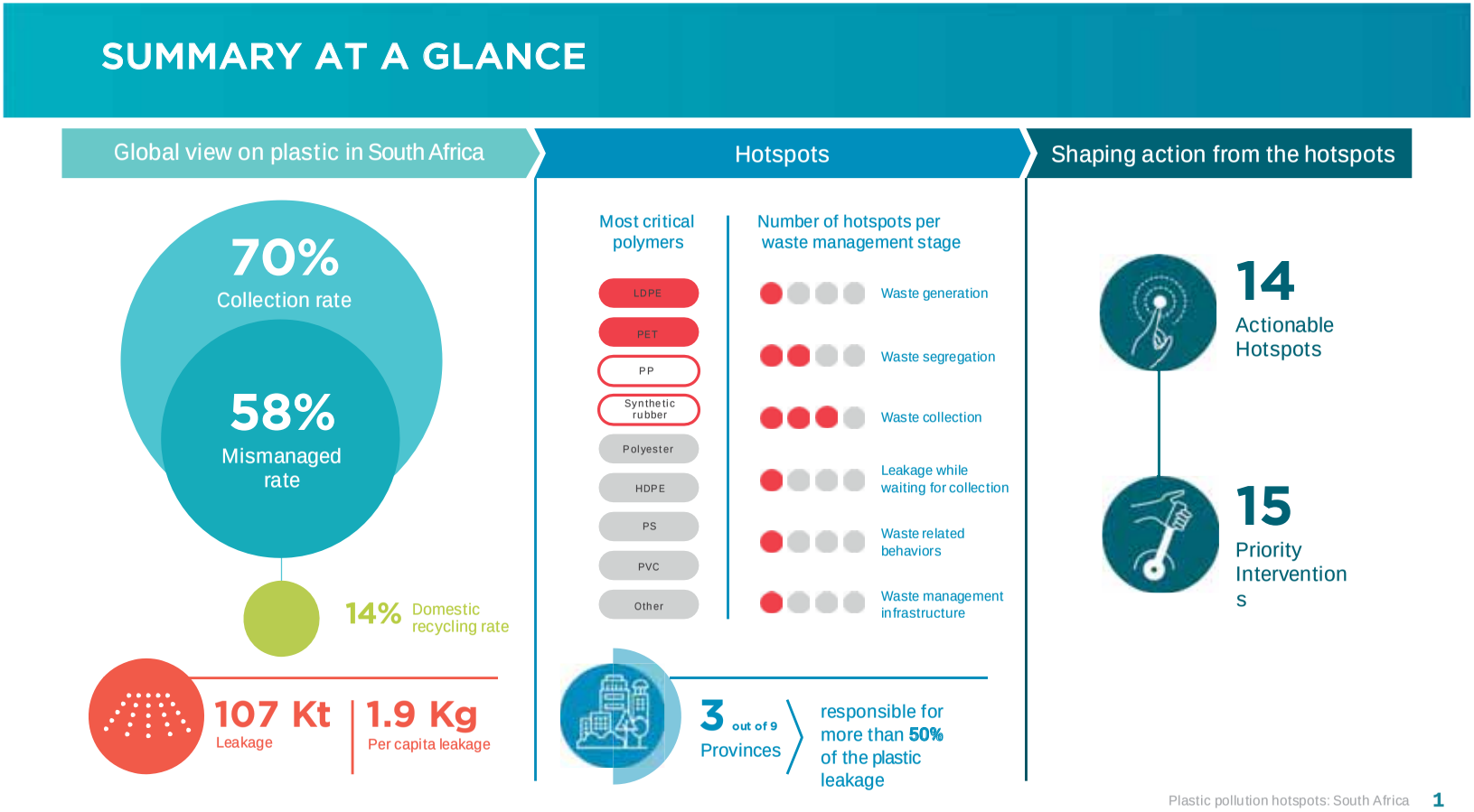
Annex 2 Data Overview: Mozambique

Summary



