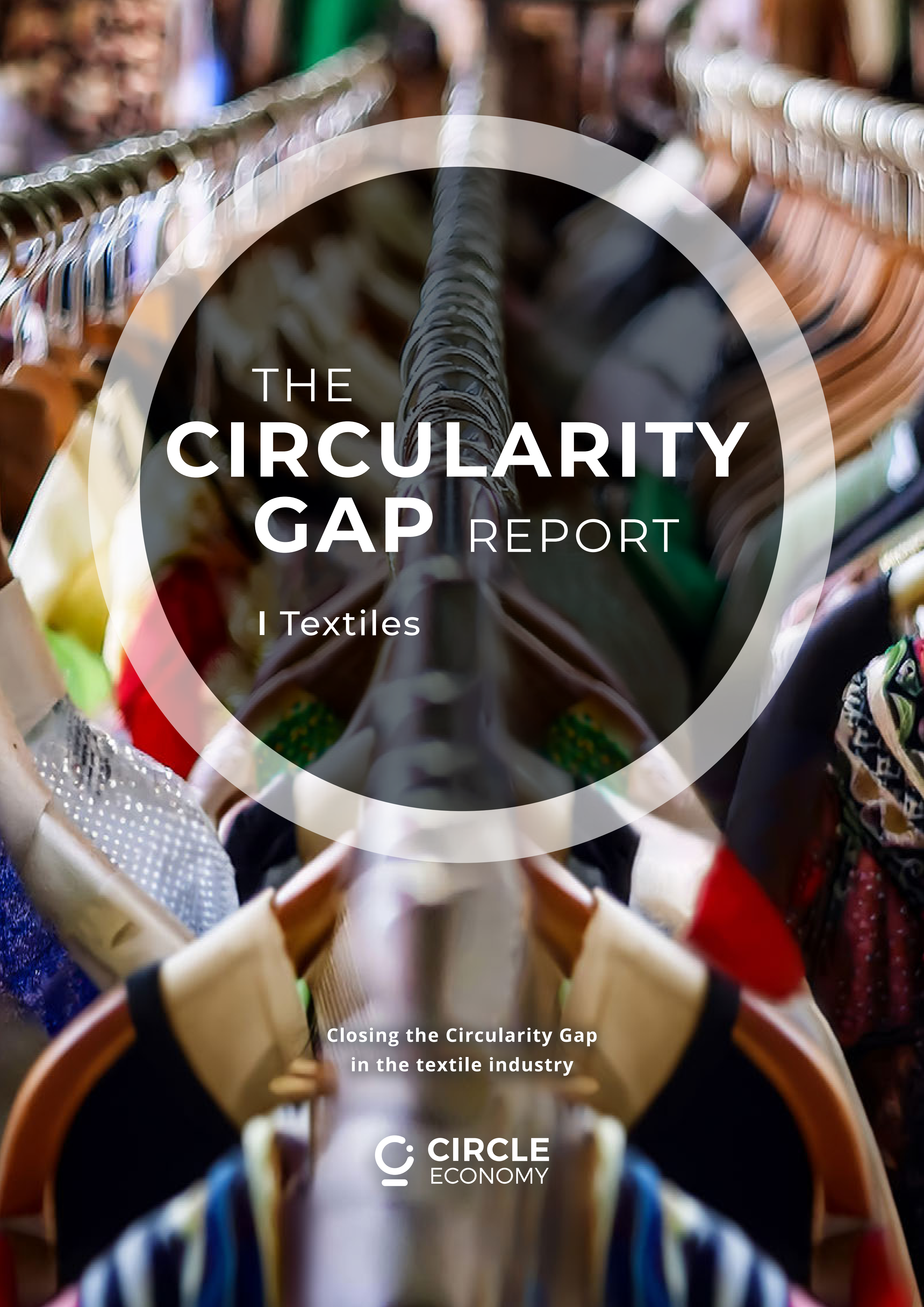


THE CIRCULARITY GAP REPORT

Textiles

Closing the Circularity Gap in the textile industry

CIRCLE ECONOMY

BEHIND THE COVER

The cover image features rows upon rows of clothing, nodding to the key message of this report: we already have more than enough textiles in circulation.

With the current fast-paced cycle of production and consumption, this abundance isn't a mark of prosperity; it's a call to re-evaluate business as usual.

We must move towards a circular system that prioritises durability, reuse and regeneration, breaking free from the cycle of consuming and producing *more* towards a future that values *enough*.

We are a global impact organisation with an international team of passionate experts based in Amsterdam.

We empower businesses, cities and nations with practical and scalable solutions to put the circular economy into action. Our vision is an economic system that ensures the planet and all people can thrive.

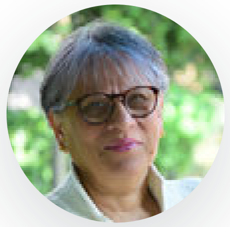
To avoid climate breakdown, our goal is to double global circularity by 2032.

The H&M Foundation, funded by the Persson family, founders and majority owners of the H&M Group, supports the textile industry in halving its greenhouse gas emissions every decade by 2050, while promoting a just and fair transition for both people and the planet.

Its projects target high-emission areas along the textile value chain where the H&M Foundation's philanthropic strengths can have the greatest impact.

Find more information at hmfoundation.com

IN SUPPORT OF THE *CIRCULARITY GAP REPORT TEXTILES*



ANITA CHESTER
Head of Fashion, Laudes Foundation

‘The textile industry has unequal, outsized impacts on people and planet, and only through concerted efforts to embrace and scale circularity does the industry stand a chance to mitigate these impacts. This report offers a thorough analysis of the state of circularity in the sector, capturing both the size of the challenge and pathways to address it. It provides a comprehensive guide to understanding the consequences of not transitioning to an inclusive, circular economy, and presents an actionable blueprint to achieve circularity across the entire value chain, with recommendations for industry stakeholders, investors, policymakers and other actors within the ecosystem.’

HOLLY SYRETT
Vice President of Impact Programmes & Sustainability, Global Fashion Agenda

‘Achieving a net positive fashion industry–one that gives more to the environment, society and the economy than it takes–will only be possible if we transition to a circular economy, where growth is decoupled from the consumption of finite resources and where value is distributed fairly among all actors. The *Circularity Gap Report Textiles* supports this transition by identifying holistic indicators and impacts to prioritise collective action and drive accountability. ’

KATE GOLDSWORTHY
Professor of Circular Design and Innovation, University of the Arts London

‘The *Circularity Gap Report Textiles* highlights that the global textile industry is currently only 0.3% circular. By analysing six scenarios it reveals strategies for systemic change that consider reductions in resource use, emissions, and waste, and improvements to social and workforce issues.

This holistic approach—combining circularity metrics, environmental footprints, regional comparisons, and social dimensions makes the Circularity Gap Report Textiles a timely and critical contribution to the circularity discourse in the textile industry today.’

ESRA TAT
Executive Director, Zero Waste Europe

‘The sobering results of this report underscore the significance of demand-side measures once more, as they truly lay bare the flaws of the current system. This calls for strong action to boost circularity while ultimately limiting overall volumes of production and consumption, which outpace such advancements in circularity. Community-led local solutions to global challenges, as well as regulatory frameworks, are what we need now to address the fact that over 99% of the materials needed for global textiles manufacturing still originate from primary sources.’

DR. KERLI KANT HVASS
Assistant Professor in Circular Economy at Aalborg University, Department of Sustainability and Planning

‘This report addresses the persistent challenge of limited data and fragmented analyses in the textile industry by providing a first-of-its-kind analysis of the global state of textile circularity, including social and labour issues. The transition to a circular textiles economy is extremely slow in spite of the technologies and know-how we have available in 2024. This is well illustrated and quantified in the report, which reveals the industry's current circularity rate of an alarming 0.3%. This underlines the urgent need for serious global efforts to level the playing field for sustainable and circular practices and speed up policymaking. This valuable report can guide global policymakers and industry stakeholders to confront the industry's unsustainable practices—including the pressing issues of overconsumption and overproduction, which are major bottlenecks in reducing the impact of the textile industry.’

ANA RODES
Head of Sustainability, Recover™

‘The *Circularity Gap Report Textiles* provides a pioneering analysis of the global textile industry's circularity. Crucially for our field, it bases its recommendations on data and practical insights, highlighting the urgent need for a shift from a linear to a circular economy. It advocates for sustainable practices, better labour standards, and systemic change. Aligned with our vision at Recover™, this report underscores our belief that a sustainable transformation of the textile sector is not only necessary but entirely possible.’

LUCY SHEA
Group CEO, Futerra

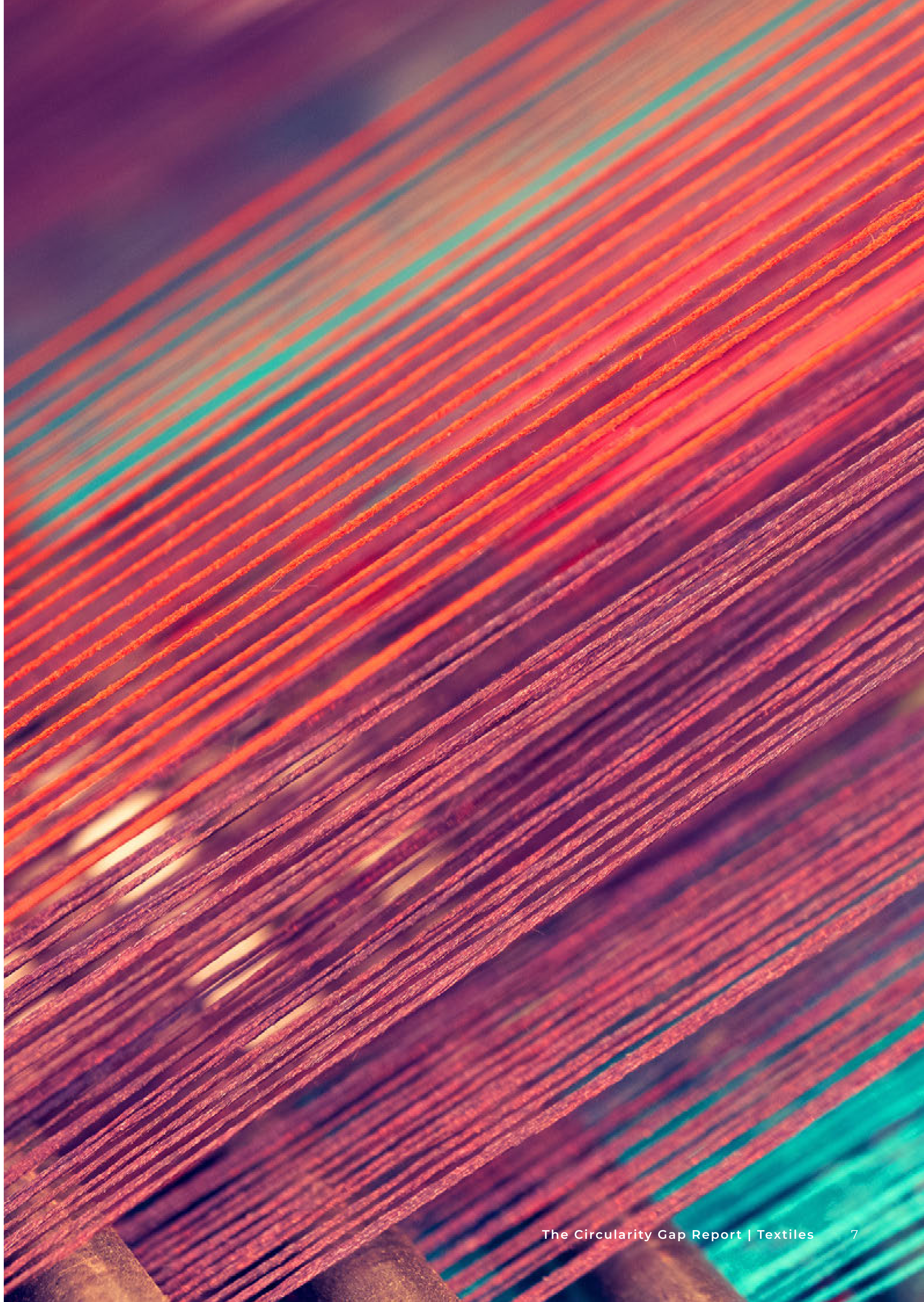
‘We need to reimagine and reconstruct the fashion industry. As the *Circularity Gap Report Textiles* highlights, the global textile industry is just 0.3% circular. The report lays out the dire state of today’s affairs but also offers scenarios for this urgently needed restructure. It gives a realistic set of solutions with numbers attached, from greater use of natural fibres to extended garment durability. Read it for actionable insights–and set your imagination free.’

ANNA PEHRSSON
R&D and Partnerships Lead, TEXAID

‘This comprehensive report on the circularity of the global textile industry is the first of its kind, offering valuable insights into the status quo. It is alarming to see that the industry is only 0.3% circular, highlighting the urgent need for measures to improve the state of the industry, tackle climate change, support sustainable production practices, reduce waste, promote resource efficiency and advance textile circularity.’

CYNDI RHOADES
Founder + former CEO, Worn Again Technologies
CEO, Circle-8 Textile Ecosystems

‘A circular economy for textiles is not inevitable, but it is achievable. The *Circularity Gap Report Textiles* provides a comprehensive examination of the state of play today, revealing that ultimately, we’re only at the starting line (0.3%). The *Circularity Gap Report Textiles* combines this first-of-its kind analysis with a set of actionable scenarios and priority areas that could genuinely help to propel the industry forwards in the race towards a circular textiles economy. It’s a cold, sharp look at reality that offers tangible pathways and insights that can focus attention and galvanise all key stakeholders around what needs doing to get closer to the finish line.’



EXECUTIVE SUMMARY

This first-of-its-kind *Circularity Gap Report Textiles*—the pioneering global *Circularity Gap Report* for an industry—examines how materials flow throughout the entire textile value chain, from design to post-consumer management. It explores how materials are extracted, transformed and managed at their end-of-life—from cotton farming and petrochemical production to spinning, weaving and dyeing to product assembly and distribution—and delves into the resource and energy inputs of each stage. This report focuses on the textiles, clothing, leather and footwear (TLCF) industries, including those used for home furnishings and upholstery, but excludes technical textiles, such as those used by the medical and automotive industries. The findings emphasise the industry's resource-intensive practices, its contribution to the overshoot of several planetary boundaries, and the necessary systemic changes required to transition to a more sustainable and circular model.

The global textile industry is 0.3% circular: of the 3.25 billion tonnes of materials it consumes each year, over 99% come from virgin sources. Despite increasing sustainability efforts, the industry remains heavily dependent on virgin materials—particularly oil-based synthetics. Synthetic fibres like polyester, derived from fossil fuels, make up 63% of the raw materials used in textile production. The industry continues to operate almost entirely within a linear ‘take-make-waste’ paradigm, with massive quantities of finite resources extracted to produce billions of short-lived items. Brands in the mass market now release up to 24 collections per year, driving overproduction and waste, with 30% of garments produced going unsold annually. At the same time, garment quality is decreasing, with brands opting for synthetic materials and centring their practices on maximising production volumes. This starkly contrasts with the principles of a circular economy, which aims to keep materials in use at their highest value for as long as possible.

The textile industry has significant environmental impacts, particularly on water eutrophication, water scarcity, and climate change. To provide a clear picture of these effects, our analysis goes beyond the Circularity Metric, evaluating the industry’s environmental footprint across various sectors and regions. We examine eight key impact categories, based on the Planetary Boundaries Framework, which measure environmental health across land, sea and air: 1) Material footprint, 2) Marine and freshwater eutrophication, 3) Water scarcity, 4) Climate change, 5) Terrestrial and freshwater acidification, 6) Air pollution, 7) Biodiversity loss, and 8) Human health. The most severe impacts include marine and freshwater eutrophication, water scarcity, and climate change. Textiles contribute to over 5% of marine eutrophication and over 4% of global freshwater eutrophication, primarily due to fertiliser runoff from cotton farming and the chemicals used in dyeing processes. Additionally, the industry accounts for 3.5% of the total water scarcity impact caused by all global manufacturing activities, often operating in regions already facing water shortages. Factors such as geographical constraints, population growth, and competing industrial and domestic demands worsen water scarcity. The dyeing and finishing stages of the textile value chain are especially water-intensive, consuming approximately 93 billion cubic metres of water annually. The industry contributes almost 3.5% of global greenhouse gas (GHG) emissions linked to climate change, with material production, including fabric and trim manufacturing and finishing, accounting for 55% of the industry’s GHG emissions, largely due to energy-intensive wet processing.

Employing approximately 140 million people, the global textile industry profoundly influences social wellbeing and community livelihoods. The global textile workforce includes approximately 140.3 million people, with 89% working in the manufacturing phase. Of these, 61.5 million work in the informal economy. In regions like Asia, informal employment is widespread, with over 90% of textile workers in countries such as Bangladesh and India employed informally. These workers often face hazardous working conditions, low wages, and lack of social protections. Across most regions, wages in the textile sector are considerably lower than the average industrial wage. In Africa, textile workers earn 44% less than those in other sectors, while in Asia, the wage gap is 41%. Even in Europe, where regulatory frameworks are stronger, textile wages remain 31% lower than in other industries. Women, who make up a large part of the workforce, are disproportionately affected by low pay and precarious working conditions. In countries like Bangladesh, women dominate the informal sector, often receiving inadequate pay and lacking access to essential services such as healthcare.

Our analysis revealed two textile-consuming and producing giants: the United States and China. Both nations are responsible for the largest environmental impacts from consumption- and production-based perspectives, whether measured in absolute or per capita terms. However, despite these similarities, their differing roles—China as the world’s largest exporter and the US as the world’s largest importer—offer valuable insights. By examining the dynamics in these two nations, we can see that targeted local strategies could have a major influence on the overall industry. China, the world’s largest textile producer, accounts for 40% of the global material demand for production, while the US, leading in consumption, drives significant impacts in areas such as water scarcity and climate change. Notably, per capita, textiles-driven environmental impacts in the US are five to eight times higher than the global average, underscoring the importance of region-specific strategies.

Six circular strategies hold the potential to triple the textile industry’s Circularity Metric and reduce its environmental impacts by up to 50%. This report explores various scenarios and applies six circular strategies to the baseline analysis (using 2021 data) to consider their impact on the Circularity Metric and eight environmental impacts. The strategies are: 1) Shift to more natural, local and recycled fibres, 2) Increase garment durability, 3) Produce natural fibres sustainably, 4) Embrace slow fashion, 5) Advance circular manufacturing and 6) Transform regional supply chain dynamics. Individually, the scenarios have limited effects, but combined, they can triple the Circularity Metric, bringing it to 0.9%. This figure remains low largely due to the textile industry’s overwhelmingly high consumption of virgin materials. The findings highlight the critical role of vastly reducing material consumption to mitigate environmental impacts. Scenarios centred on reducing textile production via decreased consumption—namely, designing for durability and promoting slow fashion through circular business models—had the greatest impact on increasing the industry’s circularity. In the 'moderate' scenario, which reflects the lowest level of ambition, environmental impacts were reduced by 17 to 20%. A more progressive approach, the 'optimistic' scenario, achieved reductions of 26 to 35%. Ultimately, the 'ambitious' scenario demonstrated that each environmental impact could be reduced by 35 to 50%, highlighting the potential for substantial progress through meaningful changes in consumption patterns.

Making the results of this analysis a reality requires urgent and systemic change. Transitioning from linear to circular will require systemic interventions applied on a global scale, ranging from the adoption of more sustainable materials and improved recycling technologies to strong Extended Producer Responsibility (EPR) schemes and business models that promote reuse and sharing. Collaborative efforts from all stakeholders along the value chain—be they raw material producers, designers, fashion retailers, or consumers—will be essential to realise this shift. By focusing on four priority areas, we can pave the way towards a more resilient and responsible textile industry that meets both environmental imperatives and societal needs:

1. **Significantly reduce textile production** by encouraging brands to release fewer collections and **focus on durability and quality over quantity**. Brands can also be motivated to reduce production if they're supported in making circular business models—such as repair and rental—a large share of their revenue streams. Overproduction and overconsumption are major barriers, and reducing both can alleviate pressure on resources and lessen environmental impacts.
2. **Address broader environmental concerns in addition to lowering GHG emissions.** Strategies for a circular textile industry must tackle water use, biodiversity loss, and marine pollution—all of which are closely linked to textile production, especially of cotton and synthetic fibres.
3. **Ensure that a just transition is at the forefront of the shift towards a circular textile industry.** This includes improving labour conditions, ensuring fair wages, and reducing informal employment, particularly in the Global South. Circular economy models must promote social equity, especially for women and vulnerable workers.
4. **Drive a coordinated effort across sectors to realise the full potential of a circular textile industry.** Governments, businesses, and financial institutions must invest in technologies that enable circularity, such as recycling infrastructure and sustainable material innovation. Policy frameworks should enforce mandatory circular practices, while financial mechanisms should incentivise sustainable business models.

CONTENTS

GLOSSARY

Ancillary inputs are the material inputs used to produce a product, yet are not part of the product itself: energy and chemicals, for example. [Source]

Consumption refers to the usage or consumption of products and services meeting (domestic) demand. *Absolute consumption* refers to the total volume of either physical or monetary consumption of the economy as a whole. In this report, when we talk about *consumption* we are referring to absolute consumption.

Core inputs are the raw materials and essential resources directly involved in the main production process of a product. In the context of this report, these are used to produce and manufacture textiles: for example fibres, zippers and buttons.

Cycling refers to the process of converting a material into a material or product of a higher (upcycling), same (recycling) or lower (downcycling) embodied value and/or complexity than it originally was.

Environmental impacts refer to the effects of human activities on natural systems, including air, water, soil, and ecosystems, often resulting in changes that can be detrimental to biodiversity, ecosystems, and human well-being.

Extended Producer Responsibility (EPR) is a policy mechanism that places responsibility on producers for the collection, sorting, and recirculation of their products after they have been used by consumers. It is also known as a tool to deliver funding and capital investments for the infrastructure needed for sorting, reuse, repair and recycling systems, in addition to delivering transparency and traceability of global material flows. Thus, EPR also works as an incentive to spur collective action for circularity targets. [Source]

Fibre is defined as a unit of matter that encompasses both natural and synthetic materials that meet a specified criteria of flexibility, fineness, and length-to-diameter ratio, making them suitable for use in textile products. [Source]

Materials, substances or compounds are used as inputs to production or manufacturing because of their properties. A material can be defined at different stages of its life cycle: unprocessed (or raw) materials, intermediate materials and finished materials. For example, fossil fuels are extracted, refined into petrochemicals, and synthesised into polymers, which in turn are spun into synthetic fibres and then woven or knitted into textile fabrics. Each of these can be referred to as materials. [Source]

Material footprint, also referred to as Raw Material Consumption (RMC) within this report, is the attribution of global material extraction to the domestic final demand of a country—referred to as a **consumption-based approach**. In this sense, the material footprint represents the total volume of virgin materials (in Raw Material Equivalents) embodied within the whole supply chain to meet final demand. This differs from a **production-based approach**, which measures the total amount of material extracted, processed and used within the borders of a territory, regardless of where the products are consumed. [Source]

Material flows represent the amounts of materials in physical weight that are available to an economy. These material flows comprise the extraction of materials within the economy as well as the physical imports and exports (such as the mass of goods imported or exported). Air and water are generally excluded. [Source]

Overconsumption refers to the excessive consumption of goods beyond what is necessary and sustainable.

Overproduction refers to the manufacturing of goods beyond actual market demand. This surplus often leads to excessive waste and inefficient resource use.

Planetary boundaries define the 'safe operating space' for humanity based on the planet's key biophysical processes. Originally developed by Rockström et al. (2009), the framework quantifies nine 'limits': 1) Climate change, 2) Novel entities,[1] 3) Stratospheric ozone depletion, 4) Atmospheric aerosol loading, 5) Ocean acidification, 6. Biogeochemical flows (nitrogen and phosphorus), 7) Freshwater use, 8) Land-system change, and 9) Biosphere integrity.[2] Six of nine boundaries have now been transgressed. [Source]

Post-consumer textiles are textile products that have been purchased, used, and then discarded by a consumer (including households, and commercial, industrial, and institutional entities). This excludes returned items and pre-consumer surplus. [Source]

Raw Material Equivalent (RME) is a virtual unit that measures how much of a material was extracted from the environment, domestically or abroad, to produce the product for final use. Imports and exports in RME are usually much higher than their corresponding physical weight, especially for finished and semi-finished products. For example, traded goods are converted into their RME to obtain a more comprehensive picture of the 'material footprints'; the amounts of raw materials required to provide the respective traded goods. [Source]

Reskilling refers to the process of acquiring new skills, frequently adopted to pursue different careers or due to changes in the job demand or personal career goals. [Source]

Resources include, for example, arable land, fresh water, and materials. They are seen as parts of the natural world that can be used for economic activities that produce goods and services. Material resources are biomass (like crops for food, energy and bio-based materials, as well as wood for energy and industrial uses), fossil fuels (in particular coal, gas and oil for energy), metals (such as iron, aluminium and copper used in construction and electronics manufacturing) and non-metallic minerals (used for construction, notably sand, gravel and limestone). [Source]

Resource efficiency means creating more (economic) value with less input of resources (such as raw materials, energy, water, air, land, soil, and ecosystem services) and reducing the environmental impacts associated with resource use to break the link between economic growth and the use of nature. Therefore, resource efficiency is closely linked to the concept of (relative/absolute) decoupling. [Source]

Secondary materials are materials that have been used once and are recovered and reprocessed for subsequent use. This refers to the amount of the outflow which can be recovered to be re-used or refined to re-enter the production stream. One aim of dematerialisation is to increase the amount of secondary materials used in production and consumption to create a more circular economy. [Source]

Sector describes any collective of economic actors involved in creating, delivering and capturing value for consumers, tied to their respective economic activity. We apply different levels of aggregation here—aligned with classifications as used in Exiobase. For more information on our sectoral aggregations, please refer to the Methodology Document.

