Topline report

Plastic leakage assessment of the global apparel industry

Report by

Cotton Incorporated

Introduction

It is estimated that 79% of plastic waste ends up in landfills or the natural environment, where it accumulates (rather than decompose), can enter food webs and negatively impact ecosystems through entanglement or ingestion. As awareness around plastic pollution grows, companies across sectors, including apparel, are increasingly looking for ways to reduce the plastic leakage potential of their products. Until recently, complexities of the plastic issue and the global apparel value chain have limited our understanding of the topic, thus prohibiting the assessment of the issue or impacts and the development of a clear improvement plan.

The creation of the Plastic Leak Project Guidelines (PLP, Peano et al, 2020) co-developed by Quantis and EA (Environmental Action) – the first science-based methodology to map and quantify plastic leakage across a value chain – has created an opportunity for fast-moving consumer goods sectors to better understand plastic leakage. Plastic leakage is the weight of plastic that ends up in the natural environment. The insights from a plastic leakage assessment provide a strong foundation for the industry to effectively tackle plastic pollution.

This report is based on the scientific publication of Kounina and Daystar, et al. (2024)[1]. It outlines the main findings of the first of its kind industry-wide study, applying the Plastic Leakage Guidelines to the entire apparel sector. This foundational study offers insights across the global apparel value chain. It measures the amount of plastic leakage from both cotton and polyester garments throughout their cycles in four markets. The seven-stage analysis spans from agriculture or pellet production to daily consumer use and eventually reuse and end-of-life.

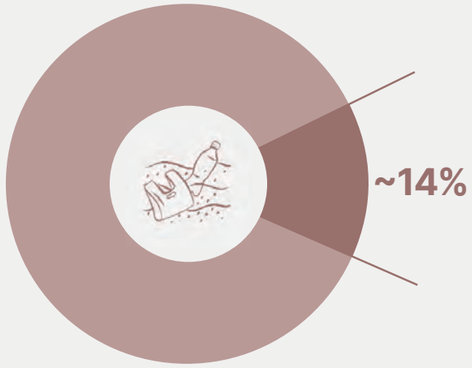
The final results present an estimate of the weight of the plastic leakage generated by the global apparel industry in 2019. This survey did not take into account the environmental, social or economic impacts of the plastic leakage.
By identifying and measuring the magnitude and location of plastic leakage, fashion brands, apparel supply chain actors, material manufacturers, and fiber producers will be better equipped to create strategies and action plans to reduce leakage across the value chain.

This study is based on best-available data, and the results can be combined with new scientific information on the impact of plastic in the natural environment when it becomes available.

[1] *Kounina A, Daystar J, Chalumeau S, Devine J, Geyer R, Pires ST, Sonar SU, Venditti RA, Boucher J (2024) The global apparel industry: a significant, yet overlooked source of plastic leakage. Nature Communications.* https://doi.org/10.1038/s41467-024-49441-4

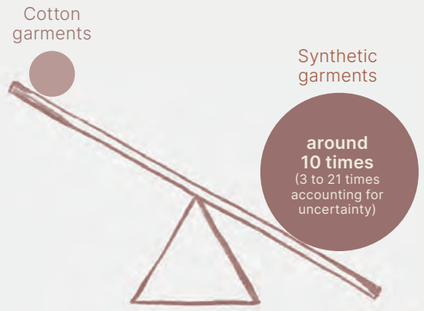
Key findings

Apparel industry responsible for 14% of plastic leakage



The global apparel industry is responsible for 8.3 million tons (Mt) plastic leakage on an annual basis, i.e. 14% of the total amount of plastic leaked into the environment annually (dominated by macroplastics from packaging and considering other microplastic sources such as paints, tire abrasion, etc.). This substantial contribution is mainly due to inadequate synthetic garment collection and treatment after disposal.

Synthetic garments cause around 10 times more than cotton garments



Synthetic garments cause at least 10 times more (3 to 21 times accounting for uncertainty) plastic leakage than cotton garments, due mainly to waste mismanagement at a garment's end-of-life as well as synthetic microfibers. Synthetic seasonal garments (used during only one season), in particular, generate more leakage than standard garments due to their shorter lifespan. The uncertainty is mainly driven by the data used for waste end-of-life in different geographies.

Leakage more likely to occur in destination countries for used clothing

Plastic leakage rates are highly dependent on the geographical region. Secondary markets — destination countries for used clothing — tend to have higher rates of leakage than primary markets. Plastic waste generation and leakage is thus shifted from geographies with robust waste management systems to geographies with less adequate waste collection and treatment.

