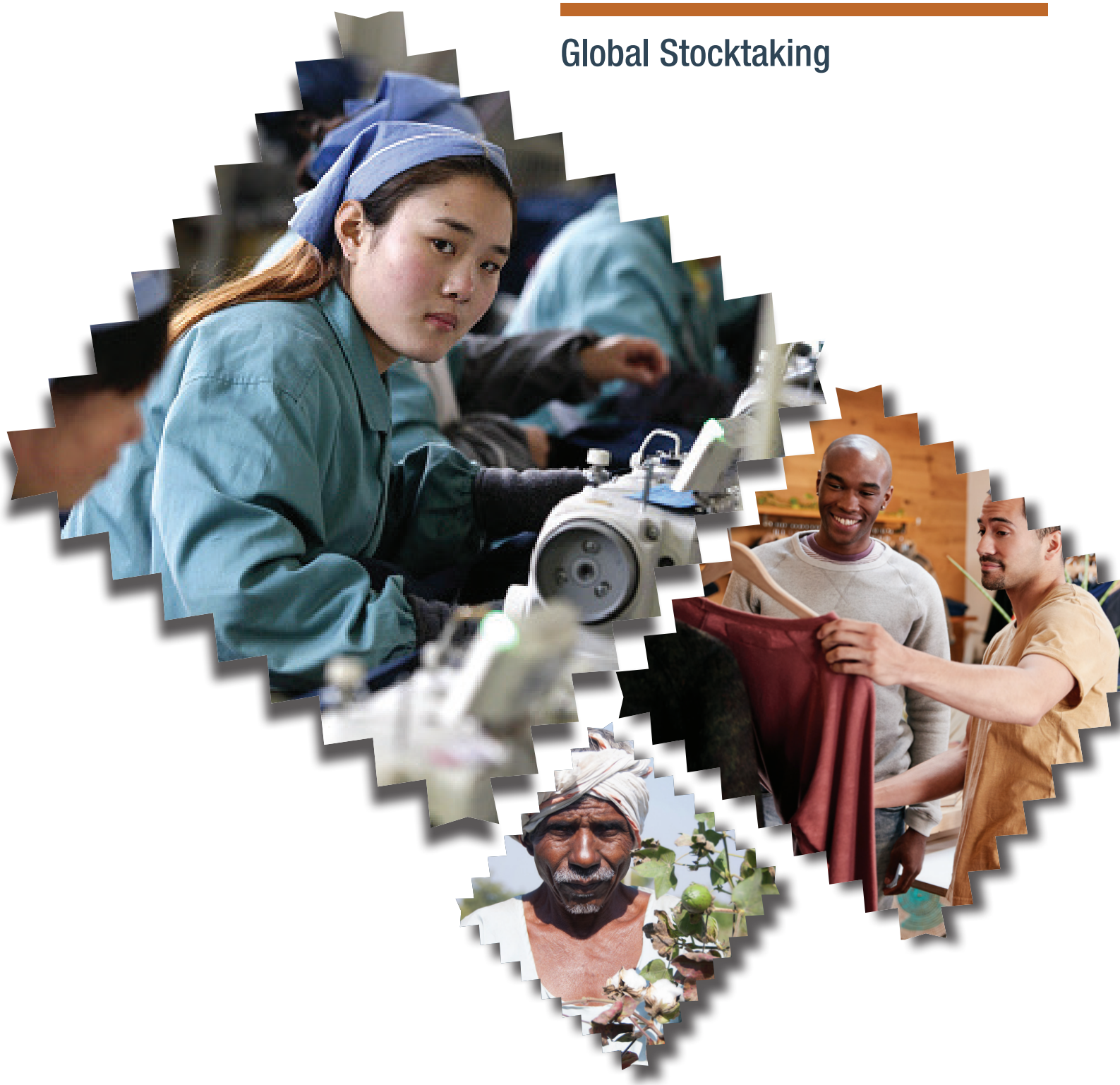
UN environment programme

Sustainability and Circularity in the Textile Value Chain

Global Stocktaking



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Executive summary

The textile industry is one of global importance, providing high levels of employment, foreign exchange revenue and products essential to human welfare. The world is producing and consuming more textiles than ever before, and the current very low re-use and recycling rates mean that more textiles are also being thrown away than ever before. This requires ever more land, water and fossil fuels, and leads to increasing pollution of the air, water and soil. However, addressing the sustainability and circularity of such a globally diverse industry, a specific feature of which is the marked power asymmetry between the suppliers and global buyers and the large numbers of small and medium-sized players operating on tight margins, presents a particular set of challenges.

This report provides an analysis of the environmental and socio-economic hotspots along the entire textile value chain and looks at a range of associated impacts, as well as at how different stages in the value chain are dominant in different impacts. Wet processing (the bleaching/dyeing/finishing stage of textile production), synthetic fibre production and laundering in the consumer use phase stand out as particularly important with respect to the impact on climate, whilst natural fibre production (cotton cultivation) and the consumer use phase stand out as particularly important with respect to the water scarcity impact. The use and release of hazardous chemicals in textile wet processing, leading to water pollution and impacting human health and ecosystems, further underlines the importance of this stage in the value chain. Microfibres are an environmental issue of increasing concern, with research continuing to shed light on their harmful effects on biodiversity, and potentially on human health as well. The release of microfibres is particularly associated with the use phase, which has been the focus of the majority of the research, but emerging evidence points to the importance of releases occurring across textile manufacturing and at textile end-of-life.

Natural fibre production (cotton cultivation) is dominant in terms of the social risks, followed by yarn and fabric production and garment assembly. The current price pressure on textile manufacturing and the consequent practice of seeking manufacturing locations where labour prices are lowest are strong contributing factors to both the environmental and social impacts. Specific attention should be focused on countries where investment and employment are most needed, but where regulations protecting workers and the environment are weakest.

Awareness of sustainability and circularity issues and the need for change in the textile industry has never been higher. A number of initiatives have made headway in addressing the most pressing social and environmental challenges, including by developing transparency standards, cotton cultivation guidelines and restricted substances lists. Nonetheless, it is clear that much more needs to be done, and that

environmental and social improvements need to become mainstream and not merely niche activities among high-end brands and large players. It is also increasingly apparent that it is the underlying nature of the textile industry that needs to change. That is, to evolve from an industry producing large volumes of essentially disposable items, to one producing valuable items that remain in use for a long period before being repurposed or recycled. Circularity will require entirely new ways of doing business, but will result in a sector that brings benefits to business, society and the environment.

Moving towards sustainable and circular textiles will require a holistic approach and changes at each stage in the value chain, involving players of all sizes and from all market segments. New business models will have to be adopted on a widespread scale, the use of hazardous substances in textile processing will have to be eliminated, and resources will have to be used much more effectively, with a shift away from fossil fuels towards renewable sources of energy and materials. But most of all, textile utilisation will have to be optimised, including a longer service life and more post-use options, along with drastically improved recycling when materials reach their end-of-life.

Technical solutions such as waterless dyeing continue to be developed to address the high use of energy, chemicals and water in textile processing. New ways of doing business, such as clothing rental services, are gaining traction, and, along with the development of new recycling technologies, promise to increase service life and post-use options. Standards and guidelines, particularly for cotton cultivation, have made inroads into some of the worst social ills of textile manufacturing. Nonetheless, all these efforts need to be intensified and extended. In particular, the right institutional environment needs to be created for innovations to flourish and to grow to scale.

Achieving systemic changes will require coordinated actions by all stakeholders and across regions. Priority needs include stronger governance and policies to drive change, collaboration and financing to enable industry-wide action, and changes in consumption habits. To enable accountability and to drive informed consumer decisions there is also a strong need for transparency and traceability in textile supply chains.

The intention of this report is to apply an evidence-based, value chain approach to identifying the hotspots and priority actions needed to advance sustainability and circularity in textile value chain, while giving examples of the many initiatives that are already being undertaken. The next step is to develop a roadmap outlining how and by whom these priority actions can be taken. UNEP looks forward to continuing to engage with governments, businesses, civil society and other actors to advance this agenda.

1. Introduction

Textiles – and fashion in particular – have always been part of human society. The value of textiles to human society goes beyond their utilitarian benefits of providing protection, warmth and comfort. How people dress and adorn their living spaces are important aspects of people's cultural and individual identity.

The social impacts of this important and profitable industry have long been an issue of global concern. With the world facing an unprecedented crisis in 2020, caused by the COVID-19 outbreak, the magnitude of these social risks and inequalities along the textile value chain is unfolding dramatically. Lockdown scenarios, shortages in raw materials supply and a collapse in demand, followed by cancellations of orders, have put millions of workers at risk. At the time of publication of this report, the fragilities of the current system are receiving much media attention. Over the past years the spotlight has increasingly turned to the environmental impacts as well, given the rapidly increasing production volumes and ever shorter lifetimes of the products: clothing production has approximately doubled in the last 15 years, while the number of times a garment is worn before being discarded has decreased 36% compared to 15 years ago (Ellen MacArthur Foundation, 2017). With less than 1% of the material used to produce clothing recycled into new clothing, the textile industry uses large amounts of resources, leading to negative impacts on the environment (Ellen MacArthur Foundation, 2017). The rapid growth in textiles has largely been accounted for by synthetic fibres (produced largely from oil), which, over the last 20 years, have grown from below 20% of global fibre production to 62% of global fibre production in 2018 (Textile Exchange, 2018).

The textile industry is notorious for its water pollution and use (and release) of chemicals. Approximately 3,500 substances have been identified as used in textile production (KEMI, 2014). Unsound practices and poor wastewater management impact not only the health of textile workers, but also communities living near facilities, consumers of textile products, waste collectors and secondary processers, and the wider environment. The impact of the industry on climate change is notable, with one source finding that the global apparel and footwear industries accounted for an estimated 8% of the world's greenhouse gas emissions in 2016 (Quantis, 2018). Particularly concerning is that the climate impact is set to increase 49% by 2030 if current trends continue (Quantis, 2018). One challenge in addressing the impacts of textiles is that their environmental impacts are disproportionate to their economic value, a result of the trend towards increasingly affordable and short-lived clothing and footwear (Ellen MacArthur Foundation, 2017).

Textiles are unique among consumer goods in part because of the economic opportunity they represent, and also because people identify intimately with their purchasing decisions. More and more consumers are basing their purchasing decisions on whether a company's practices and mission align with their

values (The Business of Fashion and McKinsey & Company, 2017). Being a sector that is sensitive to consumer preferences, the textile industry must address increasing consumer interest in the sustainability agenda. However, to do this effectively and achieve systemic change requires looking at the system as a whole. For textiles this means looking at the underlying business models and at how textiles are designed, how raw materials are sourced, how textiles are produced, promoted and consumed, and what happens to them after use. The current system for designing, producing, selling and consuming textiles, especially clothing, is almost entirely linear. Thus far-reaching, coordinated actions are required of all stakeholders if the textile value chain is to be transformed into a sustainable, circular system. This report explores the actions required to make that transition. It starts with an overview of the textile value chain, both in terms of the processes and stakeholders comprising the textile value chain and of its environmental and socio-economic impacts. Chapter 3 explores the actions required to advance sustainability and circularity in textile value chains, giving examples of the many initiatives that are already being undertaken, while Chapter 4 identifies the priority actions required.

The intention of the report is to take an evidence-based, value chain approach to identifying the priority actions needed to advance sustainability and circularity in the textile value chain. As such, it is informed by environmental and social life cycle assessment studies, and especially research undertaken for the United Nations Environment Programme (UNEP) by the Federation of Indian Chambers of Commerce and Industry (FICCI), "Mapping the Textile Value Chain, Identifying Key Hotspots at the Global Level and Assessing Trade Barriers and Opportunities" (FICCI, 2018). It also incorporates the outcomes of an expert multi-stakeholder consultation workshop "Accelerating Actions for a Sustainable Textile Value Chain within a Circular Economy", convened by UNEP in January 2019, as well as sessions held at the Fourth United Nations Environment Assembly (UN Environment Assembly 2019) and the World Circular Economy Forum (SITRA 2019). This report does not go beyond exploring the hotspots and identifying the actions needed to address them. The intention is for this report to provide a basis for the next step in the process, that of developing a roadmap delving deeper into those actions, particularly with regard to how and by whom actions should be taken.

2
The textile value chain and its hotspots

A textile is a flexible material made up of a network of natural or artificial fibres. Most textiles are formed by weaving or knitting yarn into fabric, but textiles can also be non-woven, with fibres bonded into fabric by chemical, mechanical or heat treatment. Textile products can be classified into apparel, industrial textiles and household textiles, with common examples of each application given in Figure 1. Apparel is the largest area of textile use by some margin, accounting for around 60% of global demand for fibres, with the share of household and industrial textiles roughly equal (accounting for around 20% each of global demand for fibre) (PCI Wood Mackenzie, 2016).

The textile value chain is comprised of all the activities that provide or receive value from designing, making, distributing, retailing and consuming a textile product (or providing the service that a textile product renders), including the extraction and supply of raw materials, as well as activities involving the textile after its useful service life has ended. In this sense, the value chain covers all stages in a product's life, from supply of raw materials through to disposal after use, and encompasses the activities linked to value creation such as business models, investments and regulation. At all stages in the value chain, and in the transporting of intermediate and finished products between the different stages, raw materials and energy are required and emissions are released into the environment.

For a textile product, the value chain starts with fibre production. This can either be sourcing of natural agricultural materials and their subsequent processing to extract the fibre (e.g. cotton), or crude oil extraction and the manufacture of chemicals from which synthetic fibres are made (e.g. polyester), or a combination of both, as textiles are frequently blends of natural and synthetic fibres or involve both natural materials and chemical processing in their manufacture.[1]

Subsequent manufacturing stages involve spinning the fibres into yarn, and knitting, weaving or bonding the fibres in some other way into fabric. The fabric is then subject to chemical and/or mechanical processing (known as finishing) to produce a textile with the desired properties (e.g. softness or water repellency). The next step in the value chain involves cutting and sewing the textile into the product, followed by getting the product to the user (distribution and retail). After its first use, the textile product may be used again, as happens with donated second-hand clothing, or it may be recycled to a different use. In the current predominantly linear textile value chain, very few textiles (<1%) are recycled back into clothing, with another 12% going into cascaded recycling, where they are used in products such as cleaning cloths, insulation material and mattress stuffing. Ultimately, after one or more uses, the textile will end up in some sort of end-of-life treatment. This is currently most likely to be a sanitary landfill or an incinerator plant. In a circular value chain, after re-use the textile would be used in another textile product, e.g. upcycled into a new garment, or broken down to fibre level and spun

1 For example, regenerated fibres (also called semi-synthetic or cellulosic fibres), such as viscose, lyocell and modal.

Figure 1: Classification of textile products and examples of end-use applications[3]

Industrial / Technical

Medical and hygiene
Bandages, plasters, orthopaedic belts, etc.

Sport and recreation
Tents and canopies, parachure cloth and harnes, life vests, etc.

Transportation
Seats and upholstery in automotive, aviation and marine, belting, airbargs, etc.

Construction
Safety gear, ropes and cables, geotextiles, etc.

Agricultural
Fishing and aquaculture nets, horticulture/floriculture nets and mats, etc.

Packaging
Luggage, sack bags, wrapping bags, tea bags, etc.

Household

Kitchen
Cleaning, cloths, table cloths, curtains, etc.

Bedroom
Bed linen, blankets, rugs, carpets, curtains, mattresses, upholstery and covers, etc.

Bathroom
Shower curtains, mats, towels, etc.

Textiles

Apparel

Formal and casual wear
Shirts and t-shirts, jeans, trousers, jerseys, and fleeces, etc.

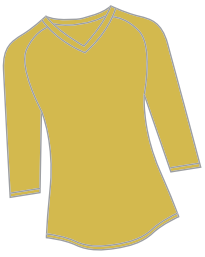
Sportswear
Swimwear, etc.

Accessories
Scarves, ties, hats, etc.

Under garments
Underwear, socks, hosiery, etc.

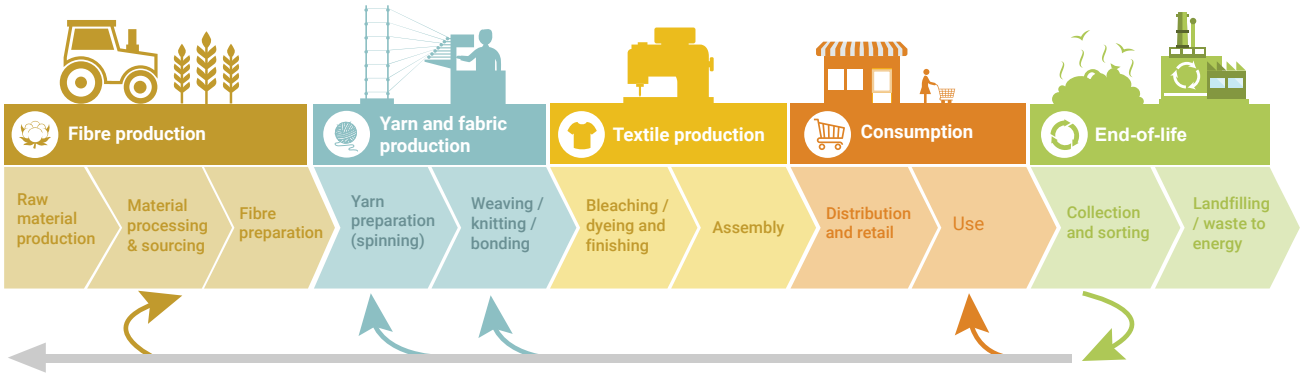
Uniforms

Footwear



3 In this simple classification household textiles include textiles of this nature (e.g. towels, bed linen, tablecloths etc.) used in non-household settings, such as hospitals, restaurants, hotels etc.

Figure 2: Linear representation of activities along the textile value chain



into yarn. There is currently some limited recycling of cotton back to fibre, while new technologies, such as chemical recycling, offer the potential to recycle synthetic textiles back to the raw materials from which they were made.

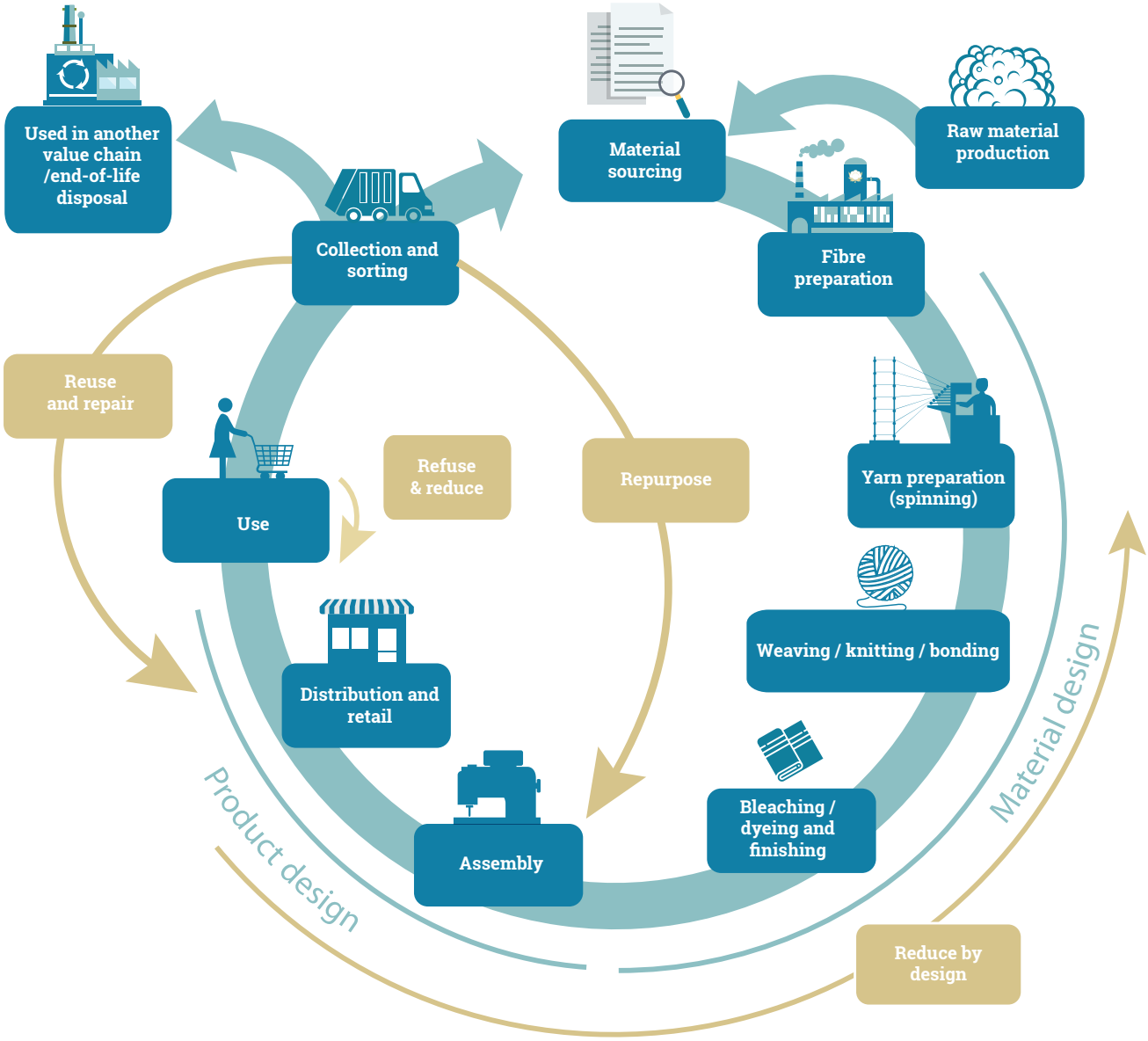
The activities associated with a value chain are often shown as a linear representation from raw material production to end-of-life treatment, albeit with the potential for the re-use, repair/repurposing and recycling of materials adding loops into the picture (such a linear representation is shown in Figure 2). The aim of circularity is to shift the "take-make-dispose" linear value chain into a circular system, where materials are not lost after use but remain in the economy, circulating as long as possible at the highest possible value. In this sense, a circular value chain such as that depicted in Figure 3[2] makes a more appropriate representation for this report. Nonetheless, a linear representation of the value chain (see Figure 2) is more representative of the status quo and is convenient for indicating where stakeholders and impacts are located along the value chain.

In addition to the activities described above, the value chain is also comprised of the actors undertaking the activities, and the stakeholders that can influence those activities. The value chain thus incorporates not only the physical processes, such as farms and factories, but also the business models and the way products are designed, promoted and offered to consumers. These non-manufacturing activities, including design, marketing, retailing, advertising and publishing, to a large degree determine the way textile products are produced and consumed. The actors and stakeholders of the textile value chain are discussed in the following section.

The value chain thus incorporates not only the physical processes, such as farms and factories, but also the business models and the way products are designed, promoted and offered to consumers

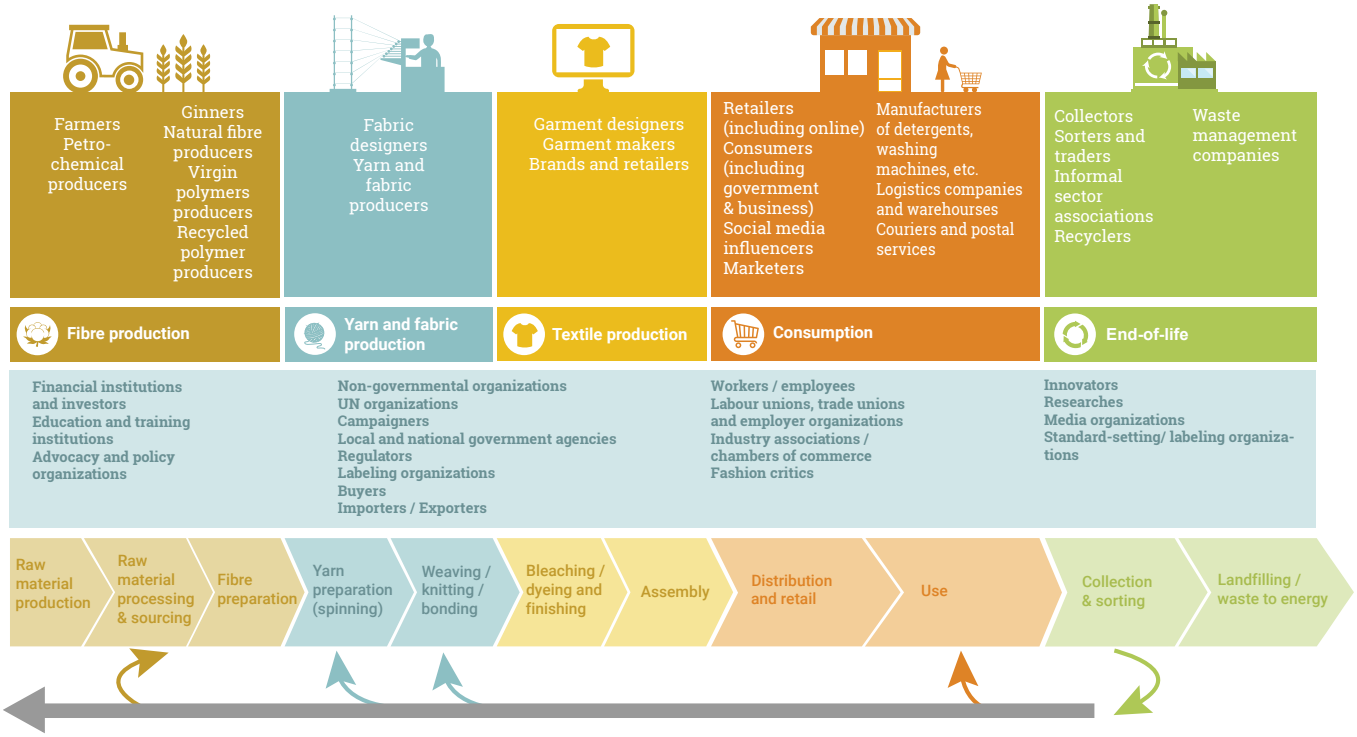
2 The representation in Figure 3 shows return loops only from after use, whereas rejects, off-cuts etc. in the manufacturing chain mean that there could also be return loops from any of the previous stages (e.g. distribution and retail, assembly, bleaching/dyeing and finishing). However, these are not shown in the figure for ease of representation.