Slow fashion refers to a shift in the fashion industry that prioritises quality over quantity and emphasises the adoption of circular business models such as repair, resale and rental services to extend product lifespans. These approaches, centred on longevity and reuse, reduce waste and resource use while providing brands with alternate revenue streams.

Value chain encompasses the full range of activities in the different phases of production, delivery to consumers, and disposal after use. This concept includes the design, production, marketing, distribution, and support to the final consumer, with each step adding value to the product. [Source]

Upskilling entails the process of acquiring new skills or enhancing existing skills with the purpose of being more competitive within the labour market. It is mainly focused on the skills related to the current field of industry of the person to adapt to changes in the job market. [Source]

1. INTRODUCTION

The textile industry stands at the crossroads of a global crisis. As unsustainable production and consumption patterns intensify, the industry is becoming increasingly resource-intensive and environmentally damaging. The *Circularity Gap Report Textiles*—the first industry-specific *Circularity Gap Report*—arrives at a time when the urgent need for systemic change is clearer than ever. The industry's rapid expansion, driven by fast fashion and increasing consumer demand, has contributed to escalating resource depletion, climate change, and social inequality. The environmental cost of this growth is vast, affecting not only ecosystems but also human health and livelihoods, particularly in regions already vulnerable to poverty and resource scarcity. This report aims to uncover the scale of the problem while outlining pathways for transformation, calling for a fundamental shift from the prevailing linear economy to a circular one. If the textile industry is to continue meeting global demand without exceeding the planet's safe limits, it must embrace circularity on a global scale.

THE LINEAR TEXTILE INDUSTRY IS DRIVING UNSUSTAINABLE LEVELS OF PRODUCTION AND CONSUMPTION

The world currently consumes 100 billion tonnes of materials each year,[3] with 3.25 billion tonnes used by the textile industry. According to the analysis in this report, only 9.6 million tonnes come from secondary sources, underscoring the industry's reliance on virgin materials. The unsustainable linear system, where up to 30% of clothing produced annually remains unsold,[4] further entrenches the cycle of resource extraction and waste. What's more, the industry's global footprint is growing exponentially. In 2022, fibre production reached a record 116 million tonnes, up from 112 million tonnes the previous year, and per capita fibre consumption has risen significantly over the decades—from 8.3 kilograms in 1975 to 14.6 kilograms in 2022.[5] As demand for textiles grows, the industry's global market, valued at €1.7 trillion (US$1.8 trillion)[6] in 2023, is expected to increase by 7.4% annually through 2030, further intensifying its environmental impact unless circular strategies are adopted.[7] Brands are able to operate in such a way—with a focus on maximising volumes—due to subsidised fossil fuels and cheap labour, resulting in decreasing clothing quality.[8, 9]

RAPID PRODUCTION CYCLES ARE STRAINING NATURAL RESOURCES

Production speeds across all market segments (see Box one in Appendix A) have increased dramatically, with mass-market brands now releasing up to 24 collections per year and luxury brands introducing intermediate collections beyond the traditional two-season format.[10, 11] Despite an estimated 100[12] to 150[13] billion garments produced annually, major brands still fail to disclose their production figures.[14] In contrast, smaller brands such as Finisterre and ASKET have committed to annual disclosures,[15] setting an example for greater accountability in an industry grappling with systemic overproduction and material waste.

DESPITE INCREASING EFFORTS TO EMBRACE CIRCULARITY, PROGRESS REMAINS SLOW

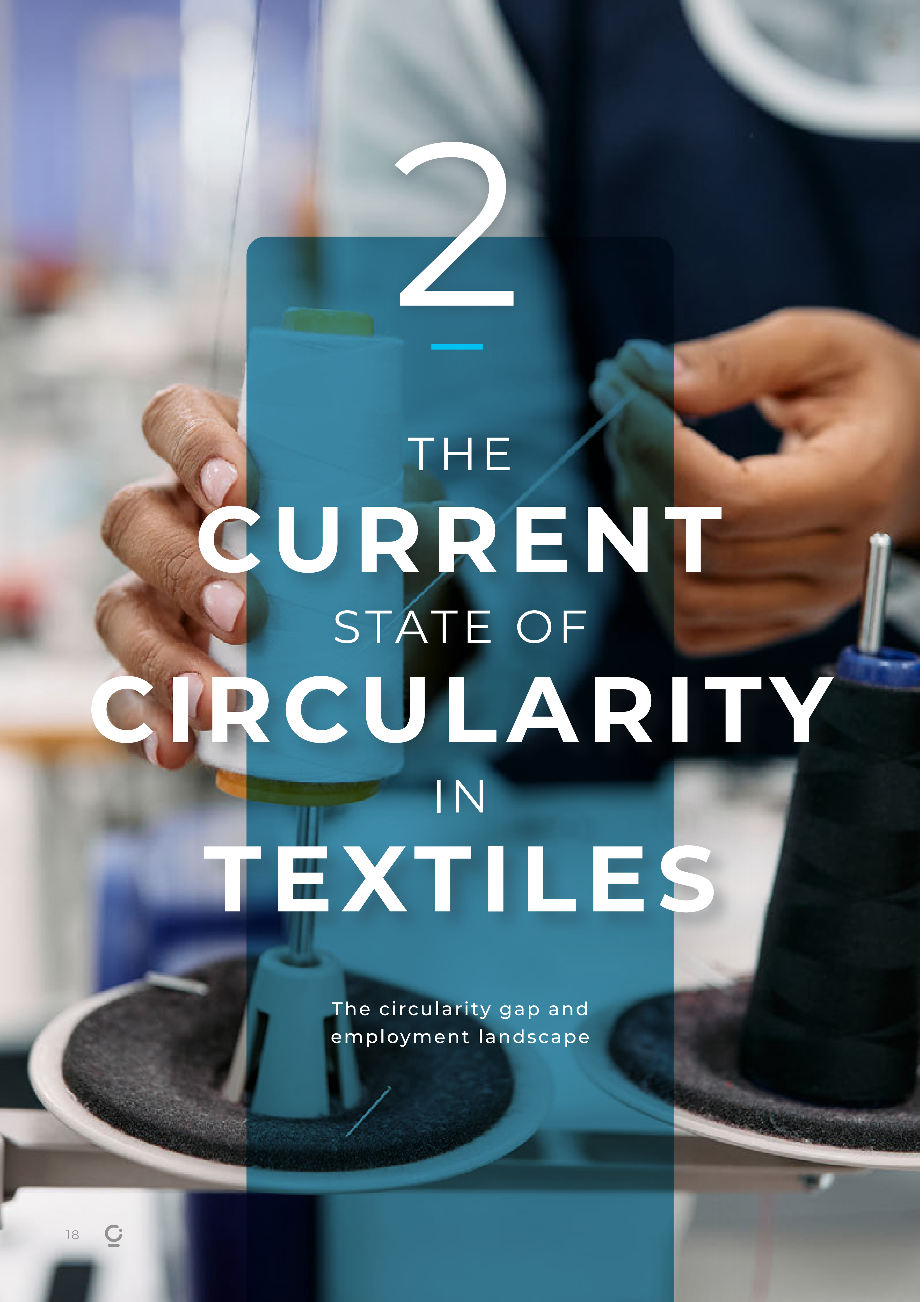
As the industry grows, its globalised nature and overproduction underscore the challenges and opportunities for advancing circularity. Policies—from local initiatives to international regulations—are crucial in shaping a sustainable future for textiles. However, current frameworks are often voluntary and fragmented, limiting their impact (see Table one in Appendix A).[16, 17] Effective governance in the textile industry is essential for promoting circular economy principles, requiring coordination among local, national, and supranational bodies to achieve socioeconomic and environmental goals.[18, 19, 20] Without a systemic shift, the textile industry will continue to strain the planet's finite resources and contribute to the degradation of both natural ecosystems and social well-being, despite growing awareness and efforts.[21]

SCOPE AND AIMS OF THE *CIRCULARITY GAP REPORT TEXTILES*

For the purposes of this report, the term 'textile industry' refers to the textiles, clothing, leather, and footwear (TCLF) industries. This includes textiles relating to household and interior products—such as bed linens, towels, rugs and upholstery—and excludes technical textiles like those used in the medical or automotive industry. The report covers the seven key stages of the textile value chain: 1) product design, 2) material extraction and processing, 3) textile production, 4) product manufacturing, 5) packaging, distribution, and retail, 6) consumer use, and 7) post-consumer use. By analysing these stages, the report identifies key areas to focus on for a more sustainable and circular textile industry.[22]

The *Circularity Gap Report Textiles* aims to provide a comprehensive analysis of the current state of circularity in the global textile industry. This includes presenting the Circularity Metric, assessing the environmental and health impacts driven by the industry, and identifying actionable circular economy strategies to mitigate these effects. Specifically, the report seeks to:

1. **Quantify the current state of circularity in the global textile industry;**
2. **Assess the environmental and health impacts driven by the industry;**
3. **Identify and model circular economy strategies to mitigate these impacts; and**
4. **Provide actionable recommendations for industry stakeholders.**



2

THE CURRENT STATE OF CIRCULARITY IN TEXTILES

The circularity gap and employment landscape

Assessing the circularity of the textile industry requires a clear understanding of how materials and resources flow through the global value chain. By measuring these flows, we can better grasp the current level of circularity and pinpoint where improvements are most needed. This analysis goes beyond just environmental impacts; it also considers the social dimension, ensuring that the shift towards a circular economy benefits all workers, especially those in informal or vulnerable roles. As the textile industry grapples with overconsumption, waste, and resource depletion, adopting circular strategies offers a path to a more sustainable and socially just future. This chapter explores the key metrics and challenges that define the state of circularity in the global textile industry today.

MEASURING THE CIRCULARITY OF A GLOBAL INDUSTRY

Today, the global economy consumes 100 billion tonnes of materials annually. A portion of this consumption—known as the Circularity Metric—comes from secondary materials.[23] Knowing how materials are extracted, transformed, delivered, consumed, and wasted in an economy is essential for identifying and addressing opportunities to transform into a lower-impact system. To this end, Circle Economy started measuring the global economy's material flows and state of circularity in its first edition of the *Circularity Gap Report* in 2018. This approach builds on and is inspired by leading academic work and has since been adapted to suit different contexts, including national and regional levels.[24, 25]

Typically, we measure circularity by looking at materials flowing into the economy. In the case of the textile industry, we measure it by analysing what materials flow through the global value chain, and how. This gives value chain actors an understanding of the current state, providing a jumping-off point for informed decision-making. Boosting circularity has two objectives, which can be achieved through four key strategies.

The core objectives of increasing an industry's Circularity Metric are:[26]

- **Objective one:** Resource extraction from the Earth's crust is minimised, and biomass production and extraction is regenerative;
- **Objective two:** The dispersion and loss of materials is minimised, meaning all technical materials have high recovery opportunities, ideally without degradation and with optimal value retention; emissions to air and dispersion to water or land are prevented; and biomass is optimally cascaded.

The four strategies we can use to achieve these objectives are:

- **Narrow flows—Use less:** The amount of materials (including fossil fuels) used in the making of textile products and service are decreased. This is done through circular design, greater resource efficiency or increasing the usage rates of materials and products. In practice: Sharing and rental models, manufacturing improvements and less resource-intensive agricultural practices.
- **Slow flows—Use longer:** Resource use is optimised as the functional lifetime of textiles is extended. Durable design, materials and service loops that extend life, such as repair, both contribute to slowing rates of extraction and use. In practice: Durable material use, modular design, design for reuse, repair and refurbishing.
- **Regenerate flows—Make clean:** Fossil fuels, pollutants and toxic materials are replaced with regenerative alternatives, thereby increasing and maintaining value in natural ecosystems. In practice: Regenerative and non-toxic material use, renewable energy and regenerative agriculture.
- **Cycle flows—Use again:** The reuse of textiles at end-of-life is optimised, facilitating a circular flow of resources. This is enhanced with improved collection and reprocessing of textiles and optimal cascading by creating value in each stage of reuse and recycling. In practice: Design for recyclability, and improved collection and recycling infrastructure.

There are potential overlaps between some of these strategies. For example, slowing flows can result in a narrowing of flows: by making textiles last longer, fewer new textiles will be needed, resulting in decreased material use. There are also potential tradeoffs between the four strategies. Fewer materials being used for manufacturing—narrowing flows—means that less post-industrial textile scrap will be available for cycling.

While all four flows are crucial to the success of a circular economy, our Circularity Metric captures circularity in one figure based on cycling: it measures the share of cycled materials as part of the total material consumption in a global value chain. Total consumption must decrease—through strategies such as narrow, slow and regenerate—as cycling

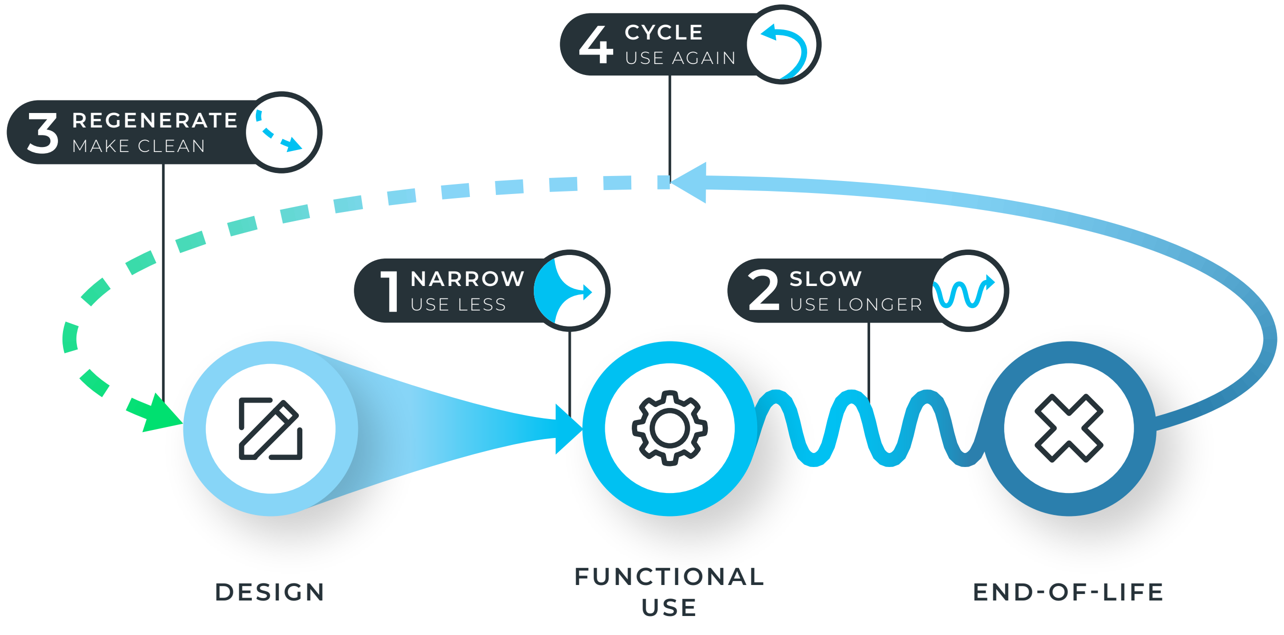


Figure one illustrates the four strategies to achieve circular objectives: narrow, slow, regenerate and cycle.

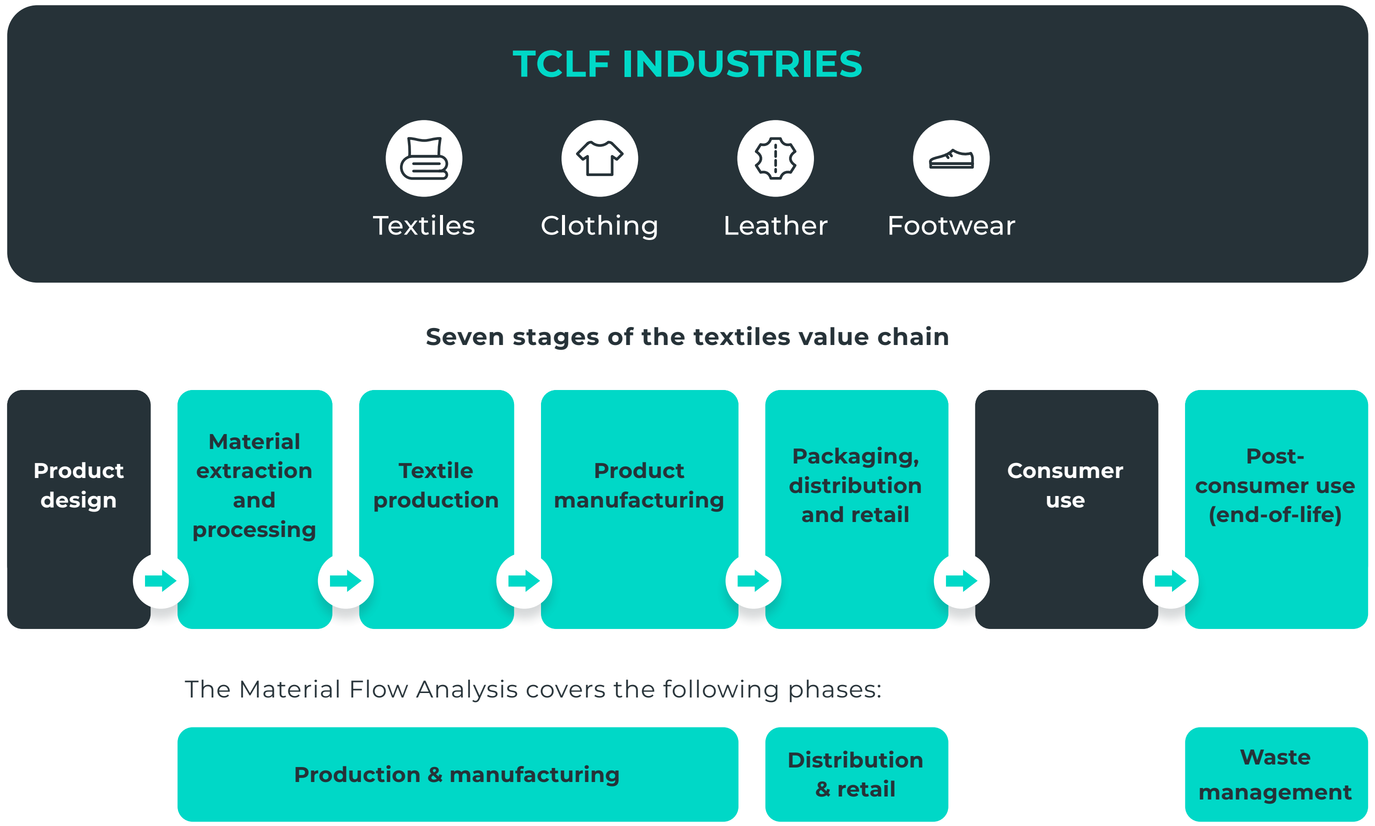


Figure two illustrates the stages of the textiles value chain included in the analysis. Product design and consumer use have been excluded from the baseline MFA and the Circularity Metric. Post-consumer use has been partially excluded.

increases for the Metric to grow meaningfully. In this way, the Metric illustrates the current progress towards achieving the circular economy's ultimate goal of designing out waste and lowering material consumption through the four listed strategies. The value of our input-focused Metric is that it allows us to track changes over time, measure progress, and engage in uniform goal-setting, as well as benchmark against other global value chains.

While the *Circularity Gap Report Textiles* covers the seven key stages of the textile value chain (illustrated by Figure two), our baseline analysis of material flows and the Circularity Metric excludes the product design and consumer use stages, and only partially includes post-consumer use. Although the design stage has significant impacts further along the value chain, it is not a material-intensive activity itself. Additionally, consumer use has been omitted due to the difficulty in attributing use phase impacts—such as emissions, energy consumption or the release of microfibres—to textile-specific activities like washing, drying, or ironing. Finally, while some waste treatment activities are present in the specific input-output model of the Material Flow Analysis (MFA), this methodology is generally considered poorly suited to assess impacts of waste management sectors and practises due to their representation in monetary rather than physical units.[27, 28] Impacts of incineration and landfilling of textile waste are, therefore, included but should be considered underestimated. Please refer to the Methodology Document for more details.

SIZING THE MATERIAL FLOWS OF THE TEXTILE VALUE CHAIN

The Sankey diagram in Figure three provides an overview of the domestic material consumption flows that have been analysed.[29] The vast majority of core inputs (104 million tonnes) come from virgin feedstock, with 63% (65.4 million tonnes) of this being synthetic sources primarily derived from oil-based polymers.

The remaining 37% (38.4 million tonnes) of virgin feedstock is sourced from natural materials like cotton, hemp, and linen.[30] Secondary sources account for 10 million tonnes of core inputs, predominantly from waste outside of the textile value chain, such as PET bottles. Only 0.27% of secondary sources (0.3 million tonnes) come from fibre-to-fibre recycling within the textile industry.

In addition to core inputs, **ancillary inputs** are essential for the production process. These include materials needed for energy, such as those used to power machinery and heat production facilities, and chemicals for agricultural inputs and dyes. On average, for each tonne of fibre used, 0.6 tonnes of chemicals, 0.7 tonnes of coal, and 1.25 tonnes of natural gas are consumed globally.

In 2021, 286 million tonnes of **ancillary inputs** resulted in the production of only 88.6 million tonnes of final TCLF products. During production, approximately one-fifth (21.9%) of materials used are lost as pre-consumer waste. Around half (51.4%) of all TCLF fibre production is for apparel, with the remainder accounting for home textiles (25.2%) and other uses (23.4%).[31]

Figures given are millions of tonnes (Mt)

Figure three illustrates domestic material consumption across the global textiles value chain in 2021.

* Percentages include pre-consumer and post-consumer waste. Total may not equal 100% due to rounding.

Discarded textiles follow several pathways, each with distinct environmental and social implications. The majority of textiles end up in landfills or are incinerated (61.4%). A smaller portion is reused or exported (8%), ends up in cascading recycling (6.3%),[32] or lost during collection and sorting (2.2%).

WHERE DO DISCARDED TEXTILES END UP?

LANDFILL AND INCINERATION

Our analysis finds that 61.4% of textile waste ends up in landfills or is incinerated. This is especially common in areas where consumers do not have convenient access to textile collection programmes. Once in landfills, textiles can take a long time to decompose and may release harmful chemicals and GHGs. Some textile waste is incinerated, which can help reduce the volume of waste but also releases pollutants and GHGs into the atmosphere. Incineration is sometimes used to generate energy, but the environmental costs can be high. Inadequate waste management infrastructure often leads to open burning and unmanaged landfills, exacerbating these issues.[33, 34]

REUSE AND EXPORT

Our analysis finds that 8% of discarded textiles are reused or exported. A substantial amount of used clothing is exported globally, primarily for resale in local markets, with the volume of traded second-hand clothing growing nearly sevenfold over the past 30 years. In 2021, the EU accounted for 30% of global used clothing exports, followed by China (16%) and the US (15%). Major importing regions include Asia (28%, led by Pakistan), Africa (19%, led by Ghana and Kenya), and Latin America (16%, primarily Chile and Guatemala).[35] Ghana's Kantamanto Market processes over 150,000 tonnes of textiles annually,[36] importing €156 million (US$164 million)[37] worth of used clothing in 2022, mainly from the UK, China, and Canada.[38]

While this trade creates jobs, these positions are often unregulated and come with harsh conditions. Low-quality imports can overwhelm local textile industries and contribute to environmental issues, particularly in the case of synthetic fibres that release microplastics and do not biodegrade.[39] In the Global North, many people donate unwanted textiles to charity shops but a significant portion is also shipped overseas; for example, the Netherlands exported 84% of its separately collected textiles in 2018. These textiles enter a complex reverse value chain, with 53% deemed suitable for reuse, 33% for recycling and 14% non-recyclable and non-renewable.[40] To combat textile waste, businesses are increasingly adopting circular economy initiatives, including take-back programmes for repair and recycling, as well as innovations in sustainable materials. Some textiles are also upcycled or repurposed into new products.

RECYCLING

Our analysis finds that 6.3% of textile waste ends up in cascading recycling, while 2.2% is lost during collection and sorting. This portion of textile waste ends up at recycling facilities, where it undergoes processes such as mechanical or chemical recycling to be transformed into new materials. Mechanical recycling involves shredding textiles and spinning them into new fibres or downcycling them into products like insulation or mattress filling. Chemical recycling breaks textiles down into their chemical components for reuse as feedstock for new fibres. However, global capacity for textile recycling is still limited. For example, the Sorting for Circularity Europe report, which assessed textile waste in six European countries, found that 74% of low-value post-consumer textiles (494,000 tonnes annually) could be suitable for closed-loop recycling. This highlights potential opportunities for recycling to reduce waste, though similar global data is currently limited and appropriate infrastructure is still lacking on a greater scale.[41]

THE CIRCULARITY METRIC FOR TEXTILES

Today, the global textile industry is 0.3% circular. The Circularity Metric refers to the proportion of secondary materials in the total raw material consumption[42] of the textile value chain. These secondary materials, which were previously waste, are reintroduced into the cycle and primarily include recycled polyester from the technical cycle[43] and recycled cotton from the biological cycle.[44] In the textile industry, only 9.6 million tonnes out of a total of 3.26 billion tonnes of raw materials consumed come from secondary materials, resulting in a Circularity Metric of just 0.3%. Most of these secondary materials originate from recycled PET bottles rather than textile waste.[45] This Metric is significantly lower than the already low global average of 7.2%,[46] underscoring how far behind the textile value chain is in utilising secondary materials, especially from its own waste.