On a weight basis, leakage is dominated by macroplastics[2]

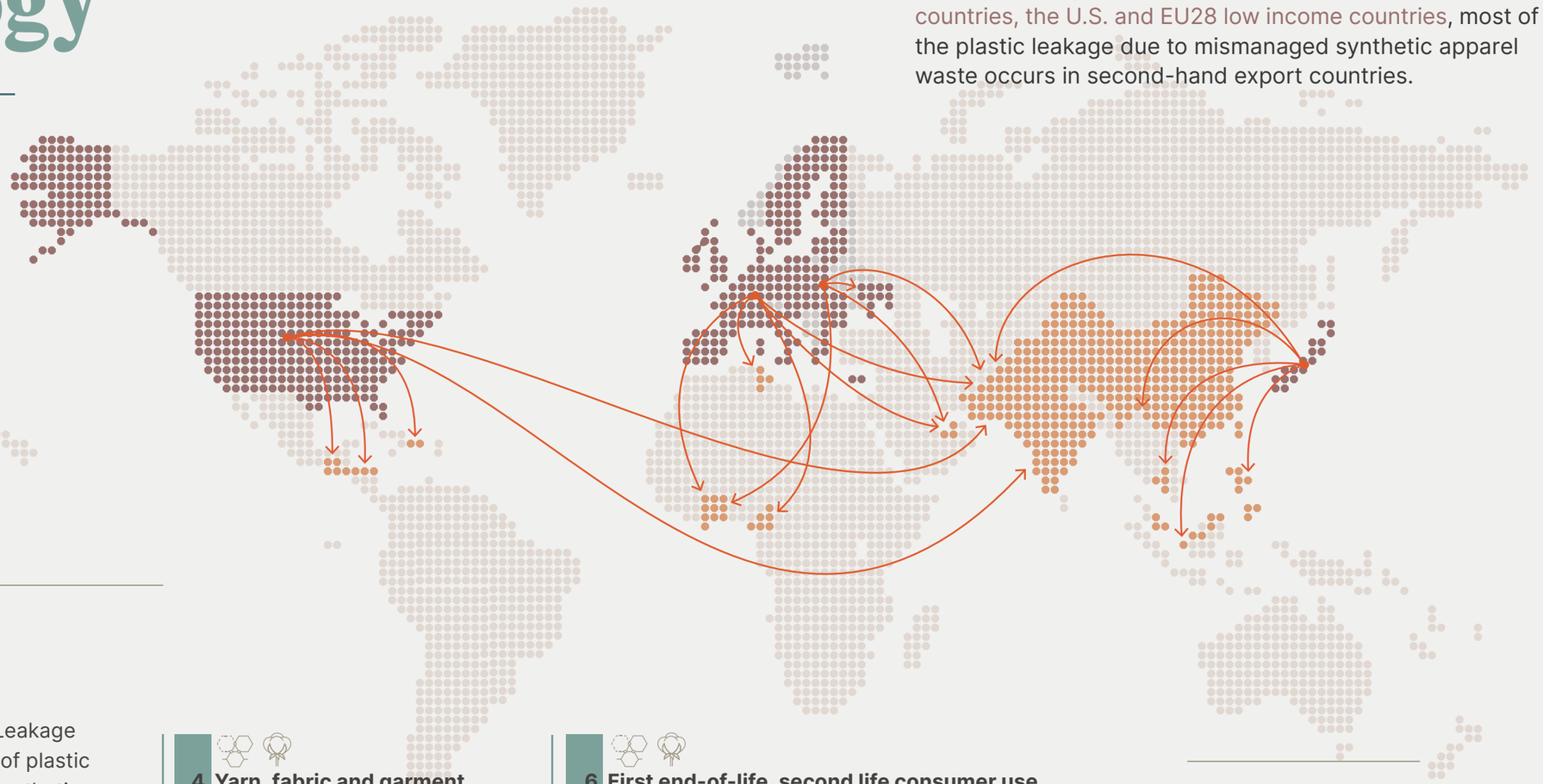
In terms of weight, improper synthetic garment disposal is the largest driver of plastic leakage in the apparel industry. By weight (unlike by the number of particles released), fiber fragments during synthetic fiber production and apparel washing (during both manufacturing and use stages) represent less than 1.5% of plastic leakage from the global apparel industry.

[2] *The definitions of macro- and microplastics are on p10.*

Methodology

This scientific analysis is divided into the seven life cycle stages described below. **Every stage, from fiber production through daily use and end-of-life, can generate plastic leakage. The quantity of leakage of each stage varies from one country to the next.**

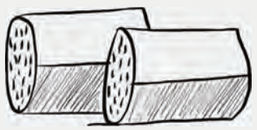
The study was conducted using the Plastic Leak Project (PLP) Guidelines (Peano et al., 2020) which were developed by Quantis and EA through a multi-stakeholder initiative with 35 organizations including apparel companies.



→ For apparel originally sold in Japan, the EU28 high income countries, the U.S. and EU28 low income countries, most of the plastic leakage due to mismanaged synthetic apparel waste occurs in second-hand export countries.