Figure 3: Representation of activities taking place in a circular textile value chain



The aim of circularity is to shift the "take-make-dispose" linear value chain into a circular system, where materials are not lost after use but remain in the economy, circulating as long as possible at the highest possible value

Figure 4: Stakeholders associated with the textile value chain



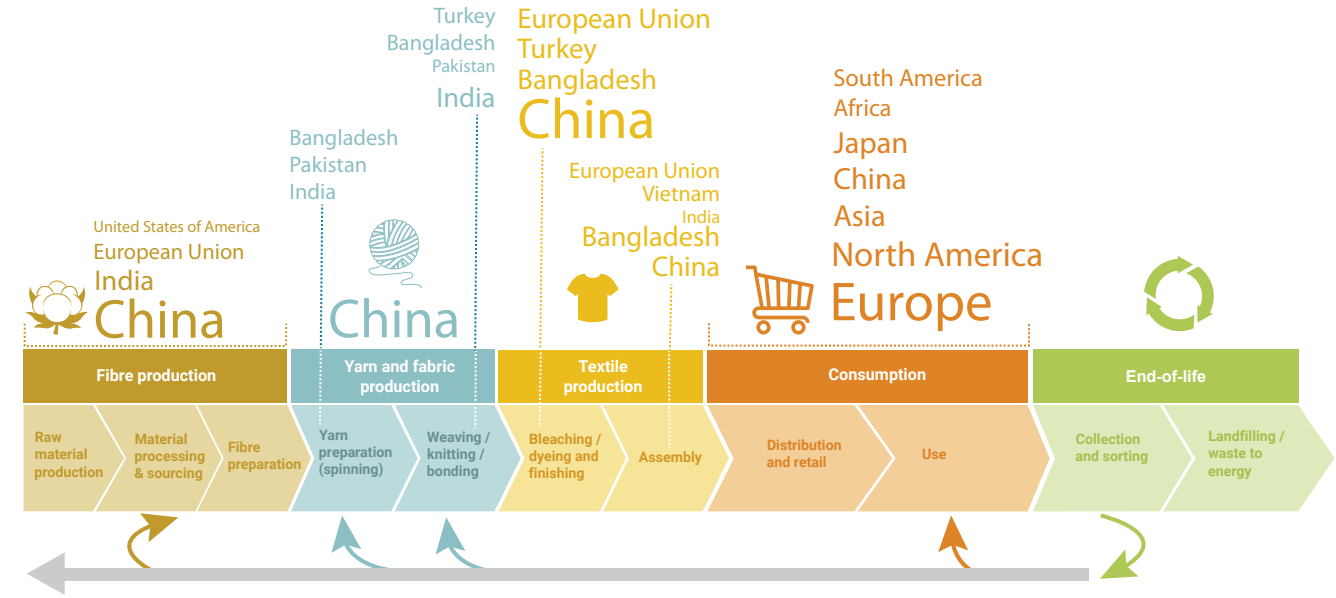
2.1 Mapping the textile value chain

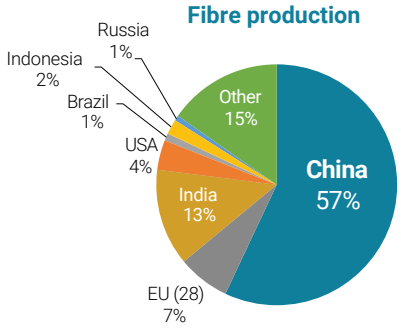
The actors and stakeholders of the textile value chain are defined as all individuals and entities that provide or receive value from designing, making, distributing, retailing or consuming a textile product (or providing the function that a textile product offers), including procuring raw materials, as well as the activities and parties involved with the textile after its useful service life has ended. The particular focus of this report is on those actors and stakeholders that have a role to play in bringing about a sustainable and circular textile value chain. This includes those actors directly involved in value chain activities, such as cotton farmers, designers, buyers and consumers, as well as stakeholders that can influence the value chain or pass on knowledge to actors in the value chain, such as government regulators, social and environmental campaigners, innovators and researchers Figure 4 lists the various stakeholders associated with the textile value chain. While some stakeholders, especially the direct actors, are involved with a particular stage in the value chain, others are more cross-cutting and operate across some or all of the value chain stages (e.g. finance institutions and advocacy organizations).

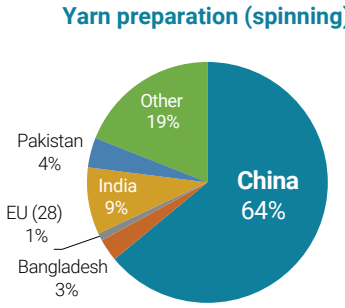
Though the value chain is truly global, the raw material extraction and manufacturing part of the textile value chain is heavily weighted towards Asia and towards developing/transitioning economies, as shown in Figure 5. China, especially, has a high share of the fibre, yarn and fabric production stages of the value chain, followed by India. Asia's share of global textile activities decreases along the textile value chain, and, as can be seen in Figure 5, countries in Asia are the largest producers of fibre, yarn and fabric by a substantial margin. There is a slight increase in global diversity for dyeing and finishing activities (although China is still the largest player, followed by Bangladesh), and a further slight increase for apparel production (although Asian countries still comprise the majority). It is only when it comes to consumption and end-of-life that there is broad global diversity, with Europe and North America as major players.

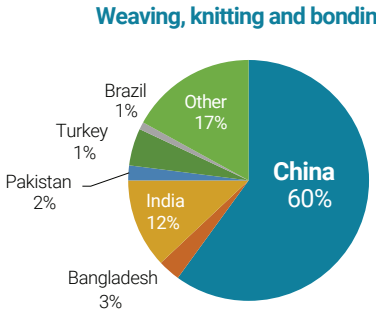
The particular focus of this report is on those actors and stakeholders that have a role to play in bringing about a sustainable and circular textile value chain

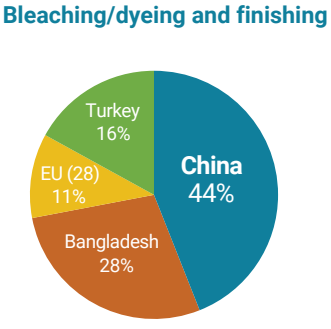
Figure 5: Geographical breakdown of global apparel production and consumption[4]

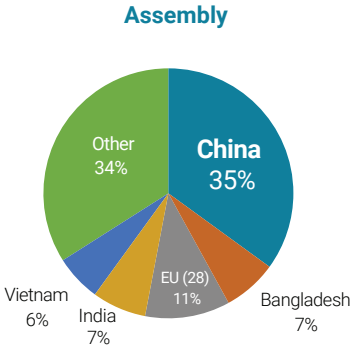


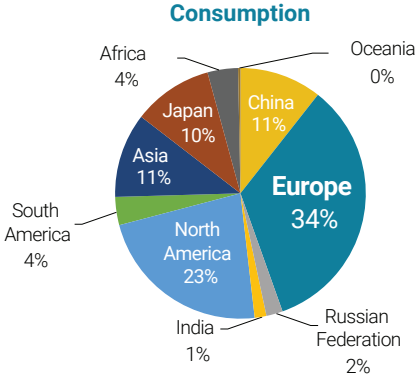












4 Fibre, yarn and fabric and textile production: share of production drawn from data from Quantis (Quantis, 2018); geographical consumption approximated by share of global emissions from consumption of clothing, using data from The Carbon Trust (The Carbon Trust, 2011).

The developing textile manufacturing countries are predominantly net exporters of textile products and intermediates, while the developed countries are predominantly net importers of textile products. The main value chain actors at the later, higher added-value stages of the value chain are institutional buyers and retailers, and/or textile product manufacturers where high capital investment or skills are required. Another notable feature of stakeholders in the textile value chain is the large number of small and medium sized enterprises that carry out the activities. These include small-scale cotton farmers, fibre, yarn and fabric producers, dyeing and finishing facilities, apparel manufacturers and recyclers. The high proportion of groups such as women and rural migrants, often marginalized in formal employment or typically employed in the informal sector in some production regions, is a particular feature of the workforce in these value chain activities.

The geographical and developed/developing country split across the textile value chain outlined above is particularly notable when it comes to understanding the environmental and social impacts of the textile sector. These are explored in the following section.

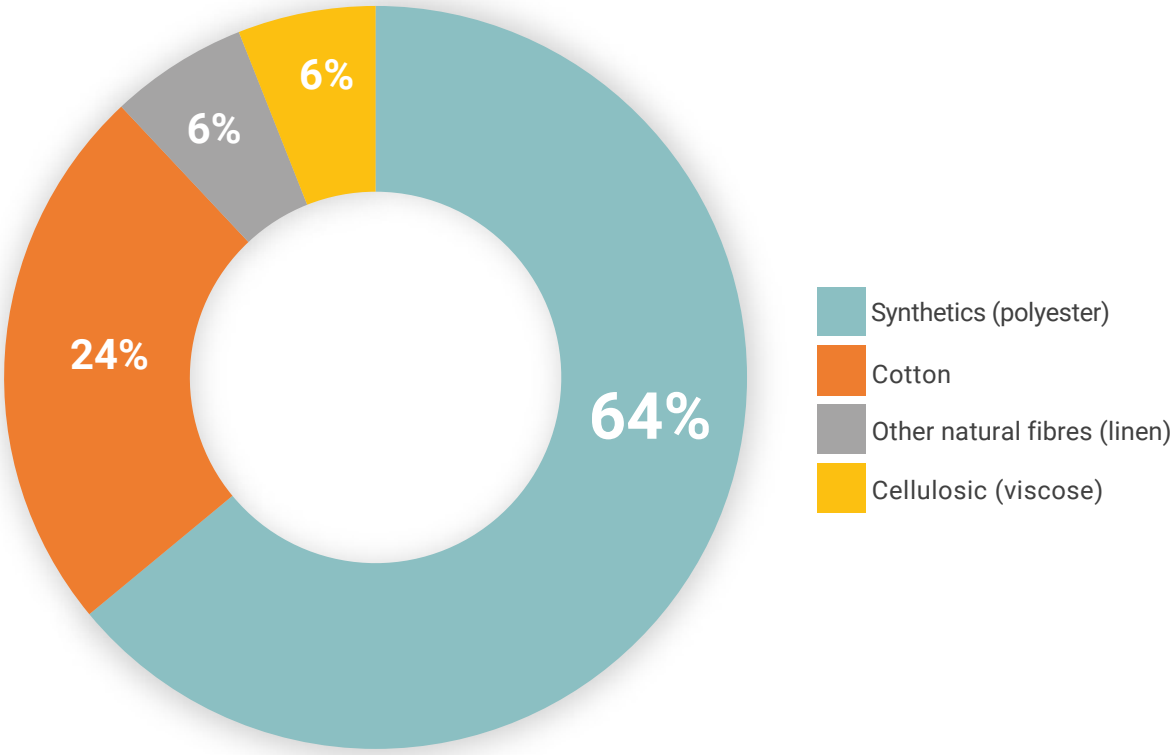
2.2 Hotspots along the apparel value chain

A hotspot is a stage in the life cycle of a product or service that accounts for a significant part of its environmental, social and/or economic impacts. The value of adopting a hotspot analysis approach is that it allows interventions to be focused on priority needs in order to achieve the greatest possible reduction in the impacts of the value chain as a whole.

The environmental and socio-economic impacts of the textile sector are discussed in the following sub-sections, and are quantified in terms of where they occur along the value chain; understanding where the hotspots are is critical to identifying corrective actions. Studies on the environmental and socio-economic impacts of the textile sector have tended to focus on clothing and apparel. This is true of the life cycle assessment studies on which the quantitative results in this section are based. The quantitative value chain results are taken from a life cycle assessment (LCA) study of global apparel. Box 1 provides details of the methodology and data underpinning the study. The social risks results are taken from a social hotspots study, of which an overview is given in Box 4. These quantitative results are supplemented by the wider literature, especially for those environmental and social impacts identified as limitations in the LCA studies. The hotspots identified are therefore applicable to apparel, although the environmental profiles of household textiles (e.g. towels, linen etc.) produced in similar value chains to apparel (i.e. spinning, knitting or weaving and textile production) are expected to be similar. However, the environmental profiles of industrial and technical textiles are potentially very different from that of global apparel presented in this section. Nonetheless, given that apparel and household textiles together account for 80% of global textile production, and that this high share is not expected to change (PCI Wood Mackenzie, 2016), the insights presented here into the environmental and social impacts of the apparel value chain can be taken as fairly indicative of the textiles sector as a whole.

> Though the value chain is truly global, the raw material extraction and manufacturing part of the textile value chain is heavily weighted towards Asia and towards developing/ transitioning economies. China, especially, has a high share of the fibre, yarn and fabric production stages of the value chain, followed by India

Figure 6: Share of fibres in global apparel in 2016



Source: Quantis (Quantis, 2018)

Also important to note when interpreting the hotspots is that certain impacts, such as those associated with land and water use, are strongly dependent on the type of fibre from which the textile is made, particularly whether it is of natural or synthetic origin. The value chain hotspots identified in this section are representative of global apparel and are thus representative of the fibre types making up global apparel. Furthermore, the hotspots reflect the baseline year of 2016 (see Figure 6), in which global apparel was estimated to be made up of 30% natural fibres and 70% man-made fibres. However, the environmental profile of the global textile sector changes over time, and will continue to do so, assuming the current trend towards an increasing share of synthetic fibres is maintained.

While the resource-related impacts of producing textiles are well quantified in life cycle assessment studies, textile manufacturing processes have impacts that are currently not well characterized in these studies. These include local water-related impacts on human health and ecosystems resulting from chemicals used in wet processing of textiles, as well as from plastic microfibres shed from synthetic textiles in their manufacturing, use and at end-of-life. Textiles are estimated to account for approximately 9% of annual microplastic losses[5] to the oceans (UNEP, 2018b). These microfibres end up in the ocean and other bodies of water, where they potentially have an effect on aquatic life, birds and even humans (given their potential to be passed up the food chain). Microfibres are discussed qualitatively in Box 2 as they are of high concern, albeit not yet well quantified, and chemicals in Box 3.

> Textiles are estimated to account for approximately 9% of annual microplastic losses to the oceans

5 Where annual microplastic losses are the total plastics less than 0.5 cm in size added to the ocean every year from land-based sources, i.e. it does not include microplastics formed from larger plastic items breaking down in the oceans.

2.2.1 Environmental impacts

Impact on climate change

The climate impact of the global apparel industry is substantial, with over 3.3 billion metric tons of greenhouse gases emitted across the value chain per year (Quantis, 2018), more than all international flights and maritime shipping combined (Ellen MacArthur Foundation, 2017)[6]. The energy intensive textile production stages account for the majority of the climate impact, as shown in Figure 8. The wet processing stages of dyeing and finishing are especially energy intensive, as large volumes of water need to be heated. The greenhouse gases emitted from burning fossil fuels (particularly coal) to generate the heat and electricity required in these stages of textile production account for their high contribution to climate impact. Asian countries, particularly China, India and Bangladesh, all account for a high proportion of the various global textile manufacturing stages (see Figure 5), and all rely heavily on fossil fuels for energy generation.

The use phase also contributes substantially to the climate impact of an apparel product (second only to dyeing and finishing). This is due to the amount of electricity used in washing and drying the garment, which – as with the production phase – varies widely depending on the electricity mix of each country, but is also determined by the income level of the consumer, the climate of the country and consumer behaviour (wash temperature, frequency of washing and whether clothes are machine dried or dried on a clothes line). The climate profile of a textile consumed in a specific country or by a specific income group might therefore be quite different from that of global apparel, shown in Figure 8. For example, an LCA on Swedish clothing consumption finds washing and drying garments to make a relatively small contributor to the overall carbon footprint of an average Swede's clothing (Sandin et al., 2019).

Fibre production makes the third highest contribution to climate impact, which arises primarily from the production of synthetic fibres. Synthetics make up close to two thirds of the total fibres used in global apparel (see Figure 6) and are produced from fossil fuels, mainly crude oil. Synthetic fibres are thus associated with high non-renewable resource use and climate emissions, which arise from extraction of fossil fuels and production of the ethylene and other chemicals from which the fibres are made.

Despite the global nature of apparel supply chains, with fibre, yarns, textiles and garments shipped in great quantities around the world, the Measuring Fashion LCA found transport between the manufacturing stages and the distribution of global apparel products to their end-markets contributed only a small amount to climate impact (and to the other impacts considered by the study) (Quantis, 2018). Distribution and retail were found to contribute only 1% to the climate impact of global apparel. This is partly due to the high energy use at the other life cycle stages, but also to the fact that clothing is a relatively light product, shipped in bulk carriers. An LCA of Swedish clothing consumption found transport during production to make a similarly negligible contribution to climate impact, with clothing distribution and retail also a relatively minor contributor. However, the Swedish LCA found transport at the use phase – transport by the user back and forth to the store – to make a surprisingly high contribution (11% of the overall climate impact) (Sandin et al., 2019). Use phase transport is typically excluded in LCA studies, but the Swedish finding suggests it should not be overlooked. That said, as with the other use phase activities (laundering) potentially giving rise to significant impacts, its importance will depend on the income level of the consumer and the particularities of the country (notably on the transport infrastructure available).

6 This comparison is intended merely to give an indication of the scale of emissions. The comparison can be criticized for lack of consistency as between the two systems; for transport, the greenhouse gas emissions given are for fuel consumption only, while for textiles, the greenhouse gases are for the full value chain, i.e. including all stages from raw material sourcing to disposal, and include full life cycle emissions (e.g. the production as well as the use of fuels).

Box 1: Methodological overview of LCA studies informing the hotspots analysis

A 2018 research study conducted by FICCI for UNEP, "Mapping the Textile Value Chain, Identifying Key Hotspots at the Global Level and Assessing Trade Barriers and Opportunities" provides the quantitative basis for the hotspot analysis. Environmental and social life cycle assessment studies were carried out in this study, with the environmental LCA building on the 2018 Quantis study "Measuring Fashion: Environmental Impact of the Global Apparel and Footwear Industries Study".

Life cycle assessment (LCA) is an assessment technique that evaluates the environmental performance of a product or service throughout its life cycle. The extraction of resources, and releases to air, water and soil are quantified at each life cycle stage, and the potential contribution of these extractions and releases to predetermined environmental impact categories is then assessed. LCA is therefore a good tool to provide a quantitative basis for a hotspot analysis.

The results of the FICCI and Quantis studies are based on the World Apparel Life Cycle Database (WALDB), with **2016 as the baseline year**. The study considers multiple fibre materials, with the results reflecting the global apparel fibre mix in 2016 (see Figure 6). Data on global fibre production is taken from The Fiber Year 2017. No distinction is made between conventional fibre materials and more sustainable fibres, with all fibres assumed to be produced conventionally. The issue of microplastics falls outside the scope of the studies.

Impact assessment is conducted according to the peer-reviewed and internationally recognized life cycle impact assessment method IMPACT 2002+ vQ2.2. In addition to the freshwater withdrawals covered by the Quantis study, the FICCI study assesses water impacts using the AWARE method. The AWARE method comes out of a consensus building process devised by the Water Use In LCA (WULCA) working group of the Life Cycle Initiative. The AWARE water scarcity footprint indicates the potential of a water use to deprive another user (human or ecosystem) by its consumption. It is based on the quantification of the relative Available WAter REmaining per area once the demand of humans and aquatic ecosystems has been met.

The life cycle system diagram for the Quantis and FICCI global apparel LCAs is shown in Figure 7. The following are considered in each of the stages:

Fibre Production covers the extraction and processing of fibres. Transportation between raw material extraction and processing, and between fibre production and yarn preparation is included.

Yarn Production covers the spinning of yarn from both filament and staple fibres. Different spinning techniques are taken into consideration (wet spinning and cotton spinning), as are losses incurred from these processes. Transportation from yarn preparation to fabric preparation is also included.

Fabric Production covers knitting and weaving yarn into fabric. Two different knitting techniques are taken into consideration (circular and flat), as are losses incurred from these processes. Transportation from fabric production to dyeing and finishing is also included.

Dyeing and Finishing covers bleaching and dyeing of the fabric as well as fabric finishing. Transportation from dyeing and finishing to assembly is included.

Assembly covers the cutting and sewing of fabric into apparel products. Potential losses incurred from these processes are included.

Distribution covers the transportation of apparel products from their assembly location to retail stores. The FICCI study includes the selling of garments to the end-users (retail). Transportation between retail stores and end-users is not included.

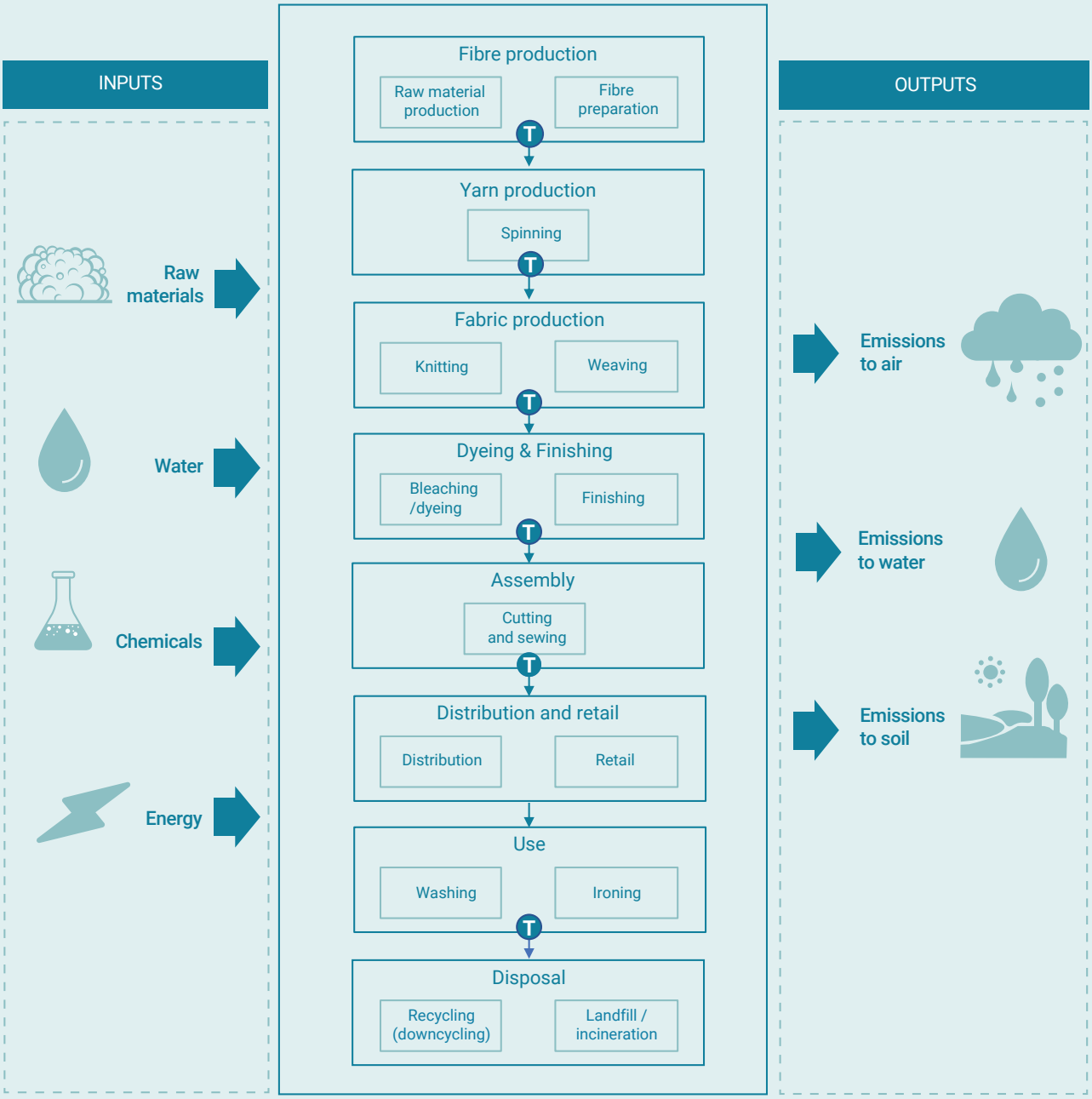
The **Use** stage is not considered in the Quantis Measuring Fashion study, but is included in the FICCI study. Washing (at an assumed temperature of 30°C), ironing and drying of apparel products is included (with 50% of apparel products assumed to be ironed and dried electrically).

Disposal covers the collection and management of apparel products at the end of their useful life (incineration and landfilling). Transportation to incineration and landfills is included.

Consistent with the methodology of LCA, not only are the above processes making up the main life cycle stages taken into account, but all identifiable upstream inputs into them are included as well. For example, cotton farming includes the production of fertilizers.