Practical challenges in quantifying circularity

Providing a year-zero baseline measurement of the circularity of a global value chain based on resource flows offers many advantages, not least that it can be used as a call to action. But the circular economy is full of intricacies, and therefore, simplifications are necessary, which result in limitations that must be considered:

1. **There is more to circularity than (mass-based) cycling.** As seen from the examination of the four flows, there are other important aspects to circularity: namely, using less, using longer and regenerating natural systems. These are captured in other ways by our analysis: using less, for example, is captured by decreases in the material footprint, while regenerating natural systems could materialise as fewer Non-circular inputs, and therefore a decrease in the carbon footprint.
2. **The Metric focuses on one aspect of circularity.** We focus only on material use, without examining other factors such as biodiversity loss, pollution, toxicity and so on.
3. **We consider relative, not absolute, numbers.** This means that if cycling increases at a faster rate than material consumption, the Metric will improve—even if the ultimate goal is for consumption to decrease.
4. **Achieving 100% circularity isn't feasible due to technical and practical limits.** Some materials are needed for stock build-up, while others, like fossil fuels, are inherently non-circular. Instead of aiming for full circularity, we should see the circular economy as a tool for managing resources more sustainably. For example, increasing global circularity to 17% could help to limit global warming to 2-degrees,[47] underscoring the importance of circular strategies in reducing resource use and emissions.

For an even more exhaustive look into the methodology behind the Circularity Gap, please refer to the Methodology Document.

A SOCIALLY JUST CIRCULAR TEXTILE INDUSTRY

The circular economy offers solutions to environmental challenges, but understanding its social impacts is equally important. To do this, we look beyond the Circularity Metric to gain insights into the textile industry's social impacts by evaluating the state of decent work. According to the International Labour Organization (ILO), decent work involves fair income, workplace security, social protection, equal opportunities, and respect for workers' rights—principles essential for a just transition to a circular economy.[48] However, our research identifies significant barriers in the textile industry, including excessive working hours, wage inequality, informality, and gender disparities, which hinder the attainment of decent work.

People are central to driving circular economy initiatives. Without a skilled workforce, crucial tasks such as sorting textile waste and extending product lifetimes (through repair, for example) cannot be effectively implemented. Unfortunately, many jobs in the circular economy, particularly in waste collection, sorting, and recycling, are of low quality, especially in the Global South, where workers face hazardous conditions and lack social protection.[49]

The global second-hand market illustrates how circular practices in the Global North can both create jobs and simultaneously undermine livelihoods in the Global South. While it provides a market for products that would otherwise go unsold in their country of origin, these labour-intensive jobs often expose workers to toxic materials and unstable wages, limiting the Global South's ability to embrace circular practices. The reliance on advanced technology in new circular business models may also restrict access to circular products and services, further exacerbating inequalities.[50]

Informality in the global workforce

Informal labour refers to economic activities that are not regulated by the government and lack social protections like health insurance or unemployment benefits. These activities are often unregistered, with workers not protected by formal labour laws. This can include self-employed individuals like street vendors or workers in unregulated sectors such as domestic work. The ILO reports that over 60% of the world’s employed population works in the informal economy.[51] Within this context, the global textile industry employs approximately 140.3 million people, with 89% (or 124.8 million) involved in production and manufacturing. Asia is a dominant player, accounting for 73% of the global textile workforce, primarily in major manufacturing hubs such as China, India, Bangladesh, and Indonesia. Informal employment is especially prevalent in Asia, where more than 90% of textile workers in countries like Bangladesh (97%) and India (91%) are informally employed. In the Americas, Brazil shows a high informality rate, with 83% of textile workers in informal roles. In contrast, Europe has far lower levels of informal employment—just 0.3% in production and manufacturing, 0.1% in distribution and retail, and only 150 workers in waste management. The ILO attributes these lower figures to robust EU regulations. Despite the crucial role of informal workers in the textile value chain, accurately estimating their numbers remains challenging due to the hidden nature of informal employment.

Gender disparities and informal labour

Informal labour is prevalent across many countries in the textile industry, particularly in the waste management phase,[52, 53] which is crucial to circular textile practices. This informality often leads to precarious working conditions, with women being disproportionately affected. Female workers in informal roles typically earn lower wages than their male counterparts, further entrenching existing gender inequalities.[54, 55, 56] In countries like Bangladesh and India, where over 90% of textile workers are informally employed, the absence of formal labour rights and social protections further exacerbates economic vulnerability.[57]

Gender disparities in these regions are pronounced, with women, who are overrepresented in informal roles, facing additional barriers due to cultural norms and power imbalances. Consequently, they endure not only lower wages but also limited opportunities for advancement and restricted access to essential services like healthcare and financial support.[58] The combination of these factors compounds their vulnerability and hinders their ability to improve their economic and social standing.

Working conditions and wage inequality

Working hours in the textile industry frequently exceed ILO standards,[59] particularly in Africa, where workers average over 70 hours per week, and in Bangladesh, where readymade garment workers regularly surpass limits due to high-pressure deadlines and low wages.[60, 61, 62] Automation and the demand for technically skilled roles, often male-dominated, further marginalise low-skilled and informal workers, creating additional barriers to achieving decent work.[63]

Wage inequality is another significant issue, particularly for low-skilled workers. In Africa, textile wages are 44% lower than the average across all sectors, while in Asia, the gap reaches 41%. In the Americas, production and manufacturing wages are 21% below the industry average, while textile wages in Oceania are 33% lower than regional averages, with the waste sector showing the largest wage gap at 54%. Although informality rates in Europe are low, textile wages are 31% lower than industry averages, and poor working conditions persist in countries with higher informality rates, such as the UK, Italy, and Poland.[64, 65, 66]

This isn’t limited to fast fashion, which often bears the brunt of labour concerns: in June 2024, an Italian court investigated LVMH's Dior subsidiary for labour exploitation, highlighting ongoing issues in the European luxury goods supply chain.[67]

TECHNOLOGICAL ADVANCEMENTS AND SKILLS GAPS

The rapid advancement of technology in the textile industry demands significant upskilling and reskilling,[68] particularly in high-income countries where the integration of advanced technologies is reshaping the value chain. In contrast, low- to middle-income countries, which rely heavily on manual labour,[69] face limited access to education and training. This skills gap hinders the adoption of circular practices like repair and recycling, particularly in regions such as Western Europe.[70]

In the waste management sector, where 60% of the workforce is medium-skilled,[71] manual sorting tasks—critical to the success of a circular textile industry—are often undervalued. Workers tasked with sorting up to 300 grades of materials must make rapid decisions about the quality and destination of items, yet their roles are typically classified as low-skilled despite the expertise required.[72]

3

UNRAVELLING THE GLOBAL IMPACTS OF THE TEXTILE INDUSTRY

The environmental and social footprint of textiles

The global textile industry profoundly shapes our environment and the quality of life in communities worldwide, influencing everything from climate change to social equity. To truly grasp these effects, we must adopt a holistic view of the value chain and its intricate connections with ecosystems. The industry's impact goes beyond emissions: it intersects with critical issues such as biodiversity loss, water pollution, and community wellbeing. This chapter examines these pressing challenges from a global lens—addressing key planetary boundaries—to a local lens, focusing on the profound effects in the US and China, the world's largest consumer and producer of textiles. These challenges are not isolated; they are deeply interconnected, underscoring the urgent need for integrated, cross-sector solutions. Here, our analysis looks beyond the Circularity Metric to evaluate the industry's environmental footprint across land, sea, and air. By exploring the global consequences of the textile industry, we advocate for coordinated efforts across sectors to mitigate harm and foster sustainability.

MEASURING ENVIRONMENTAL AND HEALTH IMPACTS

The Planetary Boundaries Framework defines the environmental limits within which humanity can safely operate to maintain the Earth's life-support systems. Developed by a group of 28 Earth system and environmental scientists, this framework outlines nine critical thresholds that, if crossed, could result in severe environmental disruption and threaten the planet's ability to sustain human life.[73] These boundaries include climate change, biodiversity loss (biosphere integrity), land-system change, freshwater use, biogeochemical flows (nitrogen and phosphorus cycles), ocean acidification, atmospheric aerosol loading, stratospheric ozone depletion, and the introduction of novel entities (chemical pollution). Staying within these limits ensures a safe space for humanity to thrive.

To assess the textile industry's impact, we used Life Cycle Impact Assessment (LCIA), a standardised method of Life Cycle Assessment (LCA), integrated with an Environmentally Extended Multi-Region Input–Output Analysis (EE-MRIOA). This approach allowed us to examine the contribution of 27 pollutants across key impact categories, including climate change, ocean acidification, biogeochemical cycles, land-system change, water use, human health, and biodiversity. These impacts were measured across sectors and regions, using both consumption- and production-based perspectives. The results are summarised into eight key categories, inspired by the Planetary Boundaries Framework:[74]

1. **Material footprint**
2. **Marine and freshwater eutrophication**
3. **Water scarcity**
4. **Climate change**
5. **Terrestrial and freshwater acidification**
6. **Air pollution**
7. **Biodiversity loss**
8. **Human health**

Textile value chain contribution to global impacts by impact categories

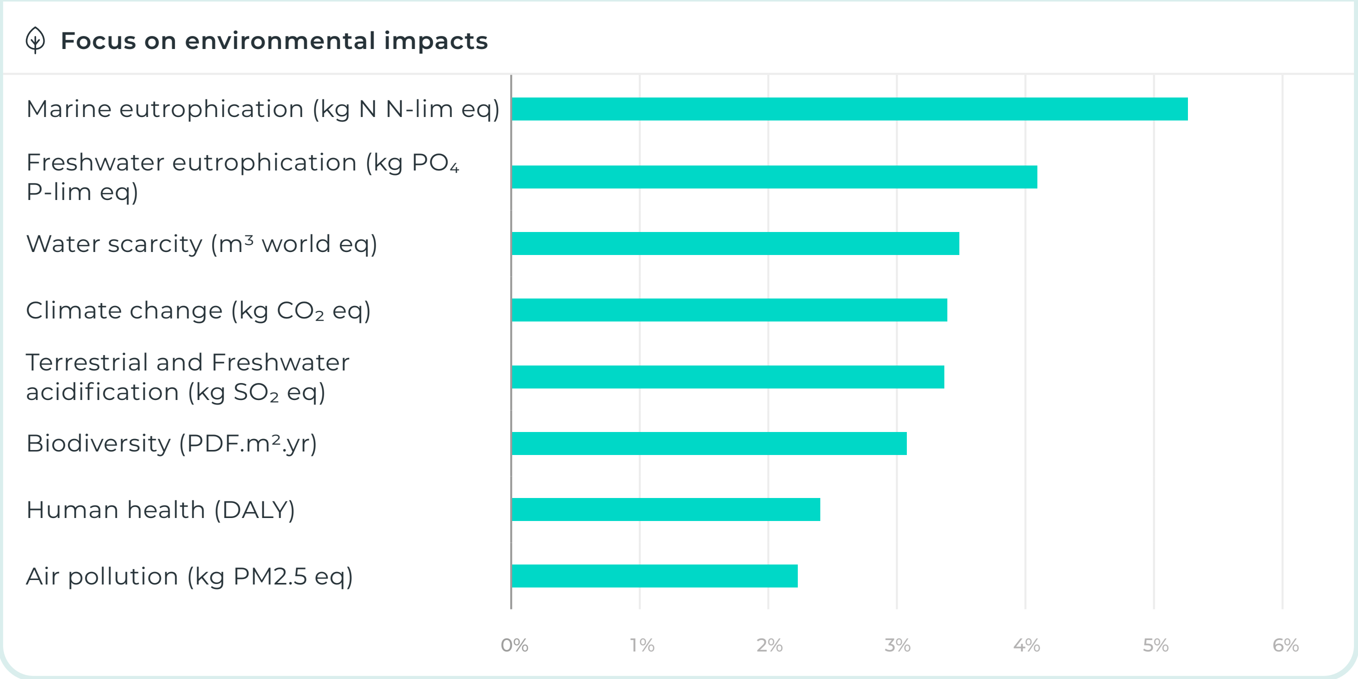


Figure four illustrates the total impact contribution of the textile industry per impact category.

Figure four illustrates the contribution of the entire textile value chain to global environmental and human health impacts, represented as percentages. The textile industry's contribution to these impacts ranges from 2.2% for air pollution to 5.3% for marine eutrophication. These distinctions provide valuable insights into where interventions are needed most across different impact categories.

IMPACT CATEGORIES

Material footprint

Our analysis shows that the textile industry significantly contributes to the global material footprint, accounting for over 3% of the total. The textile industry also accounts for over 10% of the material footprint caused by global production and manufacturing, nearly 6% of the material footprint from distribution and retail and 3% from waste management activities. The 'material footprint' refers to the resources extracted to support the production and consumption of textiles. This extraction drives many environmental issues, such as habitat destruction, soil degradation, and pollution of air, land, and water, and is the primary factor behind all other environmental impacts.

The textile industry is particularly resource-intensive, relying on the extraction of natural fibres from crops and synthetic fibres from fossil fuels. The production of these fibres demands high levels of water, land, and energy inputs. For example, cotton cultivation is extremely water-intensive, which can exacerbate water scarcity in vulnerable regions. Additionally, the industry consumes vast amounts of energy and land for fibre production, adding to its environmental footprint.

The average European consumes 26 kilograms of textiles per year, and discards 12 kilograms. The production of these textiles requires 391 kilograms of raw materials per year.[75] Our analysis specifically focuses on raw material use, excluding water and land, as part of our circular economy approach. However, the industry's heavy reliance on these resources further underscores its significant environmental impact.

Marine and freshwater eutrophication

Our analysis shows that the textile industry significantly contributes to global marine and freshwater eutrophication, accounting for over 5% and 4% of the total, respectively. Specifically, within the broader context of all industries, the textile industry drives over 27% of marine and 31% of freshwater eutrophication from production and manufacturing activities. It also drives nearly 6% of marine eutrophication from retail and 32% of marine eutrophication from waste management activities. Eutrophication, which results from the buildup of nutrients like nitrogen and phosphorus in water, poses a severe threat to marine and freshwater ecosystems. This nutrient overload disrupts ecological cycles, endangers aquatic life, and compromises water quality.[76] Furthermore, the resulting biodiversity loss and reduced ecosystem productivity have far-reaching effects on livelihoods and human well-being.[77]

Agriculture is a primary source of eutrophication, with research linking around 65% of the impact to food production activities. In the context of textiles, agriculture includes both crop cultivation for fibres and livestock farming for wool and hides. Crops grown for textiles, such as cotton, hemp, and jute, contribute to eutrophication through the use of fertilisers and pesticides. Runoff from agricultural fields carries excess nutrients into water bodies, leading to algal blooms, which deplete oxygen levels and destabilise aquatic ecosystems. Major cotton producers like China, India, and the US are particularly affected.[78] Additionally, intensive animal farming relies on fertilisers and pesticides for animal feed, while the improper disposal of animal waste and chemicals used in the tanning process further intensifies eutrophication.[79]

Water scarcity

Our analysis shows that the textile industry significantly contributes to global water scarcity, accounting for almost 4% of the total. It is responsible for around 21% of the water scarcity caused by global production and manufacturing, primarily due to its intensive water use for processes such as dyeing and finishing. The industry also drives nearly 6% of water scarcity from distribution and retail and 7% from waste management activities. The sector ranks among the top global consumers of water, significantly impacting water-stressed regions. In 2017, textile production was estimated to consume 93 billion cubic metres of water annually.[80] The industry often operates in areas already facing water scarcity, where geographical factors, population growth, and industrial and domestic demands exacerbate the issue. Water scarcity can result from several factors, including demand exceeding supply, poor infrastructure, and unequal distribution. For instance, Bangladesh's textile industry generates 217 million cubic metres of wastewater,[81] further straining limited water resources.[82]

Water is a critical resource throughout the textile value chain, from crop cultivation and fossil fuel extraction to processing and dyeing. It is essential for various processes, including dye dilution, chemical transport, fabric rinsing, and colouring. However, water usage varies greatly depending on the type of fibre being produced. Cotton, the most water-intensive fibre, requires particularly high volumes, especially during cultivation. Other fibres, such as modal, nylon, silk, and viscose, while produced in smaller quantities, also demand considerable water resources. Modal and viscose rely on water for pulping, while nylon and silk need it for polymer and fibre spinning processes.[83] Additionally, the release of untreated wastewater containing chemicals and dyes from textile production contributes to significant environmental degradation.[84]

High water consumption is concerning in light of the severe consequences of water scarcity: it affects communities dependent on water for drinking, sanitation, and agriculture, contributing to poverty, food insecurity, and public health risks, such as waterborne diseases. Ecosystems are also at risk, with diminishing water resources threatening biodiversity, intensifying desertification, and disrupting ecosystem function. Additionally, water scarcity often leads to resource conflicts, worsening environmental degradation and social vulnerability. Climate change intensifies these challenges by reducing water availability and increasing unpredictability.[85]

Climate change

Our analysis shows that the textile industry significantly contributes to global climate change, accounting for over 3% of the total. Moreover, 13% of global production and manufacturing's climate impacts can be attributed to the textile industry. The industry also drives over 6% of water scarcity from retail and 5% from waste management activities. GHGs, particularly CO_2, are the primary drivers of climate change, affecting ecosystems and weather patterns worldwide.[86] The textile industry contributes to rising GHG emissions through the extensive use of fertilisers and pesticides for natural fibre production, land-use changes to expand agricultural areas, the production and finishing of materials, and the reliance on fossil fuels for both synthetic and natural fibre manufacturing.

GHG emissions are generated across several key stages of the textile supply chain. Raw material extraction, which includes cultivation and extraction from plants, animals, or the Earth, accounts for 21% of emissions. The processing of these raw materials into yarn and other intermediate products contributes a further 15%. Material production, which includes producing and finishing fabrics and trims, is the largest source of GHG emissions, responsible for 55%, particularly due to wet processing. The final stage, the assembly and manufacturing of finished textile products, adds an additional 9% to the industry's overall GHG emissions.

GHG emissions from the textile industry vary significantly depending on the processing steps and the type of fibre used. Synthetic fibres like nylon, acrylic, and elastane produce the highest GHG emissions per kilogram of fabric due to their energy-intensive production.[87, 88] Although polyester has lower GHG emissions per unit than other synthetics, its large-scale production results in the highest overall impact on climate change. The material production stage, especially wet processing, is the largest contributor to GHG emissions for both synthetic and natural fibres. Additionally, textile processing releases pollutants such as perfluorinated compounds (PFCs) and volatile organic compounds (VOCs) during dyeing, bleaching, and finishing, which have significant global warming potential. The disposal of textiles in landfills also generates methane, another potent GHG.[89]

Terrestrial and freshwater acidification

Our analysis finds that the textile industry significantly contributes to global terrestrial and freshwater acidification, accounting for over 3% of the total. Additionally, 14% of global production and manufacturing's terrestrial and freshwater acidification is attributed to the textile industry. Acidification of both soil and water occurs when acidic compounds accumulate in the environment, leading to widespread ecological and social impacts. Terrestrial acidification primarily results from atmospheric pollutants such as sulphur dioxide (SO2) and nitrogen oxides (NOx), which cause acid rain. This acid rain degrades soil quality, impairs nutrient absorption by plants, and reduces biodiversity. Freshwater acidification, caused by similar pollutants, affects lakes, rivers, and soils, harming aquatic species like fish and amphibians and disrupting entire ecosystems. Both forms of acidification have significant social impacts, reducing agricultural productivity, threatening food security, and exposing human populations to health risks from contaminated water and toxic metals released from soil and sediment.[90]

The textile industry's contribution to acidification is largely driven by the use of fertilisers and pesticides in natural fibre production, which increases nitrogen compound deposition in soils, contributing to both terrestrial and freshwater acidification. Additionally, the production of synthetic fibres and cotton involves chemical treatments and dyeing processes that release harmful substances into the environment via industrial wastewater. The energy-intensive nature of textile manufacturing, especially in countries where fossil fuels dominate the energy mix, such as China, India, and Vietnam, further exacerbates acidification through the emission of sulphur and nitrogen oxides.[91]

Air pollution

Our analysis shows that the textile industry significantly contributes to global air pollution, accounting for over 2% of the total. The industry contributes to global air pollution primarily through production and manufacturing (7% of industry impact), distribution and retail (6%), and waste management (3%). Air pollution occurs when chemicals, particulates, or biological substances are released into the atmosphere, causing harmful effects on humans, ecosystems, and the environment. Notably, the retail stage of the textile value chain contributes nearly as much to air pollution as manufacturing, which is unusual compared to other environmental impacts.

Various activities throughout the textile value chain generate air pollutants. Nitrous oxides and sulphur dioxide are released mainly during energy generation for manufacturing and transportation. Additionally, VOCs arise from processes such as coating, curing, drying, wastewater treatment, and chemical storage. Chemicals used in dyeing and bleaching, including aniline vapours, carrier hydrogen sulphide, chlorine, and chlorine dioxide, further contribute to air pollution within textile manufacturing facilities. Particulates released during cotton handling also cause atmospheric pollution.

The production of synthetic fibres, which rely on petrochemicals derived from crude oil,[92] adds to both GHG emissions and air pollution.[93] Transportation by water, air, and road also plays a significant role in worsening air quality. Despite the prevalence of these pollutants, accurate and comprehensive data on emissions is often lacking due to difficulties in sampling, testing, and quantification.[94, 95] These emissions not only present environmental risks but also pose serious health concerns for communities near textile production sites.

Biodiversity loss

Our analysis shows that the textile industry significantly contributes to global biodiversity loss, accounting for over 3% of the total. Around 17% of biodiversity loss caused by global production and manufacturing can be attributed to the textile industry. It also drives over 6% of water scarcity from distribution and retail and 6% from waste management activities. Biodiversity encompasses the diversity of life on Earth, including fungi, insects, animals, and humans, and is crucial for maintaining ecosystem services that the global economy depends on.[96] Biodiversity loss and ecosystem collapse are now considered among the top five risks humanity will face in the next decade, according to the World Economic Forum's 2020 *Global Risks Report*. Around 80% of threatened and near-threatened species are endangered by three major socioeconomic systems: food, land and ocean use; infrastructure and the built environment; and energy and extractives, which exert the most significant business-related pressures on biodiversity.[97] In particular, the textile industry contributes to biodiversity loss through activities such as soil degradation from intensive agriculture and ocean acidification.[98]

For instance, the global wool industry produces approximately 1.2 million kilograms of clean raw wool annually from a worldwide sheep population of 1.2 billion. Each sheep yields around 4.5 kilograms of wool per year, sufficient to make about ten metres of fabric or six sweaters. To produce this wool, an adult sheep requires between 1.5 and 3 square metres of space, translating to roughly 0.2 hectares of land per six sweaters.[99] This calculation also includes wool used for non-garment purposes, such as carpets and furniture. Additionally, cotton cultivation often expands at the expense of forests and other natural habitats,[100] with conventional cotton farming's monoculture practices causing soil degradation, biodiversity loss, and ecosystem disruption.[101]

Ocean acidification, driven by CO_2 emissions—including those from textile production—further harms marine ecosystems. Approximately one-third of human-released CO_2 is absorbed by the oceans. As CO_2 emissions rise, ocean pH levels decline, impairing the oceans' capacity to absorb CO_2 and mitigate acidification, which threatens marine biodiversity.[102]

Moreover, the textile industry significantly contributes to microplastic pollution through materials and embellishments used in garments, such as prints, coatings, buttons, and glitter.[103] Synthetic plastics, including those in textiles, take decades to degrade, particularly in marine environments.[104] Studies show that plastic debris in coastal areas can reduce seawater pH by up to 0.5 units, damaging marine life.[105] Marine plastic pollution primarily originates from land-based sources, including sewage discharge, transportation of goods, and illegal dumping, with rivers and canals acting as conduits.[106] In 2020, it was estimated that 75% of all marine litter consisted of plastic,[107] with 14 tonnes made up of microplastics—tiny fragments between 0.001 and 5 millimetres in size, formed as plastics degrade.[108, 109] Globally, 16 to 35% of microplastics entering oceans come from synthetic textiles, with 0.2 to 0.5 million tonnes of microfibres from textiles reaching the marine environment annually through washing, wearing, and disposal.[110]

Human health

Our analysis shows that the textile industry significantly contributes to global human health impacts, accounting for over 2% of the total. This contribution is spread relatively evenly across the value chain, with production and manufacturing accounting for over 7% of the total global impact, distribution and retail for 6%, and waste management for 4%. Environmental factors tied to human health issues include climate change, which manifests through events like heat waves, and indirectly affects health by contributing to malnutrition. Exposure to toxic chemicals, particulate matter, and marine pollution further threatens livelihoods and access to freshwater, worsening human health outcomes.[111, 112] To assess these impacts, the Disability-Adjusted Life Years (DALY) metric is used, which reflects both years lost due to premature death and years lived with illness or disability.

Our findings indicate that these impacts are concentrated in key textile-producing regions, particularly China, the US, and India. The textile and garment sectors are highly labour-intensive, especially in countries where long working hours, poor wages, and inadequate safety standards exacerbate social inequality and exploitation.[113, 114] Workers face chronic fatigue, physical strain, and mental health challenges from prolonged working hours, while unsafe factory conditions often result in accidents.

Low wages perpetuate poverty, limiting workers' ability to meet basic needs and deepening economic inequality. Vulnerable populations, including women and children, are disproportionately affected by low pay and unsafe working conditions, with women particularly at risk of exploitation.