Synthetics Cotton

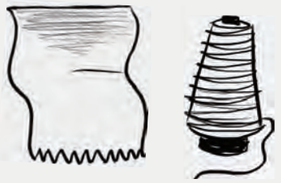
1 Pellet production: Leakage during the production of plastic pellets used to make synthetic materials such as polyester fibers and plastic packaging.



2 Packaging production: Leakage from plastic pellets during the manufacturing of packaging, mulching plastics, module and bale wraps.

3 Cotton cultivation: Leakage from the use of plastic applied to agricultural soil, such as mulching plastic, and items which may be mismanaged at the farm-level such as module wraps or crop input packaging.

4 Yarn, fabric and garment production: Leakage during the textile and apparel manufacturing stage, including production of yarn, fabric (including dyeing and finishing), and garments.



5 Retail and consumer use: Leakage from improper disposal of product packaging and fiber fragments.

6 First end-of-life, second life consumer use, and second end-of-life: End-of-life leakage for garments in each country of consumption, including shares of items exported for second life.
The coloured areas on the map show primary market sources and the arrows show the secondary markets that contribute most to the plastic leakage.

In the case of the European Union (28 countries in 2019), the countries were divided into two groups, depending on their GDP to better reflect variability within Europe.

Primary market	Key secondary markets
EU High income →	Pakistan, Tunisia, Ghana, United Arab Emirates, Cameroon, Other markets
EU Low income →	Pakistan, Ukraine, Togo, United Arab Emirates, Cameroon, Other markets
US →	Guatemala, India, Dominican Republic, Honduras, Pakistan, Other markets
Japan →	Philippines, Malaysia, Cambodia, Pakistan, China, Other markets

- Primary markets: market where new garments are sold
- Secondary markets: markets into which used garments are imported for a second life
- → Export to secondary markets

7 Road transport throughout the value chain: Microplastic leakage from truck tire abrasion that occurs across the value chain.

1 Situation of the apparel industry

Total global apparel industry plastic leakage is ~8,300,000 metric tons of plastic per year, based on the results from this study.

~8,300,000

metric tons of plastic per year

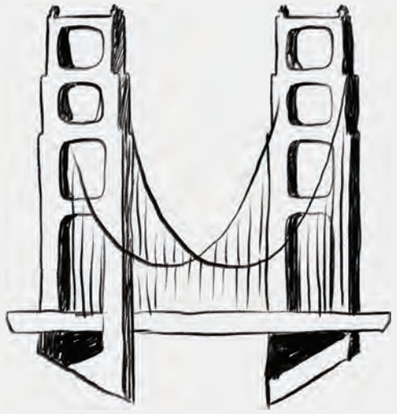
~98% macroplastics

~2% microplastics

This plastic weight of ~8,300,000 metric tons is equivalent to:

820 times
the weight of the Eiffel Tower (10,100 metric tons).

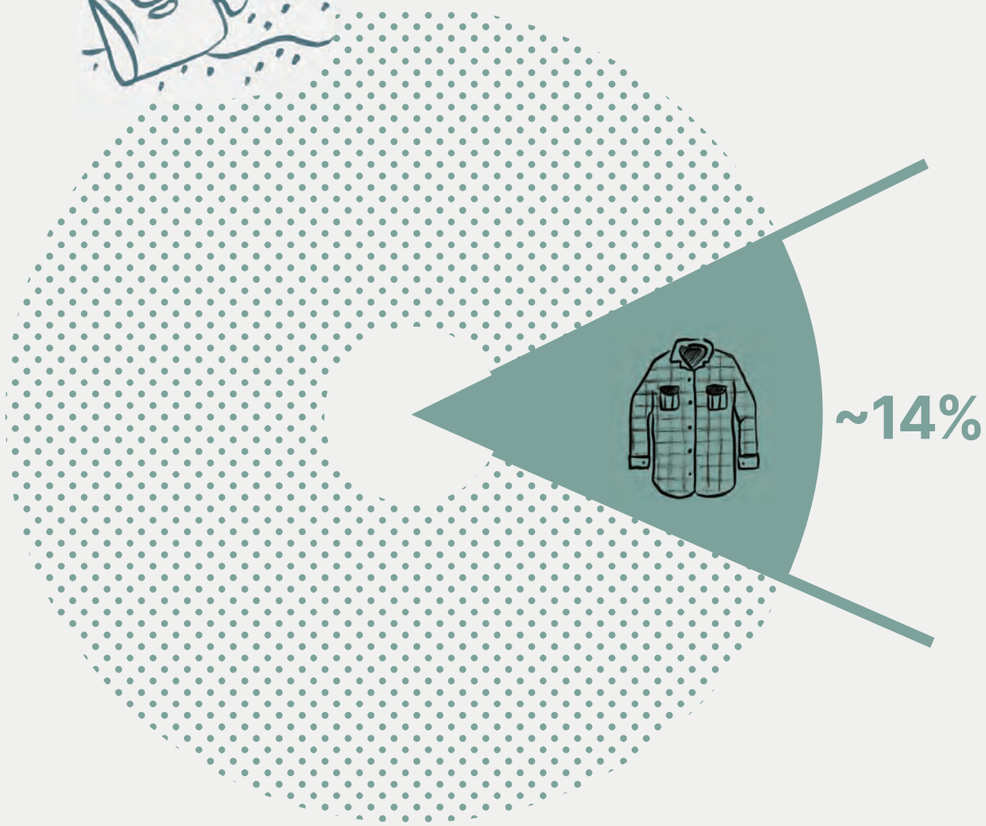
More than
23 times
the weight of the Empire State Building (365,000 metric tons).