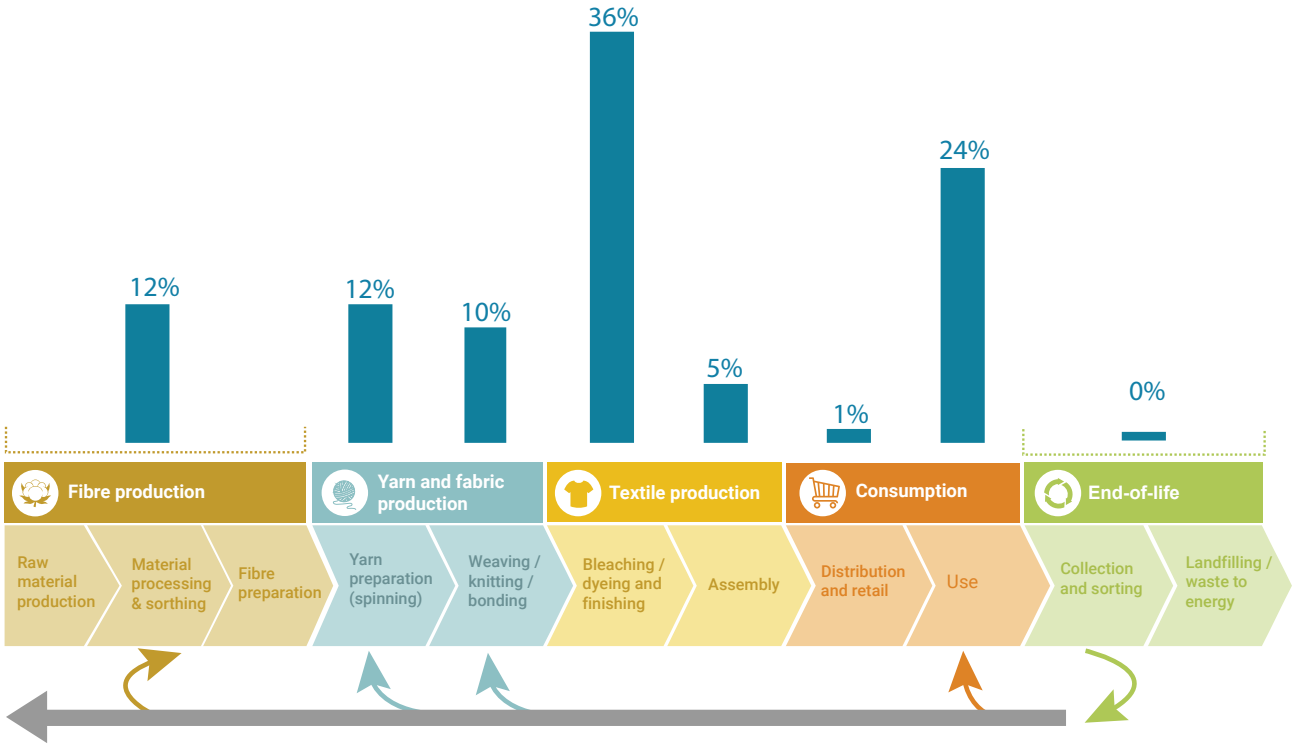
A full description of data sources, assumptions, limitations and key uncertainties in the study can be found in the full Measuring Fashion methodological report (Quantis, 2018). Significant sources of uncertainty are due to data gaps in, amongst others, the proportion of fibres used in apparel, local water impacts of dyeing processes, and the geographical breakdown of manufacturing locations.

Figure 7: The life cycle of the global apparel system considered in the Quantis and FICCI LCA studies



"T" denotes a transport process

Figure 8: Climate impact across the global apparel value chain



Source: LCA on global apparel, see Box 1.

Apparel end-of-life makes a negligible contribution to climate impact. Currently only around 13% of clothing is recycled, predominantly to lower value uses, such as insulation and cleaning cloths (Ellen MacArthur Foundation, 2017), for which little or no energy intensive processing is required[7]. Landfilling and incineration are associated with releases of greenhouse gases, but the fact that textiles have very low degradation rates in landfill results in the climate impact from end-of-life being small compared to the other value chain stages.

While emissions from apparel disposal do not stand out as a hotspot to be addressed, increasing re-use, repair/repurposing and closed-loop recycling will decrease climate emissions across all stages of the value chain (with the exception of the use phase). Nevertheless, it is important to take a life cycle approach and ensure that any impacts from increased re-use, repair/repurposing and recycling of textiles, such as emissions from collection and transport, do not exceed the emissions avoided by producing less fibre, fabric or textiles (Zamani, Sandin, and Peters, 2017).

Life cycle assessment studies have shown that extending the useful life of clothes and changing laundry practices (e.g. cold washing and line drying) have the potential to create the greatest reduction in climate impacts (UNEP 2017). A Swedish LCA reinforces this with its finding that if each garment is used twice as many times before disposal, almost half the climate impact is mitigated (Sandin et al., 2019).

While emissions from apparel disposal do not stand out as a hotspot to be addressed, increasing re-use, repair/repurposing and closed-loop recycling will decrease climate emissions across all stages of the value chain

7 The results in Figure 8, drawn from FICCI (FICCI, 2018), do not include energy use in recycling processes.

Impact on water resources

The global apparel industry consumes some 215 trillion litres of water per year (Quantis, 2018). Viewed from the perspective of the consumer, in Sweden, this amounts to some 610 kilolitres per person per year (with water weighted according to the scarcity of water in the country in which it is used) (Sandin et al., 2019). The spread of freshwater use across the global apparel value chain is shown in Figure 9. Value chain stages that are significant consumers of water are raw material production, bleaching, dyeing and finishing in textile production, and use (laundering). High water use in fibre production is due to the high levels of water required in growing cotton. Other natural fibres that do not require irrigation make a much lower contribution to value chain water use, while synthetic fibres require relatively little water in their manufacture.

The impact that water use has on water availability for human and industrial purposes and for ecosystem services varies from country to country, as each geographical region experiences different degrees of water scarcity, depending on the availability of fresh water and the number of competing users. When weighted for country-level water scarcity, raw material production (cotton growing) makes the highest contribution to the water scarcity footprint of the apparel value chain, followed by yarn production, as shown in Figure 10. The distribution of water impact across the value chain is strongly influenced by the proportion of cotton in the apparel fibre mix. For example, in the global apparel LCA on which the results in Figure 10 are based, cotton makes up 24% of global apparel. In a study on Swedish clothing, where cotton makes up 49% of apparel, the dominance of cotton production in the water scarcity impact is very much more pronounced (it accounted for 87% of the water scarcity impact) (Sandin et al., 2019)

The FICCI hotspots study (see Box 1) also looks at water impact in terms of the countries most affected. China accounts for the largest share (34%) of the total water scarcity footprint of global apparel. This high percentage is because China both grows cotton and has a high share of yarn and textile production. India (12%) and the USA (5%) are the countries with the next highest shares of the water scarcity footprint of global apparel.

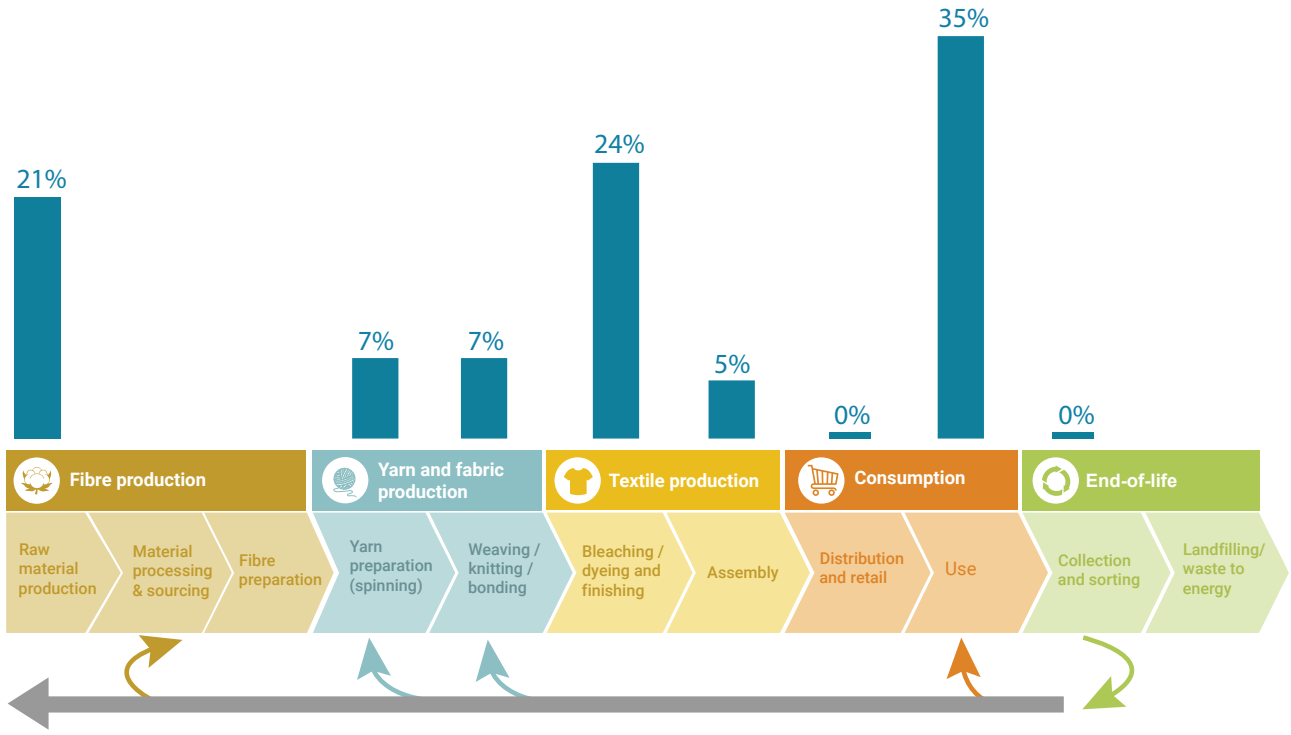
The manufacture and use of textile products are not only associated with consumption of large volumes of water, but the chemicals and detergents used in manufacturing processes and in washing textiles pollute natural waterways when effluents are released without sufficient treatment. Thus, the textile sector has a significantly larger impact on water scarcity than direct water use alone, by polluting water and rendering it unfit for other uses (note that only the water scarcity directly associated with water consumption is reflected in Figure 10).

A further impact that the textile sector has on water quality is the release of microfibres. Microfibres – tiny strands of staple fibres or filaments – have been found just about everywhere that studies have tested for them, from bottled drinking water to Arctic ice. The prevalence of microfibres in wastewater and wastewater treatment sludge, together with the relationship observed between abundance of microfibres in shoreline sediments and human population density, has led to laundering of textiles being identified as a major source of microfibres (Henry, Laitala, and Klepp, 2019). The emerging issue of microplastics[8] arising from the textile sector is explored further in Box 2.

> The global apparel industry consumes some 215 trillion litres of water per year

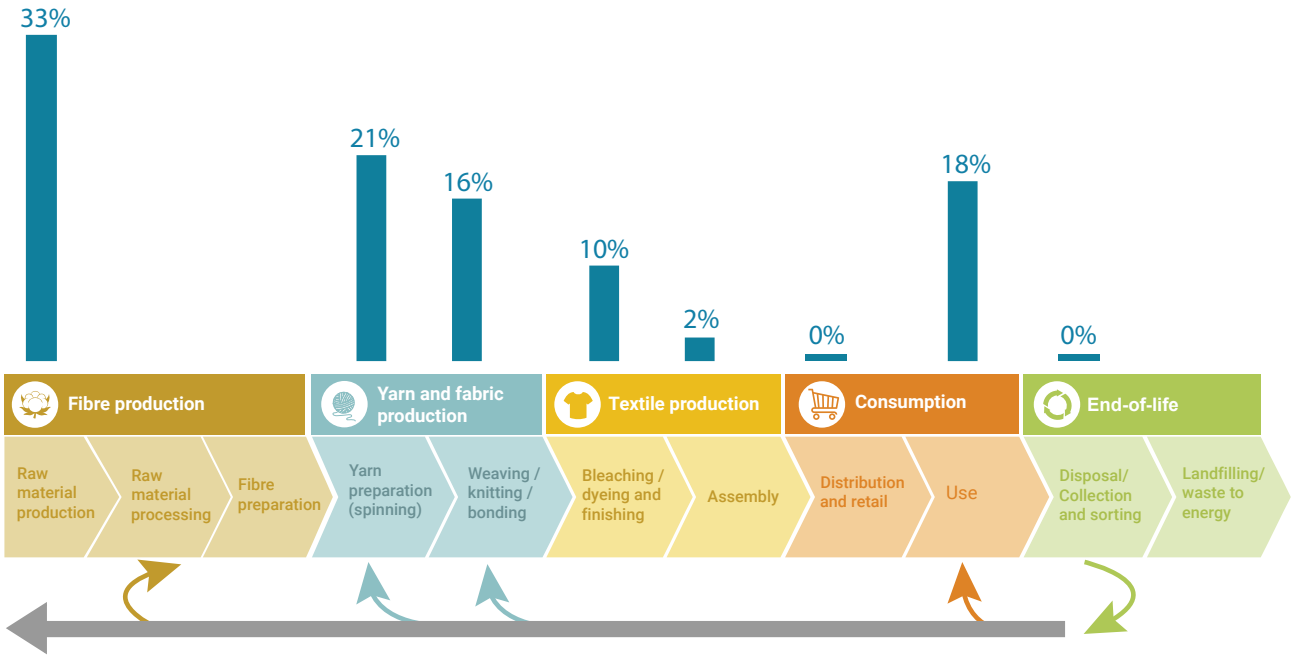
8 Microfibres of synthetic origin are a sub-class of microplastics, where microplastics are defined as plastic particles with a diameter of less than 5 mm.

Figure 9: Freshwater use across the global apparel value chain



Source: LCA on global apparel, see Box 1.

Figure 10: Water scarcity footprint across the global apparel value chain



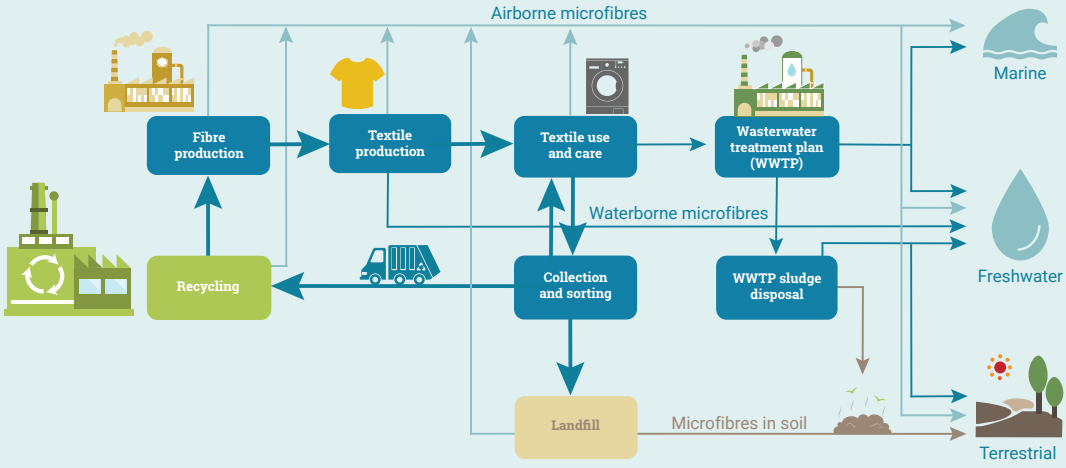
Source: LCA on global apparel, see Box 1

Box 2: Potential releases and impacts of microfibres from the textile value chain

Textiles release fibres into the environment during production, use and end-of-life disposal, though only limited research has been carried out to determine the potential hotspots of microfibre release. Research on microfibre release from textiles has tended to focus on the parameters affecting release, such as washing machine type, wash duration, wash temperature and detergent use, as well as on the potential for different kinds of fabrics to shed (Carney Almroth et al., 2018; De Falco et al., 2018; Zambrano et al., 2019). Along with the use phase, textile processing is likely to be a significant source of microfibres. Roos et al. (2017) identified production practices that reduce shedding in garment production, and found no evidence to suggest that fabrics made from recycled fibres shed more than those made from virgin fibres. High quantities of microfibres were found to be released from a textile production wastewater treatment plant even after 95% of microfibres had been removed, with the high volumes of effluent released from textile processing translating into significant quantities of microfibres released even when their concentration in the effluent was low (Xu et al., 2018). Little evidence of the potential for textiles to release microfibres at their end-of-life is available in the literature, although landfills have been identified as a potential source of airborne microfibres (Barnes et al., 2009). Potential pathways of microfibre release from textiles and their impacts are depicted in Figure 11.

Recent research indicates a higher presence of microfibres of natural and semi-synthetic origin than previously appreciated (Barrows, Cathey, and Petersen, 2018; Stanton et al., 2019). Cellulose-derived microfibres have been found in high concentrations in a number of different environments (Henry, Laitala and Klepp, 2019). However, while natural fibres are biodegradable, which potentially reduces their environmental threat, the risks that they pose remain poorly understood (Stanton et al., 2019), for example, in terms of the time taken to biodegrade in the marine environment and the release of chemicals contained in the fibre. Despite how ubiquitous microplastics are in the environment, the mechanisms causing their ecological impacts are poorly understood. This is in part due to the multifaceted nature of the potential impacts, with evidence of physical, chemical and biological mechanisms acting individually or in combination (Henry, Laitala and Klepp, 2019). The major physical impact occurs through ingestion, the effects of which have been relatively well documented for marine organisms, but less so for terrestrial organisms. **Chemical impacts of microfibres in the environment include leaching of toxic chemicals**, such as dyes or fire retardants (de Souza Machado et al., 2018), while **biological and environmental impacts include the potential for microfibres to carry POPs and provide a habitat for pathogenic bacteria,** thereby enabling the spread of such disease-causing bacteria to new locations and habitats (Kirstein et al., 2016).

Figure 11: Sites in the textile value chain of potential releases of microfibres and major pathways to the environments in which they cause impacts



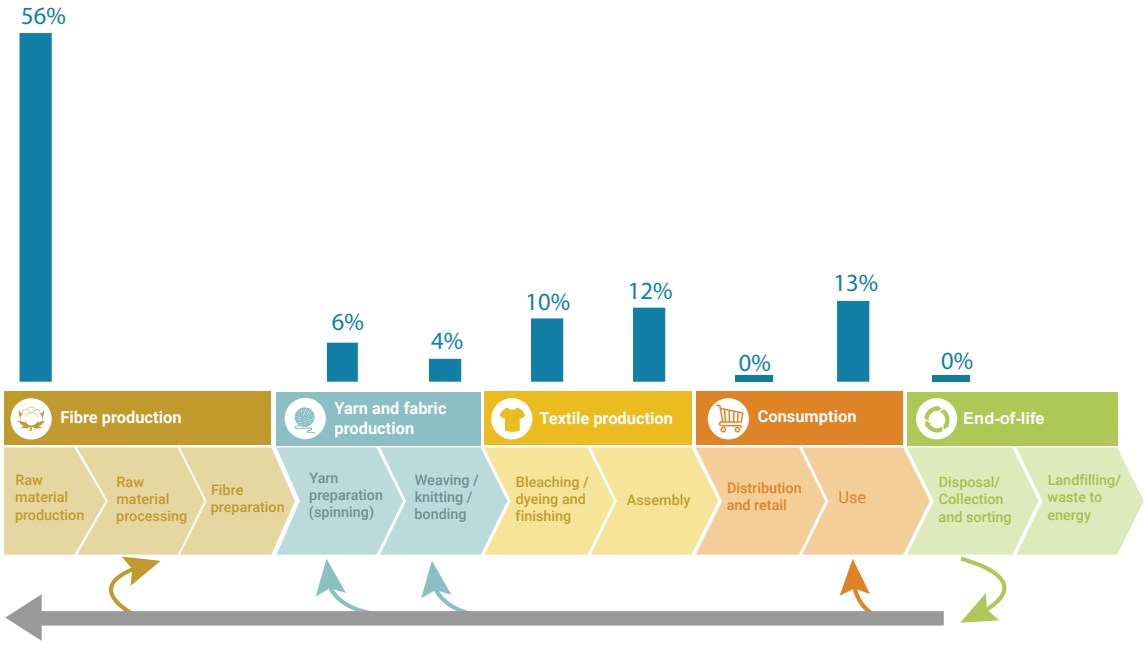
Adapted from: Henry (Henry, Laitala and Klepp, 2019)

Impacts from land use

Land use is one of the main drivers of loss of biodiversity worldwide, and land use and related pressures are responsible for nearly two thirds of the world's terrestrial surface having declined beyond a "safe" level in terms of biodiversity intactness within planetary boundaries (Newbold et al., 2016). Land use associated with global apparel is strongly weighted towards the fibre production stage (see Figure 12). The land use hotspot at fibre production arises overwhelmingly from cotton cultivation, with a small contribution from cellulosic fibres. Synthetic fibres have only a small land footprint. The contribution to land use of the other value chain stages is indirect, in that it relates to the land associated with producing the energy used in manufacturing and laundering textiles. Whether individual countries have land use profiles similar to the global apparel profile will therefore depend on the particular energy mix of the country, and especially the degree of biomass in the energy mix.

The dominance of fibre production in the value chain land footprint is even more remarkable considering that in 2016 (the baseline year of the analysis shown in Figure 12) natural fibres made up about one third of global fibre production. Cotton cultivation uses 2.5% of the world's arable land. Other natural fibres also have high land footprints, with wool at the top end of the scale, requiring 278 hectares per tonne of fibre, compared with just over 1 hectare per tonne for cotton (although the fact that wool is in many cases a by-product of meat production, with grazing often taking place on land that is not suitable for growing crops, complicates the direct attribution of land use to wool) (Turley et al., 2009). Regenerated or cellulosic fibres, such as viscose, modal, and lyocell, have smaller land footprints than other fibres produced from agricultural sources. However, given the steady increase in demand for these fabrics and the fact that over 140 million trees were used for making viscose in 2018, it is of paramount importance to ensure that wood is not sourced from ancient and endangered forests or other controversial sources (Canopy 2018).

Figure 12: Land use impact across the global apparel value chain[9]



9 Land use impact is assessed according to the IMPACT 2002+ methodology and is measured in units of potentially disappearing fractions (PDFs), which relate to the likelihood of species loss. Source: LCA on global apparel, see Box 1.

Box 3: Chemicals use in wet processing of textiles

The textile industry is notorious for its impact on water systems. Despite this notoriety, surprisingly little data exists on the scale of water pollution from textile processing, and the often cited claim that 20% of industrial water pollution is attributable to the dyeing and treatment of textiles is unsubstantiated[10]. Producing textiles requires a considerable array of chemicals, including dyes; basic commodity chemicals such as oils, starch, waxes and surfactants; and specialized chemicals such as flame retardants, dirt and water repellents, and biocides to reduce bacteria or mould growth (UNEP 2013, 2019a). On average, **producing 1 kg of textiles requires 0.58 kg of various chemicals** (Ellen MacArthur Foundation, 2017). Kant (Kant, 2012) estimates that in excess of **8,000 chemicals are used in the various textile manufacturing processes**. A study by the Swedish Chemicals Agency identified approximately 3,500 substances being used in textile production (KEMI, 2014). Of the 2,450 substances able to be analysed (the rest were not analysed due to confidentiality), 750 were found to be hazardous to human health, with 299 considered to be functional substances of high potential risk to human health, i.e. substances intentionally added and expected to remain in the finished articles at relatively high concentrations. 440 substances were found to be environmentally hazardous, with 135 of these functional substances of high potential risk to the environment (KEMI, 2014).

China is the largest consumer of textile chemicals, accounting for 42% of global consumption. Of China's textile chemical consumption, 41% are surfactants (including dye additives, antistatic agents and softeners), 24% are sizing chemicals and 13% are lubricants (UNEP, 2013).

Many of the chemicals used in textile production are known to have adverse health and environmental impacts. Hazardous chemicals found in effluents from textile processing facilities include some known to cause cancer and disrupt hormonal systems in humans and animals. Toxic chemicals, such as alkylphenols and perfluorinated compounds (PFCs) are particularly problematic as they cannot be removed by wastewater treatment plants. Flame retardants, including brominated and chlorinated organic compounds, are another particularly hazardous class of chemicals used in the production of some textiles. Many dyes contain heavy metals, such as lead, cadmium, mercury and chromium (VI), known to be highly toxic due to their irreversible bioaccumulative effects, whilst azo dyes contain carcinogenic amines (Greenpeace, 2018).

10 This figure originates in a journal article (Kant, 2012) where it is cited as coming from The World Bank. However, an investigation by journalists from Ecotextile News found The World Bank was unable to confirm or locate the origin of the figure (Mowbray and Glover, 2019)

Impacts on ecosystem quality

Hotspots in the textile value chain with regard to impacts on ecosystem quality are fibre production (cotton cultivation) and the wet processing stage of textile production (bleaching/dyeing and finishing).

The high impact of cotton cultivation on ecosystem quality is due to land use (habitat loss), water use, soil degradation and the high use of agricultural chemicals. Global cotton cultivation is estimated to require 200 thousand tonnes of pesticides and 8 million tonnes of fertilizers per year, some 16% and 4% of total global use of pesticides and fertilizers respectively (despite cotton accounting for only 2.5% of arable land use) (Ellen MacArthur Foundation, 2017). Cotton is a water intensive crop, grown predominantly in dry regions. Extensive and/or poor irrigation practices severely impact regional freshwater resources, potentially depleting surface or ground water bodies, and affecting river catchments and wetlands downstream of water extractions. Furthermore, the agrichemicals used in growing cotton pollute freshwater ecosystems with excessive nutrients, salts and pesticides (WWF, 1999). The fact that cotton is grown in hot, arid regions also increases the risk of soil degradation, as the soil in such regions is often of poor quality with low organic content. Soil is therefore vulnerable to erosion by wind and water and to salinization resulting from poor irrigation practices (WWF, 2007).

Textile production is a chemical intensive sector, using and releasing hazardous chemicals with significant human health and environmental impacts (see Box 3). Toxic chemicals are used and released all along the supply chain from the production of the raw material to the finishing of the articles, and in waste management (chemicals can leach out as textiles degrade in landfills, while incineration can lead to harmful emissions) (UNEP, 2019a). Ecosystem impacts are generally underestimated in LCA studies on textiles due to gaps in data on the identity and quantities of chemicals used in textile processing, as well as gaps in the ability of LCA models to describe the effects arising from the toxicity of these chemicals when they get into the environment (Roos et al., 2019). However, when these are included, such as in Sandin et al. (2019), and when the focus is only on direct emissions (i.e. excluding indirect toxic emissions associated with energy production and fossil fuels) the bleaching/dyeing and finishing stage of textile production is a clear hotspot in terms of ecotoxicity impact. For the six garment types considered by Sandin et al. (2019), the high freshwater ecotoxicity impact of wet treatment was found to be caused mainly by the large amount of chemicals used (and emitted), rather than their highly toxic nature.