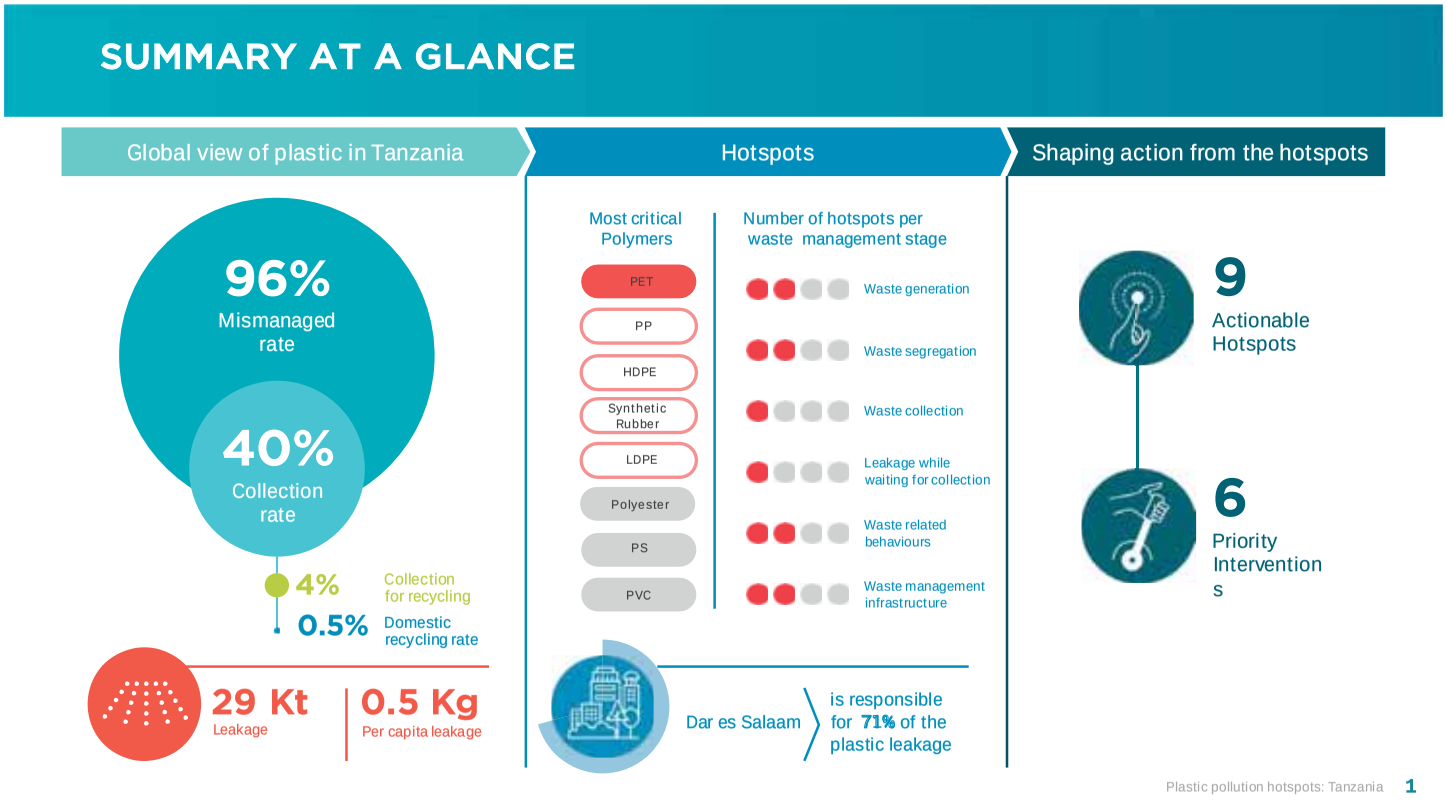
Annex 3 Data Overview: South Africa

Summary