Almost
9 times
the weight of the Golden Gate Bridge (887,000 metric tons).

Global plastic leakage

Macroplastics from packaging and other microplastic sources such as paints, tire abrasion, etc.



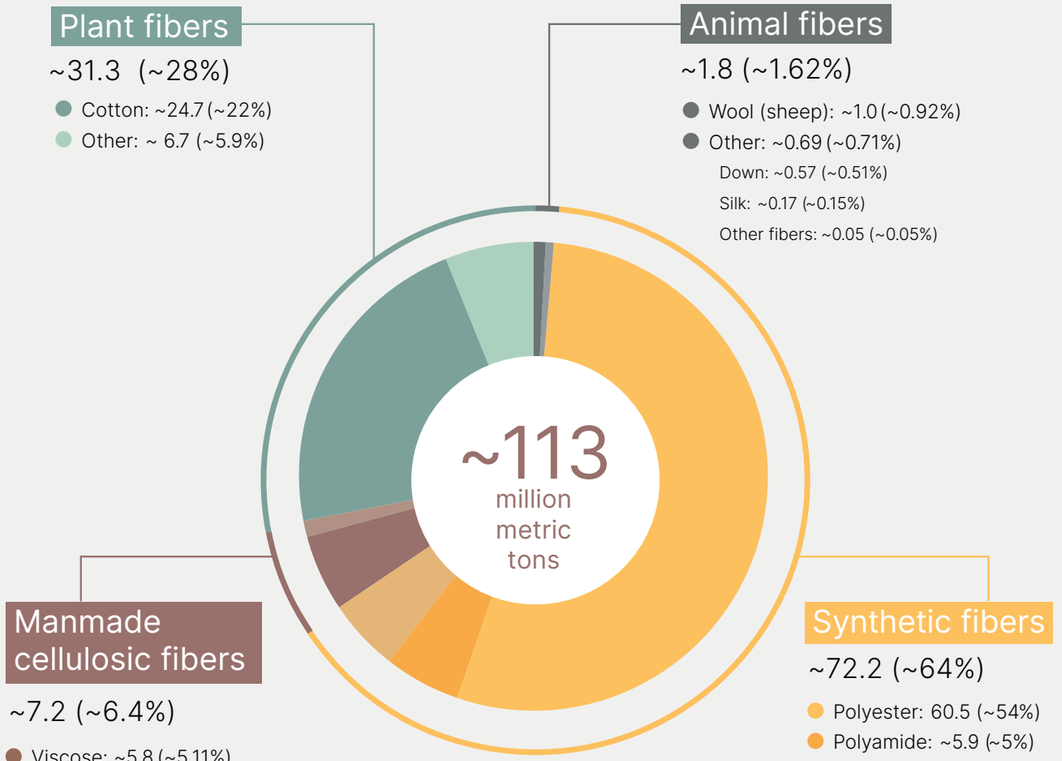
The global apparel industry is responsible for 14% of overall plastic leakage.

2 Synthetics vs. Cotton fibers

This study quantified the amount of plastic released into the environment during the production, use and disposal of cotton and synthetic garments. For the latter, the majority of plastic leakage occurs during its second life in developing countries where waste management systems are inadequate.

Global fiber production in 2021[3]

in million metric tons and as % of total fibers



[3] *Textile Exchange 2022, Global fiber production in 2021 (in million metric tons).*

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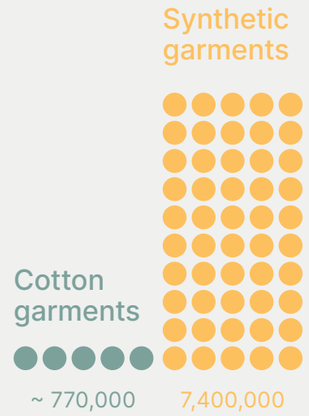
Synthetic apparel causes around 10 times more plastic leakage than cotton garments across the garment life cycle (metric tons per year).



~8,300,000 metric tons (including 120,000 for other fibers)

Plastic leakage from synthetic fibers-based garments occurs at each stage of a garment life cycle. The latter stage is particularly common when poor waste management infrastructure leads to unwanted garments ending up in waterways. Cotton garment plastic leakage mainly comes from packaging end-of-life.