The energy intensive stages of the textile value chain (as indicated by their relative contributions to climate impact, see Figure 8) are shown by LCA studies to be hotspots in terms of their impacts on ecosystem quality (Sandin et al., 2019). This is because mining and emissions associated with burning fossil fuels, particularly coal, have high ecosystem impacts. The high use of fossil energy in textile finishing and the electricity consumed in the use phase results in these value chain stages being hotspots for energy-related impacts on ecosystem quality.

> The bleaching/dyeing and finishing stage (wet treatment) is a clear hotspot in terms of carcinogenic human toxicity, and also a hotspot for non-carcinogenic human toxicity in garments with a high proportion of synthetic fibres

2.2.2 Socio-economic impacts

Damage to human health

As discussed above for ecosystem impacts, hazardous chemicals are used (and emitted) all along the textile value chain. Taking direct emissions alone (i.e. excluding indirect toxic emissions associated with energy production and fossil fuels), cotton production is a clear hotspot in terms of non-carcinogenic human toxicity impact (Sandin et al., 2019). The bleaching/dyeing and finishing stage (wet treatment) is a clear hotspot in terms of carcinogenic human toxicity, and also a hotspot for non-carcinogenic human toxicity in garments with a high proportion of synthetic fibres. The use of detergents, dyes and water-repellent agents accounts for the high carcinogenic human toxicity impacts in the six garments considered (Sandin et al., 2019). Box 3 provides some details about the chemicals used in the wet processing of textiles.

The cost to the textile industry of poor chemical management, as indicated by the value opportunity of eliminating occupational illnesses by 2030, is estimated at €7 billion per year (GFA and BCG, 2017). Furthermore, hazardous chemicals used in producing textiles have far-reaching effects. Textile workers who come into direct contact with the chemicals bear the brunt of the toxicity and cancer risks, but chemicals discharged into rivers affect local communities and contaminate drinking water, while chemicals in textiles coming into contact with human skin can put the wearers at risk. Furthermore, hazardous chemicals have the potential to build up in secondary materials, and have therefore been identified as a barrier to recycling, potentially putting workers collecting and processing secondary materials at risk. The fact that women make up the majority of the textile workforce means they are disproportionately affected by these health impacts (see Box 5).

As with ecosystem quality impacts, LCA studies show that value chain stages with high energy use are associated with high potential impacts on human health (due to the high human health impacts associated with extracting and burning fossil fuels, particularly coal). The high fossil energy use in textile finishing and the high consumption of electricity in the use phase mean that these value chain stages are hotspots for human health damage.

The potential for ingestion and inhalation of microfibres in humans, and their possible impacts on human health are an emerging concern. The issue of microfibre releases from textiles is discussed in Box 2. The limited observational evidence available suggests that human exposure to microfibres from synthetic textiles is unlikely to cause human health impacts at current levels of exposure (World Health Organization, 2019), although research to close the knowledge gaps should be a priority, and precautions should still be taken to limit exposure (Henry, Laitala, and Klepp, 2019). A recent review concludes that comprehensive studies on a range of plastic materials at relevant concentrations are needed, as well as modelling of chronic exposure, to obtain a more realistic assessment of the potential risks to human health (Lehner et al., 2019).

Social risks

The garment industry is a substantial contributor to employment in many countries, especially of women, and creates significant economic opportunities in developing countries, particularly export opportunities. However, the garment industry is beset by poor working conditions, including excessive working hours and low wages, with workers exposed to abusive practices such as sexual harassment, and unsafe working conditions (ILO, 2016). Unacceptable working conditions and some instances of modern slavery and child labour have made cotton cultivation and textile production the focus of NGO campaigns and significant media attention. In particular, the collapse of the Rana Plaza building in Dhaka, Bangladesh in April 2013, in which more than 1,132 people were killed and more than 2,500 injured, most of them women and girls, brought the poor labour conditions faced by workers in the garment sector to global attention (ILO, n.d.).

A social life cycle assessment (SLCA) of a low-cost garment provides the quantitative basis for the social hotspots analysis that this section is based on. Box 4 provides details of the SLCA and the scope of the analysis that follows, which should be regarded as one particular way of analysing social risks. The SLCA identifies fibre production as the stage in the apparel value chain with the highest social risks, as shown in Figure 14 and Figure 15. For the majority of social risk indicators identified as relevant to textiles (child labour, corruption, forced labour, gender inequality, high conflict, fragility in the legal system, exposure to toxins and hazards and sector average wages below the country minimum wage), activities at the fibre production stage are responsible for the highest proportion of these risks. Risks associated with fibre production were found to account for between 49% and 57% of the various social risks identified, with the exception of the risk of fatal and non-fatal injury, where fibre production was responsible for an even higher share of the risk (68%), and the risk of excessive working time, where the high risks associated with garment assembly reduce the relative contribution from fibre production. The high social risks of fibre production are overwhelmingly due to natural fibre production. The markedly higher social risks of natural fibre production (cotton farming) compared to synthetic fibre production (petrochemical industry) can be seen in Figure 14 and Figure 15. They are even more striking bearing in mind that these results are for a low-cost garment made up of 70% synthetic fibres and only 30% natural fibres.

The high social risks of fibre production are overwhelmingly due to natural fibre production. The markedly higher social risks of natural fibre production (cotton farming) compared to synthetic fibre production (petrochemical industry) can be seen in Figures 14 and 15. They are even more striking bearing in mind that these results are for a low-cost garment made up of 70% synthetic fibres and only 30% natural fibres

Box 4: Methodological overview of the social hotspots analysis used to identify the social risks hotspots

The FICCI social hotspots study uses the social hotspots database (SHDB)[11] to provide a quantitative assessment of the social risks associated with producing a low-cost garment. The SHDB is built on the UNEP Guidelines for Social LCA (UNEP-SETAC, 2009), and is an extended input/output life cycle inventory (LCI) database that enables the modelling of products systems and an assessment of their potential social risks. It is based on the Global Trade Analysis Project (GTAP)[12] global economic equilibrium model, which contains data for 57 economic sectors in 113 different regions. The SHDB converts the GTAP data on wage payments into estimates of worker hours, skilled and unskilled, for each sector in each GTAP country/region. These labour hour intensity factors are then used with a social risk characterization model drawing on hundreds of data sources, including, among others, the International Labour Organization (ILO), the World Health Organization (WHO), the U.S. Departments of Labor and State and the World Bank (Norris and Norris, 2015). The social risk impact categories considered in the SHDBs are shown in Figure 13.

The FICCI SLCA **covers a low-cost garment considered to be manufactured globally**, i.e. the fibre origins and the countries of production/ manufacturing at each life cycle stage are taken in proportion to global apparel production, as formulated in the Measuring Fashion LCA on global apparel production (see Box 1). The global fibre breakdown is also that of the Measuring Fashion LCA, except that the SHDB only allows a distinction between natural and synthetic fibres, i.e. the proportions of cotton and other natural fibres are combined, and synthetic and semi-synthetic fibres are combined in the SLCA. The use and end-of-life of the garment are not considered in the SLCA since the method relies on the availability of cost data, which are readily available for garment production, but very difficult to obtain for use and end-of-life.

Figure 13: Social risk categories and themes covered in the SHDB (Norris and Norris, 2015)[13]

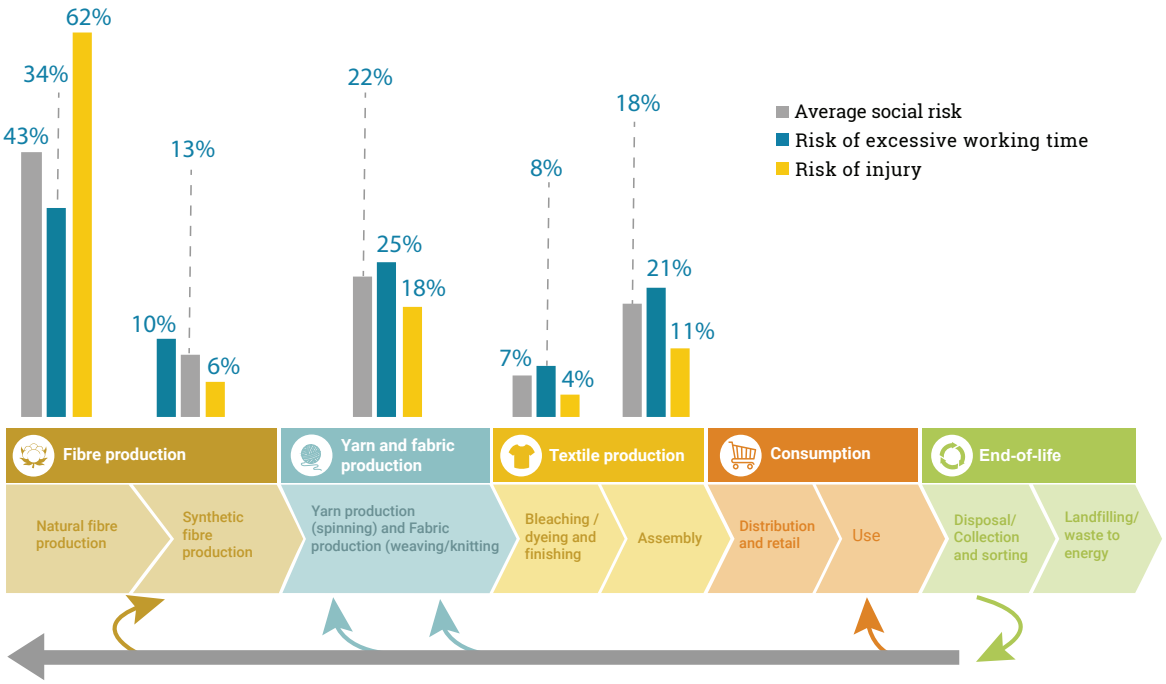
Note: Shaded boxes are those considered in the FICCI Social hotspots analysis of a low-cost garment, which this report builds upon.

11 http://www.socialhotspot.org/

12 https://www.gtap.agecon.purdue.edu/

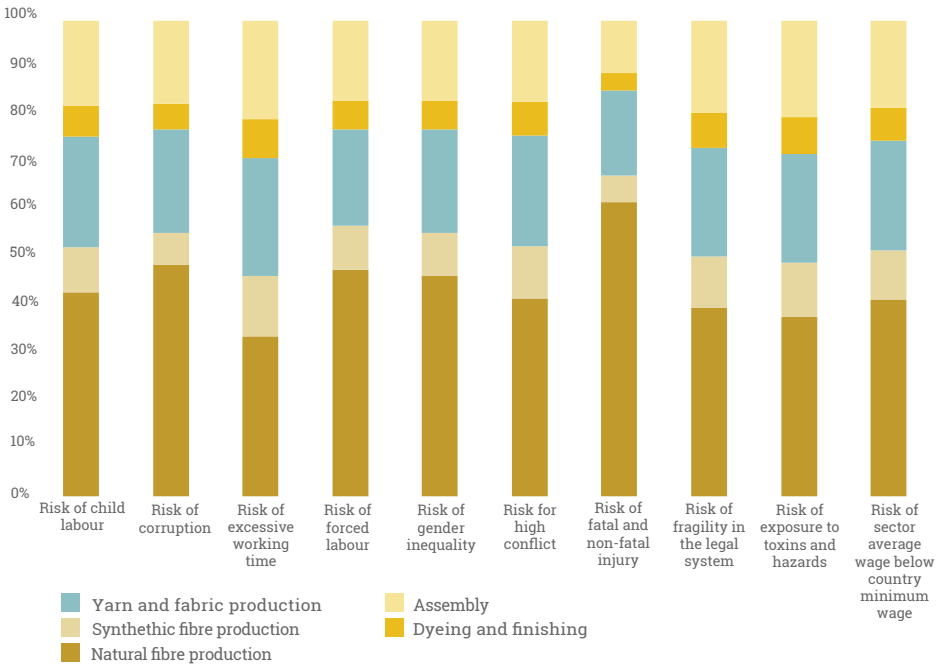
13 Updated to include social themes added to the SHDB since 2015.

Figure 14: Social risks across the textile value chain



Note: For the manufacture of a low-cost garment made of 30% cotton and 70% polyester. "Average social risk" is the average of the social impact risk indicator scores for child labour, corruption, forced labour, gender inequality, high conflict, fragility in the legal system, exposure to toxins and hazards, and sector average wages below the country minimum wage. Source: Social LCA on global apparel, see Box 4. A lack of data meant that the use and disposal phases were not included in the analysis, and that yarn and fabric production were combined into a single stage.

Figure 15: Contribution of the textile life cycle stages to each of the ten social impact risk indicators identified for the global apparel industry



Note: For the manufacture of a low-cost garment made of 30% cotton and 70% polyester). Source: Social LCA on global apparel, see Box 4.

The yarn, fabric, textile production and assembly stages of the value chain are also associated with social risks, with yarn and fabric production the next most significant after fibre production, followed by garment assembly[14]. As would be expected from the geographical breakdown of the textile value chain (see Figure 5), China and India are the countries with the highest social risks due to fibre, yarn and fabric production, with Bangladesh having equally significant risks at the later stages of textile production (assembly). It is interesting to note that India was found to have the highest social risks in fibre and textile production, despite having a much lower share of global production than China, indicating significantly higher social risks in India compared to China across the indicators considered.

The high social risks of textile production arise as a consequence of the highly skewed economics of the global textile value chain, something that has come under the global spotlight during the COVID-19 pandemic (see Box 7). High economic added value per stage occurs only towards the consumption end of the textile value chain[15], with low-cost, low-skill activities occurring at the earlier stages of the value chain (FICCI 2018). Consumer expectation of low prices and competition for market share among brands and retailers have led to labour-intensive fibre and textile production being directed to developing/transitioning countries. Three common practices in the textile value chain contribute to its high social risks (Lindenmeier et al., 2017; Lund-Thomsen and Lindgreen, 2018; Perry and Towers, 2013):

- Demand for ever shorter lead times: The apparel market is characterized by short-lived products, whose designs are saleable for only a few months or even weeks. This puts pressure on producers to constantly keep up with the changing demand, with the result that workers are often required to work long hours.
- Demand for flexibility: The requirement for market agility due to high market volatility means thatproducers must be able to adjust their production to meet customer demand, resulting in instability in jobs and incomes; and
- Continual search for lower prices and better business terms: This puts pressure on producers to operate where costs are lowest and thus where minimum wage requirements and labour standards are insufficient, poorly enforced or non-existent.

The complexities of the global textile value chains add to the prevalence of poor social conditions in fibre and textile production. The lack of traceability across globally dispersed textile value chains, with a large number of enterprises operating across a number of countries with varying commercial, legal and ethical standards, hampers the ability of buyers and retailers to identify non-ethical suppliers. However, the increasing recognition of reputational risks in their supply chains, coupled with pressure from consumer campaigns and governments for greater transparency and responsible business conduct (see Box 6 and the European Parliament report (European Parliament, 2017)), has led to big brands and retailers taking greater responsibility for their supply chains. There is a risk, however, that rather than providing guidance to improve the performance of their suppliers, brands will instead divert their business away from high risk locations. This could have devastating consequences for those areas and those segments of the population (notably women) that rely on the income opportunities that the textile sector provides.

The complexities of the global textile value chains add to the prevalence of poor social conditions in fibre and textile production

14 The fact that the social hotspots analysis (see Box 4) was based on economic flows meant that the same degree of breakdown in the textile value chain was not possible for social indicators as for environmental indicators. It also meant that the use and disposal phases could not be included in the social hotspots analysis.

15 Only 25% of the price paid for a garment relates to the physical material and production costs (FICCI, 2018).

Box 5: Women in textiles

A particular feature of the textile industry is the large number of women in its workforce. This feature of women making up the majority of the workforce is typical of many countries, but it is not universal. **Women make up 70% of the 3 million people employed in garment factories in Bangladesh, and Mexico and Cambodia have even higher percentages, but in India the majority of garment workers are men** (UNEP, 2016).

Economic practices that have seen textile manufacturing diverting to developing economies (such as the continual search for lower prices, flexibility and ever shorter lead times) are also responsible for the prevalence of women in the textile work force. This is because women are universally paid less than men, and the ability to pay women lower wages than men is seen as a way to enhance investments and increase profits, while keeping the cost of goods low for export (UNEP, 2016). At the same time, the gender gap is especially persistent when it comes to leadership roles. Government and corporate policies that exploit the "labour-cost advantage" of hiring women entrench gender stereotypes and perpetuate the concentration of women in unskilled, high turnover jobs.

The fact that **women's' jobs** are in the "bottom tier" of textile production systems means they **have the highest risks of occupational injuries and exposure to hazardous chemicals** (UNEP, 2016). Furthermore, women are particularly susceptible to the health risks from chemicals used in the wet processing of textiles due to the nature of the chemicals: for example, chemicals contributing to the development of breast cancer and endocrine-disrupting chemicals leading to reproductive problems (UNEP, 2016).

The gender gap in access to land, education and financial inclusion means that the impact of the textile value chain on women goes beyond the fact that they are a major component of the textile workforce. For example, in many countries, women will continue to be excluded from economic opportunities in cotton cultivation while laws preventing women from owning and/or inheriting land persist. The gender gap in business performance, due among others factors to access to finance, information and communications technology (ICT) use, skills, human capital, agency and the business environment (the latter involving elements such as time for child care, harassment and property holding), will continue to see women excluded from economic opportunities along the value chain unless these are addressed. Currently, **less than one percent of spending of large businesses on suppliers is earned by women-owned businesses** (UN Women, 2017). Thus, while the fashion industry in particular has been identified as having high potential to increase economic opportunities for women, improving women's financial inclusion in the sector is essential if such potential is to be achieved - for example, through provision of access to markets and suppliers, providing funding to entrepreneurs and SMEs, provision of market information, and education and training on business and financial matters (African Development Bank Group, 2016). As well as financial inclusion, companies should ensure that women are included in decision making and social dialogue processes (see also Box 6), and are enabled to have equal and meaningful participation in consultations and negotiations in line with due diligence (OECD, 2018).

It is essential in transitioning to a sustainable and circular textile value chain that the structural and economic factors preventing the inclusion of women are addressed. It is especially important that the transition to a sustainable textile system, for example with fewer low-income jobs and demand for higher-skilled work, does not further disadvantage women. Nonetheless, with a strong focus on access to higher education, skills development and business performance, the transition offers great opportunities.

Box 6: The role of social dialogue and due diligence as defined by the ILO and OECD

Social dialogue has been a key part of the work of the International Labour Organization (ILO) since its foundation. The 2019 Centenary Declaration for the Future of Work stressed the importance of social dialogue for long-lasting peace and social justice as defined in the ILO Constitution more than one hundred years ago.

Social dialogue comprises all types of negotiation, consultation or simply exchange of information between, or among, representatives of governments, employers and workers, on issues of common interest relating to economic and social policy. It can take place at the national, regional, or enterprise level. It can be inter-professional, sectoral or a combination of these.

Cross-border social dialogue (XBSD) can be defined as "social dialogue between or among representatives of governments, employers and workers across national borders" (ILO, 2018). International Framework Agreements are important vehicles of XBSD, **promoting respect for fundamental principles and rights at work within global supply chains and across different sectors**. They are voluntary agreements negotiated directly between multinational enterprises and Global Union Federations. International Framework Agreements encompass general principles and provisions around collective bargaining, working conditions, health and safety issues and more recently, issues around data protection and work-life balance. In terms of enforcement, a second generation of framework agreements is emerging, with improved provisions detailing implementation procedures, monitoring and dispute resolution, as well as provisions establishing the compliance responsibilities of subcontractors and suppliers. (ILO, 2018).

The OECD Guidelines for Multinational Enterprises (MNEs) (OECD, 2011) are the most comprehensive set of government-backed recommendations on what constitutes responsible business conduct (RBC).

The Guidelines cover nine major areas of RBC: information disclosure, human rights, employment and industrial relations, environment, combating bribery and corruption, consumer interests, science and technology, competition and taxation. **The OECD Guidelines are the first international instrument to incorporate risk-based due diligence[16] into major areas of business ethics related to adverse impacts.**

The OECD Due Diligence Guidance for Responsible Supply Chains in the Garment and Footwear Sector (OECD, 2018) helps enterprises implement the due diligence recommendations contained in the OECD Guidelines for MNEs in order to avoid and address the potential negative impacts of their activities along the garment and footwear supply chains. It seeks to ensure that the operations of enterprises in the garment and footwear sector are in harmony with government policies, and to strengthen the basis of mutual confidence between enterprises and the societies in which they operate. The Guidance also supports enterprises with the implementation of the due diligence recommendations contained in the United Nations Guiding Principles on Business and Human Rights, and is aligned with the ILO Declaration on Fundamental Principles and Rights at Work, relevant ILO Conventions and Recommendations and the ILO Tripartite Declaration of Principles Concerning Multinational Enterprises and Social Policy.

There are clear advantages for social partners in engaging in global framework agreements, especially in the textile sector. They support the rights of workers throughout the textile value chain and help address some of its most severe social risks. However, they should not be seen as replacing national social dialogue among governments, employers and workers or collective bargaining agreements negotiated between employers and trade unions.

16 Due diligence is the process through which enterprises can identify, prevent, mitigate and account for how they address their actual and potential adverse impacts. "Risk-based due diligence" requires that the procedures that an enterprise implements to conduct due diligence are proportionate to the severity of the adverse impact. "Adverse impact" covers negative impacts related to disclosure; human rights; employment and industrial relations; environment; combating bribery, bribe solicitation and extortion; and consumer interests (OECD, 2018).

Value loss at end-of-life

The considerable under-utilization of clothing and the very low rates of repurposing and recycling of textiles after use represent considerable loss of material value. Value loss occurs through textile products not being kept in service for as long as they could be, not being resold or repurposed when consumers discard them still in good condition – or not being sold in the first place, and being landfilled or incinerated rather than remanufactured or recycled when they reach material end-of-life. Globally, the annual cost to consumers of throwing out clothing that they could continue to wear is estimated at $460 billion[17].

An analysis of global material flows of textile fibres by the Ellen MacArthur Foundation found that just 13% of the fibre input for clothing is recycled. Less than 1% of this is closed-loop recycling, i.e. fibre recycled back into clothing, rather than into lower value uses, such as cleaning cloths and insulation. This is estimated to equate to an annual material value loss of more than $100 billion (Ellen MacArthur Foundation, 2017). It is however worth noting that one conclusion of The Circular Fibre analysis is that better reporting standards and data consolidation are needed on a global level, given the lack of knowledge of what happens to textiles at end-of-life (Ellen MacArthur Foundation, 2017).

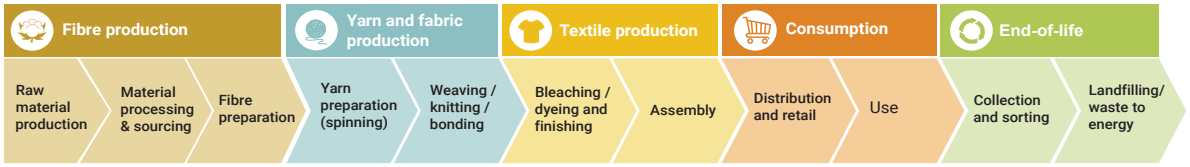
A review of the environmental impact of textile re-use and recycling found that re-use is always more beneficial than recycling, and that, in general, textile re-use and recycling reduce environmental impacts compared to incineration and landfilling (Sandin and Peters, 2018). Smaller recycling loops are more environmentally beneficial than larger loops. That is, recycling back to fabric has the potential to avoid both the production of raw materials and the subsequent fibre, yarn and fabric production processes, while recycling back to fibre only avoids the production of raw materials. For those impacts where textile production accounts for the majority of the impact, such as climate impact, recycling back to fibre can have relatively low mitigation potential (if any at all, if the recycling process itself has high energy inputs). However, recycling cotton fabric back to fibre can potentially reduce the water footprint by 90%, since raw material production accounts for a significant majority of the water impact. Nonetheless, while fabric recycling can potentially mitigate more impacts than recycling back to fibre, fabric recycling may often be unfeasible due to the material being too worn out or the difficulty of finding a suitable end use (Roos et al., 2019).

Furthermore, the type of fibre being recycled makes a difference. Recycling of cotton has the potential to mitigate freshwater depletion and the use of pesticides and fertilizers (along with their impacts), while recycling polyester fibres has potential to mitigate fossil resource depletion and climate impact (Roos et al., 2019). Finally, it is important to note that closed loop recycling (i.e. recycling textiles back into textiles) is not automatically "better" than open-loop recycling. There are cases when recycled textile materials hold a much higher economic value in another industry sector (Roos et al. 2019). One example is using low-grade recycled textile fibres to reinforce thermoplastic biocomposites for the automotive industry.

Despite the clear environmental benefits of extending the life of clothing, the re-use of textiles can lead to both positive and negative socio-economic impacts. A growing movement to recycle and re-use textiles, particularly in the European market, has seen used clothing collected and exported overseas. The sorting and trading of used clothing creates business opportunities and employment in both the exporting and importing countries, while generating government revenue through tax and providing access to affordable clothing. The export of 12,000 tonnes of Nordic textiles to Africa is estimated to support more than 10,000 market sellers and their families (Watson et al., 2016a). However, there are also potentially negative effects, with the importation of used clothing putting local textile producers out of business and flooding landfill sites with waste textiles in countries that typically do not have the waste management facilities to deal with them (Leal Filho et al., 2019; Watson et al., 2016b; Wetengere, 2018). However, studies are in development that look more deeply into the implications of the export of used textiles (Watson et al., 2016a).

17 Estimated for 2015 based on the Circular Fibres Initiative materials flow analysis and Euromonitor International Apparel & Footwear 2016 Edition (Ellen MacArthur Foundation, 2017).