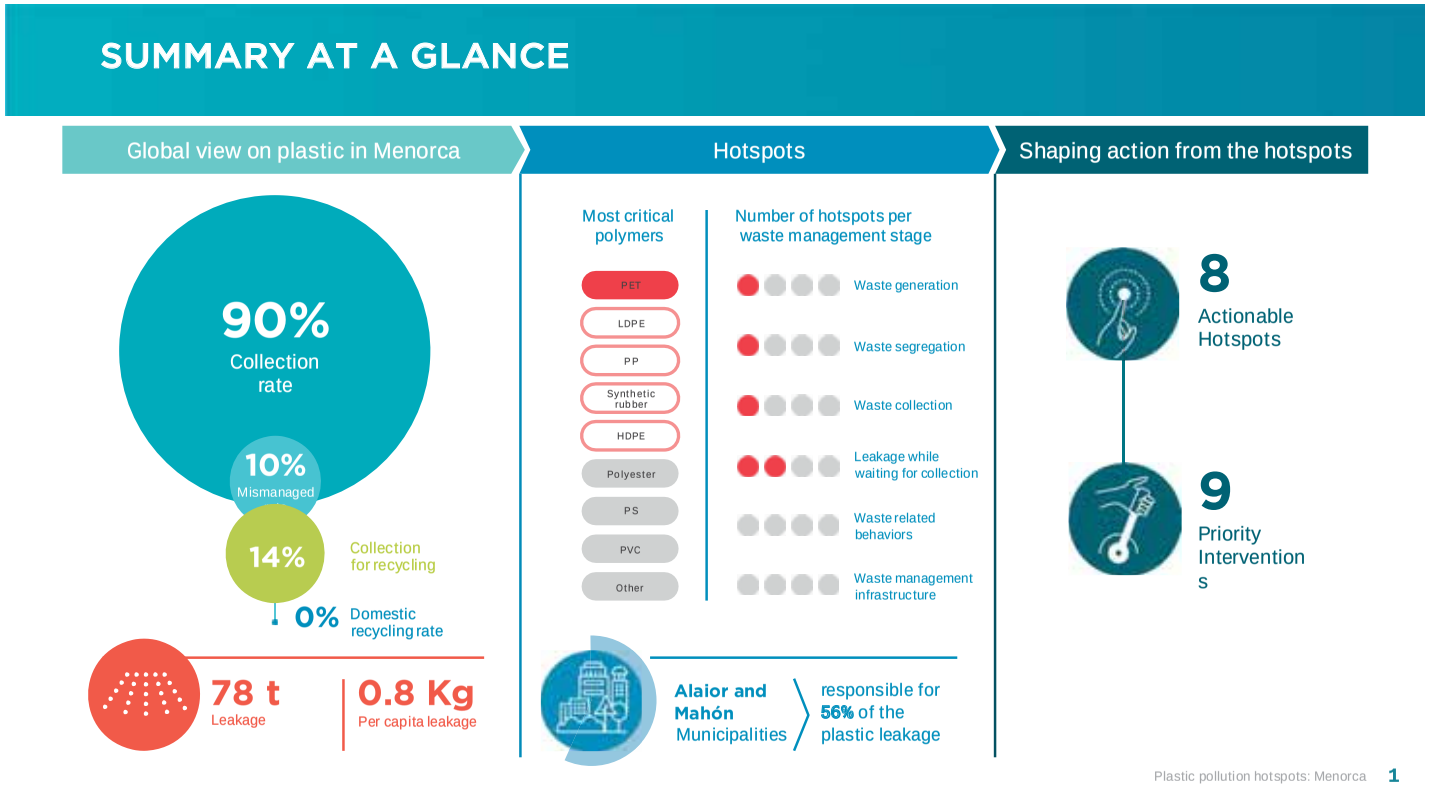
Annex 4 Data Overview: United Republic of Tanzania