↓

Synthetic seasonal garments generate more leakage than standard garments due to their shorter lifespan.

Seasonal garments have an assumed duration of consumer use less than or equal to one year. As such, they have a higher annual leakage rate than standard garments, which have a longer lifespan (of over one year).

3 Geographical differences

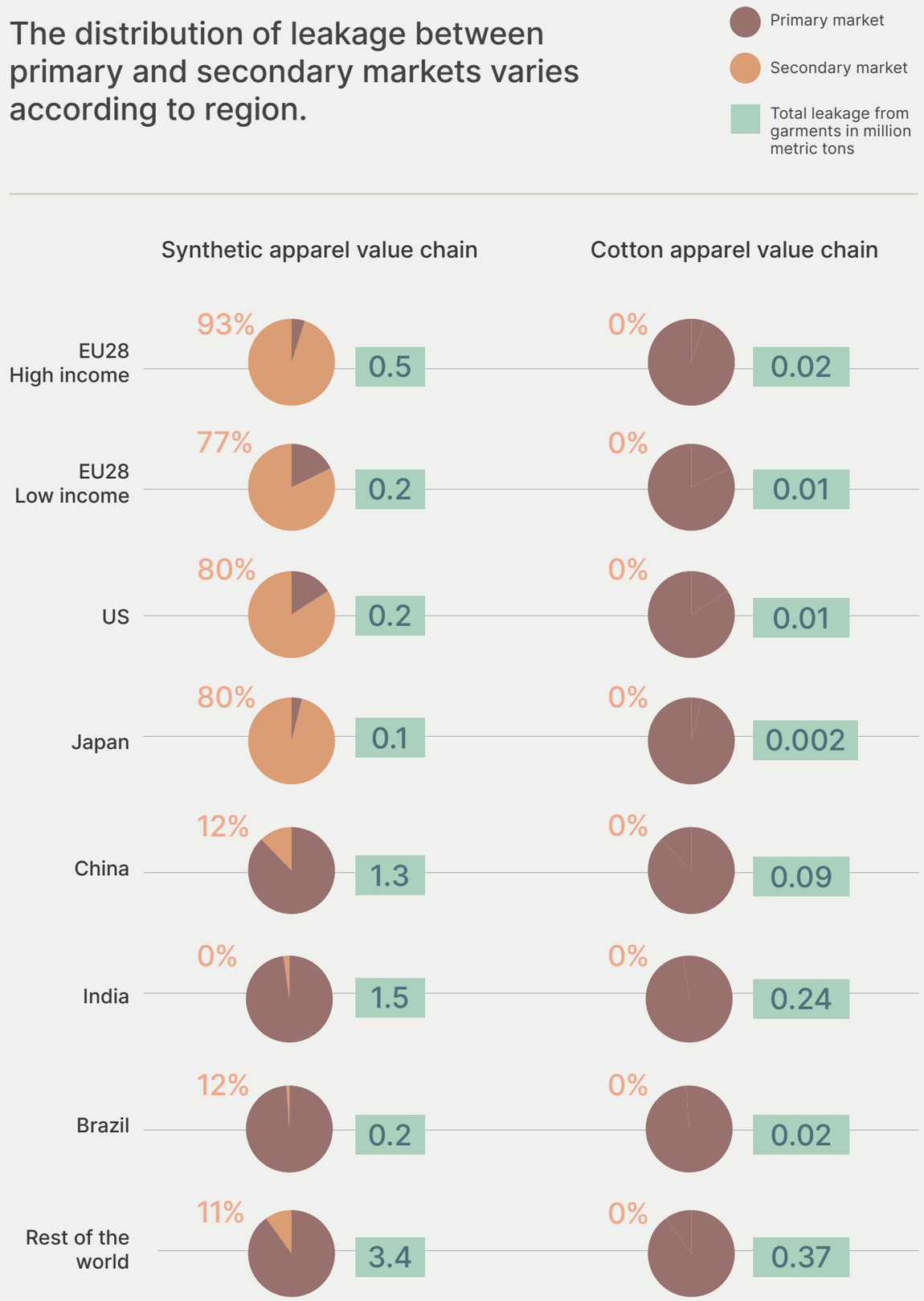
High consumption in middle and high income markets.
Among the countries considered in this study, middle and high-income regions (US, EU-28, Japan, and China) are responsible for the majority of global apparel consumption.

China and India: primary markets with highest leakage.
Clothing produced and consumed in China and India generate significantly more leakage than any other regions considered in the study, as a high rate of synthetic garment waste is mismanaged after first use.

Leakage from the cotton apparel value chain.
For cotton garments, most leakage occurs from plastic use in consumer and supply chain packaging in primary markets. In China, another source is agricultural mulching plastics which will remain in the soil.