Figure 16: Environmental, social and economic hotspots of the global apparel value chain



Impacts	Hotspots										
Climate	Fossil fuels used in production of synthetic textiles				Coal-based energy used in textile production			Electricity used in washing and drying			
Water scarcity	Water used in cotton cultivation							Water used in washing			
Land use	Land used in cultivating cotton leads to habitat loss and impacts on biodiversity										
Ecosystem quality	Fertilisers, herbicides and pesticides used in cotton cultivation				Chemicals and water pollution in textile production			Electricity and detergent used in washing and drying; microfibres releases			
Human health	Agrochemicals used in cotton cultivation; risk of injury and exposure to toxins and hazards		Risk of injury and exposure to hazards		High use of chemicals (risk of exposure to toxins and hazards); high use of coal-based energy	Risk of unsafe working conditions					
Social risk	Risk of child labour, forced labour, excessive working time, below minimum wage pay, gender inequality and conflict		Risk of child labour, forced labour, excessive working time, below minimum wage pay, gender inequality and conflict			Risk of child labour, forced labour, excessive working time, below minimum wage pay, gender inequality and conflict					
Governance risks	Risk of corruption and fragility in the legal system		Risk of corruption and fragility in the legal system			Risk of corruption and fragility in the legal system					
Value loss											Materials and resources lost in landfill and incineration
							Economic value add highly skewed to top end of value chain				Textile "dumping" disrupting local industries

Note: Although different textile products produced in different geographies using different technologies and fibre sources will show different environmental and socio-economic hotspots, the available literature points to the impacts listed here being the highest points of impact for the global apparel value chain. Note also that for each impact considered, not all impacts are shown but only the highest points in the value chain (i.e. the hotspot).

Summary

Based on the environmental and socio-economic impacts described in the earlier paragraphs, the resulting hotspots (i.e. highest impacts) along the textile value chain, which are also summarized in Figure 16, are:

Fibre Production	• High use of **fossil fuels** to produce **synthetic fibres** (which involves climate, human health and ecosystem quality impacts) • High use of **agrichemicals, land** and water to produce **natural fibre**s, especially cotton (leading to biodiversity and ecosystem quality impacts) • **Unsafe working conditions** and **fragility of the legal system** (leading to human health impacts and social risks)
Yarn and Fabric Production	• **No hotspots identified** (although there are climate, human health and ecosystem quality impacts, along with social risks, the available life cycle data shows yarn and fabric production is not among the top contributors to impacts when the whole value chain is considered)
Textile Production	• High use of **fossil fuels** for heat and electricity generation in energy-intensive textile processes (which involves climate, human health and ecosystem quality impacts) • Use of **hazardous chemicals** (leading to high human health and ecosystem quality impacts, particularly via water pollution) • **Release of microfibres** (leading to ecosystem quality impacts and potential human health impacts) • **Unsafe working conditions** and **fragility of the legal system** (leading to human health impacts and social risks)[18]
Use Phase	• High use of **electricity** in the care of textiles over their lifetime (fossil fuels used for energy production, leading to climate, human health and ecosystem quality impacts) • High use of **water** and releases of **microfibres** in washing textiles over their lifetime (leading respectively to water scarcity, ecosystem quality and potential human health impacts)
End-of-Life	• **Low rates of recovery** of textiles at end-of-life leading to high material value loss and non-renewable resource depletion

18 As explained earlier in the section, human health impacts include injuries and exposure to toxins and hazards, while social risks considered in the analysis include low wages, excessive working hours, forced labour and child labour, gender inequality, corruption and fragility in the legal system.

Box 7: The impact of COVID-19 along the textile value chain

In 2020, as this report is published, the world is facing an unprecedented crisis caused by the COVID-19 outbreak. The textile sector, which is labour and capital intensive, is badly affected; many of the fragilities that are now in the spotlight have existed for a long time due to fundamental inequalities and the disproportionality in the way economic value is added along the textile value chain. **The crisis sheds light on the magnitude of social risks and inequalities, which occur particularly in upstream activities in the textile value chain.**

COVID-19 and economic impacts

The crisis caused by the global COVID-19 pandemic and its economic consequences further highlights and exacerbates the vulnerabilities along the textile value chain. Induced by a **collapse in demand from consumers, complete lockdown scenarios, shortages in raw material availability and cancellation of orders, the entire textile sector has faced extreme deceleration**. An example is the shutdown of Chinese factories in early 2020. The disease unfolded in China early on, and measures were taken in response to the outbreak when other parts of the globe were not yet as badly affected. As China is a major supplier of fibre, yarn and fabrics, textile manufacturing processes across the globe encountered raw material deficits due to the disruption of value chains. At the same time SMEs involved in the production stage experienced increased pressure to repay their debts to banks.

- According to a survey undertaken between 28 March and 6 April 2020 among members of the International Textile Manufacturers Federation, orders for textiles went down by 31% on average worldwide, while turnover is expected to decrease by 28% on average in 2020 compared to 2019 (International Textile Manufacturers Federation, 2020).
- As of April 2020, a survey of over 500 facilities across all main production regions worldwide has shown that 86% of production facilities have been impacted by cancelled or suspended orders. As a result, 40% are struggling to pay their workers (Boston Consulting Group, Sustainable Apparel Coalition and Higg Co., 2020).
- An online survey of Bangladeshi employers, administered between 21 March and 25 March 2020, found that when orders were cancelled 72% of buyers refused to pay for raw materials such as fabric already purchased by the supplier (Anner, 2020).

COVID-19 and social impacts

The consequences of the COVID-19 outbreak have further exacerbated existing social and human rights issues. Most fashion brands pay their suppliers only after delivery. This means that manufacturers who had already purchased materials and remunerated their workers are left with stocks if brands cancel or hold their orders. Subsequently, these cancellations of orders and stopping of payments by fashion brands and retailers have put enormous financial pressure on those situated at the textile production stage (Fashion Revolution, 2020b). As the majority of textile factories are located in countries with no or limited regulations for workers' social protection, textile workers are especially vulnerable to the negative consequences of the pandemic. **As women make up the majority of textile workers, they are also proportionately more vulnerable to the impact of the COVID-19 pandemic on the industry** (UNEP, 2016).

The crisis caused by the global COVID-19 pandemic and its economic consequences further highlights and exacerbates the vulnerabilities along the textile value chain

In the immediate short term, the COVID-19 outbreak has provided the impetus to revisit our relationship with nature

Brands and retailers have been criticized for focusing on saving jobs for their direct employees alone, and neglecting the impacts their decisions might have on their suppliers' workers. An additional challenge for the textile sector is the lack of transparency, which has made it difficult to hold brands accountable for potential disruptive impacts especially further up their supply chain.

With cancellations of orders worth hundreds of millions of US dollars, producers in Asian countries, which typically pay lower wages, are struggling to survive in the COVID-19 crisis. Myanmar, Cambodia and Bangladesh are the worst hit (Klawitter, 2020). **Cancellations of orders have greatly impacted the economy and subsequently led to workers being furloughed or dismissed – as an illustration, textile products represent more than 80% of Bangladesh's exports.**

- In Bangladesh, 4 million workers have been put at risk, mostly women, with 1 million garment workers having already lost their jobs in April 2020 (UNECE, 2020).
- According to a survey of employers in Bangladesh, which was undertaken in March 2020, 72.4% of furloughed workers had already been sent home without pay and 80.4% of dismissed workers had not received severance pay by that time (ILO, 2020).
- In the Cambodian province of Kandal, less than half of the garment workers affected by factory suspensions had received their wages by the end of May (Sen, 2020).
- In Pakistan, 85% of workers have no contract, making it easy for factories to implement forced dismissals (Toppa, 2020).
- In India, the pandemic has resulted in the large-scale migration of workers: migrant labourers facing an existential crisis are returning to their native regions.

The situation is aggravated as the workers in the upstream processes in the value chain (fibre production, yarn and fabric production, textile production) are typically highly dependent on their income to provide shelter, food and security for themselves and their families (Boston Consulting Group, Sustainable Apparel Coalition and Higg Co., 2020), because the extremely low earnings that are the general rule do not enable them to accumulate savings (Anner, 2020). **Only 2% of brands reviewed in the Fashion Transparency Index 2020 publish data on the percentage of workers in the supply chain who are paid above the minimum wage** (Fashion Revolution, 2020a). Even in countries that protect dismissed workers through unemployment insurance or wage subsidies, many informal workers fall through the safety net, leaving those who can least afford it at disproportionately high risk (Fine et al., 2020).

Furthermore, textile workers face disproportionately high health risks in their workplace due to the lack of measures preventing infection by the spread of COVID-19. In May 2020, workers in garment factories in Bangladesh, which reopened despite a nationwide coronavirus lockdown, were forced to return to work in cramped conditions where mask-wearing and physical distancing were not enforced. As of April 2020, 1,000 textile factories in Bangladesh were operating again (Ellis-Petersen and Ahmed, 2020).

COVID-19 and environmental impacts

In the immediate short term, the COVID-19 outbreak has provided the impetus to revisit our relationship with nature. According to research by Global Fashion Agenda and McKinsey, two thirds of consumers state that sustainability has become a more important priority than combating climate change following COVID-19 (GFA, 2020). This growing emphasis on sustainability is believed to stem from the desire to **"build back better"** after the effects of COVID-19, and brands are starting to respond to increased consumer pressure with a greater emphasis on "seasonless" fashion – one example is Gucci's latest announcement that they were limiting their shows to two a year, showing collections that were not specific to the season, and that this was part of an aspiration for "getting rid of the unnecessary" as stated by Gucci's Creative Director Alessandro Michele on 27 April 2020 (Holland, 2020).

The COVID-19 outbreak further highlighted the urgency of transitioning from the textile industry's current model (which is characterized by overproduction and significant impact), to a more sustainable, socially inclusive and circular model

However, alongside this potential transformation of expectations around fashion, many aspects of the COVID-19 crisis may have wide-reaching negative consequences for the fashion industry and its ability to address environmental challenges. **The fashion industry has faced one of its biggest ever financial shocks**, and brands and supplier companies are all reeling after factory and store closures, cancelled orders and massive decreases in consumer spending caused major cash flow challenges, a breach in trust between supply chain actors, and the need to cut many jobs or even close factories or businesses altogether. According to McKinsey and Business of Fashion in their report "The State of Fashion 2020", **there is expected to be a 30% drop in this revenue in the coming year and a slow recovery into 2021** (The Business of Fashion and McKinsey & Company, 2019). In the light of this new environment within the textiles industry, many are questioning whether sustainability programmes and commitments can survive such an economic free-fall, and whether suppliers will be prepared to invest the time and funds required to meet sustainability demands made by brands that have not stood by them during the crisis. .

There are some signs of hope. For example in the BCG, SAC and Higg Co. report "Weaving a better future; Rebuilding a more sustainable fashion industry after Covid-19", researchers note that "surveys with key stakeholders, study of prior global crises, and analysis of economic trends and consumer sentiment make it clear that fashion risks irrecoverable self-inflicted wounds if it abandons sustainability and value chain partnerships in the face of COVID-19. While sustainability is in danger in some areas of the industry, companies that embrace it will be among the leaders of a resurgent fashion industry on the other side of the pandemic". They conclude that repairing relationships with suppliers and focusing efforts on core priorities will help protect sustainability efforts across the value chain.

The COVID-19 crisis has also potentially created a significant increase in waste production across textile types. As hygiene standards increase to prevent further spread of the virus, waste generation is rising due to the disposal of personal protective equipment such as masks and gloves. Incorrect discarding of these items results in environmental impacts, which have become visible as face masks are washing up on shorelines, polluting oceans and maritime ecosystems (Kassam, 2020). In addition to a stark increase in waste, there is a risk that massive stocks of apparel will not reach end-consumers. This would represent a significant resource and economic loss, as well as enormous textile waste.

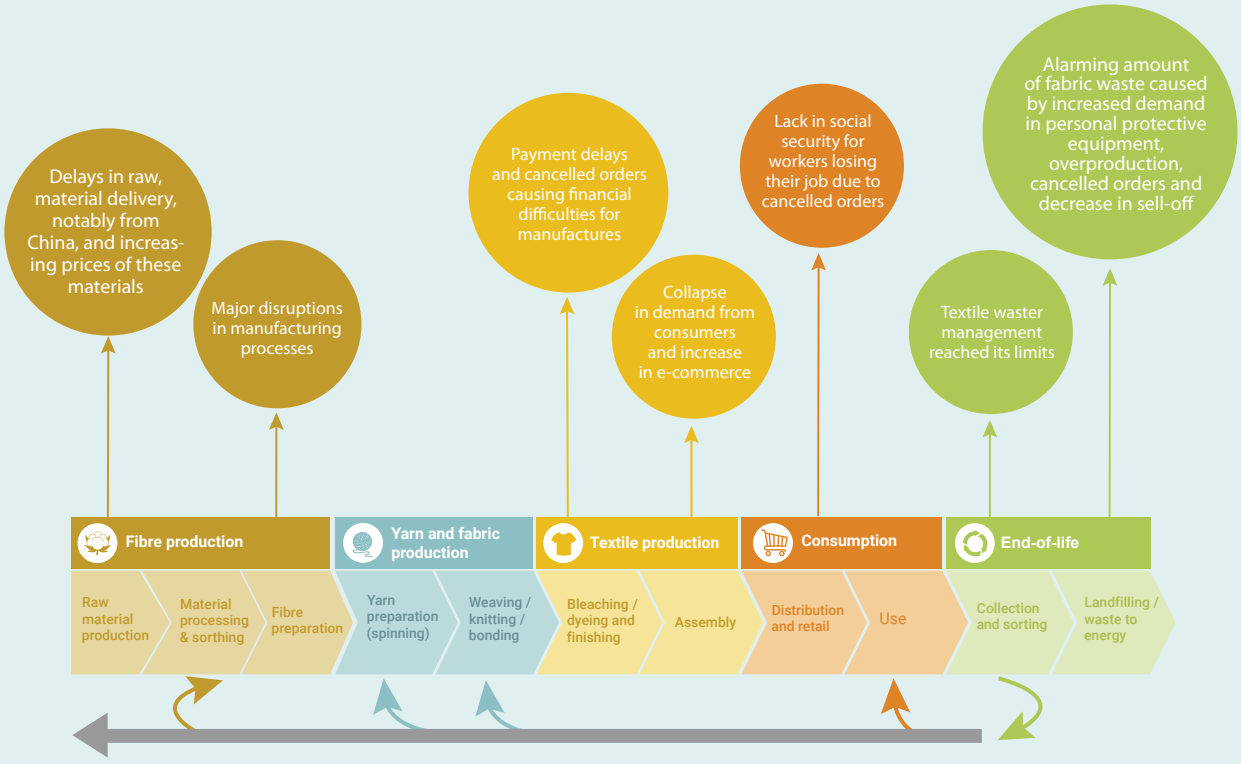
The occurrence of unnecessary fabric waste due to overproduction, cancelled orders and decrease in sell-off is even more alarming considering the fact that, according to the Fashion Transparency Index 2020, only 27% of brands publish information about the steps they are taking to reduce the amount of waste created before their clothes hit the shelves. Only 18% of brands explain their approach to developing circular solutions that enable textile-to-textile recycling (Fashion Revolution, 2020a).

During the crisis, the textile recycling industry was not operating as a result of possible health risks to employees and lockdown scenarios, and had reached full storage capacity as stocks grew. When charity shops and second-hand stores were closed due to lock-down, demand in end markets of second-hand apparel decreased and the quality of donated clothes was at its lowest standard in history (Doherty, 2020). Extremely high rates of unsold stock (GFA, 2020) could exacerbate these challenges, and lead to extreme discounting of excess stock, further reducing the value of products in the eyes of the consumer, flooding second-hand markets globally, or leading to stock incineration by brands. All of these outcomes would potentially waste the materials and resources put into the items produced.

The COVID-19 outbreak further highlighted **the urgency of transitioning from the textile industry's current model (which is characterized by overproduction and significant impact), to a more sustainable, socially inclusive and circular model.** The demand is there from the consumer side, but this is tempered by some increasingly challenging realities about the global value chain. Strategies to help the industry "build back better" must take account of these challenges in order to be effective.

The COVID-19 crisis has also potentially created a significant increase in waste production across textile types

Figure 17: COVID-19 impacts along the textile value chain (non-comprehensive examples)




Serious
GAME

3 Advancing sustainability and circularity in the textile value chain

This chapter looks at the actions needed to move the current linear textile system with its high social risks to one that is sustainable and circular, providing safe and secure livelihoods to all. The actions needed are informed by the value chain environmental and socio-economic hotspots (Section 2.2), and discussed in the light of actions already being undertaken by various textile initiatives. The actions required are also informed by the views of multi-stakeholder experts at recent UNEP workshops, panels and roundtables. Example boxes in this chapter showcase some of the initiatives that are already in place, tackling different sustainability aspects, but should not be read as "end state" examples of circularity in the textile value chain.

In order to identify what needs to be done to achieve sustainable and circular textiles, it is necessary to first define what such a sustainable and circular textile value chain would look like. Participants at the expert multi-stakeholder consultation workshop "Accelerating Actions for a Sustainable and Circular Textile Value Chain" which took place in January 2019 provided their vision for a sustainable textile value chain that achieves circularity. This is summarized in Figure 18. A sustainable textile industry is one that is resource-efficient and renewable resources-based, producing non-toxic, high quality and affordable clothing services and products, while providing safe and secure livelihoods. To achieve such an industry will require a shift in business model towards more circularity, informed consumers and fair, transparent and traceable value chains. Implicit in the definition of a sustainable textile value chain is that it must operate within planetary boundaries, and that consumption cannot go unchecked, regardless of how efficient and circular the system is able to become.

Circularity, as conceptualized in the UNEP circularity platform[19], provides a model to transform the current textile economic model towards a sustainable future. It requires governments, businesses and consumers to look beyond the current "take, make and dispose" extractive industrial model, and to redefine growth, focusing on positive society-wide benefits. Circularity's underlying objective is that materials should be kept at their highest possible value as they move and are retained as long as possible within the textile value chain. This reduces and disconnects the use of natural resources and environmental impacts from the economic activity of the textile industry, while continuing to enable improvements in human well-being.

Life cycle thinking, which enables the identification of strategic intervention points along the value chain and the engagement of all stakeholders, is also essential for a successful and sustainable transition to a circular textile value chain.

Circularity needs to be inclusive to not only support the conservation of the environment but also the well-being of all. Such an inclusive approach enables businesses to increase revenues by accessing impactful investors, and create new customer value as resource efficiency benefits multiply across the entire textile value chain. The transition also prompts

19 UNEP (2019b) UNEP Circularity Platform, www.unep.org/circularity

Figure 18: Vision for a sustainable and circular textile value chain that emerged from UNEP multi-stakeholder consultation workshop in January 2019

governments to invest in cost-effective solutions to address the climate crisis and the risks posed to citizens' health. This helps conserve the natural environment, as circular textile models require the extraction of fewer resources and help prevent, or at least better manage and where possible re-use, pollutants and waste, and preserve wildlife and ecosystems. Circularity generates new and decent jobs, while enabling a switch to more equitable and sustainable economies. Policy makers also have a role to play in developing supporting policies and programmes to enable an inclusive and just transition and support those at risk of being left behind – by involving relevant stakeholders in the process, in particular those from affected communities and workforces as well as their representatives (ILO, 2015).

It is also essential that circular policies and practices in the textile sector are complemented **by more responsible consumption choices,** which reinforce those policies and practices on the supply side with actions by public and private consumers. These also serve to reduce inequalities among societies at all levels, from the local to the global.

Creativity and cooperation among all textile value chain actors, supported by enabling policy frameworks established by public authorities, are essential for the transformation towards circularity. They are required to ensure nobody is left behind – especially in the informal sector, encourage meaningful behavioural change in relevant stakeholders' groups, and create innovative solutions along the value chain. Such solutions can ensure for example that toxic chemicals are kept out of, or easily separated from, recycling streams and the workers managing them, or that the utilization rate of textile products is increased through multifunctional apparel design.

Circularity is built on the overall guiding principle of "Reduce by design". Applied from the earliest stages of design of products and services, "Reduce by design" aims to reduce the amount of material, particularly raw material, and hazardous chemicals consumed during production and/or during use. Production and consumption patterns as well as end-of-life of textile products are influenced by the design of products to lead to less impact and less waste, including through rethinking business models, so that high quality, long lasting products are preferred to cheap fast fashion.

Circularity also builds upon three types of value retention loops, as follows:

> Circularity needs to be inclusive to not only support the conservation of the environment but also the well-being of all

"User-to-user" value retention processes, where a product or component remains close to its user and function.

Consumers (private consumption as well as public demand) have strong leverage in contributing to the circularity of textile products by keeping them in use for as long as possible and not buying superfluous and unsustainable products. Motivating these more responsible consumer choices by setting new trends in the civil society associated with the textile industry is essential to accompany a sustainable change in practice. "User-to-user" value retention loops translate into three distinct circular processes:

Refuse: It is a user choice to buy or use less, by saying no. It implies shifting to more sustainable lifestyles, for example rejecting packaging, shopping bags, or other textile products or services that are considered unnecessary. Refusal can also apply to a specific element of a textile product, such as rejecting the use of hazardous substances in its design. By refusing to buy or consume, users send a strong signal to the market, helping the textile industry to transition to more circular models.

Reduce: This implies consumers rethinking how they can best meet their needs and live their aspirations with minimal impacts on the planet and the people around them. It is a user choice to use textiles and associated services for a longer time, and buy less frequently. Reduction can be implemented at no cost, and has strong potential in retaining the value of a textile product or service for a longer time period.

Re-use: This refers to the using again of a textile product that is not waste. Re-use and re-sale imply a consumer choice to hand over to another user, most frequently without any intermediary and with no modification of the product. It applies to the use of second-hand products. Re-use and re-sale can be implemented at little cost, and have strong potential in retaining product value. As the potential for re-usability becomes a selection criterion when purchasing textile products, users encourage the textile industry to offer more robust products and materials, with a longer lifetime – hence fostering more sustainable consumption and production patterns.

"User-to-business" value retention processes, where a product or component is upgraded and producers involved again.

In the textile value chain, producers, in collaboration with consumers, have an opportunity to extend the lifespan of their textile products by repairing them so that they can continue to fulfil their function to users. The repair circular process is defined as follows:

Repair: This refers to the fixing of a specified fault in a product which would otherwise be considered as waste, in order to make the textile product fully functional for use for its originally intended purpose – thus extending its product lifetime. A user sends the product for repair, to a business intermediary, through the retailer or directly to repair shops. The textile product comes back to its original user or to a new one. Repair can also be considered as a service to users.

"Business-to-business" value retention processes, where a product or component loses its original function.

Producers, in cooperation with other value chain stakeholders (designers, producers, retailers, waste handlers, recyclers, raw material producers, etc.) need to work together to ensure discarded textile goods and components are not lost to disposal processes but are instead used as materials in other product systems. It translates into the following two circular processes:

Repurpose: By re-using discarded goods or components adapted for another function, the material gets a distinct new life cycle. Converting old or discarded textile materials into something useful – be it as another piece of clothing, or as a different product – allows them to return to the economy while retaining some of their value. From a user perspective, repurposing allows to add singularity through design or a new function, meaning users can obtain "one-of-a-kind" items by purchasing unique pieces. From a production perspective, repurposing enables financial savings, through the reduced production costs of reclaimed textile material, as well as reducing waste generation and associated treatment requirements.

Recycle: This refers to the operations which prevent waste disposal and allow material to re-enter the economic cycle. These are defined in Annex IV B to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Recycling operations usually involve the reprocessing of waste into products, materials or substances, though not necessarily for the original purpose, an example being textile material recycled as insulating material. Recycling is a valuable source of material. However, it requires collection systems, technology and infrastructures that are lacking in many countries.

Circularity goes beyond incremental improvements [...] and requires a system-wide approach, transforming the way textiles are designed, produced, consumed and disposed of

Importantly, circularity goes beyond incremental improvements, e.g. increasing resource efficiency, increasing recycling rates and decreasing hazardous chemical use, and requires a system-wide approach, transforming the way textiles are designed, produced, consumed and disposed of. One critical part of achieving circularity, therefore, is to bring together the many initiatives addressing different aspects of textile sustainability to advance the required systemic changes. There are already a number of initiatives and policies aiming to achieve such systemic change, for example, the Ellen MacArthur Foundation's Make Fashion Circular and the Policy Hub for Circular Economy[20]. These illustrate the multi-stakeholder nature needed to advance circularity. In addition to textile-specific initiatives, there are a number of initiatives that promote circularity more broadly, and consequently have relevance to textiles, such as the Partnership for Accelerating the Circular Economy (PACE)[21].There are also initiatives aiming to advance circularity at regional level, such as the African Circular Economy Alliance, the Latin-American and Caribbean Regional Coalition on Circular Economy and the European Circular Economy Action Plan[22].

Awareness of the environmental and socio-economic impacts of textiles has led to a considerable number of actions aimed at decreasing social risks and improving environmental performance. Initially, the focus of initiatives was social sustainability, but this has broadened to include environmental sustainability, with initiatives particularly focusing on hazardous chemical use in textile production. More recently, the rise in awareness of the unsustainable levels of resource use and volumes of waste arising from fast fashion have led to increased recognition of circularity and new underlying innovative business models advancing the circular processes key to delivering sustainability and circularity in the textile industry.

Notwithstanding the recognition that a profound transformation is needed to advance sustainability and circularity in textile value chains (the enabling conditions for these are discussed in the final section of this chapter (Section 3.6), there is still value in looking at the actions needed and initiatives being undertaken to address the hotspots at each stage in the value chain. However, it should be noted that single actions and incremental improvements in themselves will never achieve full sustainability or circularity, but should rather be seen as part of the co-ordinated value chain actions required. To give an indication of the breadth and focus of the initiatives being undertaken, examples are given in tables in the Appendix. These should be taken as illustrative only, as the large number of initiatives taking place all around the world means that the listings in the Appendix cannot hope to be comprehensive. Nor should inclusion of an initiative be taken to imply endorsement by UNEP.

3.1 Actions in fibre production

Natural fibres

The production of natural fibres is a particular hotspot in terms of ecosystem quality and water scarcity impacts, especially cotton, with its high use of water, land and agrichemicals. Actions required, therefore, are to develop and roll out farming practices that reduce these environmental impacts (water, land and chemical use).