The widespread use of hazardous chemicals in processes like dyeing, finishing, and treatment also poses health risks, including respiratory issues and skin irritation.[115] Up to 3,500 substances, such as heavy metals, formaldehyde, phthalates, azo dyes, and perfluorinated compounds (PFCs), are commonly used in textile production.[116] Many of these chemicals are harmful to human health, endangering both workers in the textile industry[117, 118] and consumers who come into contact with finished products.[119] Health risks range from skin irritation and respiratory problems to more severe outcomes like cancer, reproductive harm, and endocrine disruption.[120] Furthermore, chemical pollution from textile manufacturing and waste disposal contaminates water and soil, causing biodiversity loss and ecosystem damage.[121]

STAGES OF THE VALUE CHAIN AND REGIONS

Impact contribution across stages of the value chain

Our analysis finds that environmental impacts occur at every stage of the textile value chain, with their significance varying across different impact categories. The stages with the highest environmental footprint are typically material extraction, processing, and product manufacturing—collectively referred to as 'production and manufacturing'. These early stages are responsible for the bulk of environmental impacts. The distribution and retail phase contributes relatively consistently across all impact categories, ranging between 6 and 6.5%. Waste management activities, on the other hand, show greater variation. For instance, waste management contributes less than 1% to freshwater eutrophication but over 32% to marine eutrophication. This highlights the need to address different stages of the value chain with tailored interventions to mitigate environmental harm effectively.

Impact contribution across regions

Our analysis reveals that Asia, the Americas, and Europe account for over 90% of contributions across all environmental impact categories, with Africa and Oceania contributing the remainder. Asia leads in climate change, water acidification, air pollution, and human health impacts due to its extensive production and manufacturing and agricultural sectors, which are highly polluting. Meanwhile, the Americas contribute less to these impacts from a production perspective but drive significant environmental impacts from a consumption standpoint, highlighting how the offshoring of textile production and manufacturing and agriculture to Asia exacerbates environmental damage abroad. Oceania leads in biodiversity loss

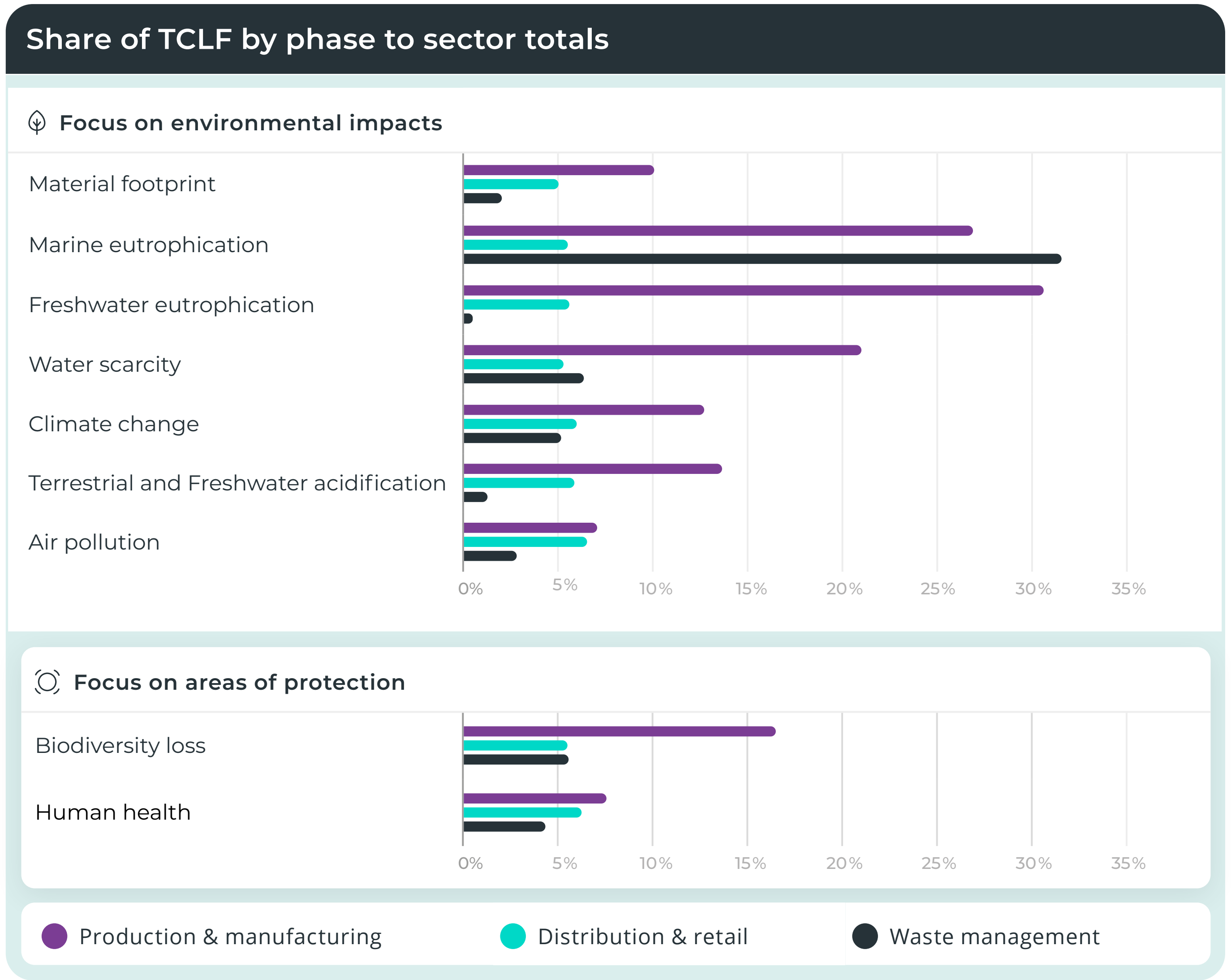


Figure five presents value chain phase contributions to total impacts per impact category.

Impact contribution of the TCLF sector by region
Production-based perspective

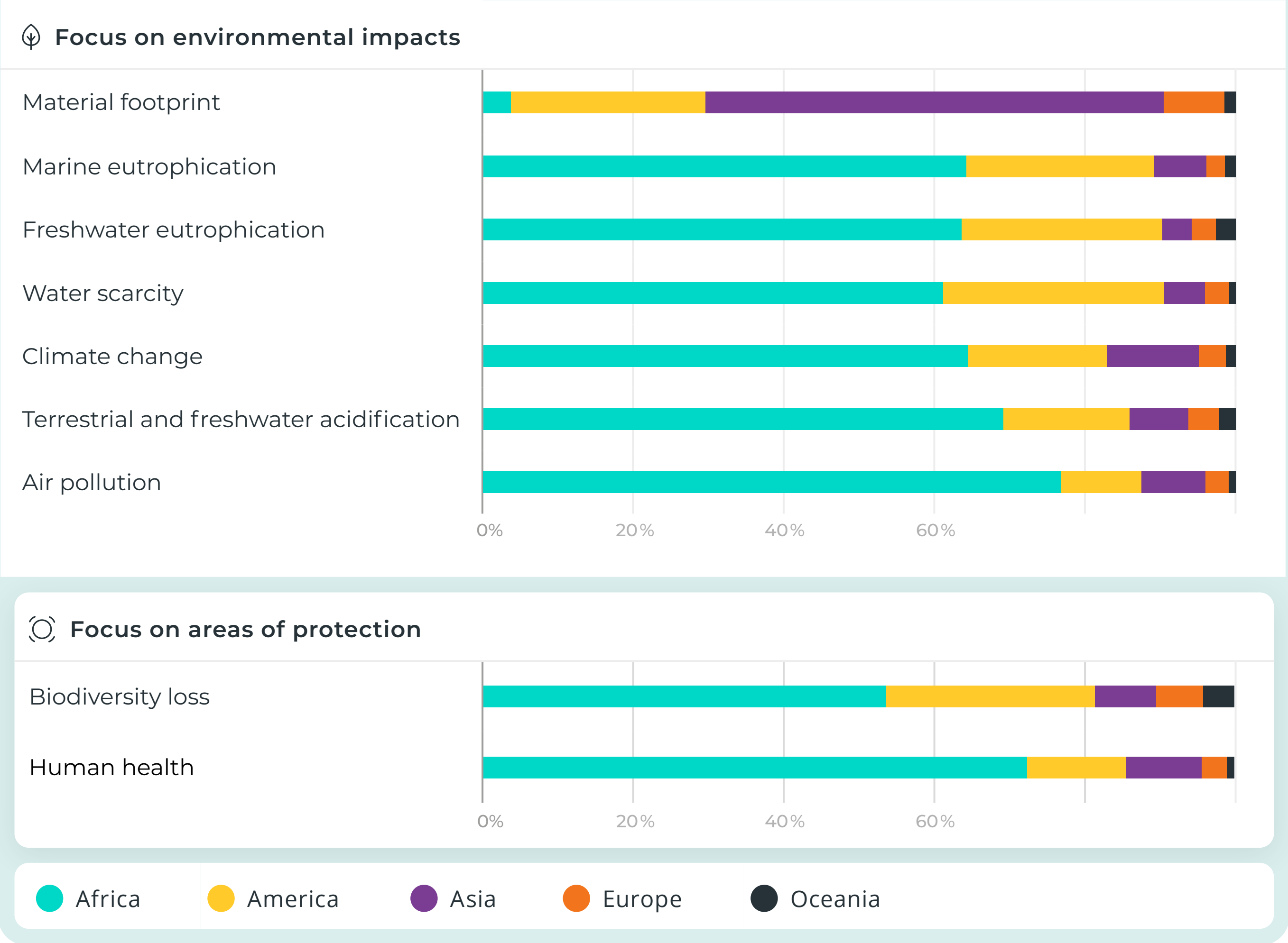


Figure six presents the impact contribution of the TCLF sector by region, taking a production-based perspective.

and freshwater eutrophication, likely driven by land use changes for cotton and wool production for importing countries. Europe's results reflect extensive outsourcing, with a significant portion of its production impacts occurring outside the region.

Our per capita analysis offers a more consistent comparison of countries' contributions to environmental degradation. High-income countries with significant textile consumption, such as the US, Australia, and Argentina, consistently rank as the top per capita contributors to environmental degradation. The US leads in per capita environmental impacts across all categories, driven by its high textile consumption, exceeding the global average by five to eight times. Other high-income countries, including Italy and South Korea, also rank among the highest per capita contributors, with most of the top ten countries showing impacts two to three times higher than the global average.

In particular, Argentina and Australia contribute heavily to freshwater and marine eutrophication, while China and the US contribute heavily across all impact categories. High-income countries with significant textile consumption, such as the US, Australia, and Argentina, consistently rank as the top per capita contributors to environmental degradation. Freshwater and marine eutrophication are particularly driven by these countries' intensive agricultural practices, while climate change impacts are largely fuelled by the use of fossil fuel-based textiles. These findings highlight that, while the largest textile production hubs are in Asia, it is the high-income, high-consumption countries that drive much of the environmental impact through their demand for textiles.

Impact contribution of the TCLF sector by region
Consumption-based perspective

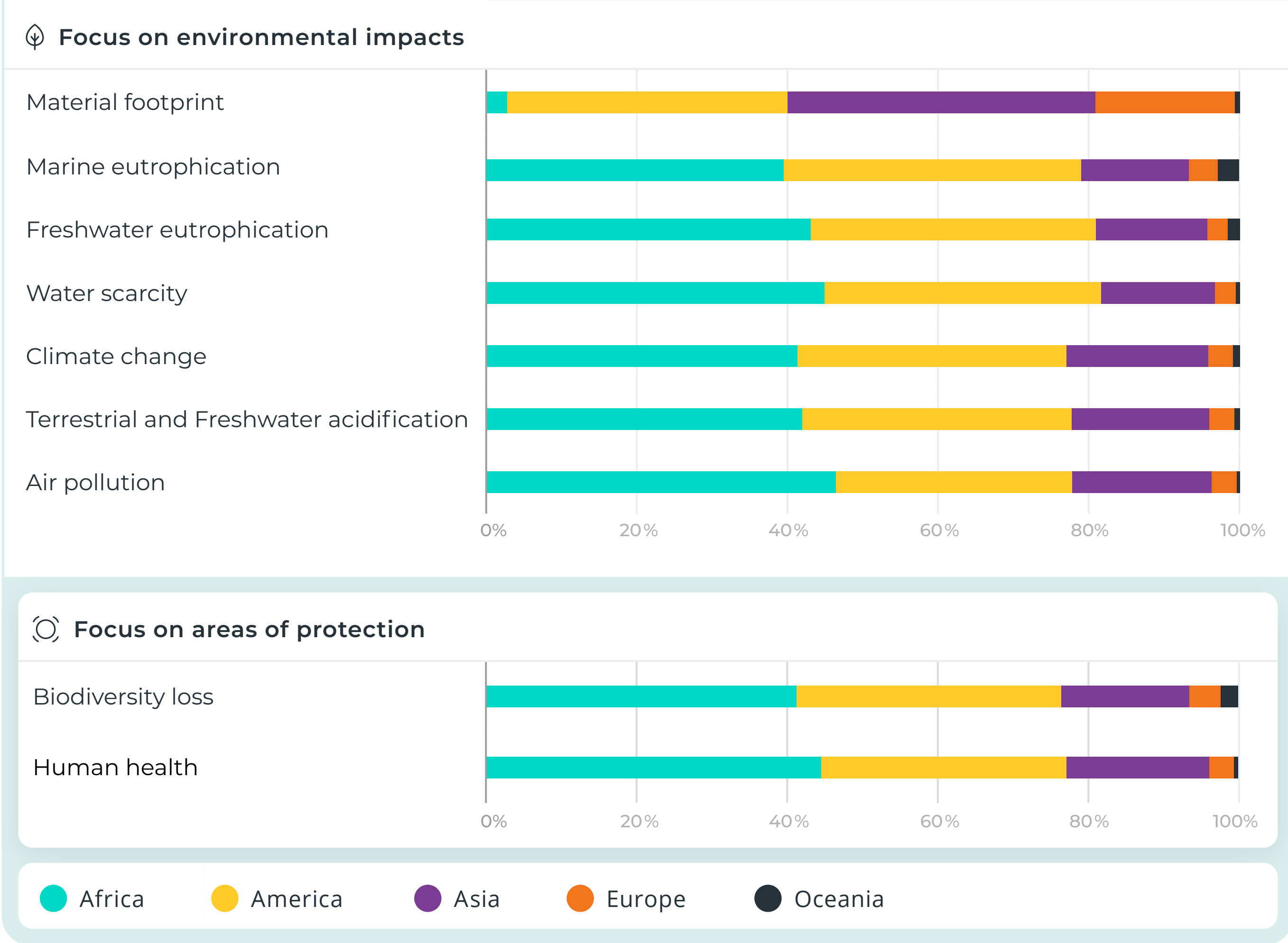


Figure seven presents the impact contribution of the TCLF sector by region, taking a consumption-based perspective.

WHAT IS THE DIFFERENCE BETWEEN PRODUCTION- AND CONSUMPTION-BASED APPROACHES?

A key difference between production- and consumption-based approaches lies in how environmental impact is measured. Production-based accounting assesses the environmental impact based on the total resources used in production within a specific country or region, regardless of where the products are consumed.

In contrast, consumption-based accounting looks at the total resources embedded in the products consumed by residents of a country or region, including imports and excluding exports. For example, a production-based approach measures the environmental impact of textile production in a country, whereas a consumption-based approach assesses the impact of textiles consumed by residents, regardless of their origin.

SPOTLIGHT ON INDUSTRY GIANTS: THE US AND CHINA

THE GLOBAL IMPACT OF TWO TEXTILE POWERHOUSES

Environmental and health impacts

Our analysis finds that the US and China are the dominant driving forces behind the textile industry's environmental impact, contributing the majority share of impact across all categories (Figures eight and nine). The US, as a high-income country, plays a critical role in environmental degradation through its massive textile consumption. In contrast, China stands out as the largest producer, driving substantial impacts through its production and manufacturing practices. Together, these two countries wield the greatest influence over the global environmental footprint of the textile industry.

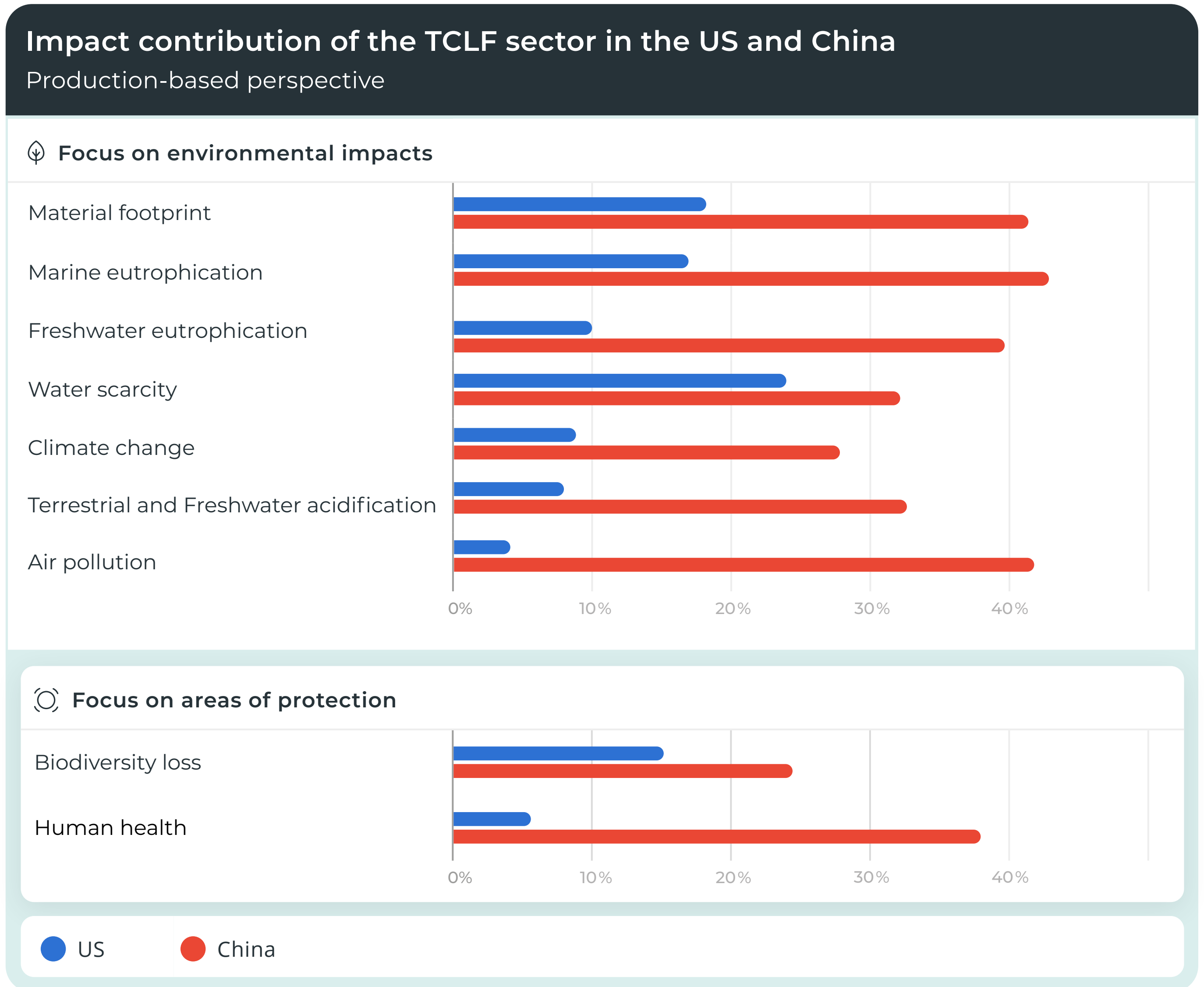


Figure eight illustrates how the US and China contribute to global impacts from a production-based perspective.

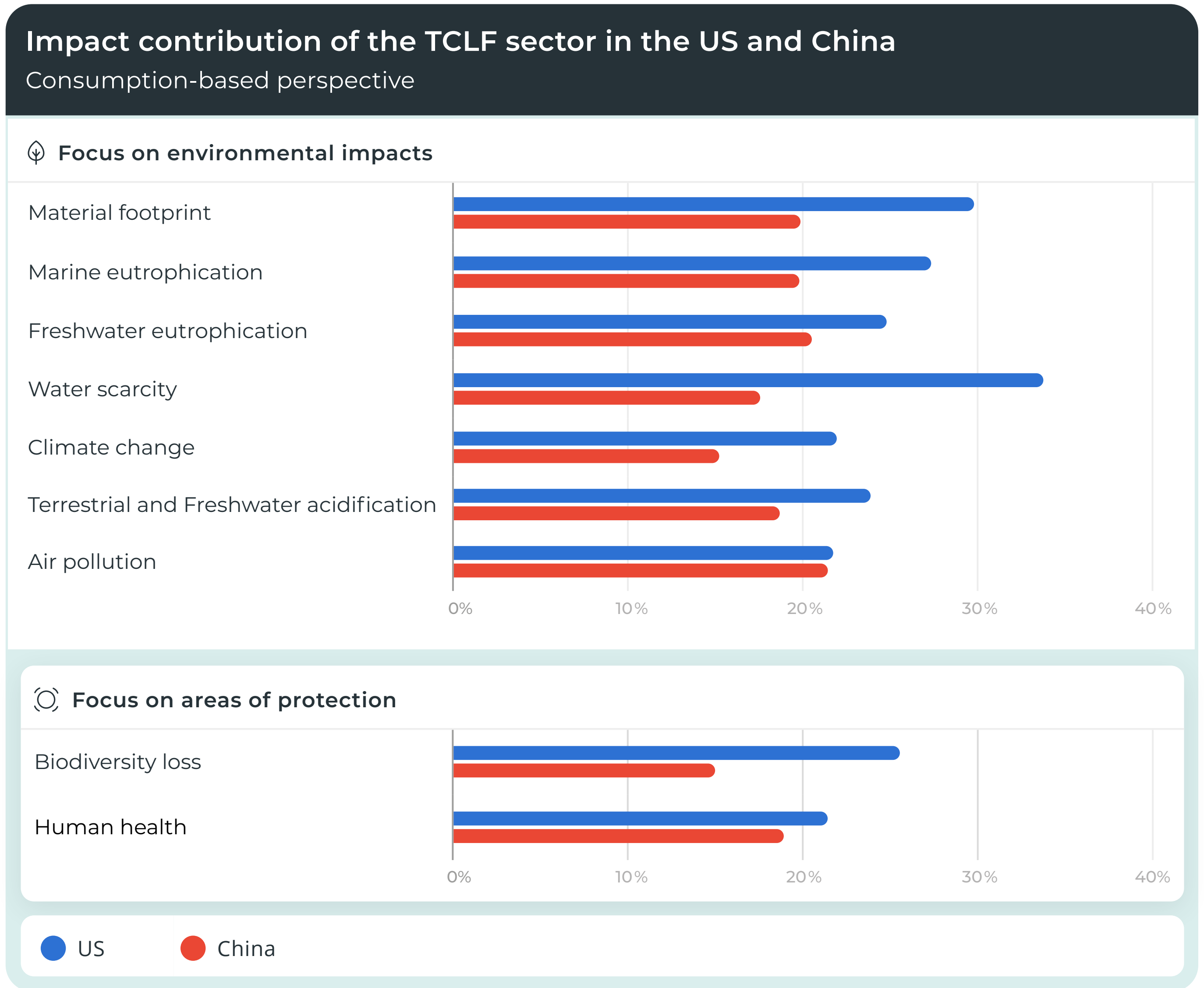


Figure nine illustrates how the US and China contribute to global impacts from a consumption-based perspective.

China is the dominant contributor across most environmental impact categories from a production-based perspective. For example, China contributes nearly 40% to the material footprint, while the US contributes just over 10%. This pattern is consistent across other categories such as marine eutrophication and water scarcity, where China's contributions exceed 40%, while the US's share remains at around 10%. Similarly, for air pollution, China's contribution is over 40%, whereas the US's contribution is around 10%. In terms of impacts on human health, China is responsible for over 40% of the global burden, whereas the US contributes only around 10%.

In contrast, when taking a consumption-based perspective, the US becomes the largest contributor across several key categories. For instance, the US contributes over 35% of the material footprint, while China contributes just over 20%. The same pattern is observed in water scarcity and climate change, where the US contributes close to 40%, while China's share is around 20%. The US also leads in air pollution and human health impacts, with its contribution in these categories reaching nearly 35%, while China's impact is just below 20%.

Managing resources and waste

The United States

The US is a significant player in the global textile industry, ranking as the third-largest producer of cotton, with an output of 3.2 million tonnes in 2021, and the third-largest producer of synthetic fibres, at 2.7 million tonnes in 2022.[122, 123] Most US cotton is sourced from the Southeastern region known as the 'Cotton Belt'. Over recent decades, fabric and textile product manufacturing in the US has declined due to lower labour costs abroad, fewer regulations, and rising consumer demand for inexpensive goods.