Second end-of-life highest source of leakage for high income countries.
For the US, EU-28 and Japan, the leakage of synthetic apparel is dominated by its second end-of-life. Apparel bought and first used in the US and the EU-28 is typically re-sold to countries in Latin America, Africa or the Asian subcontinent for a second life, where waste management systems are not as well-controlled.

The distribution of leakage between primary and secondary markets varies according to region.



4 Proportion of microplastics vs. macroplastics

All apparel value chains leak both microplastic and macroplastics into the environment. Each form of plastic poses unique environmental risks and concerns.

→ **Microplastics** are plastic items with a dimension < 5 mm. Microplastics are created mainly by fragmentation of plastic in water or soil all along the life cycle of a garment from production to usage.

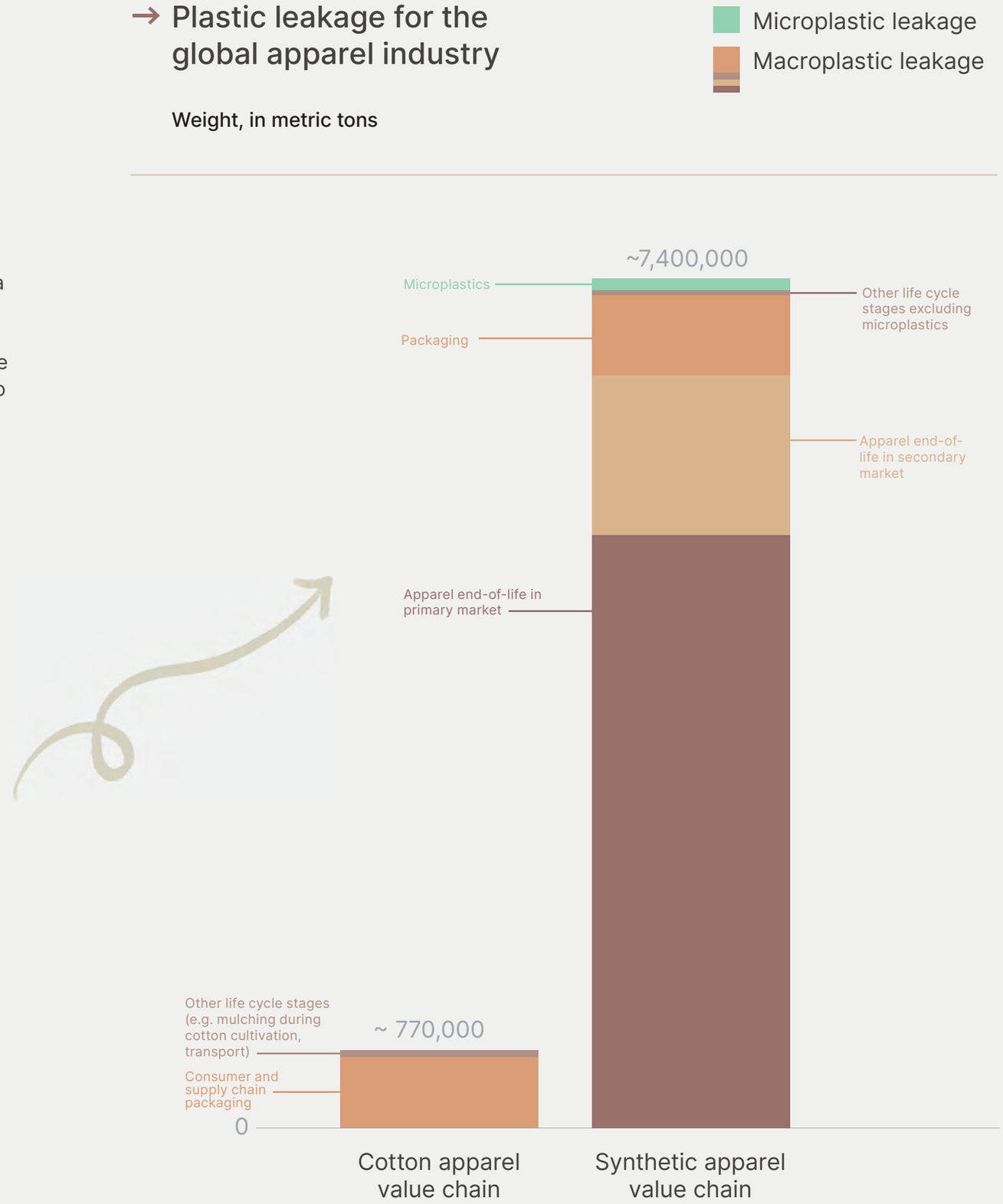
→ **Macroplastics** are plastic items with a dimension ≥ 5 mm. They are pieces of plastic remaining at the end-of-life, such as the synthetic garment itself, or from plastics used in the production, such as the use of agricultural plastics in certain fiber production regions.