Cotton cultivation is also associated with high social risks, including injuries and exposure to toxins and hazards, low wages, forced labour and child labour, gender inequality, corruption and fragility in the legal system. Actions required are government regulations against the use of toxic substances and harmful labour practices, and better enforcement of legislation protecting workers' rights and the environment (where this already exists).

20 Members of the Policy Hub for Circular Economy are the Sustainable Apparel Coalition, Global Fashion Agenda (GFA) and the Federation of the European Sporting Goods Industry (FESI).

21 https://pacecircular.org/

22 https://ec.europa.eu/environment/circular-economy/

The high social and environmental impacts of cotton farming have resulted in cotton cultivation being a particular focus area of initiatives (see Appendix A, Table A-1). Many cotton initiatives address both the environmental and socio-economic impacts of cotton farming, although some have a particular focus, such as growing organic cotton, increasing water efficiency or fair trade. The largest initiative is the Better Cotton Initiative (BCI), which has over 1,400 members and brings together actors across the value chain (farmers, ginners, traders, spinners, mills, manufacturers, and brands/retailers), together with civil society and grassroots organizations to develop sustainable cotton into a mainstream commodity. BCI also works with equivalent cotton standards in Australia, Brazil and multiple African countries.

Alongside improving cotton production practices, one critical aspect of many of the cotton initiatives is to develop supply chains that connect sustainable cotton to brands, retailers and manufacturers, including connecting intermediary partners across the supply chain (e.g. traders and processors). Traceability is therefore a central component of many cotton initiatives (see Box 8).

The high social and environmental impacts of cotton farming have resulted in cotton cultivation being a particular focus area of initiates

Recognition of the large number of initiatives working towards more sustainable cotton led to the formation of the Cotton 2040 initiative, which brings sustainable cotton standards together, along with industry initiatives and leading brands and retailers. One major output of the Cotton 2040 initiative has been the CottonUp guide, which provides a practical resource for brands and retailers wanting to source sustainable cotton.

Despite good progress in initiatives addressing the social risks and environmental impacts of cotton production, the reach of such initiatives needs to be extended; after a decade of operation, "better cotton" (as defined by the Better Cotton Initiative) accounts for 19% of global cotton, with a reach of two million farmers in 21 countries (Better Cotton Initiative, 2019). Growing this percentage and increasing the global coverage will require policy support from governments in cotton-growing countries, particularly in enforcing (or implementing) environmental protection laws and protecting workers' rights. Increasing the share of "better cotton" will also require the increased engagement of consumers and brands/retailers to create demand for sustainable cotton. Governments also have strong leverage in creating demand for sustainable cotton through implementing sustainable public procurement requirements for cotton. Furthermore, delivering on increased demand for sustainable cotton will require traceability in textile supply chains to move from being a niche "nice to have" to a mainstream requirement for textile products.

Other natural fibres, such as jute, coir, flax, sisal, hemp, ramie, kapok and kenaf, show potential as sustainable alternatives to cotton. However, a recent study found that none of these fibres has the technical feasibility to match the comfort and technical properties of cotton (Rex, Okcabol, and Roos, 2019). Furthermore, there are insufficient studies to determine whether these alternatives are always preferable environmentally (Sandin, Roos, and Johansson, 2019) The few life cycle assessments that have been conducted show a wide range of performance, largely due to methodological differences in the studies[23]. Thus, further standardization and research are required to establish the potential of these fibres, and if they prove to be more sustainable, actions to grow their market share from their current low levels should be pursued.

23 This is because for many bast fibres the fibre product is a byproduct, and the environmental performance is strongly affected by how burdens are allocated between the different products of the crop.

Synthetic and manufactured fibres

> Fossil fuel use in the production of synthetic fibres is a hotspot with regard to climate impact and non-renewable resource depletion. Actions to address these impacts include increasing the use of renewable and secondary materials in the production of synthetic fibres (while ensuring that renewable resources are sustainably sourced), and avoiding the resource loss at end-of-life (through increasing the lifespan of products and increased recovery at end-of-life).

Producing synthetic fibres from secondary materials has been a successful area of innovation, with the development of a number of fibres and fabrics produced from waste materials (see Table A-4 for some examples). However, this has largely been motivated by the plastic litter crisis, i.e. fibre produced from plastic bottles and ocean plastics, with the recycling of synthetic textiles at end-of-life still at very low levels. Initiatives to address textiles at end-of-life are covered in Section 3.5. Systemic actions avoiding the consumption of non-renewable resources will ultimately be the most effective in addressing the impacts of synthetic textiles, such as innovative circular business models that extend product lifetimes and promote the re-use and repair/repurposing of textiles. Initiatives that promote circularity in textiles are covered in Section 3.6.

Systemic actions avoiding the consumption of non-renewable resources will ultimately be the most effective in addressing the impacts of synthetic textiles, such as innovative circular business models that extend product lifetimes and promote the re-use and repair/repurposing of textiles

Synthetic fibres have been steadily increasing their share of global fibre production. A swing back to natural fibres will ameliorate the impacts of synthetic fibre production, along with the release of microfibres (microplastics) associated with use of the synthetic fabrics. However, the production of natural and regenerated fibres is also associated with environmental and socio-economic impacts and any switching of material has to be carefully assessed across the whole life cycle, including consideration of total volumes. A recent review of fibres finds that the best environmental outcomes are achieved when the functional properties of the fibre are considered along with an environmentally appropriate product life cycle (i.e. by taking into account the use phase and end-of-life management and not only the production of the fibre) (Sandin, Roos, and Johansson, 2019). Furthermore, the review finds that there are no clear "winners" when it comes to sustainable fibres. Rather, the range of environmental performance within each fibre type (representing differences in manufacturing practices) is often larger than the differences between fibre types, thereby making it impossible to draw clear conclusions around their relative performance.

The development of new innovative fibres is needed, especially those that can be used for longer or re-used and/or those that do not shed microplastics. However, life cycle assessment or impact studies are required to ensure there are no unintended consequences with new materials. While there are a number of new fibres reaching the market that claim to be more sustainable, there is often no data available to support such claims, and in general, there is a glaring lack of data on the environmental impact of fibres (Sandin, Roos, and Johansson, 2019). Thus, alongside the development of new fibres, actions are required to increase the availability of life cycle data on the production of fibres, as well as on the production, use and end-of-life of textiles made from them.

Box 8: Initiatives advancing transparency and traceability in textile value chains

Transparency and traceability are critical enabling factors in practically all initiatives to improve the environmental and social sustainability of textile products. They form a key metric in textile product labels, standards, benchmarks, voluntary certifications, pledges and agreements. These range from industry initiatives covering all aspects of the textile value chain, such as The Sustainable Apparel Coalition's Higg Index, to civil society and multi-government initiatives covering single issues, such as The Transparency Pledge and the UNFCCC Fashion Industry Charter for Climate Action (see Table A-2 for examples). There are also a number of standards that are not specific to textiles, for example SA8000 (social accountability) and CDP reporting (carbon disclosure). The International Trade Centre (ITC) Standards Map[24] provides an objective benchmark of different labels/schemes according to product/service, producing country and market covered. For individual companies, traceability to key mid-stream suppliers, also called control points, who may have greater visibility and leverage over their own suppliers and business relationships further up the supply chain, can be an option (OECD, 2018).

Despite being a requirement in standards, achieving transparency and traceability presents a considerable challenge in textile value chains. The United Nations Economic Commission for Europe (UNECE) and the ITC with its Centre for Trade Facilitation and e-Business (UN/CEFACT) are conducting a project to address these challenges in the garment and footwear sector (from raw material production to retail). The overall objective of the project is to strengthen sustainable consumption and production patterns through the development and implementation of an international Framework Initiative and a Transparency and Traceability Tool. A pilot project launched in January 2020 is to implement blockchain technology for traceability and due diligence in the cotton value chain from field to distribution. With industry partners in Egypt and Europe, the pilot will demonstrate end-to-end traceability of a product, and test cost-efficiency, scalability and transferability.

Consumers can only take more sustainable decisions if they are provided with accurate and reliable information. Calls for greater transparency in textiles are thus also seen in campaigns relying on consumers' ability to exert influence on brands and retailers through their purchasing power, such as #whomademyclothes and "Detox my Fashion" (See Table A-3 for examples of consumer campaigns). UNEP and ITC's "Guidelines for providing product sustainability information" aim to help producers make reliable claims about their products' sustainability performance and thus enable informed consumer choices. They have been tested in various sectors, including textiles, and a number of tools and case studies are available to stakeholders wanting to improve the way they communicate textile sustainability.

Knowing the composition (fibre mix) and chemical content of material for recycling is critical. Thus, traceability is also very relevant for increasing material recovery after use. One initiative with potential for textiles is "product passports" – a set of information about the components and materials contained in a product[25].

Also working on this topic is the "Green Markets and Global Value Chains" work stream of UNEP's Environment and Trade Hub, which aims to enhance the design and uptake of sustainability standards and to facilitate market access for sustainably produced and certified products. As part of the Partnership for Action on Green Economy (PAGE), the Environment and Trade Hub has provided training in one of China's leading regions for textile production and export. The Hub also offers methodologies and resources on sustainability standards which have relevance to the textile sector, including a "Guide for the Assessment of the Costs and Benefits of Sustainability Certification", a handbook on "Trade and Green Economy", and an analysis on "Green Economy and Trade – Trends, Challenges and Opportunities".

24 https://www.sustainabilitymap.org

25 European Resource Efficiency Platform (EREP) Manifesto & Policy Recommendations https://ec.europa.eu/environment/resource_efficiency/re_platform/index_en.htm

3.2. Actions in yarn and fabric production

The environmental impacts of yarn and fabric production stem primarily from the use of fossil-based electricity in their manufacturing processes (spinning and knitting or weaving). While they are not a hotspot in the value chain, in that yarn and fabric production does not show the highest impacts of all the textile value chain stages, their high energy consumption nonetheless warrants attention. Increasing energy efficiency in manufacturing and a shift to renewable energy are actions required to decrease the environmental impacts of yarn and fabric production.

Yarn and fabric production also have high social risks, most notably poor working conditions, remuneration below the minimum wage, forced labour and poor health and safety standards. Requirements for greater transparency and traceability in textile manufacturing chains and enforcement (or implementation) of legislation protecting workers' rights are actions that are needed.

Many initiatives addressing the sustainability of textiles include yarn and fabric production within the scope of their programmes. Poor working conditions and human rights violations have been a particular focus of initiatives in textile manufacturing (see Table A-5). These range from international organization-led initiatives, such as the Better Work Programme (a partnership between the United Nations International Labour Organization and the International Finance Corporation, see Box 9), to industry initiatives, e.g. the Initiative for Compliance and Sustainability, and non-profit organization initiatives, e.g. Fair Wear Foundation. Many of the platforms and programmes seeking to advance sustainability in the textile sector include both the socio-economic and environmental dimensions of sustainability, and/or are focused on addressing the Sustainable Development Goals (SDGs) (see Table A-6 for examples). Many of the initiatives are multi-stakeholder with strong industry participation, particularly of large brands and retailers.

Box 9: Actions to improve working conditions

The **Better Work Programme** is committed to assisting all stakeholders to improve working conditions in the textiles industry. As a partnership between the United Nations International Labour Organization and the International Finance Corporation (IFC), Better Work brings together governments, global brands, factory owners, unions and workers to improve working conditions in the garment industry and make the sector more competitive.

Active in more than 1,700 factories and employing more than 2.4 million workers in nine countries, the programme promotes lasting and positive change through assessments, training, advocacy, advisory services and research assessments. As a result of their participation in Better Work, factories have steadily improved working conditions and, at the same time, enhanced their productivity and profitability. They have also improved their compliance with ILO core labour standards, according to compliance assessment data produced and compiled by the programme. These changes include **improvements in compensation, contracts, occupational health and safety and working time** (ILO, 2016).

Initiatives seeking to improve transparency and traceability in textile supply chains are important enablers of sustainability initiatives in the textile sector (see Box 8). This is especially relevant for yarn and fabric production, since the higher up the value chain, the more difficult traceability becomes. Reputational risks to brands and retailers, especially of human rights abuses in their supply chain, are a strong driver of improved labour practices, yet many brands are unable to trace their supply chains beyond assembly. This has seen the development of a number of sustainability standards with traceability and transparency as a core aspect. New technologies, such as blockchain, present opportunities for supply chain traceability, potentially able to provide consumers with garment-specific sustainability information.

Many initiatives have seen steady improvements being made in the textile industry, although it is recognized that the industry still has far to go (GFA and BCG, 2018). Advances are primarily being made by large players and the premium segment, with small producers, especially in the entry-level price segment, making little headway. This is particularly concerning

given the relatively large share of the global market made up of small producers and producers in the entry-level price segment. Actions are thus needed to ensure that improvements reach all players in the value chain.

Actions relevant to driving sustainability changes in yarn and fabric manufacturing are relevant across all textile manufacturing stages, and include disseminating knowledge about sustainable alternatives, cleaner production, resource efficiency and renewable energy, and building the skills and capacity needed to implement sustainable changes. Further actions include removing the entry barriers for smaller players especially through, among others, harmonizing guidelines and standards, devising incentives for companies to change to sustainable alternatives, and creating cooperation, funding and collaboration across the industry. There is a need to deepen and extend existing alliances for implementation of sustainable practices, and for global coordination of initiatives and efforts. The UNFCCC Fashion Industry Charter for Climate Action[26] is one such initiative targeting the need for coordination as it relates to actions to address climate change. The Charter sets out the vision for the fashion and clothing industry of achieving net-zero emissions by 2050, with signatories indicating their commitment to support the goals of the Paris Agreement in limiting global temperature rise to well below two degrees Celsius above pre-industrial levels. The Fashion Industry Charter for Climate Action does not constitute a new formal initiative or registered organization, but rather the work is carried out by the signatories with facilitation and coordination from UN Climate Change.

Change cannot be expected to come from within the industry alone, and governments and consumers have a critical role to play. This includes regulators creating a legislative environment in which companies are accountable and driven to take action against poor labour and environmental practices. Governments have an important role to play in promoting and implementing the OECD Guidelines for Multinational Enterprises (MNEs), the United Nations Guiding Principles for Business and Human Rights and the ILO Tripartite Declaration on Multinational Enterprises and Social Policy and, more broadly, promoting responsible business conduct. Responsible business conduct is highly relevant for policy makers wishing to attract quality investment while ensuring that business activity in their countries contributes to broader value creation and sustainable development. Governments can promote and enable responsible business conduct through a number of actions (OECD, 2015): regulating (establishing and enforcing an adequate legal framework that protects the public interest and monitors business compliance); facilitating (clearly communicating expectations on what constitutes responsible business conduct, and providing guidance with respect to specific practices); working with stakeholders in the business community, worker organizations, civil society and the general public, and working across internal government structures as well as with other governments to create synergies and establish coherence with regard to responsible business conduct; demonstrating support for best practices; and acting responsibly in the context of the government's role as an economic actor.

Capacity building within governments is required to allow better enforcement of regulations and ensure that, at a minimum, companies comply with national laws protecting workers' rights and the environment. Further, there is a need for a policy environment and infrastructure that make the transformation and implementation of relevant technologies possible. Finally, consumers need to be educated and provided with reliable information in order to be empowered to make ethical purchases.

Poor working conditions and human rights violations have been a particular focus of initiatives in textile manufacturing

26 https://unfccc.int/climate-action/sectoral-engagement/global-climate-action-in-fashion/about-the-fashion-industry-charter-for-climate-action

3.3. Actions in textile production

The wet processing stage of textile production (bleaching, dyeing and finishing) is a hotspot with respect to climate, human health and ecosystem quality impacts. This is due to the high use of fossil fuel-derived energy and hazardous chemicals in these processes. Improvements in process efficiency (including increasing resource efficiency through the recovery of chemicals in effluent streams, implementing closed-loop processes, and recycling rejects and off-cuts), the use of clean energy sources and the banning of hazardous chemicals (or enforcement of restricted substances legislation) are actions needing to be taken.

Textile production, especially the assembly stage, is associated with high social risks. As with yarn and fabric production, these relate to poor working conditions and poor enforcement, or absence, of legislation protecting workers' and women's rights.

Recognition of the high social and environmental costs of textiles has seen the formation of a number of initiatives aiming to improve the sustainability of textiles (see Table A-6)., The UNFCCC Fashion Industry Charter for Climate Action is of particular relevance to textile production, with its high climate impact and high fossil fuel use. The Charter, which invites signatories across the value chain, includes a target of 30% greenhouse gas emission reductions by 2030 and a commitment to analyse and set decarbonization pathways for the fashion industry, drawing on methodologies from the Science-Based Targets Initiative. For example, among a number of energy-related commitments, organizations signing the charter commit to not installing new on-site coal-fired boilers or other sources of coal-fired heat and power generation, starting as soon as possible and by 2025 at the latest (UNFCCC n.d.).

While the Fashion Industry Charter for Climate Action is single-issue, many initiatives cover both the environmental and socio-economic dimensions of sustainability. The focus of initiatives tends to be on apparel and footwear, and most are wider than just textile production and include yarn and fabric production, with a few covering the whole value chain: the Sustainable Apparel Coalition promotes best practices from fibre production to retail. The actions required are largely common to all stages of textile manufacturing, and are discussed above in Section 3.2. However, the fact that textile processing (bleaching, dyeing and finishing) is a particular hotspot with regard to water pollution and hazardous chemical use has resulted in a number of initiatives being developed particularly to address this (see Table A-7 and Box 10 for examples). Campaigns such as Greenpeace's Detox My Fashion have been instrumental in raising the issue of hazardous chemical use in textiles, with the outcome that initiatives addressing the environmental sustainability of textiles, such as those listed in Table A-3, generally include the issue of chemical toxicity. Furthermore, action taken to reduce/eliminate the use of hazardous chemicals is among the criteria applied in textile benchmarks and standards (Table A-2). Wet textile processing (bleaching, dyeing and finishing) has also been the focus of technological innovations, for example, the SpinDye technology that avoids water use in dyeing completely, by adding colour during fibre production rather than at the textile production stage, and the water-free and process chemical-free DyeCoo technology (see Table A-4). Other opportunities for innovation include green and sustainable textile chemistry and advanced technologies for chemical recovery from wastewater (UNEP, 2019a).

> Advances are primarily being made by large players and the premium segment [...] Actions are thus needed to ensure that improvements reach all players in the value chain

The Zero Discharge of Hazardous Chemicals (ZDHC) Roadmap to Zero programme is an industry collaboration working to eliminate and substitute hazardous chemicals in the textile value chain. A Manufacturing Restricted Substances List (MSRL) provides the basis of the ZDHC toolkit, which delivers customizable guidance on chemical use and wastewater treatment for the industry. A number of companies and associations are taking complementary approaches to the ZDHC that are also based on an MRSL, such as the American Apparel and

Footwear Association's Restricted Substance List and ChemSec's textile guide. Furthermore, a number of global and national initiatives addressing hazardous chemicals have relevance for textile production. Chemicals in Products has been an emerging policy issue for the Strategic Approach to International Chemicals Management (SAICM) since 2009, leading to the establishment of the Chemicals in Products (CiP) Programme, hosted by UNEP. The CiP programme focuses specifically on transparency of information about chemicals in global supply chains in the textiles, toys, electronics and building materials sectors. SAICM's Chemicals in Products (CiP) programme includes a set of objectives and methodologies that facilitates stakeholders' access to information on the chemical content of manufactured products. The GEF-funded project, "Defining and Demonstrating Best Practices for Exchange of Information on Chemicals in Textile Products", aimed to identify and demonstrate best practices and stakeholder roles and responsibilities for chemicals information exchange in textile products in China.

A recently published survey into brands that have committed to the ZDHC Roadmap to Zero programme shows that, despite notable actions by large companies and luxury brands on chemicals management, transparency and substitution, much still needs to be done (Greenpeace, 2018). A lack of action by small and mid-sized players in the entry-level price segment indicates the difficulty less well-resourced companies have in finding how to start engaging with sustainability issues (GFA and BCG, 2018). Thus, while resources such as Restricted Substances Lists, guidance manuals and toolkits on chemical substitution are available, actions are required to move the application of these guides beyond the leading fashion and sportswear brands. In particular, actions are needed to catalyse the first steps to be taken by the small and medium-sized enterprises that comprise the majority of businesses in the textile industry, including providing guidance, funding and outreach that recognizes the lack of capacity and resources in small businesses. Such actions can form part of a company's risk-based water management programme for the wet processing stages, identified through risk-based due diligence – the process through which enterprises identify, prevent, mitigate and account for how they address impacts in proportion to their severity, both in their direct activities and in their supply chain (OECD, 2018).

Actions relevants to driving sustainability changes in yarn and fabric manufacturing include disseminating knowledge about sustainable alternatives, cleaner production, resource efficiency and renewable energy, and building the skills and capacity need

Action cannot be expected to come only from within the industry through companies such as ZDHC members voluntarily demonstrating best practice, and much more needs to be done by regulators to level the playing field and create a legislative environment that supports companies taking action (Greenpeace, 2018). Within the European Union (EU), several hazardous chemicals are restricted in textile products through regulations such as REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), BPR (Biocidal Products Regulation) and the Stockholm Convention regulating POPs (Persistent Organic Pollutants), with many countries having similar chemicals legislation, for example Canada and the USA (Roos et al., 2019). However, the legislative basis and related enforcement for chemicals management is lacking in some countries, especially in the developing countries that dominate textile manufacturing. Furthermore, having legislation in place does not guarantee compliance.

One action for regulators is to embed best practice with regard to eliminating the use of hazardous chemicals in all relevant chemicals, water and textile-related legislation. This can be done through measures such as setting targets for eliminating hazardous chemicals, setting limits for toxic chemicals in textiles and wastewater that reflect best practice and setting eco-design requirements based on best practice. Through national legislation, countries should adopt and enforce a Manufacturing Restricted Substances List (MRSL) for textiles, that is based on a credible, scientifically based assessment of hazards (environmental risk assessment and health risk assessment). At a minimum, enforcement

of environmental regulations is required to ensure that companies comply with national laws protecting the environment. For developing countries, a lack of training and resources hampers enforcement of legislation. There is therefore a need for governments in developing countries to be endowed with the capacity to set and enforce legislation on chemicals, and to better balance social and environmental protection against developmental needs. Furthermore, the lack of transparency and traceability in textile value chains, including a lack of knowledge on chemical content, is a considerable barrier to enforcement (actions to address a lack of transparency and traceability are discussed in Box 8). Lack of transparency is also a barrier to consumers being empowered to choose textiles that are free from hazardous chemicals.

Actions are also required by the chemical industry to take greater responsibility for the products it sells. Actions are needed to review the content and transparency of safety, toxicity and hazard data communicated by chemical manufacturers to the users of their products, as well as to develop (and promote) safer alternatives without hazardous contaminants (Greenpeace, 2018) (making sure, through life cycle assessments, that alternatives do not result in the transfer of environmental impacts).

A recent published survey shows that, despite notable actions by large companies and luxury brands on chemicals management, transparency and substitution, much still needs to be done [...] One action for regulators is to embed best practice with regard to eliminating the use of hazardous chemical in all relevant chemicals, water and textile-related legislation

Box 10: Making the Noyyal and Bhavani river ecosystems healthy by 2030

The Noyyal and Bhavani rivers, part of the Cauvery Basin, are home to unique wildlife and support much of the agricultural and industrial economy of the region. Located in the south of India, the middle Noyyal region is a major textile and knitwear hub. Responsible for **90% of total cotton knitwear exports from India, the region provides employment to over 600,000 people and contributes significantly to exports worth $3 billion**. The region faces water-related challenges that are linked to the textiles industry, such as overexploitation of surface and groundwater due to growing industrial and agricultural demand, and pollution. Even though a Zero Liquid Discharge rule is in place for the textile sector, effective enforcement is yet to happen and agricultural, industrial and urban run-off is posing a serious threat to people's well-being and biodiversity.

In order to tackle these challenges, WWF began implementing a water stewardship project in 2018[27]. **A consortium of organizations in the basin and international brands are working together to ensure that both the Noyyal and Bhavani are transformed by 2030 into healthy river ecosystems that ensure water security for people and nature**. The project has divided the area into six zones depending on the specific challenges of different parts of the rivers, such as water and energy efficiency in the textile cluster, invasive species in the forest areas, and wetland restoration. At the basin level, stakeholder mapping, institutional and policy mapping, a hydrological modelling study and an assessment of river health have been carried out to provide the relevant data for policy making. Meanwhile, at the national level, the project is developing clear policy demands based on the key challenges identified in the textile sector through stakeholder engagement, policy mapping and regulatory standards development.

27 https://wwf.panda.org/our_work/water/water_management/ws_collective_action_map_/collective_action_india/

3.4 Actions for the use phase

The care of textiles over their lifetime, with its high use of electricity and water leading to high climate and water scarcity impacts, is a particular hotspot in the textile value chain (and has high impacts on ecosystem quality and in terms of human health damage in countries where fossil fuels make up a high proportion of the electricity grid mix). Reducing these impacts will require finding ways of caring for textiles with less electricity and water use, e.g. cold washing, line drying, no ironing, water efficient washing machines etc., along with increased use of renewable energy. Caring for garments in such a way that the life of clothes is extended is also an important use phase action, since research indicates that increasing the number of times a garment is worn has the greatest effect in reducing its environmental footprint[28].

Life cycle assessment studies highlighting the importance of the use phase in addressing the climate and water impact of clothes have seen some brands devoting more attention to educating their consumers on the use of their products, as with Clevercare, a garment labelling system created in collaboration between brands and GINETEX (the international association for textile care labelling). Clevercare covers five areas of caring for clothing to reduce its environmental footprint and extend its life, namely washing practices, washing temperature, drying, ironing and dry cleaning. A similar campaign to reduce the impact of household laundry is iPrefer30, an initiative of the International Association for Soaps, Detergents and Maintenance Products (A.I.S.E.) (see Table A-3).