Summary



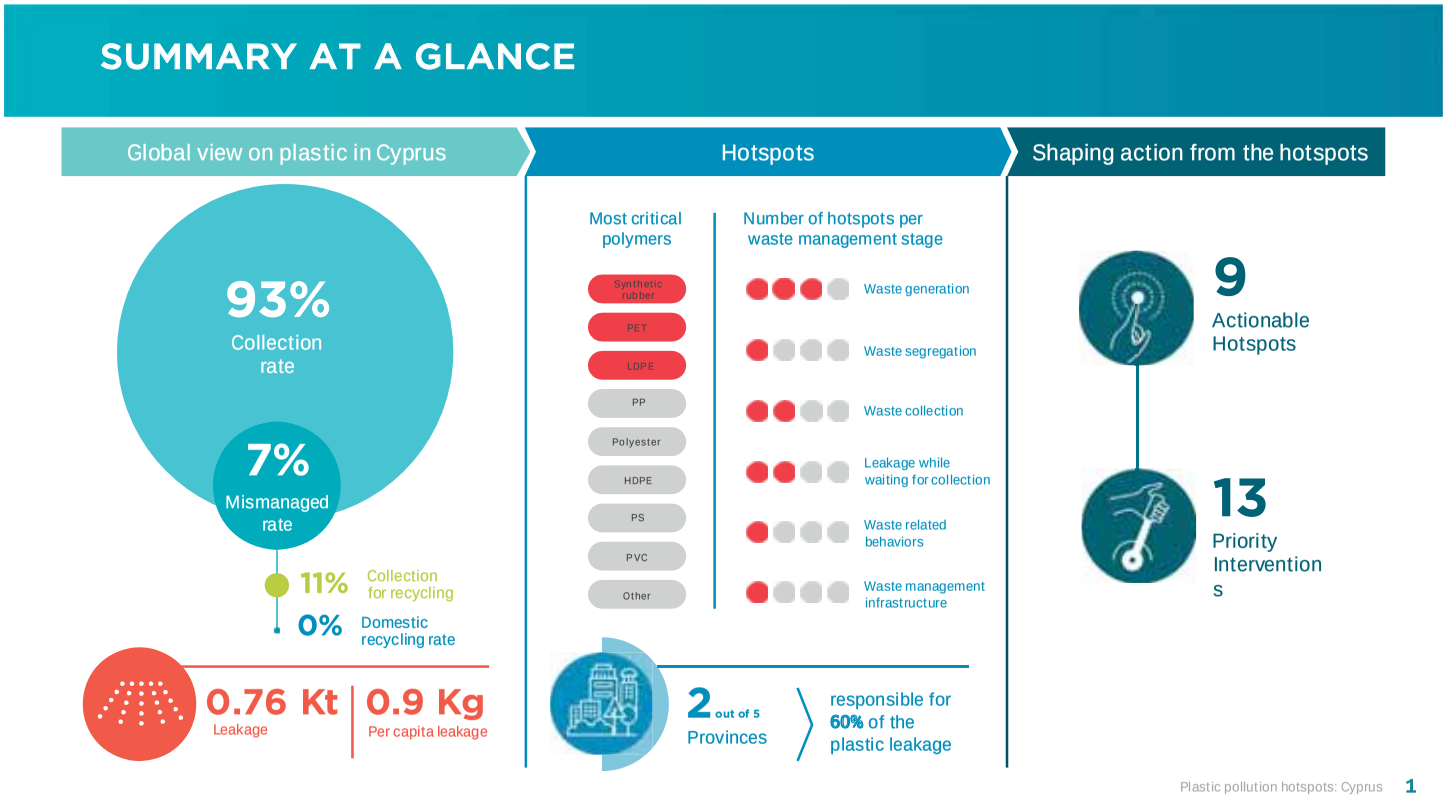
Annex 5 Data Overview: Menorca (Spain)