The findings of the study show that macroplastics from synthetic garments, in terms of weight, make up the majority of plastic leakage from the global apparel industry as a result of mismanagement of garments at end-of-life. For synthetic garments, microplastics also leak into water when garments are washed and worn. However, such microplastic releases are small by weight in comparison with the macroplastics leakage through mismanagement at the end-of-life. 120,000 metric tons leakage from other fibers (e.g. manmade cellulosic fibers, animal fibers and plant fibers other than cotton) have also been assessed but not presented in detail in this report.

It is important to keep in mind that the impacts of plastics in the natural environment are not studied here, although methods are currently being developed to assess them[4]. More research is needed to determine the environmental impacts of both microplastics and macroplastics, as both types are important to consider to paint the full picture of plastic pollution.

→ Plastic leakage for the global apparel industry

Weight, in metric tons



[4] *e.g. https://marilca.org/*

Recommendations

As a significant source of plastic leakage into our oceans, waterways and soil, the global apparel industry has a critical role to play in reducing plastic leakage. While this study provides an important first look at the issue of plastic leakage in the global apparel industry, more work is needed to develop effective strategies and action plans that can be implemented globally. The following are some initial recommendations based on the findings of this study.

Predicted increases in synthetic fiber production and usage will significantly worsen plastic pollution unless the apparel industry actively changes how it manufactures, consumes, and disposes of clothing.

Move towards true circularity

The apparel industry needs to ramp up its efforts to true circularity. This means aiming to increase the lifespan and use of clothing, enhancing waste management and recycling practices, utilizing resources efficiently, and transitioning to renewable materials. Essential strategies for this systemic shift include designing clothes for durability, and supporting reuse, remanufacturing, and recycling to ensure products and materials remain within the economy. Additionally, there is a critical need to improve waste management systems for textiles. This involves both the expansion of traditional waste management infrastructure, such as properly operated landfills and incineration facilities, and the advancement of recycling technologies, particularly in developed nations.

Packaging ecodesign is also a key lever to reduce plastic leakage.

Prioritize the use of cotton and other natural fibers to reduce plastic leakage

The production, use, and disposal of synthetic garments can result in 3 to 21 times more plastic leakage compared to garments made from natural fibers like cotton. Prioritizing the use of cotton and other natural fibers in clothing design stands out as a key strategy to reduce plastic leakage from the apparel industry. Additionally, improving waste management infrastructure in secondary markets, where apparel is frequently exported, is critical. It is important to consider the social, environmental, and economic impacts beyond plastic leakage to guide decision-making and prevent burden shifting to other areas.

Global approach, local solutions

To address plastic leakage, a global strategy and active participation across the entire supply chain are crucial for making improvements. However, since leakage varies by location, it is necessary to customize solutions to fit local conditions. This could involve implementing garment deposit schemes, enhancing waste management infrastructure, or modifying agricultural practices, like eliminating the use of plastic mulch.

Better end-of-life waste management especially in secondary markets where used clothes are exported to

As used, synthetic apparel is exported to secondary markets, plastic waste generation is shifted from geographies with robust waste management systems to geographies with inadequate waste collection and treatment. It is thus vital that textile brands and governments include secondary markets in their sustainability strategies, roadmaps, and action plans to limit plastic pollution.

Guidance and limitations of a plastic leakage assessment

- It is important to note that a plastic leakage assessment only estimates the quantities of plastic that could be leaking into the environment and does not estimate the impact this leaked plastic has on the environment, because the science on this topic is still evolving. However, these inventory data provide visibility into the geographic hotspots and life cycle stages where plastic leakage is occurring.
- Other social, environmental and economic considerations are not taken into account in the study.
- Mismanaged waste rates are based on World Bank data (2018) that represent national statistics of solid waste treatment. These data, used here as a proxy for synthetic garments, have a high uncertainty. Although these results represent state-of-the-art estimates, their accuracy will be refined when specific end-of-life treatment data for garments is available.

Definitions

Garment
The study covered the following standard cotton and polyester garments: t-shirt, shirt, pants, underwear, sweater and technical jacket.

Standard garnment
Standard garment a duration of more than one year (depending on materials).

Seasonal garnment
Seasonal garment a duration of use less than or equal to one year.

Plastic leakage
Weight (in grams) of plastic leaving the technosphere (sphere resulting from human activity) and ending up in the environment.

Macroplastics
Plastic items with a dimension ≥ 5 mm. Considered to be macroplastics once they are released into the environment.

Microplastics
Plastic items with a dimension < 5 mm.

Waste mismanagement
Waste ending up in environmental compartments instead of properly following the waste stream.

Primary market
Market where new garments are sold.

Secondary market
Markets into which used garments are imported for a second or subsequent life.

References / Sources

Read the full study **here.**

Most data for this study either comes from publicly available sources for both types of garments, their life cycles and the geographic regions or has been collected by Cotton Incorporated in previously published work.