However, actions are required to extend the reach of campaigns and consumer advice from brands. Brands and retailers have a role to play by ensuring care information on products is clear and non-contradictory. Further, innovation is required to create fabrics that are easy to care for, while devising ways to ensure the correct care is given by consumers.

Fast fashion, the trend for rapidly changing clothing lines at low prices designed to encourage consumers to buy more and keep their clothing for short periods, currently defines major parts of the fashion industry. Reducing consumption where there is over-consumption, and decoupling material inputs from business value will be vital in making the industry more sustainable, and innovative customer offers and transformation in business models will be needed to achieve that decoupling. Consumers also need to be encouraged and offered options to give garments a second life after use. Initiatives to promote more sustainable living and lifestyles, such as UNEP's Anatomy of Action[29], promote broader concepts such as "fashion slowdown", encouraging people to rethink how to curate their identity through better and lighter choices. Other actions to address over-consumption are considered further under "Enabling conditions for a wider uptake of sustainability and circularity in the textile value chain" (Section 3.6), since actions promoting circularity require brands, designers, producers and consumers to work together to develop and embrace the new business models that can design, produce and promote textiles compatible with a circular textile system.

Reducing consumption where there is over-consumption, and decoupling material inputs from business value will be vital in making the industry more sustainable, and innovative customer offers and transformation in business models will be needed to achieve that decoupling

28 Note that this works on a garment-by-garment basis and extending the life of garments will not decrease the impacts of the clothing system as a whole unless fewer garments are purchased, in other words unless it comes with a reduction in consumption in those regions or society segments where this is relevant (there are also parts of the world that struggle to meet basic needs). This is covered under "Enabling conditions" in Section 3.6 and in Box 14.

29 https://anatomyofaction.org/

Consumers have a role to play by following recommendations to wash textiles in a manner that minimizes losses and by implementing measures to mitigate losses

The release of microfibres, leading to ecosystem quality impacts and potential human health impacts, is a further hotspot of the use phase, with washing textiles thought to be the most significant site of microfibre losses in the textile value chain.

The environmental and health impacts of microfibres from textiles are emerging issues, thus initiatives are mostly about promoting research to better understand the environmental and human health implications of microfibres in the environment. Microfibres are a subset of the wider microplastics (and nanoplastics) issue, which is an active research area. Research to better understand the factors governing microfibre loss from textiles and mitigate these losses has provided partial solutions, such as washing bags, washing machine filters and advice on better laundering practices[30]. The European Commission's Circular Economy Action Plan has specific action points to address microplastics, including developing and harmonizing methods for measuring unintentionally released microplastics (especially textiles), as well as developing labelling, standardization, certification and regulatory measures on the unintentional release of microplastics (European Commission, 2020). The European Outdoor Group is leading an initiative with broad membership to better understand the challenges that microfibres present to the industry and to find sustainable solutions, and the OECD is undertaking consultations and research on options to mitigate microplastics pollution originating from synthetic textiles and their impacts on the environment and human health (OECD, 2020).

Consumers have a role to play by following recommendations to wash textiles in a manner that minimizes losses and by implementing measures to mitigate losses (e.g. placing synthetic textiles in a washing bag). As with the energy impacts of washing, actions to educate consumers are therefore important. However, more systemic and fundamental changes are needed, such as developing fibres and fabrics that do not shed microfibres, rather than relying on consumers to implement "end of line" solutions.

Similarly, governments have a role to play in increasing the proportion of wastewater collected and treated in wastewater treatment plants (WWTP) before being released into the environment, as well as in implementing WWTP technologies that capture microfibres. However, for many countries this is simply not realistic, though microfibres washing out of WWTP sludge and/or having impacts on terrestrial ecosystems have been raised as a concern, and the safe and effective disposal of sludge from WWTPs and the impacts of microfibres on terrestrial ecosystems identified as research needs. Thus, as with consumer actions, systemic changes to fibres and fabrics are required rather than relying on technologies to capture and dispose of microfibres.

Also important is continued government and industry support for research to close the critical knowledge gaps around nano- and microplastics. Particular research needs are a better understanding of the importance of the different value chain stages and types of textiles in terms of microfibre loss, as well as a better understanding of the mechanisms through which impacts can potentially occur. There is a need for standardized sampling and analysis methods so that research outcomes can be compared and new materials effectively assessed.

3.5. Actions at end-of-life

The end-of-life of textiles is not shown to be a particular hotspot in the textile value chain with respect to environmental impact; that is, the landfill and incineration of textiles do not have as high resource use and emissions as the textile manufacturing stages. However, these current end-of-life practices result in considerable material value loss, and better management of textiles once a user is finished with them has significant potential to reduce environmental impacts (through avoiding the necessity of producing new items, fabrics and fibres).

30 See for example the findings of the Life+ Mermaids project: http://life-mermaids.eu/en/

It is important to distinguish between material end-of-life and product end-of-life, where the latter is perhaps better called "after-use" or "end-of-first-use". This distinction is necessary to understand that re-use, repair/repurposing, recycling to fabric and recycling to fibre are all part of the solution of a sustainable and circular textile system. Prolonging the use of textiles is by far the most important action when it comes to reducing environmental impacts. However, ultimately the material will reach end-of-life, preferably after a long use life and a large number of re-use and repair/repurposing cycles. Material recycling then has an important role to play, although for recycling to be part of a sustainable textile system, the energy, water and chemicals used in collection, sorting and recycling textiles must be less than that used to produce them, and supporting infrastructure must be in place (Roos et al., 2019). Actions are thus required to further develop emerging recycling technologies, and to put in place sufficient policy and infrastructure support.

> Re-use, repair/repurposing, recycling to fabric and recycling to fibre are all part of the solution of a sustainable and circular textile system

Actions to prolong the use and increase the re-use, repair/repurposing and recycling of textiles from their very low levels are an important part of achieving a circular and sustainable textile system, but it should be recognized that, by themselves, these will never provide the solution. Wider, systemic actions for circularity are discussed in the following section (Section 3.6). Furthermore, overarching actions, such as those to increase transparency (see Box 8) and for materials to be "toxic free", are prerequisites for increased material recovery at end-of-life.

It is imperative to know the chemical content of recycled textiles as this determines the application in which the recycled material can be used. Despite legislation restricting hazardous chemicals in some countries, legislation and/or enforcement is still largely lacking in the countries dominating textile production (see Section 3.3). Furthermore, certain chemicals are allowed because of the value and function they bring to the final product, or because the exposure levels are estimated to be low. High-value recycling opportunities thus remain unattainable because of the need for expensive technologies to remove toxics. To be viable, large-scale textile recycling facilities require consistent feedstock material, and this is currently hampered by a lack of traceability, insufficient or absent fibre labelling legislation and mixed materials (with many fabrics and yarns being blends of natural and synthetic fibres, and the latter blends of different polymers) (Roos et al., 2019). Textile recycling will thus remain at its current low levels unless actions are taken to ensure recyclers can be confident regarding the source, composition and chemical content of their feedstock.

Table A8 provides examples of brands working with their consumers to repair and/or return purchases at end-of-life, as well as organizations working to promote the re-use, repair/repurposing and recycling of textiles. The majority of brand-led garment collection and recycling schemes are not yet profitable and are primarily offered for their marketing and consumer loyalty potential (Circle Economy, 2015). While the focus tends to be on consumer actions, it is also important for companies to take additional actions to increase re-use and recovery within the textile manufacturing stages, for example recovery of offcuts in garment assembly and rejects in textile production. These actions fall broadly under increasing resource efficiency in manufacturing (see Section 3.2). One regulatory approach to avoid waste altogether in the context of unsold goods was recently introduced in France (see Box 11).

Significant regulatory actions, such as extended producer responsibility requirements, recycling and recycled content targets and taxes on landfill, coupled with innovation and consumer education, are needed to shift recycling from being a niche activity to a core component of brands' and retailers' business. Furthermore, innovative recycling technologies can help to close material loops at textile end-of-life (see Table A-4 for examples). France introduced EPR rules for textiles in 2008, and in Sweden the government is working towards implementing EPR for textiles by 2025 (Roos et al., 2019). However, none of the advanced recycling technologies have yet reached market maturity (GIZ, 2019). Thus, further financial and technical support for textile recycling technologies is needed. Overall, it is important to consider potential

trade-offs regarding the environmental and socio-economic impacts associated with increased re-use, repair/repurposing and recycling of textiles. For example, centralizing advanced textile recycling technologies might require the shipping of textiles (with the associated climate impact), and shift textile manufacturing locations (causing socio-economic impacts). Furthermore, recycling processes require resources and energy and can themselves impact water quality. Life cycle-based studies should thus be undertaken of proposed actions and technologies to ensure these offer environmental and socio-economic benefits to the textile system as a whole.

Box 11: Ban on the destruction of unsold textile products – a new French law

Each year, between 10,000 and 20,000 tonnes of new textile products are destroyed in France. To fight this wasteful behaviour, the French government has adopted a **new measure** (as part of the new circular economy law) that prohibits the disposal of unsold non-food goods, including textiles[31]. The law will apply to all sellers in France as of **31 December 2021**. Exceptions may only be made for products for which recycling can lead to a negative environmental impact, is prohibited or is not feasible given the technical solutions available.

To comply with this law, companies must donate or recycle their unsold products. This should push them, in turn, to **rethink stock management and reduce overproduction**. This means that all stakeholders in the textile industry, from producers to retailers, are concerned.

3.6 Enabling conditions for a wider uptake of sustainability and circularity in the textile value chain

Understanding and advancing the innovations required for circularity in the textile value chain is an active area of research and advocacy (Circle Economy, 2015; Ellen MacArthur Foundation, 2017; GIZ, 2019). Multiple approaches and enablers can be leveraged to further drive innovations and advance circularity in economies; they are described below.

Promoting circular supply chains and stimulating demand for more circular products, such as those with extended product lifetimes through re-using, repairing, or repurposing, and more circular materials, such as those able to be recycled at high value, can support the transition towards more circularity. These will depend on developing underlying business models that are based on innovations in product design (e.g. making products easy to re-use, repair, disassemble etc.), consumption modes (such as rental and sharing instead of owning products), and recycling (e.g. systems and technologies to efficiently collect, sort and process materials). Innovations in products and business models need to happen alongside innovations addressing impacts in textile manufacturing, such as eliminating hazardous chemicals. Sustainable procurement is widely recognized as a strategic lever to drive innovation (UNEP, 2018a). This is true not only for government agencies through public procurement policies, but is also increasingly acknowledged by corporate buyers and business leaders. The purchasing power of sustainable procurement in business to business sales is a strong vehicle for brands and retailers to drive sustainable improvements in their supply chain.

Supporting innovative approaches such as product-service systems that provide functionality over ownership and use resources more effectively, supplier take-back systems and sharing platforms can also trigger a wider adoption of circularity and sustainability throughout the value chain. Supplier take-back systems are being trialled by a number of brands (see Table A-8). The increasing number of clothing rental services available, especially in the USA where rental subscription services are becoming available at a variety of price points (Fashionista, 2019), shows increasing consumer appetite for the subscription rental model of clothing consumption (The Guardian, 2019).

The increasing number of clothing rental services available [...] shows increasing consumer appetite for the subscription rental model of clothing consumption

A core concept of circularity is that, to be effective, actions cannot be taken in isolation. The importance of **taking co-ordinated actions across the whole value chain** should be kept in mind. For example, textiles free of hazardous chemicals are a prerequisite for high quality textile recycling (to avoid the persistence of "legacy substances"), thus actions to increase collection of textiles at end-of-life are not effective unless simultaneous actions are taken to eliminate hazardous chemicals from the manufacturing supply chain. This kind of thinking is demonstrated for instance in Make Fashion Circular's Jeans Redesign project[31], with guidelines that tackle harmful manufacturing practices associated with the production of jeans, along with minimum requirements for durability, material sourcing, recyclability and traceability (see Box 13).

Examples of initiatives devised to advance circularity in textiles are given in Table A-9, as well as in Box 12 which provides illustrations from the private sector. A common message from these is that increasing clothing utilization and improving recycling are fundamental aspects of circularity for textiles, and that this will require significant innovation across the value chain. Recent analyses of circular business models in textiles (Circle Economy, 2015; Ellen MacArthur Foundation, 2017; GIZ, 2019) conclude that fundamental changes are required in the way products are designed and used, as well as in the way progress is measured at the corporate level. Achieving circularity in textiles will require entirely new business models that move away from fast fashion at the lowest possible prices to models in which clothing and other household textiles are valued items kept in service for as long as possible. Such new business models, be they Reduce, Re-use, Repair or Repurpose, require an approach which incorporates sustainability throughout all business operations based on life cycle thinking, in cooperation with partners across the value chain.

Actions required to advance circular business models include **educating companies on the benefits and opportunities of new business models, and providing knowledge on how closed-loop systems work.** This will require case studies and tools providing insights and support that offer viable alternatives for businesses to meet customer needs (see Box 13 for examples of capacity building initiatives and tools). In advocating for these circular business models there is a need to build common metrics for assessment (e.g. displacement rate), to measure and prove the impact of these alternative models. Such common metrics should capture the life cycle perspective, in other words ensure the performance of the value chain as a whole is improved. The life cycle approach, advanced by the Life Cycle Initiative hosted by UNEP, guides the development and selection of the most appropriate actions, by highlighting the most problematic processes and stages, and comparing the relative potential impacts of solutions. The life cycle approach avoids burden shifting and makes trade-offs explicit, ensuring that the chosen alternative really is the best available for the whole value chain.

Fundamental changes are required in the way products are designed and used, as well as in the way progress is measured at the corporate level. Achieving circularity in textiles will require entirely new business models that move away from fast fashion at the lowest possible prices to models in which clothing and other household textiles are valued items kept in service for as long as possible

31 https://www.ellenmacarthurfoundation.org/our-work/activities/make-fashion-circular/projects/the-jeans-redesign

Box 12: Private sector initiatives

The private sector plays an important role in implementing the changes in practice required to move toward sustainability and circularity in textile value chains.

Refazenda[32] is a Brazilian fashion brand that uses fabric scraps and relies on handmade production and social work to create new clothes. They were able to reduce the solid waste in their activities to zero ("Zero Waste Award", Industries Federation of Pernambuco State, 2013), through patchwork re-use, upcycling and not using any metal components, raw materials that are difficult to dispose of or plastic packaging. In addition, the brand educates consumers about re-using and repurposing clothes. This includes workshops helping consumers to give another use to their own clothes, and experts offering consultations and assisting people to change their perceptions of their own clothes.

Phinix[33] is a Filipino textile recycling centre that collects waste textiles and transforms them into higher value products such as footwear and fashion accessories. Avoiding primary materials, Phinix products have more than 90% less carbon emissions than regular footwear or bags when compared on a life cycle basis (UNEP, 2018c). The brand supports social inclusion and fair working conditions by employing local Filipino shoe artisans and persons with disabilities.

Haelixa[34] and re:newcell[35] act as solution providers in the textile sector. **Haelixa** offers a product marking technology based on DNA that allows material to be traced from producer to retail, supporting claims of sustainability. The technology was successfully tested in a pilot, Tracing Organic Cotton from Farm to Consumer in India (Fashion for Good, Organic Cotton Accelerator and C&A Foundation)[36]. The pilot proved that the markers placed on cotton survived harsh processing, enabling full traceability throughout the product lifecycle.

Re:newcell is a Swedish company that has developed a unique process for industrial scale textile recycling, and recently received funding from the EU LIFE programme, the European Union's funding instrument for the environment and climate action. Re:newcell's recycling technology can transform old clothes into a virgin quality natural material called Circulose, which is already used commercially by fashion giants like H&M.

© Re:newcell

32 https://www.vivarefazenda.com.br/

33 https://www.facebook.com/pg/madebyphinix/about/?ref=page_internal

34 https://www.haelixa.com/

35 https://renewcell.com/

36 https://fashionforgood.com/wp-content/uploads/2019/12/Fashion-for-Good-Organic-Cotton-Traceability-Pilot-Report.pdf

Box 13: Capacity building initiatives and tools

The transition to sustainable and circular textile value chains **requires all stakeholders, and especially businesses working in the sector, to have relevant knowledge and capacities**. An increasing number of initiatives, of which a few examples are listed below, have taken on this role of education and capacity building.

The **Smart Textiles Institute**[37] brings together strategic partnerships across academia, business and policy makers. Their **innovations address the whole textile value chain** from education to prototype, production and commercialization with over 500 research and company projects since its start in 2006. Examples are textiles made from 100% paper, recycling jeans, redesigning fabrics to avoid waste, and printing without water.

Fashion for Good[38] published a series of circular fashion guides[39] that explain to companies how they can **transition to certified circular supply chains**, including a list of certified materials, sample project plans and business cases. These guides aim to help businesses to obtain the cradle-to-cradle certification which certifies that products were designed and produced according to circular economy principles.

The Ellen MacArthur Foundation[40] co-created the **Jeans Redesign Guidelines**[41] with more than 40 industry experts. Based on the principles of the circular economy, the guidelines set out **minimum requirements on garment durability, material health, recyclability, and traceability**. Around 50 leading brands, manufacturers and fabric mills who support this vision are getting started on putting these guidelines into practice, with the first pairs of redesigned jeans set to go on sale this year.

UNEP's Eco-innovation approach[42], based on life cycle principles, involves **developing new business models and strategies that incorporate sustainability and foster cooperation across the value chain.** Importantly, eco-innovation is specifically designed to be applied also by small enterprises and can be seen by large brands as an effective way to engage their value chain. This is especially important for textiles, due to the large number of SMMEs involved in yarn, fabric and textile production, and since sustainability progress to date has been seen primarily in the large players (GFA and BCG, 2018). UNEP has implemented eco-innovation in developing countries[43] in companies working in the chemicals value chain, including dying and spinning companies from the textile sector, and provides various tools, including a step-by-step manual for companies to implement eco-innovation and transition to more circular business models. Such business models enable the sharing of products and assets, and create value by turning incentives for product durability and upgradability upside down (shifting them from volume to performance), while also encouraging employment of new technologies and capabilities to recover and re-use resource outputs through closed loop recycling, industrial symbiosis and upcycling (UNEP, 2017). The business case for eco-innovation can be expressed in five drivers (Figure 19) and has been evidenced by a number of success stories (UNEP, 2014). Further evidence-based examples need to be provided on how circularity in the textile value chain can improve profitability, as has been done, for example, by Accenture (Fashion for Good and Accenture Strategy n.d.) and the Global Fashion Agenda (GFA and BCG, 2018). In research undertaken into the viability of three clothing service models by Accenture (Fashion for Good and Accenture Strategy n.d.) (a one-off rental of a garment for a short time period; a monthly fee paid for access to a range of garments; and the recovery and resale of a garment by the original retailer), all three were found to be financially viable for premium-market retailers, with two (recovery and resale) viable for the mid-market segment. For the low cost market however, the research concluded that clothing service models were unlikely to be viable unless consumer perceptions of fashion as a disposable commodity can be changed and garment quality and durability improved (Fashion for Good and Accenture Strategy n.d.).

37 https://smarttextiles.se/en/

38 https://fashionforgood.com/about-us/

39 https://fashionforgood.com/news/resource-library/c2c-certified/

40 https://www.ellenmacarthurfoundation.org/

41 https://www.ellenmacarthurfoundation.org/our-work/activities/make-fashion-circular/projects/the-jeans-redesign

42 http://unep.ecoinnovation.org/

43 Starting in 2020, with financial support from the European Commission, UNEP will provide eco-innovation and environmental footprinting support to SMEs in three countries in Africa (to be selected).

Figure 19: The drivers of eco-innovation (UNEP, 2014)

Building acceptance for new business models and curbing over-consumption will also require **significant consumer education**. Imaginative approaches through a range of media can change consumer attitudes, including company advertising and "traditional" campaigns that use established media, social media influencers, and even school curricula, etc. (see also Box 14). Getting consumer "buy-in" is only a reality if there are sustainable options available for them to choose. It also means brands and retailers should not send mixed messages, for example, heavily advertising and/or discounting cheap "fast" options while simultaneously promoting sustainable options. Nonetheless, the power of consumers to advocate for better options with their purchases should not be underestimated.

Sustainable fashion needs to be made more attractive, both in its design and in how it is promoted, for example through **brand ambassadors and social media influencers**. This is especially important as the majority of new consumers soon to come online will be urban youth who get information and aspirational messaging from social media. Youth set today's trends, especially in the fashion sector, and are tomorrow's decision makers. UNEP's Anatomy of Action[44] offers a media tool kit that engages people through evidence-based requests for everyday actions they can take, such as buying better and avoiding fast fashion. Engaging social media influencers in a 15-day challenge in 2019 helped reach over five million people. As fashion has long been an indispensable part of cultural and individual expression, there is considerable opportunity to use more sustainable fashion as a means for individuals to express their own identity as well as their commitment to the sustainability agenda. Reaching young and future designers is also important, so circularity should be made more prominent in design and business schools and tertiary education curricula.

Consumers, designers, corporate buyers etc. require **accurate and reliable information on the sustainability performance of textiles** if they are to be enabled to make informed decisions. Transparent and traceable textile value chains are thus a prerequisite for achieving sustainable and circular textiles (GFA and BCG, 2018). UNEP and ITC's "Guidelines for providing product sustainability information" aim to help producers to make reliable claims about their products' sustainability performance and thus enable better informed consumer choices. Traceability is required if consumer information tools, such as product labels, are to be able to provide consumers with accurate information on the origin of items, their material and chemical content and the impact they are having on people and the planet (see also Box 8). Table A 2 lists product labels, certifications, benchmarks and agreements that work towards that end. It should be noted that the credibility of product sustainability information increases if such tools are developed collaboratively, for instance with the **participation of public authorities, academia or NGOs.**

44 https://anatomyofaction.org/, a contribution of UNEP to the One Planet network Sustainable Lifestyles and Education Programme.

Stimulating the innovation required for circularity in textiles and leveraging the funding required, especially in supporting start-ups and growing innovations to scale, are important actions. Table A-10 provides examples of funds aiming to stimulate innovation in the textile sector. For instance, Fashion for Good's Innovation Platform aims at sparking and scaling technologies and business models that have the greatest potential to transform the industry. The Platform has mapped over 1,500 innovators in order to identify relevant technologies at different value chain stages[45]. While not particularly focused on circularity, there are other textile platforms supporting start-ups and fostering partnerships, such as the African Development Bank's Fashionomics Africa Initiative, which aims to grow sustainable incomes from the fashion industry for women and youth in Africa (African Development Bank Group, 2016). There are also public sector funds that are not textile-specific, such as the European Commission's Eco-Innovation Programme , which was established to help innovative and environmentally beneficial products and services become fully-fledged commercial prospects.

Sustainability and circularity will not be achieved in the textile value chain without **governments being a driver for change, for which strong advocacy will be required** (Ecopreneur.eu, 2019). While it is the role of business to act responsibly, governments have a primary duty to protect the public interest and ensure that stakeholder rights are respected (OECD, 2011). A broad coalition of social and environmental NGOs has developed a Civil Society European Strategy for Sustainable Textiles, Garments, Leather and Footwear, with the intention of providing recommendations on what the upcoming EU Strategy for Textiles should encompass in order to maintain a high level of ambition. As such, the Strategy covers the social, environmental and governance implications of the textile sector, and includes forward-looking proposals on due diligence, product policy framework, waste, unfair trading practices, international trade, support to producing countries, alternative business models and a multi-stakeholder platform (European Environmental Bureau, 2020).

Strategic options available to regulators include, among others, ensuring transparency, taxing resource use and environmental pollution (while shifting taxation away from labour), increasing brand level accountability, including through risk-based due diligence, disclosure, sharing and reporting mechanisms, and setting up minimum requirement standards for textile products on the market (and restricting those products that do not meet the standards). These actions are crucial to providing a regulatory environment in which circular businesses can be viable, in other words creating a "level playing field" (Ecopreneur.eu, 2019) (see also Box 15). Building capacity in the regulators is therefore also a crucial need. Extended producer responsibility and sustainable public procurement policies are among those being advocated in order for governments to create a demand for more sustainable goods and support the needed changes in textiles (Environmental Audit Committee, 2019; European Parliamentary Research Service, 2019). Other incentives governments can put in place include VAT reductions, import benefits and funding for start-ups.

The annual "pulse of the fashion industry" – published by the Global Fashion Agenda and The Boston Consulting Group and based on the Sustainable Apparel Coalition's Higg Index – shows that actions to improve their sustainability performance are being taken by almost half (by market share) of players in the global fashion industry. While this is promising, there are some worrying signs: progress at best-performing large companies and luxury brands is stalling, while almost one third of the fashion industry has yet to take action (GFA and BCG, 2018). Slowing progress indicates that there is a limit to what incremental improvements can achieve, and that there is a lack of commercially viable technology solutions of the systemic, disruptive nature needed to change the status quo. Actions are thus required to create the market environment to allow such solutions to flourish. Stalling progress among the front-runners also suggests there is a limit to what companies can achieve individually. To this end, one crucial action is to **build active collaboration across the industry, for example by implementing joint processes allowing innovations to be brought to scale.** While such collaboration platforms exist (see Table A-6 for examples) these need to be strengthened. The pre-competitive collaboration needed will require strong industry leadership and a strong strategy for the industry as a whole. Collaboration is also particularly relevant for SMEs, who may lack the resources, as well as access to knowledge and technologies. Better coordination is also required among the many existing initiatives. At the United Nations level, this is addressed through the recently launched "Alliance for Sustainable Fashion", which serves as an umbrella coordinating the various UN projects that advance the fashion value chain's contribution to achieving the targets of the Sustainable Development Goals.

45 https://fashionforgood.com/innovation-platform/

Box 14: Changing consumption habits

Textiles (and fashion in particular) have always been part of human society. They not only protect people from the elements and adorn living spaces, but also enable people to express their cultures, status and individuality. The sector is unique partly because of its growth and profitability, and partly because people identify intimately with their purchasing decisions. Recently, **sustainable fashion has been increasingly highlighted in the media** along with calls for transparency along the value chain and re-use and vintage trends. **Even cultural influencers are now advocating for unique styles, and more informed and better decisions when purchasing fashion.** However, responsibility for closing the loop lies not only with people – who are affected by price, trends, advertising and available options – but also with companies, who design, produce and market products, and governments, who set the infrastructure for (global) value chains to function. To effectively close the loop, new business models, more reliable consumer information and more desirable and affordable sustainable products are needed.