On the consumption side, the US plays a major role, with the average American purchasing 69 garments annually as of 2021—a notable increase from 40 garments per year in the 1990s.[124] This surge in consumption has led to significant textile waste, much of which ends up in landfills. In 2018, the US generated 17 million tonnes of textile waste, reflecting a slight increase from previous years.[125] The majority of this waste—66%—is disposed of in landfills, while 19% is incinerated for energy recovery, and only 15% is recycled.[126]

In addition to domestic production and consumption, the US imports substantial amounts of new and used textiles, including €26.4 million (US$27.8 million) in used clothing and €83.4 million (US$87.8 million) in textile scraps, primarily from Asia and Central and South America.[127, 128] The country also exports €959 million (US$1.01 billion) in used clothing, mainly to lower-income countries in the Americas, along with €68 million (US$72 million) in textile scraps.[129] Total textile exports, largely consisting of unfinished products such as raw cotton and yarn, amounted to €33 billion (US$34.5 billion), with Mexico, Canada, and China as the primary destinations.[130, 131]

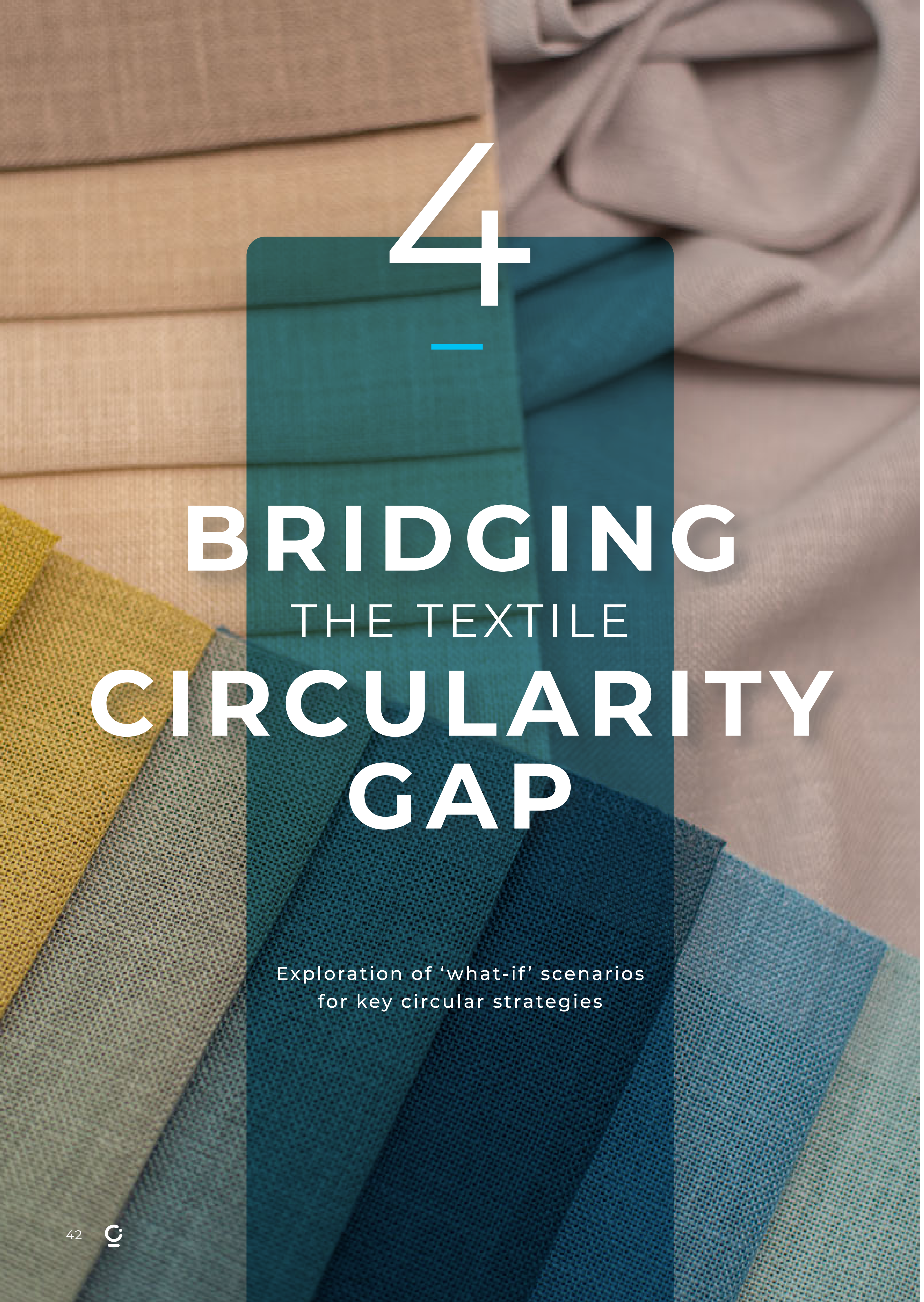
China

China is the world's largest textile producer and exporter, with the textile industry concentrated in 50 clusters, primarily in Guangdong, Shandong, Zhejiang, Fujian, and Jiangsu provinces,[132] which account for 70% of total production.[133] The country is also the second-largest cotton producer globally,[134] growing nearly six million tonnes annually, mainly in the Xinjiang Uyghur Autonomous Region (XUAR).[135] Additionally, China dominates synthetic fibre production, generating over 60 million tonnes annually,[136] with polyester, nylon, and elastane comprising a significant portion.

In 2022, China's textile exports reached approximately €384 billion (US$404 billion), primarily consisting of finished articles.[137] The country also imports €39.5 billion (US$41.6 billion) in textiles, with Vietnam, the US, and Italy as key suppliers,[138] highlighting China's strategic control over the entire textile value chain. Despite banning certain types of waste imports, including textiles,[139] China remains a significant exporter of used textiles, amounting to €768 million (US$809 million) in used clothing and €35 million (US$36.6 million) in textile scraps in 2022.[140, 141]

In addition to textiles, China accounts for 36% of global leather production,[142] with livestock farming for leather mainly located in the western provinces,[143] supported by large cattle and pig populations and an extensive tanning industry.[144] Furthermore, China is the top exporter of finished leather products and the largest global producer of fur, with fur farming concentrated in the northeast and manufacturing occurring in the industrialised eastern provinces.[145]

Waste generation in China's textile industry presents an ongoing challenge, with an estimated 20 to 26 million tonnes generated annually,[146] 30% of which remains unsold.[147] In 2016, the country landfilled 19.7 million tonnes of textile waste, roughly 14.5 kilograms per capita.[148] Compounding this issue, textile recycling in China faces substantial obstacles, with a current recycling rate of less than 1%.[149]



4

BRIDGING THE TEXTILE CIRCULARITY GAP

Exploration of ‘what-if’ scenarios for key circular strategies

Now that we have presented how the global textile industry contributes to a range of environmental and social impacts, it’s time to suggest a remedy. For key areas—those with the biggest potential for impact—we have formulated six scenarios that explore and entertain the ‘what-if’, allowing us to dream big and imagine a more circular, resource-light and low-impact textile industry. They explore a potential path forward and sketch which aspects of the value chain and interventions could be most impactful in reducing a wide range of impacts. These findings underscore the importance of reimagining our relationship with materials to reduce the production and consumption of textiles on the whole—beyond prioritising efficiency gains alone. These scenarios reveal both the challenges and potential of circular interventions, underscoring the need for bold, coordinated actions on a global scale to achieve meaningful progress.

BRIDGING THE CIRCULARITY GAP: 'WHAT IF' SCENARIOS

Scenarios in the *Circularity Gap Reports* are largely free from the constraints of regulation or political realities. They also do not account for technological scalability and the quality of physical flows, such as the quality of post-consumer textile waste or product performance. They are deliberately non-time-specific and exploratory. Ultimately, their real-life materialisation does not inform our analysis. This approach allows us to freely imagine what our society could look like with truly transformational change: a textile industry shifting away from its linear past. Below, we present possible scenarios that allow us to 'dream big' and sketch which levers are most impactful in reducing environmental impacts.

We have focused on **six ‘what-if’ scenarios** that represent key leverage points for the textile industry, using 2018 as the baseline year for our analysis. These scenarios are: 1) Shift to more natural, local, and recycled fibres, 2) Increase garment durability, 3) Produce natural fibres sustainably, 4) Embrace slow fashion, 5) Advance circular manufacturing, and 6) Transform regional supply chain dynamics. Within every scenario, three levels of ambition are explored—moderate, optimistic, and ambitious—all resulting in different outcomes. Each scenario focuses on three key dimensions: resource and material flows, production and supply chain dynamics, and consumer behaviour and societal values. These dimensions align with circular economy principles of narrowing, slowing, regenerating and cycling resource flows, as described in Figure one.

This analysis explores how circular economy strategies can reduce environmental impacts using the environmentally extended multi-regional input-output tables (EE-MRIOTs) system from the baseline assessment and macroeconomic modelling. This general macroeconomic model lacks the detailed accuracy of engineering models like dynamic MFAs and LCAs specific to the textile industry. Additionally, our static and deterministic model provides a snapshot of the global economy in a specific year, using ranges to test result sensitivity, unlike dynamic models that consider time-dependent variables and probabilities. Therefore, these results should be interpreted cautiously as they offer an exploration of potential impacts rather than precise, feasible interventions.[150]

1. SHIFT TO MORE NATURAL, LOCAL, AND RECYCLED FIBRES

1.1 Use more natural fibres

The textile industry produces a wide range of fibres, from everyday clothing to specialised performance gear. In recent decades, the shift towards synthetic fibres—such as polyester, nylon, and acrylic—has been driven by their cost-effectiveness, durability, and versatility.[151] These materials now dominate the market, making up 65% of global fibre production, or 75.5 million tonnes.[152] However, synthetic fibres pose significant environmental challenges, as they are derived from petrochemicals and contribute to carbon emissions and environmental degradation throughout their lifecycle.[153] In light of the growing push for sustainability, there is increasing interest in replacing synthetic fibres with natural alternatives.

Natural fibres, which include plant-based fibres like cotton and linen, man made cellulosic fibres (MMCFs) such as viscose, and animal fibres like wool and silk, account for the remaining 35% of global production. Plant-based fibres represent 27% (31.5 million tonnes), MMCFs contribute 6.3% (7.3 million tonnes), and animal fibres make up 1.7% (2 million tonnes).[154] While these fibres are often valued for their biodegradability and lower environmental impact, their production also raises concerns: natural fibres require significant amounts of water and fertilisers, pesticides, and synthetic chemicals during farming and processing.

In response to the growing demand for sustainability, there is an increasing interest in substituting synthetic fibres with natural alternatives. Completely eliminating synthetic materials is not a viable solution, given the large volumes already in circulation, while a total shift to natural fibres could pose its own risks: ecosystem depletion, for example, especially given the current scale of textiles production. A more practical approach could centre on prolonging the lifetimes of existing synthetic fibres through reuse and recycling, while increasing the use of natural fibres.

Results: Scenario 1.1

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Material footprint	-3.60	-6.25	-8.90
Climate change	-0.90	-1.2	-1.50
Human health	+1.30	+3.2	+5.20
Water scarcity	+2.90	+5.6	+8.30
Air pollution	+2.60	+5.7	+8.80
Biodiversity	+5.50	+11	+16.60
Marine eutrophication	+9.00	+17.9	+26.80
Terrestrial and Freshwater acidification	+10.20	+20.6	+31.00
Freshwater eutrophication	+11.60	+23	+34.30
Circularity Metric		+9.6% (0.29% –› 0.32%)	

To this end, this scenario proposes substituting a portion of virgin fossil-based synthetic textiles with natural fibres—thus **regenerating flows**. However, not all clothing can be made entirely from natural fibres. Certain products, like sportswear and shoes, require synthetic blends to achieve necessary qualities such as elasticity, moisture-wicking, and durability.[155] Blended materials are crucial for the performance and longevity of these items, with 20 to 60% of products requiring synthetic blends. This scenario assumes a one-to-one fibre replacement at equivalent costs between synthetic and natural categories. It also assumes that local fibre availability is unconstrained. In the moderate scenario, 20% of newly produced textiles are made from monofibre natural fibres. In the optimistic scenario, this share increases to 40%, and in the ambitious scenario, 60% of new textiles use monofibre natural fibres.

1.2 Use more plant-based fibres and increased recycling

Plant-based fibres, such as cotton and linen, have been used for centuries, valued for their natural origins and numerous benefits. Unlike animal-derived fibres like wool and silk, plant-based fibres are sourced from biodegradable and renewable agricultural crops, making them an attractive option for sustainable textile production. This scenario not only considers a shift to plant-based fibres but also explores increasing the use of recycled plant-based materials, particularly cotton.

Recycled cotton currently makes up just 1% of the plant fibre market, or 0.25 million tonnes, as per our analysis. The challenges of mechanical recycling for cotton, such as fibre degradation, persist, but improvements in monofibre composition—where textiles are made from a single plant fibre—could simplify recycling and enhance material quality. Additionally, advancements in mechanical recycling and spinning techniques are helping to mitigate some of these limitations. By increasing the proportion of recycled plant-based fibres, the goal is to reduce the environmental impacts associated with virgin fibre production.

This scenario proposes substituting a portion of virgin fossil-based synthetic textiles with plant-based fibres and increasing recycling rates, thereby **regenerating** and **cycling flows**. However, not all textiles can be made solely from plant-based fibres due to technical and economic constraints: as noted, blended materials are assumed necessary for 20 to 60% of products. Our modelling assumes a one-to-one substitution of synthetic fibres with plant-based alternatives, maintaining the same cost across product categories. Additionally, the scenario models a reduction in the use of virgin fibres by increasing the share of recycled content. In the moderate scenario, 20% of new textiles are made from monofibre plant-based fibres. This increases to 40% in the optimistic scenario and 60% in the ambitious scenario.

Results: Scenario 1.2

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Material footprint	-3.1	-5.8	-8.5
Climate change	-0.5	-1.2	-0.4
Human health	+3.4	+7.3	+11.2
Water scarcity	+3.8	+7.6	+11.4
Air pollution	+5.6	+11.6	+17.6
Biodiversity	+9.1	+18.4	+27.7
Marine eutrophication	+15.4	+30.7	+46.1
Terrestrial and Freshwater acidification	+18.3	+36.8	+55.4
Freshwater eutrophication	+18.9	+37.8	+56.8
Circularity Metric		+35.3% (0.29% → 0.4%)	

CONCLUSIONS: SCENARIO ONE

Our analysis reveals that this scenario negatively impacts all environmental metrics, except for material footprint and climate change. This is primarily because synthetic fibres are more efficient regarding water and land use, but less so in terms of CO_2 emissions and material footprint. Substituting synthetic fibres with natural fibres (Scenario 1.1) leads to greater overall environmental impact reductions than using only plant-based fibres (Scenario 1.2), given the higher resource demands of conventional plant fibres. These findings highlight the trade-offs between materials and the importance of sustainable production practices across all fibre types.

2. INCREASE GARMENT DURABILITY

Synthetic fibres, such as polyester and nylon, dominate global fibre production, making up 65% of the market. These fibres offer advantages over natural fibres—such as durability, resistance to stretching, shrinking, and abrasion—that extend garment lifespans and reduce the need for frequent replacements.[156, 157, 158] This scenario explores increasing the use of synthetic fibres to enhance garment durability, thus potentially lowering overall consumption and waste.[159]

Advances in monofibre compositions and recycling technologies are improving the sustainability of synthetic fibres. Monofibre designs simplify the recycling process, making it easier to recover and reuse materials. Currently, 13.6% of polyester fibres are made from recycled materials. This scenario aims to increase this share through improved recyclability and the use of recycled content.[160]

This scenario keeps synthetic textiles in use for longer, whilst increasing the share of recycled synthetic materials—thus **slowing** and **cycling flows**. However, not all textiles can rely exclusively on synthetic fibres due to performance needs and economic constraints, with blended materials necessary for 20 to 60% of products. Our model assumes a one-to-one substitution of virgin synthetic fibres with recycled or more durable alternatives. In the moderate scenario, 25% of newly produced textiles are made with monofibre synthetic fibres, accompanied by a 20% reduction in overall textile consumption. In the optimistic scenario, 50% of new textiles are made with monofibre synthetic fibres, leading to a 30% reduction in consumption, while the ambitious scenario sees 75% monofibre synthetic fibres and a 40% reduction in consumption.

Results: Scenario two

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Terrestrial and Freshwater acidification	-18.5	-27.9	-37.2
Freshwater eutrophication	-17.7	-26.6	-35.4
Air pollution	-15.4	-23.1	-30.8
Biodiversity	-15.3	-23.0	-30.6
Human health	-14.7	-22.1	-29.5
Water scarcity	-14.4	-21.6	-28.8
Material footprint	-13.9	-20.9	-27.9
Climate change	-13.6	-20.5	-27.3
Marine eutrophication	-12.1	-18.3	-24.4
Circularity Metric		+170% (0.29% → 0.8%)	

CONCLUSIONS: SCENARIO TWO

This scenario is the most effective in reducing textile and apparel consumption. Extending the lifespan of garments, whether they are made from synthetic or natural fibres, has very positive environmental impacts. While synthetic textiles show significant potential for durability and lowering material demand, similar outcomes can also be achieved with MMCFs like viscose, derived from wood pulp. Although MMCFs were not specifically modelled in this scenario, they represent a viable alternative. However, while synthetics perform well in terms of material efficiency and CO_2 impact, concerns about microplastics—an issue not captured in our impact categories—highlight the need for caution in promoting them.

3. PRODUCE NATURAL FIBRES SUSTAINABLY

The textile industry is a major contributor to water use, chemical inputs, and carbon emissions, and transitioning to lower-impact natural fibres through regenerative agricultural practices, for example, is a key solution. Regenerative agriculture enhances soil health, biodiversity, and resilience to extreme weather while supporting local communities. Sustainable techniques like no-till farming, efficient irrigation, and organic production can help lower resource consumption.[161]

Organic cotton, for example, can reduce GHG emissions by up to 46%,[162] although its yields are around 18.4% lower than conventional methods, presenting a trade-off.[163] Substitution with materials like hemp, which uses 50% less water and pesticides than cotton, offers further reductions in environmental impacts.[164] Similarly, MMCFs such as TENCEL™ Lyocell and Modal fibre use processes that reduce emissions and water use by at least 50%.[165] Next-generation MMCFs derived from waste streams provide additional sustainability benefits by reducing waste and dependence on traditional raw materials.[166]

This scenario focuses on producing natural fibres through sustainable practices, which can significantly reduce the environmental impact of textile production—thus **narrowing** and **regenerating flows**. Sustainable practices are applied exclusively to natural fibres, with reductions in water, pesticide, and energy use. For cotton, projected reductions include 46% lower GHG emissions,[167] 62% less air pollution,[168] 91% reduced water use,[169] and 30% less nitrogen and phosphorus fertiliser use, with a 14% increase in land use. In the moderate scenario, 20% of cotton is grown organically, increasing to 40% in the optimistic and 60% in the ambitious scenario. For leather, a 50% reduction in environmental impacts is modelled (except for land use), with 25% of leather produced sustainably in the moderate scenario, 50% in the optimistic, and 75% in the ambitious scenario.

Results: Scenario three

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Marine eutrophication	-0.8	-1.6	-2.4
Water scarcity	-0.3	-0.6	-1.0
Terrestrial and Freshwater acidification	-0.2	-0.4	-0.6
Climate change	-0.2	-0.3	-0.5
Human health	-0.1	-0.2	-0.4
Air pollution	-0.1	-0.2	-0.4
Material footprint	0	0	0
Biodiversity	0	0	0
Freshwater eutrophication	0	0	0
Circularity Metric		+0% (0.29% –> 0.29%)	

CONCLUSIONS: SCENARIO THREE

The outcomes of this scenario are modest: this is because all environmental impacts could be modelled for leather, which has a relatively small market share, but not for cotton, which has a greater market share. The limited overall impact for all natural materials highlights that reducing production and consumption has a greater effect than improvements in material efficiency alone. Additionally, the results are constrained by the limited scope of the natural fibres included in the analysis and a lack of data on potential reductions in impacts for certain areas.

4. EMBRACE SLOW FASHION

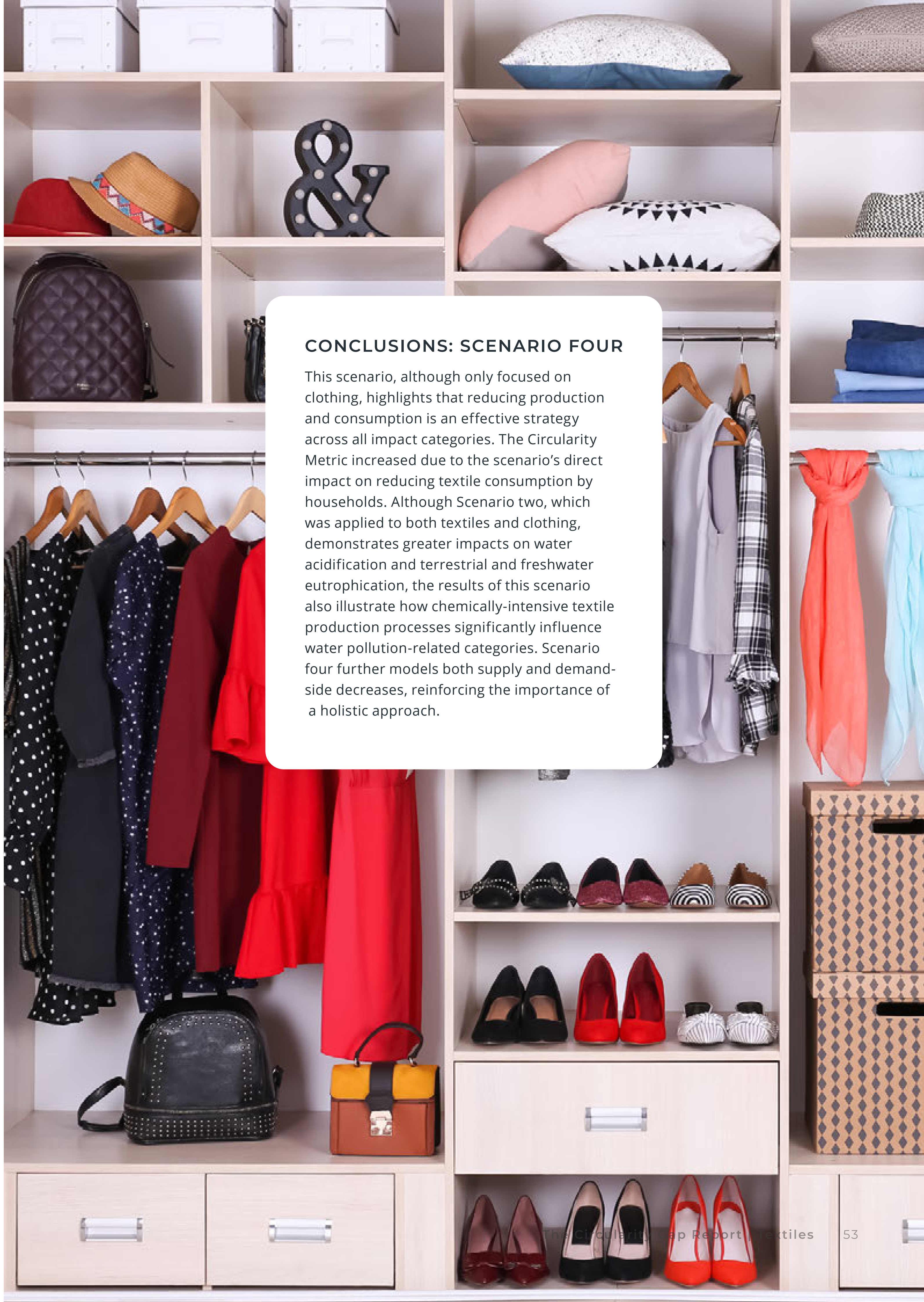
By 2030, global clothing and footwear consumption is projected to increase by 63%, from 62 million tonnes in 2022 to 102 million tonnes.[170] Slow fashion presents a solution by advocating for more mindful production and consumption.[171] This scenario combines supply and demand strategies to assess their potential in reducing the industry's environmental footprint, thereby **narrowing and slowing flows**.

On the supply side, reducing the number of fashion collections brands release and adjusting production volumes can help align output with actual market needs, minimising unsold products. Over the past two decades, brands have released new collections more frequently, driving resource use and waste.[172] This part of the scenario models a reduction in the share of unsold clothing as a key metric. In the moderate scenario, unsold stock decreases by 25%, lowering it to 22.5% of total output. The optimistic scenario assumes a 37.5% reduction, bringing unsold items to 18.75%, while the ambitious scenario envisions a 50% reduction, lowering it to 15%. Alongside fewer unsold clothes, a decrease in overall sales is assumed to help mitigate overproduction.

On the demand side, promoting reuse, repair, clothing libraries, rentals, donations, and do-it-yourself (DIY) fashion extends garment lifespans and reduces consumption. Trends already indicate a shift towards sustainable fashion.[173] Sharing platforms that offer rentals and peer-to-peer exchanges, particularly popular among younger, eco-conscious consumers, broaden access to garments without the need for new purchases.[174] Additionally, repair options, including repair cafés, pop-up events, and online tutorials, are expanding, enabling individuals to extend garment use.[175, 176] Brands can also scale up circular business models by offering repair, rental and resale options themselves, also diversifying their revenue streams. This part of the scenario assumes an increase in household use of raw materials for DIY repairs. A small rebound effect is also modelled, with households purchasing 0.2 units of raw materials for every unit of textile reduction. The model evaluates three ambition levels: a 5% reduction in overall consumer textile consumption for the ambitious scenario, 3.75% for the optimistic, and 2.5% for the moderate scenario.