The global assessment was performed by applying the leakage rate found by garment type to the global number of garments produced and bought in each primary market in 2019, for both synthetic apparel (polyester, nylon, acrylic, elastane) and cotton apparel. An estimation of the total weight of garments produced yearly was made based on production data from the U.S. Department of Agriculture (USDA, 2019) and Trade Data Monitor (2020).

References

Kounina A, Daystar J, Chalumeau S, Devine J, Geyer R, Pires ST, Sonar SU, Venditti RA, Boucher J (2024) The global apparel industry: a significant, yet overlooked source of plastic leakage. Nature Communications. https://doi.org/10.1038/s41467-024-49441-4

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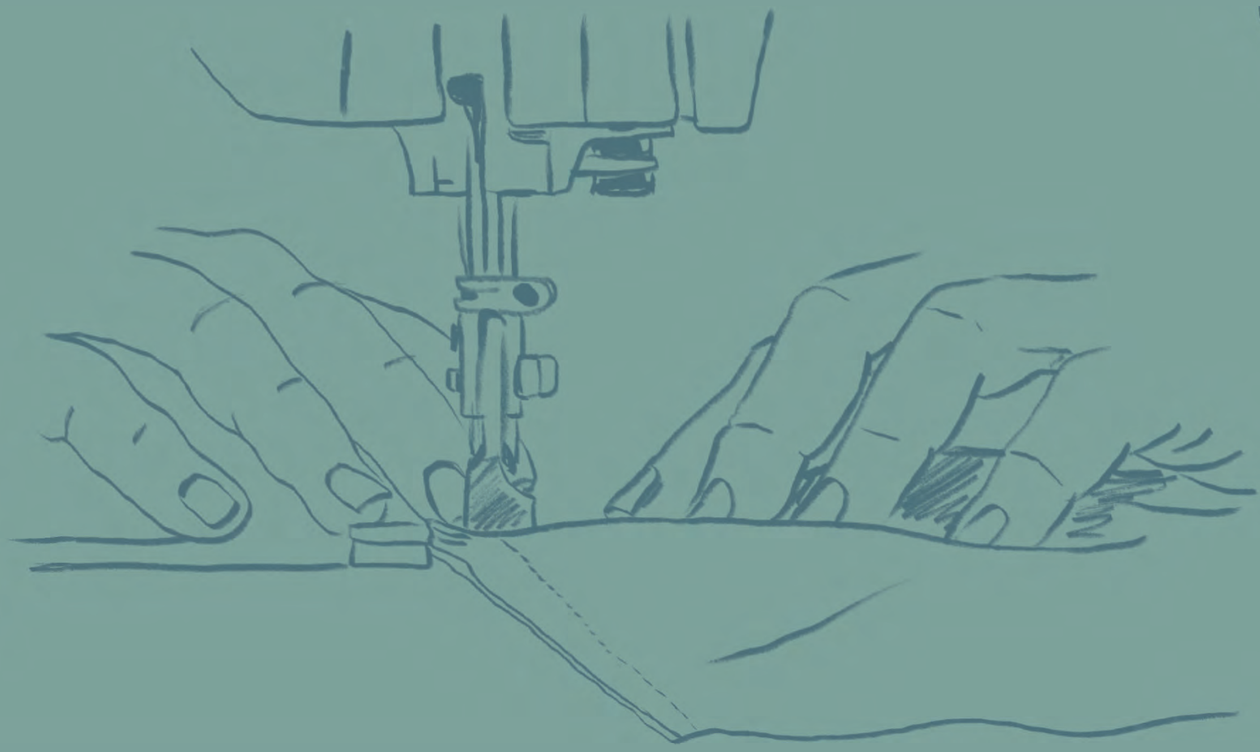

About the Plastic Leak Project (PLP)

The Plastic Leak Project (PLP) Guidelines (Peano et al. 2020) are an outcome of the PLP multi-stakeholder initiative convened by Quantis and EA to develop better metrics to help shape operational solutions and effective actions to address the plastic pollution crisis. The PLP provides a methodology as well as supporting data to enable companies to perform a plastic leakage assessment of their product, service and/or organization. It includes guidance for calculating micro- and macro-plastic leakage quantities at each life cycle stage and at product and corporate levels, ultimately for including them in a comprehensive multi-indicator environmental assessment. Four plastic leakage routes are covered to date:

1. Plastic products and packaging (due to waste mismanagement)
2. Textiles (due to textile washing)
3. Transport (due to tire abrasion)
4. Pellet production

About Cotton Incorporated

Cotton Incorporated is the research and promotion company for Upland cotton. Funded by U.S. cotton growers and importers of Upland cotton-containing products, the not-for-profit organization's mission is to increase the demand for and profitability of cotton. As a resource for the cotton industry, Cotton Incorporated conducts or oversees 450 research and educational projects in an average year. Research areas range from the development of agricultural and textile innovations to analyses of commodity and market data.

Learn more about the commitment to sustainability through research at CottonToday.com or Cottoninc.com

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