Summary



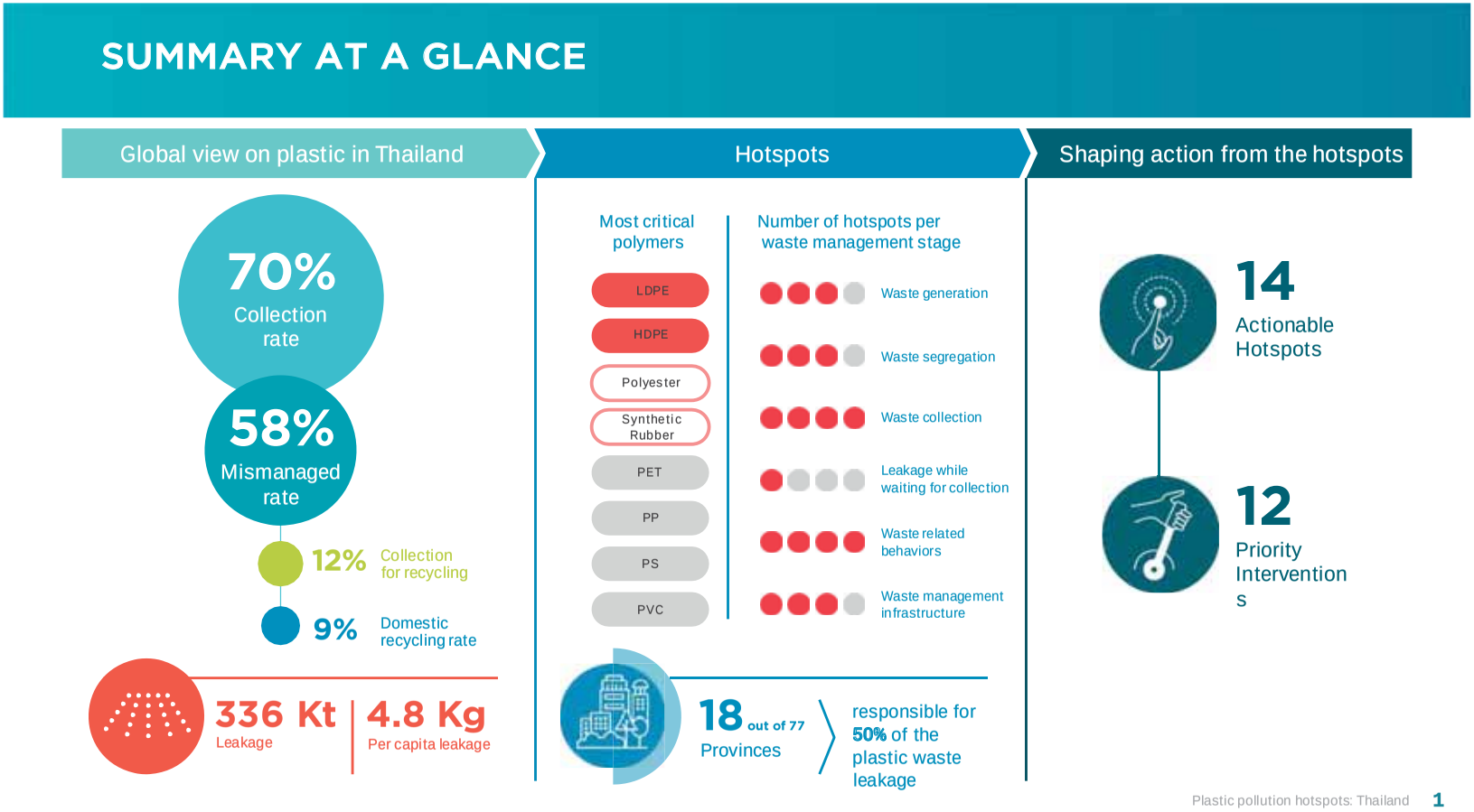
Annex 6 Data Overview: Republic of Cyprus