Results: Scenario four

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Water scarcity	-6.1	-9.0	-11.9
Freshwater eutrophication	-5.7	-8.5	-11.2
Biodiversity	-5.6	-8.4	-11.1
Air pollution	-5.3	-7.9	-10.5
Material footprint	-5.2	-7.8	-10.3
Human health	-5.2	-7.8	-10.3
Terrestrial and Freshwater acidification	-5.2	-7.8	-10.3
Climate change	-5.1	-7.6	-10.1
Marine eutrophication	-3.4	-5.1	-6.7
Circularity Metric		+11.4% (0.29% –> 0.33%)	



CONCLUSIONS: SCENARIO FOUR

This scenario, although only focused on clothing, highlights that reducing production and consumption is an effective strategy across all impact categories. The Circularity Metric increased due to the scenario's direct impact on reducing textile consumption by households. Although Scenario two, which was applied to both textiles and clothing, demonstrates greater impacts on water acidification and terrestrial and freshwater eutrophication, the results of this scenario also illustrate how chemically-intensive textile production processes significantly influence water pollution-related categories. Scenario four further models both supply and demand-side decreases, reinforcing the importance of a holistic approach.

5. ADVANCE CIRCULAR MANUFACTURING

5.1 Improve material efficiency

Traditional textile manufacturing methods often result in fabric loss due to imprecise cutting, pattern layout mistakes, and manual errors, all contributing to increased GHG emissions and waste. For instance, in 2021, Bangladesh's apparel industry and fabric mills alone generated 577,000 tonnes of pre-consumer waste:[177] materials discarded during the production and manufacturing process, such as fabric scraps, yarn, and defective products.[178] To combat this, technologies like computerised and laser cutting systems have significantly reduced fabric waste by enabling precise cutting and minimising errors. For example, laser cutting follows the contours of digital patterns, ensuring maximum fabric utilisation. Additionally, nesting software can be used to arrange pattern pieces in the most efficient layout, further optimising fabric use by fitting the pieces together like a puzzle, leaving minimal gaps and reducing waste.[179]

Computer-aided design (CAD) software also plays a crucial role in reducing waste. It allows for digital pattern creation and direct transfer to cutting machines, eliminating manual errors and enhancing precision. CAD integration enables quick adjustments and optimisations, reducing fabric waste during production. Moreover, adopting lean manufacturing principles helps eliminate waste throughout the entire production process by streamlining workflows and reducing non-value-added activities.[180]

This scenario models a shift toward more efficient production methods—thus **narrowing flows**. It focuses on improving material efficiency in textile production by implementing advanced technologies such as Best Available Techniques (BATs) to reduce pre-consumer waste. Our modelling assumes average processing losses of 26% for yarn-to-fabric and fabric-to-product stages in apparel manufacturing, and 14% in textiles, excluding fibre-to-yarn processes. Based on estimates that avoidable losses range from 25 to 75%, the scenario outlines three possible pathways: a moderate 25% reduction in losses, an optimistic 50% reduction, and an ambitious 75% reduction. Achieving these reductions will require significant investment in advanced machinery and equipment.

Results: Scenario 5.1

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Terrestrial and Freshwater acidification	-2.6	-5.2	-7.8
Water scarcity	-2.4	-4.7	-6.9
Air pollution	-2.3	-4.6	-6.8
Material footprint	-2.3	-4.5	-6.7
Human health	-2.0	-4.2	-6.3
Freshwater eutrophication	-2.1	-4.1	-6.1
Biodiversity	-1.9	-4.0	-6.0
Climate change	-1.9	-3.9	-5.8
Marine eutrophication	-1.6	-3.2	-4.7
Circularity Metric		+10.3% (0.29% –› 0.32%)	

Results: Scenario 5.2

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Marine eutrophication	-6.6	-9.9	-13.2
Climate change	-4.1	-6.1	-8.1
Terrestrial and Freshwater acidification	-2.1	-3.2	-4.3
Human health	-1.5	-2.3	-3.1
Biodiversity	-1.4	-2.2	-2.9
Water scarcity	-1.0	-1.6	-2.1
Air pollution	-0.7	-1.1	-1.5
Freshwater eutrophication	0	0	0
Material footprint	+0.30	+0.4	+0.50
Circularity Metric		+0% (0.29% –› 0.29%)	

5.2 Incorporate cleaner production methods

The textile industry is a major contributor to environmental pollution through excessive water consumption, chemical usage, and carbon emissions. A significant advancement in this area is the adoption of waterless and low-water dyeing technologies. Innovations like supercritical CO_2 dyeing and air dyeing drastically reduce or eliminate the need for water in the dyeing process. Traditional dyeing methods can consume up to 150 litres of water per kilogram of fabric, whereas supercritical CO_2 dyeing eliminates water use and cuts energy consumption by 80%.[181] Similarly, digital textile printing uses precise amounts of dye and ink, significantly reducing waste, water, and energy consumption compared to traditional methods. In regions with high carbon-intensive energy mixes, like China, digital printing can reduce CO_2 emissions by 7.8 kilograms per kilogram of fabric compared to screen printing.[182]

Additionally, the use of biodegradable chemicals for dyes, detergents, and finishes helps minimise pollution, as these alternatives break down easily and reduce the persistence of harmful substances in the environment.[183] Advanced air filtration systems in manufacturing facilities capture airborne pollutants and particulate matter, reducing both indoor and outdoor air pollution. Water treatment and recycling systems purify wastewater, allowing for its reuse in production processes, which helps reduce freshwater consumption and prevent the discharge of pollutants into natural bodies of water.[184] Finally, incorporating renewable energy sources such as solar, wind, and hydroelectric power in textile manufacturing further lowers CO_2 emissions and reduces dependence on fossil fuels.

This scenario focuses on reducing environmental pressures of textile production by implementing advanced technologies aimed at lowering water usage and waste generation—thus **narrowing** and **cycling flows**. It proposes the widespread adoption of cleaner production methods, with varying levels of ambition for reducing emissions, air pollutants, and water use. In the moderate scenario, a 50% reduction is applied, while the optimistic scenario assumes a 75% reduction and the ambitious scenario models a 100% reduction.

CONCLUSIONS: SCENARIO FIVE

To reduce wasteful manufacturing processes and the environmental pollution associated with the textile industry, substantial investment in advanced machinery and technology is crucial. However, these technological improvements come with trade-offs in material environmental impact categories. Similar to the dilemma of replacing a washing machine with a more efficient model versus extending its lifespan, adopting new technologies may introduce environmental costs that must be carefully evaluated to ensure truly sustainable practices within the industry. Notably, the impact on the Circularity Metric is zero in Scenario 5.2, as the scenario primarily focuses on reducing waste rather than material use. This aligns with Scenario 5.1's findings: reduced material, fossil fuel and water use are linked to a wide array of environmental impacts.

6. TRANSFORM REGIONAL SUPPLY CHAIN DYNAMICS

The global textile industry faces challenges due to its heavily globalised supply chain. A large share of production is concentrated in regions like the Asia Pacific, where ethical concerns regarding labour practices and environmental regulations often arise.[185, 186] Additionally, the environmental impact of long-distance transportation contributes significantly to the industry's carbon footprint.

Localising production helps reduce emissions by cutting transportation distances and shortening supply chains, making the industry more resilient to disruptions like pandemics, trade disputes, and natural disasters. This approach also boosts local economies by generating jobs, enhancing skill development, and attracting investment in related sectors. Closer proximity to production centres fosters collaboration between designers, manufacturers, and researchers, leading to higher product quality and faster innovation.[187]

Moreover, as demand for ethically produced, locally sourced products grows, brands can meet these preferences by offering more transparent supply chains, sustainable practices, and fair labour standards, improving both supply chain efficiency and resilience.

This scenario explores the potential benefits of shifting production from the Asia Pacific to the US and Europe while promoting more localised consumption across all regions—there by **narrowing flows**.
In modelling this scenario, it is assumed that raw material prices remain consistent across regions. Our model evaluates three scenarios: a moderate shift with a 10% production decrease in the Asia Pacific, an optimistic 15% decrease, and an ambitious 20% decrease. These reductions are offset by production increases in the US and Europe of 5% (moderate), 7.5% (optimistic), and 10% (ambitious). Additionally, global textile consumption is assumed to decrease by 5% (moderate), 7.5% (optimistic), and 10% (ambitious), reflecting a more sustainable balance between production and consumption to narrow flows. No major infrastructural changes are assumed to affect production capacity in different regions.

Results: Scenario six

	MODERATE SCENARIO (% CHANGE)	OPTIMISTIC SCENARIO (% CHANGE)	AMBITIOUS SCENARIO (% CHANGE)
Terrestrial and Freshwater acidification	-6.5	-9.2	-11.8
Water scarcity	-6.3	-8.9	-11.5
Air pollution	-6.3	-8.9	-11.5
Material footprint	-5.9	-8.3	-10.7
Human health	-5.7	-8.1	-10.4
Freshwater eutrophication	-5.2	-7.4	-9.5
Biodiversity	-4.7	-6.6	-8.5
Climate change	-4.5	-6.4	-8.3
Marine eutrophication	-3.9	-5.5	-7.0
Circularity Metric		+12% (0.29% → 0.33%)	

CONCLUSIONS: SCENARIO SIX

The impact of this intervention is moderately distributed across various environmental categories, with a relatively even distribution overall. The primary reduction in impact stems from the fact that production in the US and Europe is cleaner and less material-intensive than in Asia. However, there are trade-offs to consider, particularly regarding the increased demand for production facilities in the US and Europe, which would lead to additional raw material extraction. It is also important to note that this scenario does not address the potential negative social and economic effects of localising production in the US and Europe. For instance, if major parts of textile production were to move from countries like Bangladesh to Europe, it could have significant consequences for workers in Bangladesh and the country’s economy as a whole, as the textile industry is a major contributor to its GDP and employment. However, these considerations are beyond the scope of this analysis as the scenarios presented are purely hypothetical and intentionally modelled outside of real-world constraints.

UNLOCKING IMPACT THROUGH SYSTEMIC CHANGE: THE POWER OF COMBINED CIRCULAR STRATEGIES

Individual strategies have a limited effect on the Circularity Metric and the environmental footprint of the textile industry. However, when combined, these interventions can bring substantial benefits. By harnessing the cross-intervention synergies in our most ambitious scenarios, we can boost the industry's **Circularity Metric from 0.3% to 0.9%**—more than doubling the initial figure. This seemingly modest increase, despite a significant reduction in material footprint (-39%) and environmental impacts, is mainly due to the overwhelmingly high consumption of virgin materials, which outweighs gains in secondary material use. While reducing virgin material consumption by one-third has a notable relative impact, the very low baseline of 0.3% limits the potential for a higher Circularity Metric.

The combined scenario reveals the total potential of circular interventions in reducing the environmental impacts of the textile industry. Notably, the substitution of synthetic fibres with natural fibres (Scenario one) is the only scenario with considerable trade-offs between impact categories, showing negative impacts on all water-related categories, biodiversity, and air pollution. As a result, this scenario was excluded from the combined scenario results. Each intervention influences environmental impacts differently, highlighting their critical role in driving a circular textile industry. For example, cleaner manufacturing (Scenario five) had the most significant impact on marine eutrophication, primarily due to the reduction in water pollution from industrial facilities.

The environmental impacts of the combined scenarios vary depending on the level of intervention (Figure ten). In the ambitious scenario, reductions across all categories range from -35% for marine eutrophication to -50% for water acidification. The optimistic scenario achieves reductions of -26 to -35%, while the moderate scenario results in reductions of -17 to -20%. Consumption-focused scenarios, like the use of durable synthetic fibres and slow fashion, generally deliver larger reductions (-5 to -28%) compared to production-focused interventions (0 to -10%). For more information on how combined scenario results differ by value chain phases or regions, please refer to Appendix C.

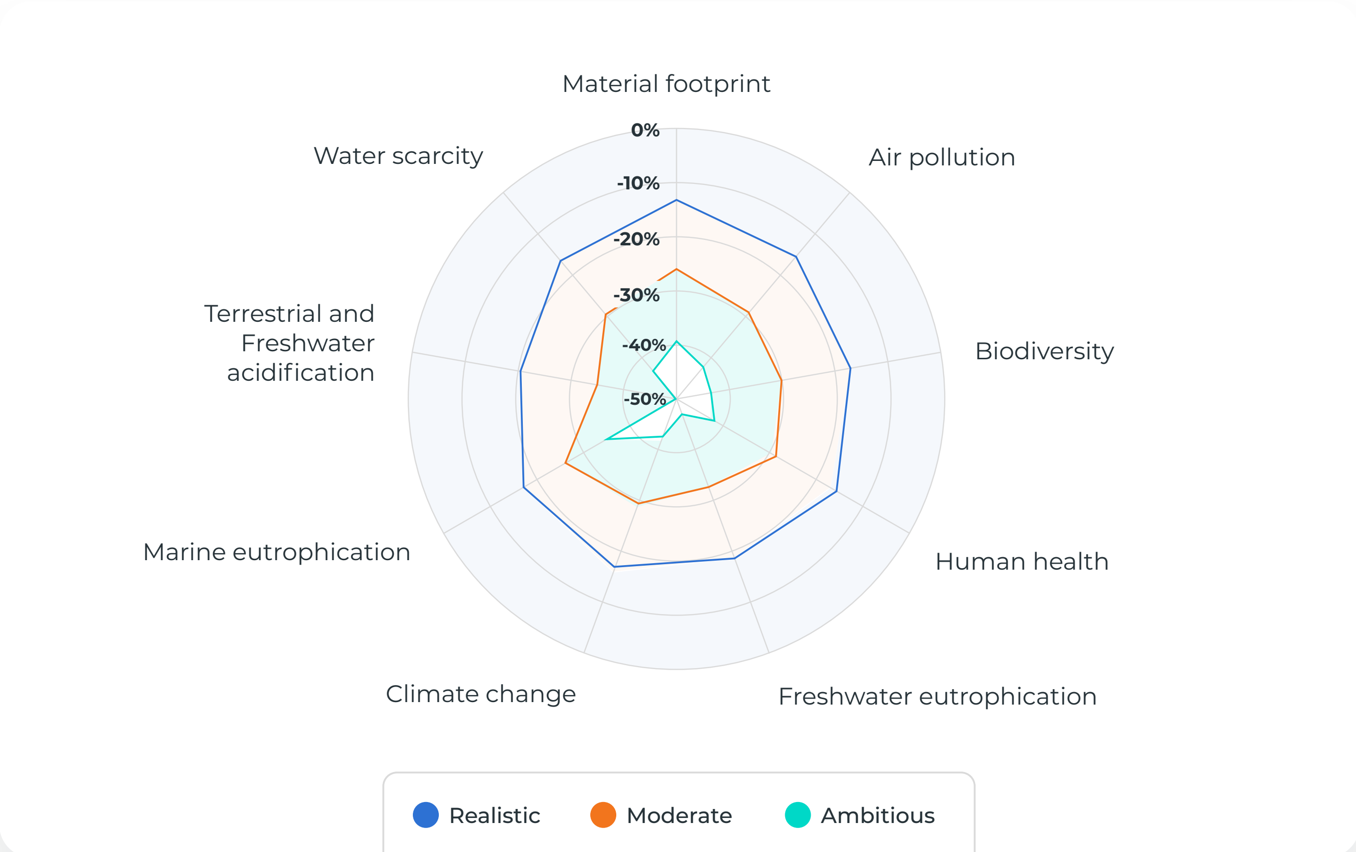


Figure ten illustrates the impact of the combined circular strategies.

CONCLUSIONS: COMBINED SCENARIOS

As outlined above, individual strategies can make notable contributions to environmental impact reduction but fall short in terms of significantly improving the textile industry's circularity. While ambitious interventions can triple the Circularity Metric from 0.3% to 0.9%, this modest gain reflects the industry's still overwhelming reliance on virgin materials, which undermines broader progress.

The findings in this chapter emphasise that the path to greater circularity requires the textile industry to undergo a complete transformation. This transformation must prioritise a drastic reduction in virgin material use and a shift toward secondary materials. This is exemplified by scenarios that focus on reducing consumption, like designing long lasting products and promoting slow fashion, which have demonstrated the greatest positive impact on individual environmental categories. However, it's essential to remember that the circular economy is a systems-based framework, and its true value lies in its scalability to address global challenges like climate breakdown. Ultimately, while the current Circularity Metric remains low, its significance becomes clear when viewed in the global context: an increase to 0.9% is hugely impactful when considering the sheer scale of the global textile value chain. The vastness of the industry means that even modest improvements in circularity can lead to substantial reductions in environmental impacts across the board.

5

THE WAY FORWARD

Call to action

The textile industry has the potential to transform its value chain, yet its Circularity Metric of just 0.3% highlights its unsustainable nature. The industry contributes to a wide range of environmental impacts, which differ by region, making a coordinated effort across the value chain essential to reducing these impacts to levels safe for both people and the planet. Circular strategies offer a way to not only combat climate breakdown on a global scale but also address interconnected challenges such as water scarcity, biodiversity loss, and human health.

To drive meaningful, systemic change, the industry must adopt four core circular strategies: 1) regenerate material flows by designing products for circularity; 2) narrow material flows by reducing production and demand; 3) slow material flows by extending product life; and 4) cycle material flows by prioritising recycled materials over virgin resources. Of these, narrowing material flows is perhaps the most critical and immediate priority, as revealed by the results of the scenario analysis. Reducing the sheer volume of textile production and consumption addresses the root of the problem: overproduction and overconsumption.

The transition to a circular economy will not be easy—nor will it take place overnight. While the core strategies provide a path for transformation, current efforts remain fragmented and insufficient. Positive steps, such as businesses incorporating repair services, rental models, and more efficient production practices, offer hope, but are still too small in scale to drive global impact. Additionally, smaller circular initiatives, like re-commerce and product life extension, struggle to scale due to a lack of coordination and financial support. Recycling at scale faces similar hurdles, with sorters and recyclers requiring stronger business cases and consistent feedstock to operate efficiently.[188] The industry's deep reliance on a linear model, which prioritises profit over sustainability and disregards the environmental and social costs of its operations, reflects a broader market failure that must be addressed in order to create a viable future for circular models.

Going circular requires coordinated efforts across industry, academia, government, and finance. To overcome these barriers, it is essential to strengthen coordination across all stakeholders, enhance transparency and traceability, and create market conditions that prioritise sustainability over low-cost, high-volume production. Only through unified global action and integrating science, technology, policy, and finance can the textile industry achieve the level of circularity necessary to protect the environment and ensure long-term sustainability.

To achieve this, our recommendations are given on the following pages.

1. TRANSFORM THE INDUSTRY BY CUTTING PRODUCTION VOLUMES

WHO?

Brands, retailers, solutions providers, consumers, governments, third sector organisations.

HOW?

The textile industry needs to undergo systemic changes to address overproduction, reshape production cycles, and reduce resource consumption. Fast fashion and home textile's rapid production cycles and high waste generation place an unsustainable strain on the circular economy and exacerbate environmental degradation. Comprehensive global efforts are needed to shift towards sustainability and circularity.

Introduce a global Strategy for sustainable and circular textiles:

An inclusive, global, and nationally adaptable strategy (similar to the EU's[189]) could establish international standards for durability, repairability, and recyclability, mandate the use of recycled materials, and introduce a Digital Product Passport for transparency. This strategy would address overproduction, greenwashing, and microplastic pollution while encouraging sustainable practices and circular business models worldwide.

Reduce overproduction:

Brands must be encouraged to produce fewer collections, focusing on quality over quantity. Implement policies that limit annual new collection releases and offer incentives for companies that reduce overproduction and waste. Initiatives like Vivienne Westwood's 'Buy Less, Choose Well' campaign illustrate how promoting fewer, better-quality fashion items can help, but this needs to be scaled globally to address the industry's massive footprint.

Extend product lifespans:

Initiatives such as Japan's Mottainai Campaign, which promotes valuing resources through reuse and repair, and France's repair bonus scheme, which subsidises repair shops and second-hand stores, are positive steps but not enough to drive change at scale. Similar initiatives that promote repair, rental and reuse need to become commonplace. Governments can further support the second-hand market by reducing or eliminating VAT on second-hand sales, but broader and more robust policies are needed. Platforms like Rent the Runway and MyWardrobeHQ offer promising models for rental services that reduce demand for new products, but their impact is still limited.

Promote circular design and durable textiles:

Encouraging brands to adopt circular design practices is essential for improving textile reuse and recyclability. Implement standards like the EU's Ecodesign Directive, along with scaling initiatives such as the Jeans Redesign guidelines, which have helped leading brands rethink how jeans are made, to drive significant industry transformation.

Adopt resource-efficient production practices:

Promote best practices and technologies that reduce resource use (such as DyeCoo), laser cutting, 3D knitting, and digital fabric printing. Governments must provide technical assistance and funding through programmes like the US Department of Energy's Better Plants initiative to improve energy efficiency and reduce emissions.[190] Expanding access to advanced production technologies in low-income regions, as seen with India's Technology Upgradation Fund Scheme and the African Development Bank's Boost Africa Initiative, is essential.[191, 192]

Encourage domestic textile consumption:

Promote locally produced textiles by launching 'buy local' campaigns that encourage consumers to support domestic manufacturers. Governments should pair these initiatives with tax incentives and subsidies to enhance the competitiveness and sustainability of local textile industries. For example, Europe-based C&A FIT (Factory for Innovation in Textiles) uses increased automation and digitisation to produce jeans more efficiently. Investing in local infrastructure will not only reduce the carbon footprint and waste within the textile supply chain but also strengthen resilience against fluctuations in export-driven trade. Similar to the European Regional Development Fund, funding local textile hubs and infrastructure projects can help further minimise the environmental impact associated with long-distance transportation.

Increase fibre-to-fibre recycling:

Consumers should also be informed about the need to separate their textiles at the end of use and utilise separate collection schemes offered by brands, local governments, and charities to facilitate recycling. Post-consumer fibre-to-fibre recycling has seen significant progress for materials like wool and denim, but this needs to be normalised and scaled across the industry. For wool, Italy's Prato region serves as a key hub for both pre- and post-consumer wool recycling, with brands like Asket and Colourful Standard already incorporating 100% recycled wool and cotton into their permanent collections.[193, 194] While the use of pre-consumer recycled cotton is not yet common practice, it is gaining traction and can be found in the collections of premium sustainable brands like Stella McCartney and Patagonia, as well as budget retailers like Primark.[195] Scaling these practices further will help divert textiles from landfills and make recycling a standard part of the industry, contributing to a more circular textile economy.

2. SET ENVIRONMENTAL PRIORITIES BEYOND CARBON REDUCTION

WHO?

Governments, brands, retailers, research institutions, third sector organisations.

HOW?

While carbon reduction remains a priority, the textile industry's broader environmental impacts, particularly on marine and freshwater ecosystems, must not be overlooked. Current efforts focusing solely on carbon reduction are insufficient; a more holistic approach is necessary.

Focus on water management and pollution prevention:

Expanding global initiatives—like China's Cleaner Production Partnership Programme, for example—to include comprehensive water reuse strategies can reduce water consumption and contamination in textile production.[196] Tackling water acidification and eutrophication requires stricter global wastewater standards and collaboration between sectors, especially in regions with high pollution from textile manufacturing. Implement comprehensive environmental management systems in textile factories and farms to prevent pollution and toxic leaks. Adopting standards like ISO 14001 can ensure compliance with regulations and foster continuous improvement. Increase monitoring and expand reporting to ensure compliance and address emerging contaminants. Develop community health initiatives, such as Cascale's Higg Facility Environmental Module (Higg FEM), to address the health impacts of textile production and establish emergency response plans per International Finance Corporation (IFC) recommendations. To reduce water pollution in the US, stricter National Pollutant Discharge Elimination System (NPDES) regulations on textile wastewater could be enforced, requiring advanced treatment technologies. Similarly, reducing US air pollution could require stricter standards under the Clean Air Act, targeting PM2.5 pollutants alongside updated regulations on emissions of volatile organic compounds.

Promote cleaner production processes:

Governments must encourage the adoption of cleaner production technologies that minimise the use of fossil fuels and reduce overall environmental and social impacts. Clean by Design, an initiative that promotes sustainable manufacturing practices by improving energy efficiency in textile mills, should be expanded globally. Introduce grants and subsidies, similar to the EU's LIFE Programme, which funds cleaner production projects. Third-party audits, inspired by the EU's Eco-Management and Audit Scheme, can also be rolled out to assess environmental impacts and ensure accountability.[197]

Implement global environmental standards:

Regulatory frameworks like the EU's REACH Regulation provide a model for controlling pollution and managing chemicals in textile production, but these standards must be expanded globally. Implementing uniform wastewater treatment and chemical use standards across major textile-producing countries will help mitigate the environmental footprint of textile production at scale.

3. ENSURE A SOCIALLY JUST CIRCULAR TRANSITION

WHO?

Governments, brands, manufacturers, workers' unions, third sector organisations.

HOW?

Ensuring a socially just transition to a circular economy is essential, with a focus on decent work, fair wages, and improved working conditions. While frameworks exist to protect workers, they are not widespread or robust enough to address the scale of exploitation in the global textile industry.

Formalise labour rights and ensure fair wages:

Global Extended Producer Responsibility (EPR) schemes must include provisions for fair wages and decent working conditions throughout the supply chain. Legally binding agreements between brands, suppliers, and trade unions, based on frameworks like the ILO Decent Work and EU Corporate Sustainability Due Diligence Directive (CSDDD), should be enforced worldwide.

Support skill development and worker transitions:

To support skill development and worker transitions as textile production evolves, it is essential to equip workers with the skills needed for technology-assisted roles in the circular economy. Expanding programmes like India's Integrated Skill Development Scheme can provide on-the-job training, while initiatives such as the Circular Fashion Partnership in Bangladesh can help workers prepare for circular economy jobs. Additionally, frameworks modelled after Germany's Energiewende programme can support workers transitioning to green sectors, ensuring job security and new opportunities.[198] The EU's Just Transition Fund can aid regions and workers affected by shifts towards sustainability, while policies like Singapore's SkillsFuture can offer financial support and training for workers to gain new competencies.[199] Upskilling designers is also key, as seen in Wageningen University's self-paced online Circular Fashion course or the various circular design and entrepreneurship courses led by the OR Foundation in Ghana.