Summary



Annex 7 Data Overview: Thailand

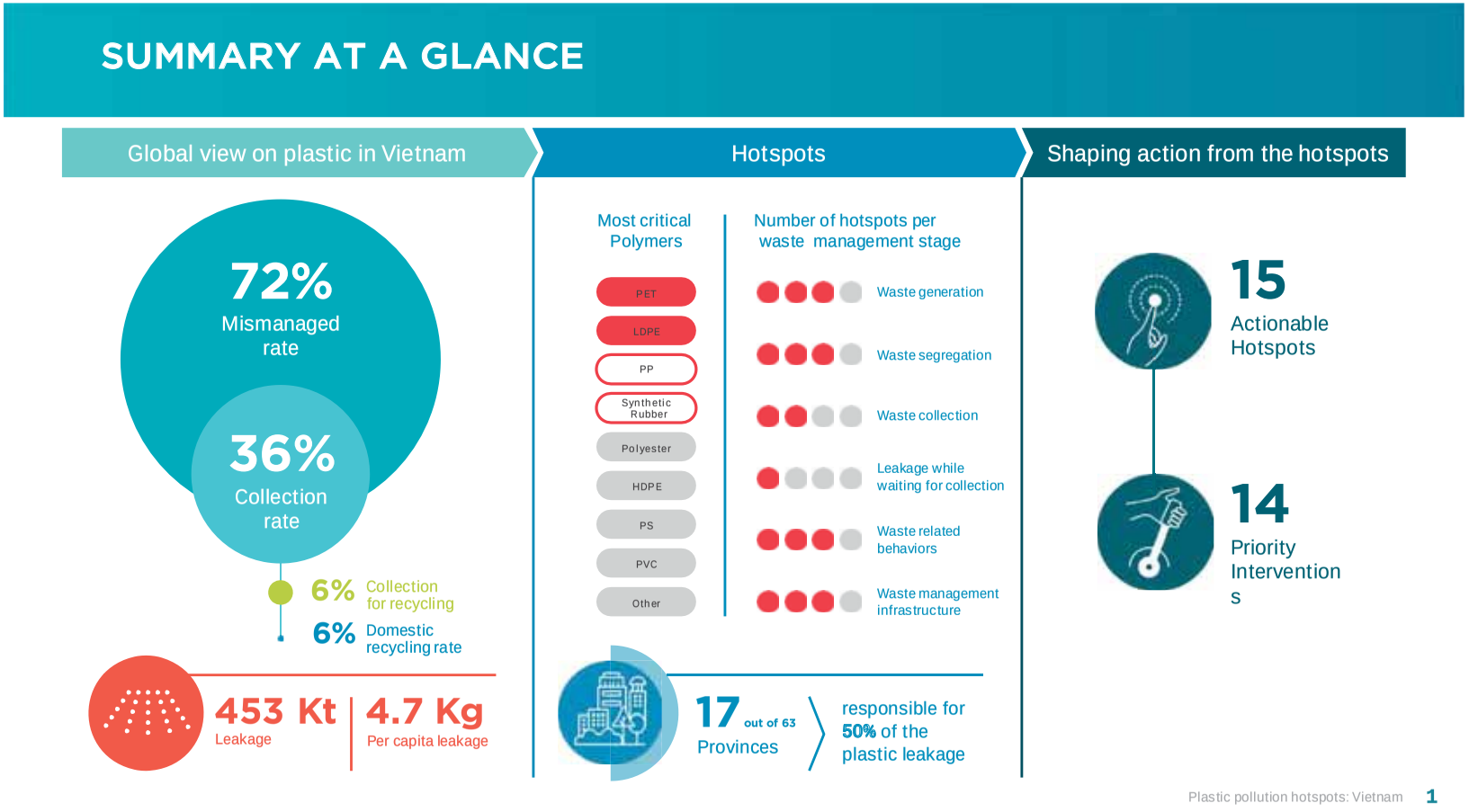
Summary



Plastic pollution hotspots: Thailand 1

Annex 8 Data Overview: Viet Nam

Summary



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