Close the gender gap:

Targeted programmes must be scaled globally to provide technical training, mentorship, and financial support for women in the textile industry. Launching programmes that provide technical training and mentorship, along with scholarships for advanced textile technologies, can empower female workers. For example, initiatives like the HERproject by BSR focus onleadership and technical skills for women in global supply chains,200 while India's Skill India Mission offers specific scholarships and mentorship programmes in textiles.201 Programmes such as the Women in
Textiles initiative by Fashion Revolution and Pakistan's Women's Economic Empowerment project provide specialised training and development opportunities to enhance career prospects and equitable wages for women.202, 203 The Gender Equality Seal by the UNDP also encourages companies to adopt practices promoting gender equality, for example. Gender equality can be further promoted by developing national certification programmes, similar to Rwanda's Gender Equality Seal, which recognises
textile companies that demonstrate commitment to gender equality and support for female workers.

Regulate subcontracting practices:

The lack of transparency in multi-layer subcontracting often leads to worker exploitation. Governments must introduce policies restricting the number of subcontracting layers and encouraging direct contracts between manufacturers and contractors.[204] Prioritise transparency in sub-contracts, following models such as the Accord on Fire and Building Safety in Bangladesh—although primarily focused on health and safety, the Accord also requires brands to disclose all factories they work with, including subcontractors, which helps monitor and improve conditions.[205]

Introduce regulations, similar to Mexico's labour law reforms, to enforce direct employment relationships and ensure adherence to labour laws, thereby strengthening oversight and accountability in the textile supply chain. Enact legislation akin to the California Transparency in Supply Chains Act and the UK Modern Slavery Act to mandate transparency and compliance with labour laws throughout the textile supply chain, safeguarding worker rights and promoting fair treatment.

Include the informal sector in the transition:

The informal sector, particularly socially disadvantaged workers, plays a key role in waste management and recycling, yet remains underrepresented in circular economy initiatives. Greater involvement of trade unions, workers' organisations like WIEGO, and marginalised groups is essential for creating inclusive policies. More research is needed to understand the impact of circular interventions on informal workers and explore pathways beyond formalisation to improve their working conditions and opportunities.

4. COORDINATE ACTION ACROSS SCIENCE, TECHNOLOGY, POLICY, AND FINANCE

WHO?

Governments, financial institutions, technology innovators, research institutions, brands, solution providers.

HOW?

The transition to a circular textile economy requires a coordinated approach across science, technology, policy, and finance. Fragmented efforts will not be enough to tackle the industry's global impact.

Globalise circular economy indicators:

Collaborate to establish Circular Economy Performance Indicators (CEPIs) for tracking metrics like material circularity rates and recycled content across the industry. The World Business Council For Sustainable Development's Circular Transition Indicators (CTI) offers a framework that can be applied to businesses globally.[206] These indicators must be integrated into global reporting systems and mandated through international regulations.

Improve data collection and availability:

Establish open-source data systems to gather detailed information on material use, waste generation, recycling rates, and working conditions. Blockchain technology should be utilised to streamline data collection and sharing across supply chains, ensuring transparency, following examples like Provenance and IBM's Food Trust blockchain.

Implement global labelling standards and third-party verification:

Implement global labelling standards that go beyond fibre composition, requiring companies to disclose labour practices, including gender pay disparities, child labour prevention, and fair treatment of migrant workers. Establish low-cost third-party verification systems to certify sustainability claims, promoting trust among consumers.

Engage in industry agreements for traceability:

Industry agreements, such as the Fashion Industry Charter for Climate Action, should be expanded to enhance traceability of emissions and materials using standardised parameters. These agreements provide a framework for ensuring companies track and disclose emissions throughout the supply chain, helping to meet global climate and sustainability goals.

Strengthen the enforcement of greenwashing regulations:

Strengthen the enforcement of greenwashing regulations, like the EU Unfair Commercial Practices Directive and Green Claims, by improving cross-collaboration between EU and national consumer authorities. Empower consumers to take collective action and ensure companies adhere to transparent sustainability practices. Strengthened regulations will drive sustainable practices across the textile industry and build consumer trust in green products.

Implement global policies:

Expand EPR schemes and the EU Waste Framework Directive to create standardised regulations worldwide. Draw on examples like France's EPR scheme, which mandates that textile brands contribute to a fund supporting textile collection, sorting and recycling. This ensures that countries are not disproportionately burdened by waste imports from higher-income nations. By homogenising waste designation laws and increasing EPR fees based on new product volumes, sustainable practices will be promoted, environmental pollution reduced, and health risks mitigated. Harmonising regulations to facilitate the international movement of recycled textiles is critical. Quality standards must also be established to ensure that recycled materials can flow across markets smoothly. There is also a need for harmonised trade regulations to facilitate and promote the use of recycled fibres. Currently, recycled fibres are restricted from accessing the market in certain due to a lack of correct Harmonised System (HS) codes or because high duties apply. Address these issues to promote the more seamless trade of recycled materials across borders and ensure that global markets support circular practices.

Foster closed-loop recycling and sustainable fibres:

Invest in sustainably-sourced, renewable biobased synthetic fibres, such as those produced through regenerative agriculture, to reduce the industry's reliance on virgin materials. Programmes like ReHubs and the British Fashion Council's Circular Fashion Ecosystem project must be expanded globally to create robust markets for reusable textiles and secondary raw materials.

Provide financial support for green technologies:

Governments and the financial sector must collaborate to support the adoption of eco-friendly technologies in the textile industry. While subsidies and tax incentives can encourage companies to invest in cleaner production, as seen in the US Energy Policy Act's Section 179D,[207] the transition will require a mix of financing mechanisms. Businesses can secure debt financing through commercial or public banks via instruments like sustainability-linked loans or green bonds, that are discounted when achieving goals measured by environmental impact indicators. Establish green tech investment funds to further drive investment in cleaner production.

Facilitate green financing:

Green financing mechanisms must be made accessible to small- and medium-sized enterprises (SMEs) in the textile industry. Governments should establish green investment funds to support investments in regenerative agriculture, recycling technologies and infrastructure with financing options including grants, low-interest loans, and subsidies. Public-private partnerships, such as the Apparel Impact Institute's Fashion Climate Fund, can further scale sustainability investments. Additionally, investing in innovative recycling technologies, like chemical recycling methods to convert textile waste into reusable fibres is essential. This requires diverse financing options, such as through the EU's Horizon programme or other early-stage and scale-up financing options. Collaborative partnerships between academia and industry, such as those facilitated by the MIT Energy Initiative, are critical to advance clean manufacturing processes and significantly reduce the industry's carbon footprint, leading to more sustainable textile production.

Leverage the financial sector in the circular transition:

Transitioning the textile industry will require a combination of different financing types, such as debt financing, equity investment and grants. Large corporations will have to bear significant costs but can leverage sustainable financing mechanisms from banks and equity investors. Ensure that SMEs are given targeted financial support, focusing more on grants or blended financing options that link returns to environmental impact.

APPENDIX A: SECTORAL LANDSCAPE, TRENDS AND POLICIES

Box one presents a segmentation of the fashion market, outlining the key categories from haute couture to mass market. Each segment is defined by its level of craftsmanship, pricing, and target audience, with examples of prominent brands that represent each tier. The table highlights the diversity within the fashion industry, ranging from exclusive, made-to-measure luxury pieces to affordable, trend-driven offerings aimed at a larger consumer base.

Table one provides an overview of various policy instruments supporting the circular economy agenda in the textile industry. These instruments, which range from legislative and regulatory frameworks to voluntary agreements and innovation initiatives, highlight global efforts to promote sustainability within the industry. The table categorises these instruments by type, offering descriptions and examples to illustrate their application in different regions and contexts.

1. **Haute couture:** Exclusive, made-to-measure, high level of craftsmanship. Includes luxury brands such as Christian Dior, Hermès, Elie Saab, Iris Van Herpen, Jean Paul Gaultier, and Maison Margiela.
2. **Designer ready-to-wear (or prêt-à-porter):** Standardised sizes, designer pieces. Designer brands such as Vivienne Westwood, Gucci, Balenciaga, Chloé, Prada, Calvin Klein, and Stella McCartney.
3. **Diffusion:** Standardised sizes, designer pieces, lower price points, larger audiences. Designer and premium brands such as CK Jeans by Calvin Klein, Polo Ralph Lauren, Love Moschino, CDG Comme des Garçons, MM6 Maison Margiela, Stella McCartney x Adidas.
4. **Bridge-to-luxury:** Between high-end and mass market. Premium brands such as Guess, Diesel, DKNY, Coach, Marc Jacobs, Patagonia, Eileen Fisher, and Reformation.
5. **Mass market:** Trend-driven, affordable retail price, largest audience. Fast fashion brands such as Zara, H&M, and Uniqlo.

Box one explains the fashion market's segmentation. Adapted from: Beyond the make-or-buy dichotomy: Outsourcing creativity in the fashion sector (2012).[208]

TYPE	DESCRIPTION	EXAMPLE(S)
Legislative and regulatory instruments	Laws and regulations set by authorities to influence behaviour and protect public interests, with binding requirements and penalties for noncompliance.	• **EU REACH Regulation:** Controls hazardous substances in textiles by requiring manufacturers to register chemicals used, ensuring harmful substances like certain dyes and flame retardants are restricted or phased out for safer products.[209] • **EU Waste Framework Directive:** Requires separate textile collection by 2025.[210] In July 2023, the European Commission proposed a new revision of the directive, prioritising harmonised Extended Producer Responsibility (EPR) rules to finance and organise the management of increased separate collection of discarded textiles.[211] • **China's Circular Economy Promotion Law:** Targets recycling 30% of textile waste and producing 3 million tonnes of recycled fibre annually by 2025.[212, 213]
Economic and fiscal instruments	Tools like subsidies, taxes, and incentives used to influence economic behaviour and support circular models.	• **EPR Regulations** (France, the Netherlands, Sweden, Hungary and Australia,[214] as well as State governments like California[215]): Producers responsible for end-of-life product management. Currently, the average EPR fees are between €0.01 per unit (France) and €0.42 per kilogram (Hungary). • **Sweden:** Reduced value-added tax (VAT) 12% on repair services for clothing, shoes, and household textiles (12%) to encourage reuse.[216] • **India:** Lower Goods and Services Tax (GST) on recycled fibres and yarns, encouraging investment in recycling infrastructure and technologies, and more affordable retail prices on sustainable products.[217] • **France:** Proposed €5 penalty on 'ultra-fast' fashion per individual item of clothing sold in France starting 2025, as well as a ban on advertising for such products. This penalty will rise to €10 by 2030. French law will define fast fashion based on factors like the quantity of clothes produced and how quickly new collections are introduced.[218]

TYPE	DESCRIPTION	EXAMPLE(S)
Agreement-based or cooperative instruments	Voluntary agreements between governments and actors to collaborate on shared goals, often via pub-lic-private partnerships.	• **American Circular Textiles (ACT):** The ACT group, a coalition of leading organisations driving the circular economy conversation in the US, has released its first whitepaper outlining key policy priorities for advancing circular fashion domestically.[219] • **Fashion Pact:** Coalition of fashion brands, including Chanel, Adidas, and businesses like Inditex and H&M Group, committed to climate, biodiversity, and ocean protection goals.[220] • **Bangladesh Fire and Building Safety Accord:** Legally binding global framework agreement between global brands, retailers, and trade unions designed to improve garment worker safety.[221, 222] • **EU Generalised System of Preferences (GSP):** Offers preferential tariffs for products meeting sustainability and labour rights criteria.[223] • **UN Global Plastics Treaty:** Impacts textile use of plastics and waste management. Its resulting international legally binding instrument shines a light on the impacts of waste on communities with informal waste pickers where pollution is being created.[224]
Information and communication instruments	Awareness-raising tools like campaigns and ecolabels to promote sustainable practic-es and influence consumer behaviour.	• **EU Ecolabel for Textiles:** Certification identifying sustainable textile products based on strict environmental criteria, covering the entire lifecycle from raw material extraction to disposal. It is the only EU-wide ISO 14024 Type I ecolabel.[225] • **Fashion Revolution:** Global campaign for transparency, for example, 'Who Made My Clothes?' • **Fashion Checker:** Investigates whether brands pay factories enough for fair and safe working conditions. This initiative, by the global Clean Clothes Campaign, is funded by the European Union and supported with data from Fashion Revolution.

TYPE	DESCRIPTION	EXAMPLE(S)
Knowledge and innovation instruments	Initiatives that promote research, innovation, and collaborative learning to foster circularity.	• **Organisation for Economic Co-operation and Development (OECD) Due Diligence Guidance for Responsible Supply Chains:** Guidelines for responsible business conduct throughout global supply chains. During their annual forum, the OECD facilitates exchange between governments, the private sector and stakeholders.[226] • **Jordan's Ready-Made Garment Circularity Initiative:** Identifies strategies to reduce textile waste in Jordan's Ready-Made Garment sector.[227] • **World Circular Textiles Day:** Celebrates advancements in circular textiles. The open-source platform WCTD Knowledge Hub captures the community's circular textile advancements.[228]

Table one summarises policy instruments supporting the circular economy agenda for textiles.

APPENDIX B: TEXTILE ACTIVITIES IN THE US AND CHINA

Localised effects of a global industry

It is essential to examine the local impacts of the textile industry in key countries like China and the US. Their roles in production and consumption have significant effects on local ecosystems, resources, and communities. Understanding these regional consequences—such as water scarcity, pollution, and biodiversity loss—emphasises the need for targeted, location-specific solutions to the industry's sustainability challenges.

In both the US and China, textile manufacturing contributes to dangerous levels of air pollution (Table two). Dyeing, printing, and finishing processes emit volatile organic compounds (VOCs) and hazardous air pollutants (HAPs), while mechanical fibre processing adds to particulate matter (PM) pollution in both countries.[229, 230, 231] Our analysis finds that air pollution in the form of PM2.5 emissions amounts to 0.14 million tonnes in the US and 1.51 million tonnes in China. Air pollution from textile manufacturing increases healthcare costs due to respiratory illnesses and reduces workforce productivity, particularly in low-income and rural areas. Human health is also significantly affected, with 3.72 disability-adjusted life years (DALYs) lost in the US and 26.1 DALYs in China per year.

Textile production in China and the US has substantial impacts related to water resources (Table three). The US textile industry uses five billion kilograms of chemicals annually,[232] while China's textile industry discharges 1.84 billion tonnes of wastewater, accounting for 10% of total industrial discharge.[233] Our analysis finds that in China, heavy freshwater usage contributes to severe water scarcity, with 937 billion cubic metres of freshwater used annually, compared to 708 billion in the US. Water pollution also leads to acidification—worsening public health and disrupting aquatic ecosystems—with China experiencing 10.2 billion kilograms of SO_2 equivalent in acidification, four times higher than the US at 2.42 billion kilograms.

The textile industry's land use in both countries has direct environmental and social implications (Table four). Only 0.2% of US cotton is produced organically, covering 11.7 thousand hectares, leading to greater land impacts compared to polyculture organic methods.[234] In China, 0.5% of cotton is organic, representing 15.9 thousand hectares, with 75% of production concentrated in Xinjiang.[235, 236, 237] The degradation of agricultural land due to non-organic cotton farming further reduces local food production, straining rural economies in both countries. In 2018, 11.3 million tonnes of textiles were landfilled in the US, contributing to soil contamination and inefficient land use,[238, 239] while China landfilled 19.7 million tonnes, worsening land degradation.[240, 241] Our analysis finds that in both countries, biodiversity is affected, with China losing 527 billion Potentially Disappeared Fractions (PDF) of species per square metre per year compared to 325 billion in the US.

Examining the localised effects of the textile industry in key production and consumption countries such as China and the US is essential for increasing overall industry circularity and minimising its environmental impacts. By prioritising circular solutions, stakeholders can reduce resource consumption and advance environmental sustainability, driving the transition towards a more circular textile industry.

Air

KEY IMPACTS PER YEAR

Category	US	CHINA
Climate change (Mt CO_2eq)	2,340	7,280
Air pollution (Mt PM2.5eq)	0.14	1.51
Human health (DALY x105)	3.72	26.1

Implications on biodiversity, ecosystem services and people

Healthcare & productivity losses: Air pollution from textile manufacturing increases healthcare costs due to respiratory illnesses and reduces workforce productivity, leading to lower economic output.

Social inequality & environmental justice: Textile factories, often in low-income or rural areas, disproportionately impact marginalised communities, exacerbating existing inequalities.

Supply chain risks & economic vulnerability: Climate change disruptions, such as water scarcity, raise production costs and lead to job losses, particularly in regions heavily reliant on the textile industry.

Global climate impact: The US and China contribute heavily to climate change through their textile industries' GHG emissions, worsening global warming, extreme weather events, and rising sea levels.

Table two lists the air pollution impacts of textile production in the US and China.

KEY DRIVERS

Category	US	CHINA
Energy consumption	Energy sources for textiles are primarily oil (36%), natural gas (33%), renewables (13%), coal (10%), and nuclear (8%).[242, 243]	The textile industry is largely powered by coal (58%), petroleum (19%), renewables (12%), natural gas (8%), and nuclear (3%).[244, 245]
Chemical consumption	Dyeing, printing, and finishing processes emit VOCs and hazardous air pollutants (HAPs) in both countries.[246, 247, 248]	
Dust & fibre particles	Mechanical fibre processing (for example, carding, spinning) and fabric cutting generate dust and fibres, adding to particulate matter pollution in textile facilities.[249]	

Circular economy policy instruments

US

Clean Air Act (CAA)
Legislative and regulatory instrument

- **Cycle:** Regulates textile air pollutants, encouraging cleaner technology adoption.
- **Regenerate:** Protects air quality and human health by limiting emissions from textile production.[250]

Energy Policy Act
Legislative and regulatory instrument

- **Cycle:** Promotes energy efficiency and renewable energy in textile manufacturing, cutting GHG emissions.
- **Narrow:** Targets energy waste reduction in textile production.[251]

Greenhouse Gas Reporting Programme (GHGRP)
Information and communication instruments

- **Cycle:** Requires textile manufacturers to report GHG emissions, promoting accountability.
- **Narrow:** Drives companies to reduce emissions through efficiency improvements.[252]

CHINA

Carbon Intensity Reduction Targets & Carbon Emission Trading Scheme (ETS)
Legislative and regulatory instrument & Economic and fiscal instrument

- **Cycle:** Encourages cleaner technology and resource efficiency.
- **Regenerate:** Reduces GHG emissions to support environmental sustainability.[253]

Air Pollution Control Act
Legislative and regulatory instrument

- **Cycle:** Sets emission standards, reducing pollution from textile manufacturing.
- **Regenerate:** Enhances air quality through stricter control of industrial emissions.[254]

Cleaner Production Promotion Law
Legislative and regulatory instruments

- **Cycle:** Promotes cleaner production practices to minimise pollution.
- **Regenerate:** Aims to restore ecosystems through reduced industrial pollution.[255]

Water

KEY IMPACTS PER YEAR

Category	US	CHINA
Water scarcity (m3 world eq x109)	708	937
Water acidification (kg SO2 eq x109)	2.42	10.2
Marine eutrophication (kg N N-lim eq x109)	0.14	1.51
Freshwater eutrophication (PO4 P-lim eq x106)	18.3	74.7

Implications on biodiversity, ecosystem services and people

Water scarcity & competition: Excessive water use in textile manufacturing strains already stressed water supplies, leading to conflicts and economic disruptions.

Water pollution & degradation: Textile wastewater discharge, often untreated, contaminates water bodies, harming ecosystems, public health, and industries reliant on clean water.

Regulatory risks & business challenges: Stringent water pollution regulations pose compliance challenges, with potential fines, legal liabilities, and reputational damage for non-compliance.

KEY DRIVERS

Category	US	CHINA
Chemical consumption and discharge	The US textile industry uses approximately five billion kilograms of chemicals annually, contributing to water pollution through the release of toxic dyes and substances into water bodies.[256]	China's textile industry discharges 1.84 billion tonnes of wastewater annually, accounting for 10% of total industrial discharge, significantly contributing to water pollution.[257]

Table three lists the textile industry's impact on water in the US and China.

KEY POLICY

Category: Circular economy policy instruments

US

Clean Water Act (CWA)
Legislative and regulatory instruments

- **Cycle:** Controls textile wastewater discharge, promoting treatment and reuse.
- **Regenerate:** Protects water quality critical to ecosystems impacted by textile pollution.[258]

National Pollutant Discharge Elimination System (NPDES)
Legislative and regulatory instruments

- **Cycle:** Requires permits for wastewater discharge, ensuring treatment meets quality standards.
- **Regenerate:** Preserves water quality to support ecosystem health near textile production sites.[259]

Resource Conservation and Recovery Act (RCRA)
Legislative and regulatory instruments

- **Cycle:** Manages hazardous waste from textile production, including wastewater treatment, to reduce environmental harm.
- **Regenerate:** Protects water resources, essential for sustainable textile manufacturing and overall environmental health.[260]

CHINA

Water Pollution Prevention and Control Law
Legislative and regulatory instruments

- **Cycle:** Regulates the discharge of pollutants into water, encouraging treatment and reuse within the textile industry.
- **Regenerate:** Aims to restore water quality and protect affected ecosystems.[261]

Water Law
Legislative and regulatory instruments

- **Narrow:** Promotes efficient water use and conservation in textile manufacturing.
- **Regenerate:** Focuses on maintaining water quality and availability for sustainable future use.[262]

Cleaner Production Promotion Law
Legislative and regulatory instruments

- **Narrow:** Encourages adoption of cleaner production technologies in the textile industry to reduce water consumption and pollution.
- **Cycle:** Supports the recycling and reuse of water resources in textile manufacturing.
- **Regenerate:** Promotes practices to enhance the regeneration of water resources.[263]

Environmental Protection Tax Law
Legislative and regulatory instruments

- **Narrow:** Imposes taxes on water pollutants, incentivising reductions in water pollution and promoting resource efficiency.
- **Cycle:** Encourages treatment and recycling of wastewater to reduce the textile industry's environmental footprint.[264]

Land

KEY IMPACTS PER YEAR

Category	US	CHINA
Biodiversity (PDF.m2.yr x109)	325	527
Implications on biodiversity, ecosystem services and people	**Habitat destruction:** Fossil fuel extraction, textile cultivation, and manufacturing lead to biodiversity loss and ecosystem disruption. **Land degradation:** Cotton cultivation contributes to soil erosion, compaction, and nutrient depletion, reducing agricultural productivity and land resilience. **Community displacement:** Large-scale land acquisition for textile production displaces communities, leading to conflicts over land tenure and disrupting livelihoods.	

KEY DRIVERS

Category	US	CHINA
Monoculture, non-organic cotton agriculture	Only 0.2% of US cotton is produced organically, covering 11,700 hectares, driving greater land impacts compared to polyculture organic methods.[265]	Only 0.5% of China's cotton is organic, representing 15,900 hectares, with 75% of production in Xinjiang.[266, 267, 268]
Chemical leakage from waste	11.3 million tonnes of textiles were landfilled in 2018, contributing to soil contamination and inefficient land use.[269, 270]	19.7 million tonnes of textile waste were landfilled in 2018, exacerbating land contamination and inefficient resource use.[271, 272]

Table four lists the textile industry's impact on land in the US and China.

KEY POLICY

Category	US	CHINA
Circular economy policy instruments	**Resource Conservation and Recovery Act (RCRA)** *Legislative and regulatory instruments* • **Cycle:** Regulates hazardous waste management from creation to disposal, promoting recycling and preventing environmental contamination. • **Regenerate:** Ensures protection of natural resources and public health through proper waste management practices.[273] **Solid Waste Disposal Act (SWDA) Amendments** *Legislative and regulatory instruments* • **Cycle:** Focuses on improving waste disposal practices and increasing textile recycling efforts. • **Narrow:** Encourages resource efficiency in textile manufacturing and waste reduction through improved production processes.[274] **Partnerships for Climate-Smart Commodities** *Economic and fiscal instruments* • **Regenerate:** Provides financial and technical assistance to agricultural projects promoting land regeneration and sustainable farming practices. • **Cycle:** Develops markets for agriculture projects that recycle resources and reduce waste.[275]	**Soil Pollution Prevention and Control Action Plan** *Legislative and regulatory instruments* • **Regenerate:** Implements measures to prevent soil pollution, ensuring healthier soil for cotton cultivation and other agricultural activities. • **Slow:** Encourages practices to maintain soil health, extending agricultural productivity.[278] **Environmental Protection Law** *Legislative and regulatory instruments* • Cycle: Encourages recycling and proper waste management to reduce environmental impacts. • Regenerate: Supports the protection and improvement of soil and land quality for sustainable use.[279] **Law on the Prevention and Control of Environmental Pollution by Solid Wastes** *Legislative and regulatory instruments* • **Cycle:** Regulates solid waste management, promoting textile waste recycling and reuse. • **Narrow:** Aims to reduce solid waste generation through efficient production processes and resource use. • **Regenerate:** Encourages compostable textiles and safe disposal to restore environmental quality.[280]

Land

KEY POLICY

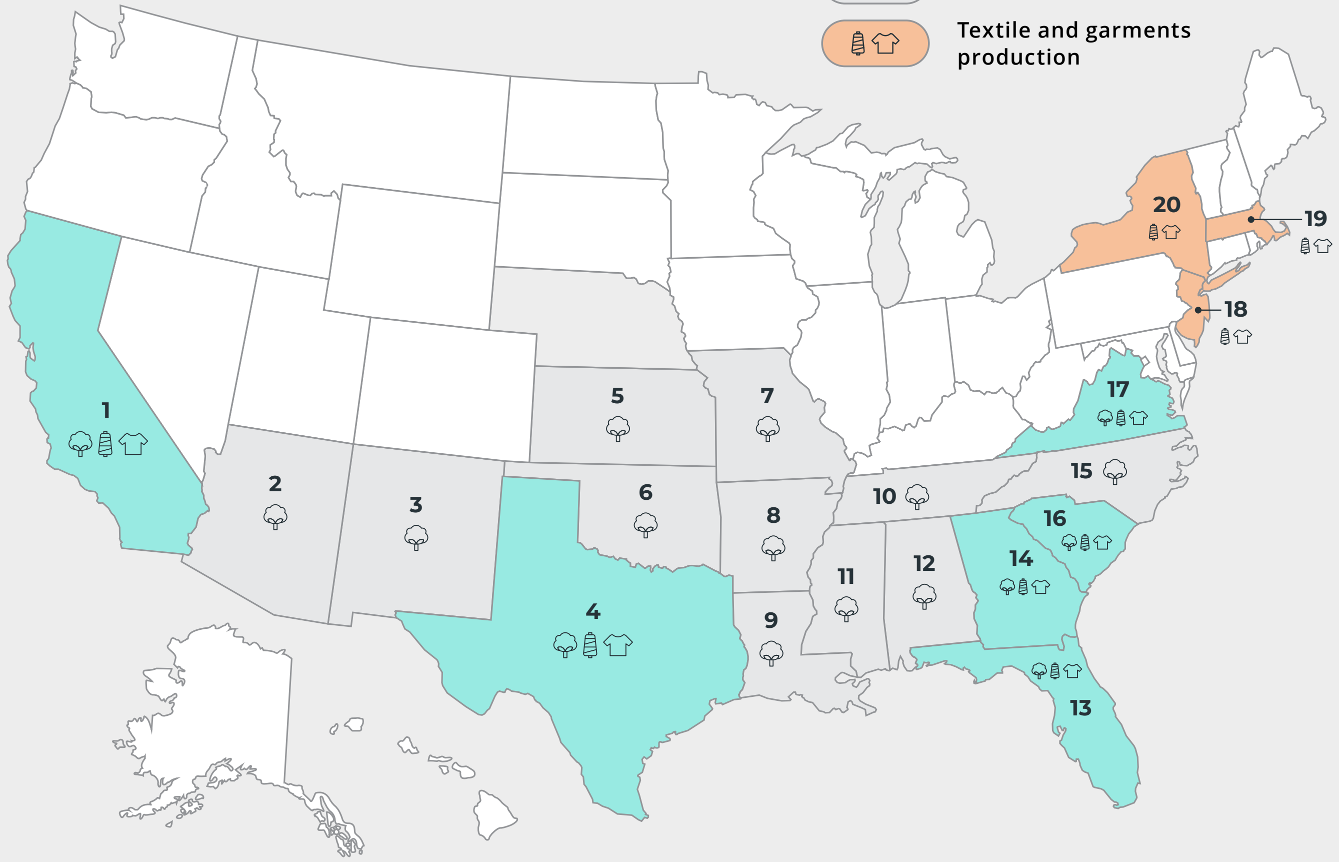
Category	US	CHINA
Circular economy policy instruments	**Environmental Quality Incentives Programme (EQIP)** *Economic and fiscal instruments* • **Regenerate:** Provides assistance to farmers for conservation practices that improve soil health, water quality, and biodiversity, including cotton growers. • **Slow:** Encourages sustainable practices to extend the productive life of agricultural lands.[276] **Conservation Reserve Programme (CRP)** *Agreement-based or cooperative instruments* • **Regenerate:** Sets aside and restores environmentally sensitive land to regenerate ecosystems. In the textile industry, it encourages fallowing cotton fields to restore soil health, reduce erosion, and protect pollinator habitats.[277]	

Table four lists the textile industry's impact on land in the US and China.

Figures eleven and twelve show the main states in the US and provinces in China where textile activities are concentrated.

Legend

- Cotton, textile and garments production
- Cotton production
- Textile and garments production

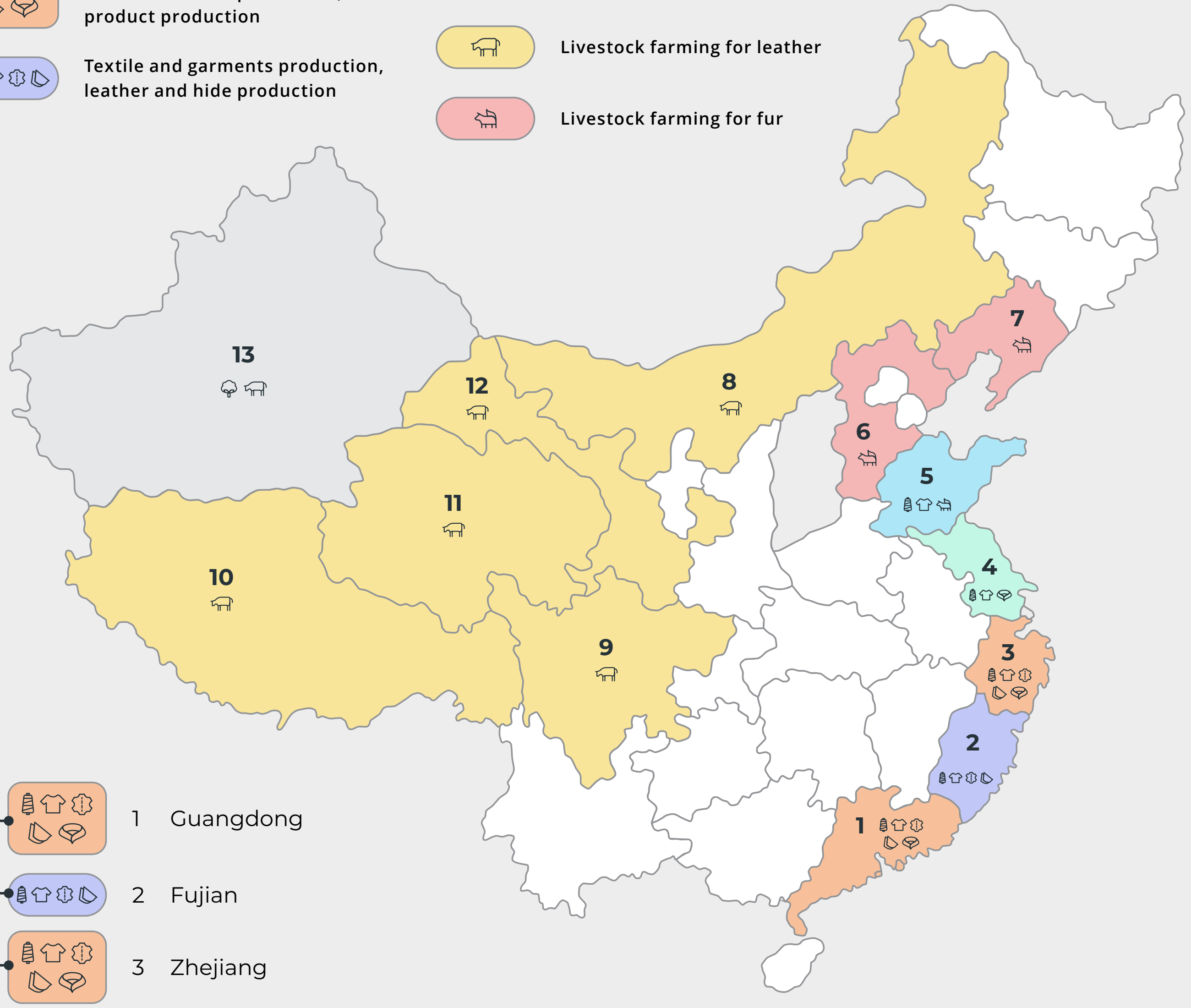


1	California	8	Arkansas	15	North Carolina
2	Arizona	9	Louisiana	16	South Carolina
3	New Mexico	10	Tennessee	17	Virginia
4	Texas	11	Mississippi	18	New Jersey
5	Kansas	12	Alabama	19	Massachusetts
6	Oklahoma	13	Florida	20	New York
7	Missouri	14	Georgia		

Figure eleven depicts where textile activities are concentrated in the US.

Legend

- Cotton production and livestock farming for leather
- Textile and garments production, leather and hide production, fur product production
- Textile and garments production, leather and hide production
- Textile and garments production, fur product production
- Textile and garments production, livestock farming for fur
- Livestock farming for leather
- Livestock farming for fur



1	Guangdong	8	Inner Mongolia	12	Gansu
2	Fujian	9	Sichuan	13	Xinjiang (produces nearly all of China's cotton)
3	Zhejiang	10	Tibet		
4	Jiangsu	11	Qinghai		
5	Shandong				
6	Hebei				
7	Liaoning				

These 5 provincies account for 70% of China's total textile production

Figure twelve depicts where textile activities are concentrated in China.

APPENDIX C: COMBINED SCENARIOS PER VALUE CHAIN PHASE AND REGION

Breaking down the combined scenario results by value chain phase reveals that the manufacturing phase, including agriculture, shows the greatest potential for reducing impacts (Figure thirteen). At the optimistic ambition level, waste management also contributes significantly, particularly with a 7.7% reduction in marine eutrophication due to nitrogen leaching from landfills.

A regional, production-based approach (Figure fourteen) shows that 60 to 80% of impact reductions occur in the Asia Pacific region, with air pollution seeing the highest reduction (81%) due to the coal-based energy mix in China and India. Africa shows larger reductions in biodiversity (7%) due to land cover types, while the Americas exhibit higher reductions in biodiversity (27%) and freshwater eutrophication (33%).

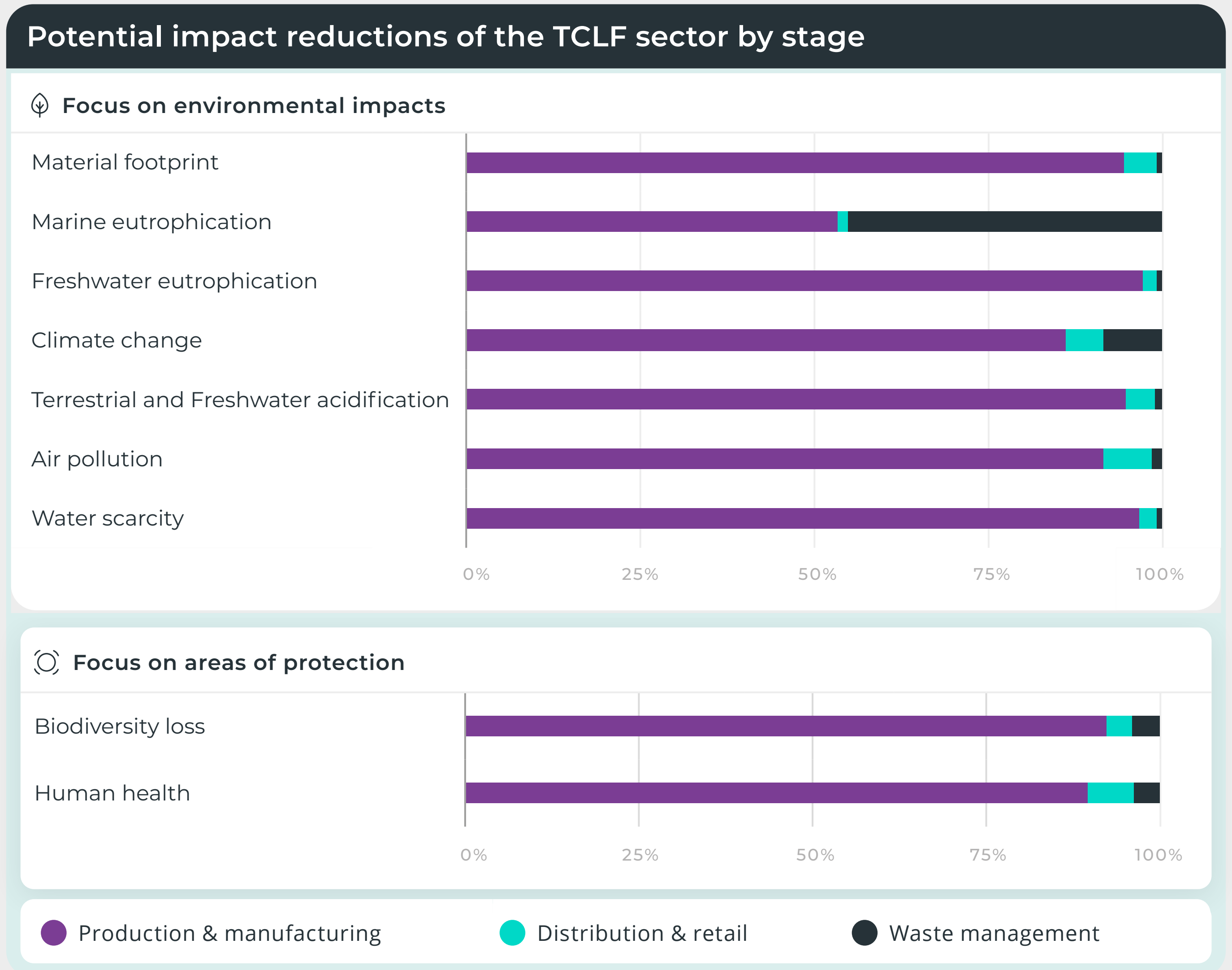


Figure thirteen illustrates the potential impact reduction of the combined circular strategies (optimistic) by supply chain phase.

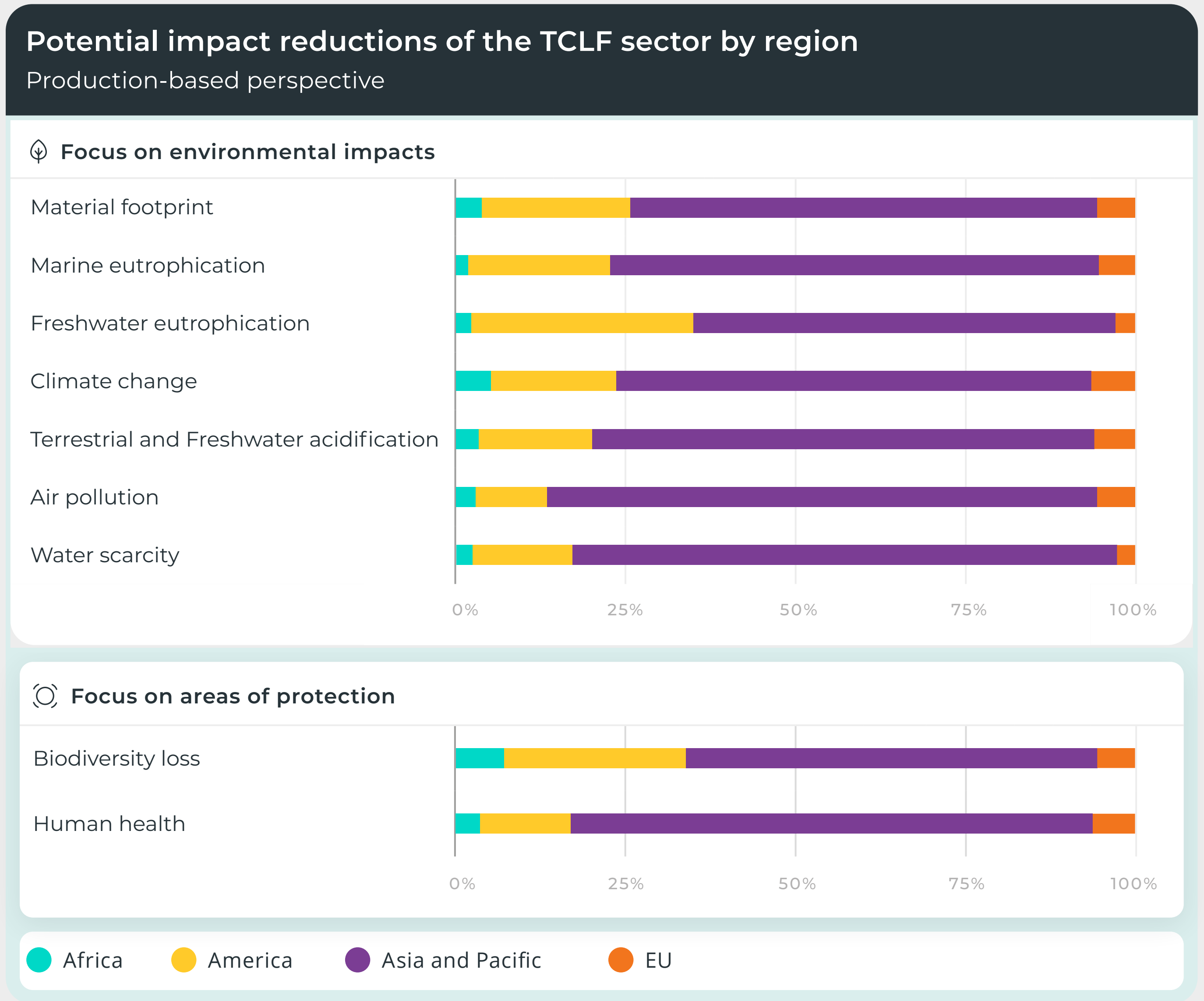


Figure fourteen illustrates the potential impact reduction of the combined circular strategies, by region, from a production-based perspective.

In contrast, taking a consumption-based approach (Figure fifteen) reveals that impacts shift from the Asia Pacific to the Americas and the EU, with 40 to 60% of impacts driven by consumption in the Asia Pacific region. Marine eutrophication, air pollution, and water scarcity see the highest reductions. The Americas' consumption patterns significantly influence freshwater eutrophication and biodiversity, while the EU's impact on these categories is lower.

Potential impact reductions of the TCLF sector by region

Consumption-based perspective

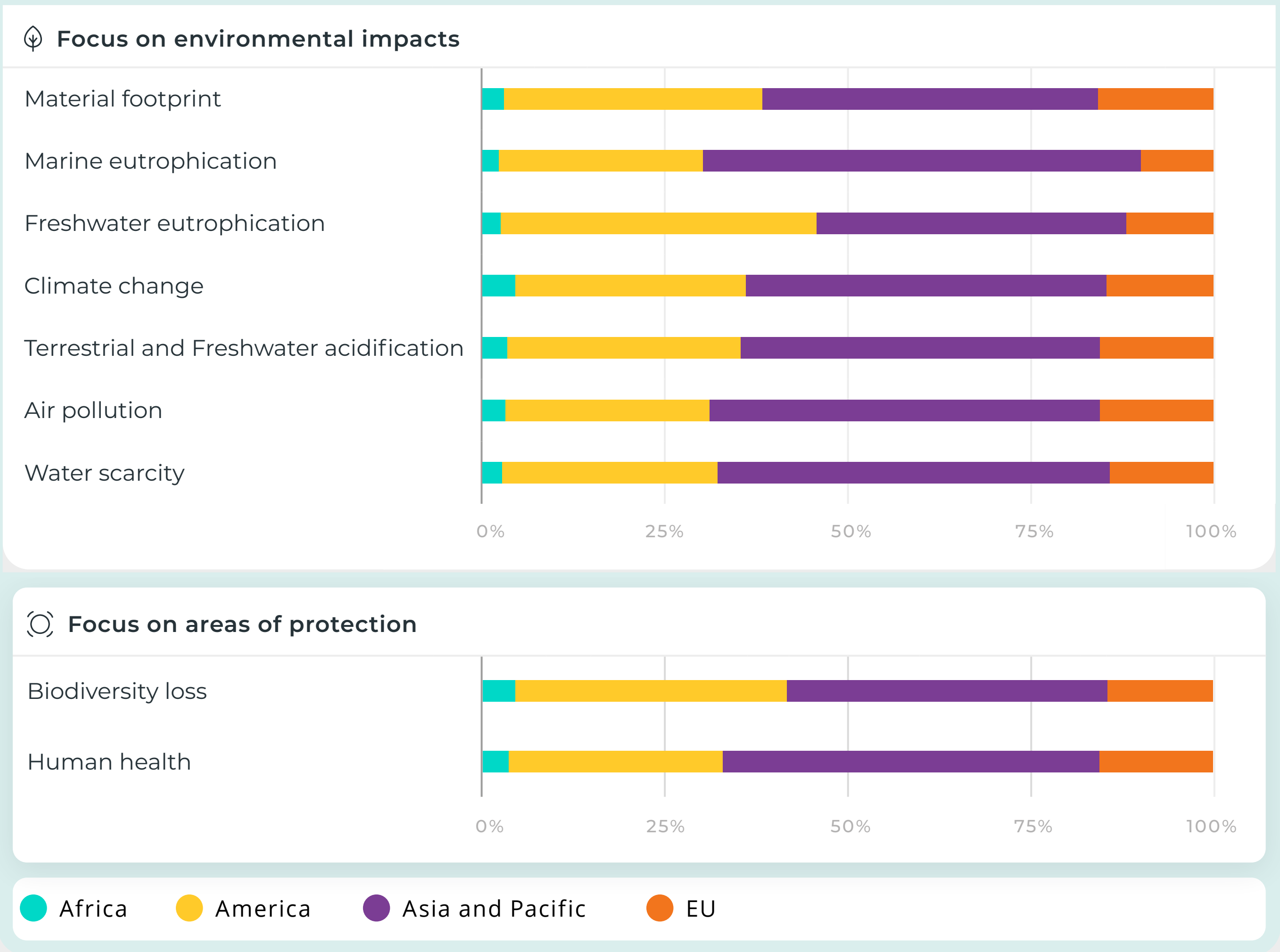


Figure fifteen illustrates the potential impact reduction of the combined circular strategies, by region, from a consumption-based perspective.

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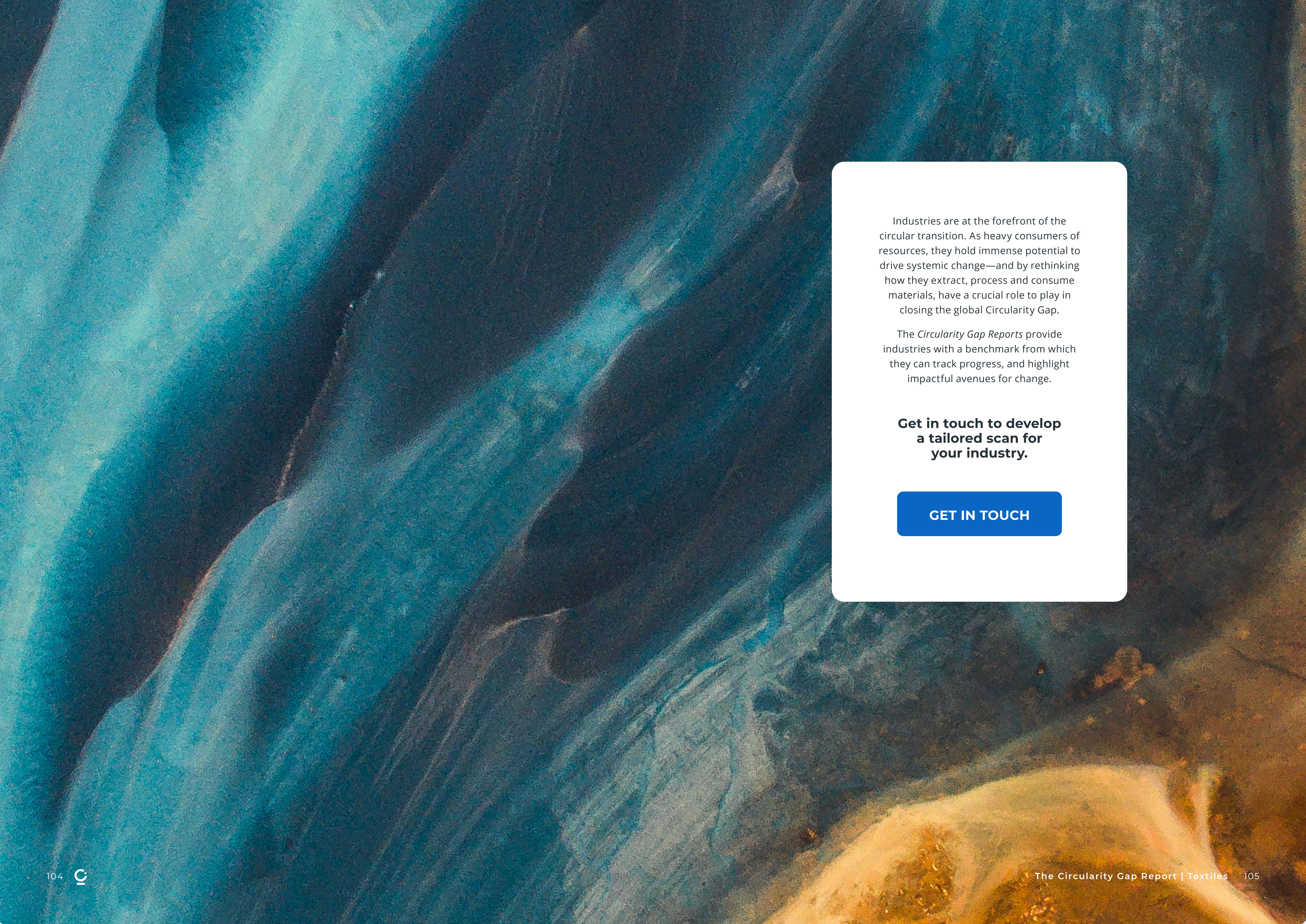

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