The **Guidelines for Providing Product Sustainability Information**[46], developed by UNEP and ITC, provide five fundamental principles – reliability, relevance, clarity, transparency and accessibility – and five aspirational principles – three dimensions of sustainability, behaviour change and longer term impact, multi-channel and innovative approaches, collaboration and comparability – which lay the ground for effective communication to consumers.

These principles help companies **to improve advertising for more sustainable products** to ultimately allow consumers to have access to more reliable information. A road testing exercise[47] with three different actors from the textile sector highlighted how these principles are applied in practice.

The **Anatomy of Action**[48]**, a social media tool kit** developed by UNEP and the UnSchool of Disruptive Design, inspires individuals to better understand the impact of their actions and offers ideas on how to live more sustainably. Slow Fashion is one of its key action areas – within which "be unique and create your own look" leads to suggestions to shop vintage, share or redesign old wardrobe pieces or buy fewer and better clothes. Other campaigns that raise consumers' awareness and inspire actions include the **"Wardrobe Change"** campaign[49] of the European Environmental Bureau (EEB) and the **Textile Smart**[50] information campaign run by the Swedish Consumer Agency and the Swedish Chemicals Agency.

One example of an initiative that not only educates consumers but also enables them to change their consumption patterns is Nuw[51]. It offers a platform to borrow or swap rarely worn clothes, building on sharing economy principles and keeping clothing in use for a longer period. The idea was born when founders Aisling and Ali volunteered in India. Experiencing the reality of fast fashion, they wanted to change the industry for the better. A first trial was run at the founders' university, Trinity College, Dublin, where Aisling organized a platform to share and swap outfits for an upcoming ball. **Within three weeks, 350 people had signed up and 60 pieces were borrowed**. Following the successful trial, a web platform and an app were launched, making Nuw available to communities across the UK and Ireland.

© Nuw

46 https://www.oneplanetnetwork.org/resource/guidelines-providing-product-sustainability-information

47 https://www.oneplanetnetwork.org/consumer-information-scp/product-sustainability-information-hub

48 https://anatomyofaction.org/

49 https://meta.eeb.org/2020/01/23/new-wardrobe-change-campaign-calls-for-textile-transformation/

50 https://textilsmart.hallakonsument.se/

51 https://www.thenuwardrobe.com/nujourney

Box 15: Government cooperation and initiatives – examples from the EU

A good example of **how governments can support the transition** to a more sustainable and circular textile value chain is the **European Union (EU) Circular Economy Action Plan** as part of the European Green Deal. Several tools help to implement the goals set by these plans:

The European **REACH** (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulation aims to improve the protection of human health and the environment through early identification of the properties of **chemical substances.** The responsibility to manage risks from chemicals and provide safety information is placed on the industry by requiring **manufacturers and importers to gather information** on the chemical substances they deal with. This information must be registered in a central database. Bearing in mind the intensive use of chemicals in the textile industry, this certification is especially relevant for European textile companies.

The **EU Ecolabel** is a certification scheme that can be awarded to a wide range of product groups including textile products, which covers all kinds of textile clothing and accessories, interior textiles, fibres, yarn, fabric and knitted panels as well as cleaning products. The ecolabel ensures limited use of substances harmful to health and the environment, reduction in water and air pollution, and colour resistance to perspiration, washing, wet and dry rubbing and light exposure.

In 2017, the EC published Green Public Procurement (GPP) criteria[52] for textiles, with the aim of directing public purchasing towards environmentally friendly textile products and services such as uniforms, workwear and personal protective equipment. **Life Cycle Costing (LCC) tools,** which help public procurers to make more cost-effective and environmentally friendly decisions, are embedded in the EU GPP criteria. Considering that Europeans consume on average 26 kg and discard about 11 kg of textiles per person per year 2, the importance of the GPP criteria becomes clear. Case studies from the Netherlands showed that within one year, the **purchase of more sustainable clothing for the fire service saved 134 tonnes of CO2 emissions** and a minimum recycled fibre content for the purchase of towels and overalls saved 69 tonnes of CO_2[53]..

Examples of cross-governmental cooperative initiatives are **REBus**[54] and the **European Clothing Action Plan (ECAP)**[55]. REBus is an EU Life+ funded project that enables companies to transform their strategies into profitable, resilient and more resource efficient business models. An example of the impact of REBus is the work with the Dutch waterways, public works and environment authority (Rijkswaterstaat), which included replacing the workwear of lock stewards with workwear made of 100% recyclable materials. The multi-stakeholder-initiative ECAP, coordinated by the Waste and Resources Action Programme (WRAP), brought together local governments, recycling companies and fashion institutions to provide communication campaigns, public procurement criteria and also guidance for professionals in textile collection and production. ECAP reported total savings of **834,000 tonnes of CO2e** mainly due to retailers being encouraged to use recycled polyester, regenerated cellulosics and nylon, which have lower carbon emissions than traditional materials, **50,100,000 m3 of water** savings from the implementation of sustainable cotton fibre action plans and the fibre-2-fibre pilots, and **4,670 tonnes of waste diversion from landfill,** which was achieved mostly by retailers changing high level fibre compositions, and increasing the quantities of used textiles collected for recycling and re-use.

52 https://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm

53 https://ec.europa.eu/environment/gpp/pdf/200406_JRC120265_eu_green_public_procurement_criteria_for_textile_products_and_services_guidance_document.pdf

54 http://www.rebus.eu.com/

55 http://www.ecap.eu.com/wp-content/uploads/2019/09/FIBRE_TO_FIBRE_GUIDANCE_TOOL.pdf

4 Priority actions needed

Three core needs drive the priority actions required to advance sustainability and circularity in textile value chains. These are 1) the need for stronger governance to drive the change; 2) the need for collaboration and financing to implement solutions; and 3) the need to change consumption habits. The priority actions needed to address these needs and thereby advance sustainability in textiles are discussed in the following sub-sections and summarized in Table 1.

4.1 Stronger governance and policies

Governments are an essential driver for change, and gaps in policy and legislation are hampering the move to a more sustainable and circular textile value chain. While actors in the textile industry are increasingly engaged in implementing more sustainable and circular business models, and while it is recognized that some countries are championing supportive programmes, additional efforts are needed to create coherent policy frameworks which drive sustainability and circularity in the textile value chain. Policies and legislative frameworks are required that enable businesses to shift to new business models without hindrance. Eco-design requirements and production standards can level the playing field. Governments need to further regulate against toxic substances and harmful labour practices. Such enabling legislation needs to consider the whole value chain and especially the hotspots, namely resource efficiency and chemicals in textile production, agricultural practices in natural fibre production and non-renewable resource use in synthetic fibre production, as well as addressing both social and environmental concerns. Governments also have a role to play in enabling an inclusive and just transition, and involving relevant stakeholders in the process, including those from affected communities and workforces as well as their representatives.

There is a lack, especially, of implementation mechanisms to drive action. This includes disincentives, such as taxation of unsustainable practices and virgin materials, as well as incentives, such as decreased taxes on secondary raw materials, investments in research and development and sustainable public procurement. The latter, especially, holds promise for stimulating demand for sustainable textiles, having the potential to use public procurement of textile products by local and national government agencies to pilot and promote new business models, such as selling services rather than products.

The lack of capacity within governments to enforce legislation, and a lack of global coordination between governments, also need to be addressed if stronger governance is to be attained.

4.2 Collaboration and financing

There is increasing recognition that leveraging existing solutions and best practices will not be enough to achieve a sustainable textile industry, and that innovative solutions and new business models are required (Ellen MacArthur Foundation, 2017; GFA and BCG, 2018). However, there are gaps in technology, especially with regard to the systemic changes needed to move beyond small incremental improvements. There are also gaps in knowledge and experience with new business models, specifically in how to move away from existing business models to new circular and resource-efficient business models, and to provide the education, skills and support needed for new business models to flourish.

Significant support is thus needed for research and development into new business models and practices, and especially to accelerate the scaling of circular business models and sustainable solutions. This will require new or strengthened collaboration platforms, involving public-private partnerships and other relevant stakeholders (e.g. academia). Achieving the level and speed of change needed in the textile industry must involve all actors, especially the smaller manufacturers that have yet to make significant sustainability improvements. Unprecedented collaboration throughout the textile value chain is required, creating a strong network of support, with extensive mentorship and capital investment. Such collaboration will instil the mindset that circularity is a value-chain-wide endeavour, and that it needs to be embedded at the design stage.

Further, there is a lack of funding for developing and scaling the new business models. There is also a lack of funding for implementing more sustainable practices in the yarn, fabric and textile manufacturing stages of the value chain, especially where these are small enterprises operating in developing countries. One important action is thus for partnerships to leverage funding from financial institutions, especially in those parts of the world where funding is difficult to leverage (and where the highest social and environmental impacts are occurring).

There is a need for spaces and mechanisms which facilitate the deep level of collaboration required. In the context of the need for stronger governance and policies, governments in particular need such spaces for collaboration. With a considerable track record in projects directly involving textiles, as well as in the required associated disciplines (e.g. eco-innovation, life cycle thinking etc.) the United Nations is in a good position to provide such support, building on the strong base of existing networks and forums.

4.3 Change in consumption habits

Governments and brands/retailers are unlikely to take action at scale unless there is considerable advocacy. To this end, gaps in consumer awareness need to be addressed, and knowledge of and a preference for sustainable apparel and household textiles created among consumers. There is, especially, a need to address over-consumption and fast fashion (acknowledging that in some parts of the world, clothing has to be affordable to meet basic human needs), as well as to instil habits to reduce the climate impacts of garment care and extend the life of garments. Furthermore, it also requires "buy-in" from consumers for new circular business models, such as clothing subscription-rental models, while re-use, repair/repurposing and recycling models require consumers to return their clothes to stores or collection depots and/or participate in sharing platforms/clothing exchanges. Educating and motivating consumers to play their role in the solution are critical. This implies a sufficient number of forward-looking brands and retailers providing consumers with sustainable options, so that consumers can exercise their purchasing power. New, innovative campaigns are needed that extend the reach of existing campaigns, for example using social media influencers and United Nations ambassadors to change lifestyle perceptions of what is "fashionable". Along with education and awareness raising, other options to motivate consumers should be implemented, such as discounts/refunds to incentivize sustainable purchases (again requiring the participation of forward-looking brands and/or governments, in the case of tax breaks). Most importantly, conditions must be put in place that make it easy for consumers to choose sustainable options.

Furthermore, consumers need information if they are to be able to make ethical and sustainable choices. Consumer information tools, such as product labels, or trusted company-level analysis are thus important to enable better informed decisions. However, product labels require better coordination to reduce confusion as well as actions to increase their applicability across products and improve their reliability and relevance (including better monitoring of environmental, social and economic impacts, and traceability of the textile value chain to ensure the truthfulness of information). Brands/retailers and governments, working with civil society organizations, all have a role to play in implementing actions to change consumer behaviour.

Table 1: Priority actions required to create a sustainable and circular textile value chain[56]

		Priority Actions		
		Actions responding to unsustainable consumption	**Actions to support business model innovation**	**Actions to close gaps in production and technology**
Key Needs	**Stronger governance and policies**	Incentivize new business models that increase textile utilization and reduce consumption; tax unsustainable practices and virgin materials and decrease taxes on secondary raw materials; implement eco-design requirements and production standards to level the playing field.	Create incentives for innovative business models and the use of sustainable materials (e.g. through sustainable public procurement, subsidies); invest into research & development.	Regulate against toxic substances and harmful labour practices, considering the whole value chain and its hotspots as well as a just transition.
	Collaboration and financing	Develop innovative solutions and new business models that increase the life span of products and reduce consumption (e.g. through refuse, reduce (by design), re-use, repair, repurposes & recycle).	Provide education, skills and support for scaling of circular business models and sustainable solutions (e.g. through new or strengthened collaboration mechanisms, involving publi-private partnerships and cross-government collaboration); leverage funding from financial institutions.	Instil mindset that circularity is a value-chain wide endeavour that need to be embedded at the design stage; encourage value chain collaboration; strengthen global knowledge sharing, making guidelines available and ensuring businesses receive the information.
	Change in consumption habits	Change consumer attitudes (through education & motivation) to what is fashionable by i) improving industry communication and advertising of new business models, ii) running awareness-raising campaigns using emerging media, such as social media influencers and UN ambassadors, and iii) providing information to consumers through tools such as product labelling.	Build consumer acceptance for product longevity that reduces consumption, for service over ownership models (e.g. rental subscriptions), and for returning products after use (e.g. for repair, refurbishing and recycling); implement options such as discounts/refunds to incentivize sustainable purchases.	

56 The priority actions were identified by multi-stakeholder experts through an analysis of gaps.

Conclusions

This report takes a systematic value chain approach to identifying the environmental and socio-economic impacts of textiles so that the priority actions needed to advance sustainability and circularity along the value chain can be identified.

The increasing consumption, manufacture and use of textile products affect the global climate, the quality of ecosystems and human health, through their high use of energy, chemicals, land and water. The textile industry also has high social risks despite the much-needed employment and essential human services it provides. Although all the value chain stages have high use of energy and/or natural resources (leading to high environmental impacts), the extensive use of chemicals in cotton cultivation and wet textile processing makes these stages, particularly, stand out in terms of their impacts on human health and ecosystems. Activities in these stages not only affect the health of the textile workers directly, in particular where working conditions are unsafe, but also that of the wider communities by polluting the environment in which the activities are carried out.

The environmental and social impacts of textiles are made harder to address because of business models that require speed and flexibility of production as well as manufacturing in locations where labour prices are lowest. The result is that textiles are predominantly manufactured in countries where investment and employment are most needed, but where regulations protecting workers and the environment are weakest.

Despite the number of initiatives steadily improving the environmental and social performance of textiles, it is clear that more needs to be done. In particular, improvements need to move beyond incremental changes being made by large and high-end players to systemic changes undertaken by players of all sizes and market segments. Such systemic changes need to challenge the predominant business model of fast fashion, and to move from an industry producing large volumes of essentially disposable items, to one producing valuable items that remain in use for a long period before being repurposed or recycled.

Moving towards sustainable and circular textiles will require changes at each stage in the value chain, involving players of all sizes and market segments. The use of hazardous substances in textile processing will have to be eliminated, and resources will have to be used much more effectively, with a shift away from fossil fuels towards renewable sources of energy and materials. The life span of clothing and other textile products will have to be considerably increased, along with radically improved recycling when materials reach their end-of-life. Sustainable and circular textiles will thus require entirely new ways of doing business, but will deliver an industry that benefits business, society and the environment.

Achieving these changes will require coordinated actions by a range of stakeholders. Priority needs are stronger governance and policies to drive the change, collaboration and financing to enable industry-wide participation, and changing consumption habits. A further overarching need is for real accountability across the value chain, whether this is achieved through specific transparency and traceability efforts or through collective programmes to drive systemic change.

UNEP aims to provide leadership and convene partners to address all three core needs, in particular to develop knowledge and solutions to advance towards a sustainable and circular textile value chain, while supporting the sound management of chemicals. This will contribute to achieving the 2030 Agenda for Sustainable Development, especially SDG 12 on responsible consumption and production.

This report has identified the priority actions needed to advance circularity and sustainability in textile value chains through an evidence-based approach. The next step is to undertake a deeper analysis of the identified priority actions in order to develop a roadmap outlining how and by whom these can be addressed in order to move towards a more circular textile value chain. A subsequent report in this series will provide such a roadmap based on stakeholder consultations. In support of the United Nations Environment Assembly (UNEA)-4 Resolution 1 on "Innovative pathways to achieve sustainable consumption and production" adopted in March 2019, UNEP, in collaboration with the International Resource Panel, will build on these findings to provide evidence and quantitative analyses on the environmental, macro-economic and social impacts of value retention processes and other policy frameworks in the textile value chain. UNEP looks forward to continuing to engage with governments, businesses, civil society and other actors to advance this agenda.

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Appendix A

Table A1: Initiatives to promote sustainable cotton cultivation and transparency in cotton value chains

Name	What it is about	Stakeholder targeted	Value chain stage
Better Cotton Initiative	Started by a WWF roundtable initiative in 2005, BCI has over 1,400 members and brings together farmers, ginners, traders, spinners, mills, cut & sew, manufacturers, retailers, brands, civil society and grassroots organizations committed to developing Better Cotton as a sustainable mainstream commodity. https://bettercotton.org/	Cotton farmers, yarn, fabric, textile and apparel manufacturers, brands and retailers	Fibre (cotton), yarn, fabric, textile and apparel production
Cleaner Cotton Sustainable Cotton Project (SCP)	Non-profit promoting agricultural sustainability in California's Central Valley, building connections with growers, consumers, manufacturers and retailers; farm programme utilizing biological farming practices and eliminating toxic chemicals. http://www.sustainablecotton.org/	Cotton farmers, buyers	Fibre (cotton), yarn, fabric, textile and apparel production
Cotton Connect	Enterprise working with brands and retailers to develop resilient cotton supply chains by connecting brands and retailers to farmers to create a transparent supply chain, training farmers in agro-economic practices, and supporting the enhancement of farmer livelihoods and strong farming communities. http://cottonconnect.org/	Cotton farmers, brands, retailers	Fibre (cotton), yarn, fabric, textile and apparel production
Cotton Made in Africa (CMiA) Aid by Trade Foundation	Promotes decent work for cotton farmers and ginnery workers in sub-Saharan Africa, to protect the environment and to create transparency in the textile supply chain. https://www.cottonmadeinafrica.org/en/	Cotton farmers	Fibre (cotton), yarn, fabric, textile and apparel production
Cotton 2040 Forum for the Future	Multi-stakeholder initiative to increase the use of sustainable cotton internationally, bringing together international brands and retailers, sustainable cotton standards, existing industry initiatives and other stakeholders across the value chain. Launched the CottonUp guide to support brands and retailers to source sustainable cotton. http://cottonupguide.org	Cotton farmers, brands, retailers, manufacturers	Fibre, yarn, fabric, textile and apparel production
InoCottonGrow	Pakistani and German partners working to identify technically, economically and institutionally feasible ways of increasing the efficiency of water use along the cotton value chain. https://www.inocottongrow.net/	Cotton farmers	Fibre production (cotton cultivation)
Organic Cotton Accelerator	Multi-partner initiative (brands, supply partners, NGOs, knowledge institutes and sector platforms) that unites key industry players committed to taking action on growing organic cotton. https://www.organiccottonaccelerator.org/	Cotton farmers	Fibre (cotton), yarn, fabric, textile and apparel production

Name	What it is about	Stakeholder targeted	Value chain stage
Sustainable Cotton Cluster Cotton South Africa	Programme that brings together stakeholders of the cotton value chain, including the public sector, organized labour, consumer organizations and service providers. https://cottonsa.org.za/	Brands, retailers, fibre, yarn, fabric and textile producers	Fibre (cotton), yarn, fabric, textile and apparel production
West Africa Organic & Fairtrade Cotton Coalition	Multi-stakeholder coalition to promote organic cotton systems and improve farmer skills in organic and Fairtrade cotton in West Africa. The coalition is sustained by the cotton producer organizations from Mali, Benin, Burkina Faso, and Senegal and works closely with the national cotton societies while being supported by the Swiss-based organizations ecos and FiBL and their cotton partners from the international organic and Fairtrade movement. http://cotton-coalition.com/	Fibre producers, governments,	Fibre (cotton), yarn, fabric, textile and apparel production
Yarn Ethically & Sustainably sourced (YESS) Responsible Sourcing Network (RSN)	Aims to drive modern slavery out of cotton production by eliminating the market for cotton produced with forced labour, and increasing the use of ethical and sustainable cotton. https://www.sourcingnetwork.org/yess	Brands, retailers, fabric producers	Fibre, yarn, fabric, textile and apparel production

Table A2: Product labels, certifications, benchmarks, pledges and agreements

Name	What it is about	Stakeholder targeted	Value chain stage
Bluesign	Product label and verification scheme that provides solutions in sustainable processing and manufacturing to industries and brands. https://www.bluesign.com/en	Consumers, brands, manufacturers	Textile production
CircularID Connect Fashion Global Initiative	Digital system for identification and management of products in the circular economy. https://www.connect-fashion.com/	Brands, retailers and manufacturers	Value chain
Corporate Fiber and Materials Benchmark Textile Exchange	Benchmark to help companies systematically measure, manage and integrate a preferred fibre and materials strategy into their business operations, to compare progress, and to communicate performance and progress to stakeholders. https://textileexchange.org	Brands, retailers, manufacturers	Value chain
Dutch Agreement on Sustainable Garments and Textiles	Signatories commit themselves to fighting discrimination, child labour and forced labour; undertake to support a living wage, health and safety standards for workers, and the right of independent trade unions to negotiate; pledge to reduce the negative impact of their activities on the environment. Signed by industry associations, trade unions, NGOs, and the National Government of the Netherlands. https://www.imvoconvenanten.nl/garments-textile/agreement?sc_lang=en	Retailers, manufacturers, textile producers, government	Fibre, yarn, fabric and textile production

Name	What it is about	Stakeholder targeted	Value chain stage
Facts Certification Program Association for Contract Textiles (ACT)	Standard to recognise textiles that conform to the multi-attribute standard NSF/ANSI 336 and that are third-party certified; indicates a textile has been evaluated for environmental, economic and social aspects across its life cycle. https://contracttextiles.org/facts-sustainability-certification/#facts	Brands, retailers, yarn, fabric and textile producers	Yarn, fabric and textile production
Fashion Industry Charter for Climate Action UNFCCC	Charter resulting from UNFCCC and fashion stakeholders working to identify ways in which the textile, clothing and fashion industry can move towards a holistic commitment to climate action and achieve net-zero emissions by 2050. Signatories commit to working collaboratively on climate action. https://unfccc.int/climate-action/sectoral-engagement/global-climate-action-in-fashion/about-the-fashion-industry-charter-for-climate-action	Brands, retailers, fibre, yarn, fabric and textile producers	Fibre, yarn, fabric and textile production
Fashion Pact	Global coalition of companies in the fashion and textile industry committed to a common core of key environmental goals in three areas: stopping global warming, restoring biodiversity and protecting the oceans. The Fashion Pact was presented to Heads of State at the 2019 G7 Summit in Biarritz. https://thefashionpact.org	Brands, retailers and textile producers	Textile production
Forest for Fashion Initiative Programme for the Endorsement of Forest Certification (PEFC)	PEFC, in partnership with UNECE and FAO, linking forest-based materials from sustainably managed forests with the world of fashion. https://www.pefc.org	Brands, retailers and raw material producers	Fibre production
Global Organic Textile Standard (GOTS) OTA (USA), IVN (Germany), Soil Association (UK) and JOCA (Japan)	Collaboratively developed and harmonized voluntary standard defining globally recognized requirements that ensure the organic status of textiles from field to finished product. GOTS includes social and environmental criteria and is based on third party certification. https://www.global-standard.org	Consumers, brands, retailers and manufacturers	Fibre, yarn, fabric, textile and apparel production
Gruener Knopf	German voluntary certification scheme with 26 social and environmental sustainability criteria targeting the entire lifecycle of textiles. Certification is undertaken by third-party accredited verifiers. https://www.gruener-knopf.de/	Brands, retailers, textile producers, consumers	Fibre, yarn, fabric, textile production
Higg Index Sustainable Apparel Coalition	A suite of tools that measure the sustainability performance of a company or its products so as to empower businesses to make improvements that protect the well-being of factory workers, local communities, and the environment. https://apparelcoalition.org/the-higg-index/	Manufacturers	Yarn, fabric, textile and apparel production

Name	What it is about	Stakeholder targeted	Value chain stage
Nordic textile re-use and recycling commitment Nordic Council of Ministers	Voluntary certification system aimed at tackling a lack of transparency on the fate of post-consumer textiles collected by organizations. http://norden.diva-portal.org/smash/get/diva2:788266/FULLTEXT01.pdf	Consumers, brands, recyclers	End-of-life
Oeko-Tex	Portfolio of independent certifications and product labels that enable companies along the textile chain and consumers to make responsible decisions in favour of products that are manufactured in a fair way and do not harm human health or the environment. https://www.oeko-tex.com/en/our-standards	Consumers, brands, manufacturers	Fibre, yarn, fabric, textile and apparel production
Project SU.RE Indian Textiles Minister, Clothing Manufacturers Association of India (CMAI), United Nations in India, IMG Reliance	A commitment by India's apparel industry to set a sustainable pathway for the Indian fashion industry. SU.RE stands for "Sustainable Resolution" https://pib.gov.in/PressReleasePage.aspx?PRID=1582685	Brands, retailers, textile producers and governments	Fibre, yarn, fabric and textile production
Sustainable Clothing Action Plan (SCAP) WRAP UK	Collaborative framework and voluntary commitment to deliver industry-led targets for reducing the use of resources in the clothing industry. http://www.wrap.org.uk/sustainable-textiles/scap	Brands, retailers and manufacturers	Value chain
Transparency Pledge Coalition of nine labour and human rights organizations	Aims to help the garment industry reach a common minimum standard for supply chain disclosures by getting companies to publish standardized, meaningful information on all factories in the manufacturing phase of their supply chains. https://transparencypledge.org	Brands, retailers, fibre, yarn, fabric and textile producers	Fibre, yarn, fabric and textile production

Table A3: Campaigns

Name	What it is about	Stakeholder targeted	Value chain stage
#whomademyclothes Fashion Revolution	To increase public awareness and channel consumer demand towards increased company disclosure. Publishes The Fashion Transparency Index. https://www.fashionrevolution.org/	Consumers, brands, retailers	Fibre, yarn, fabric and textile production

Name	What it is about	Stakeholder targeted	Value chain stage
Textile Smart Swedish Environmental Protection Agency, Swedish Consumer Agency, Swedish Chemicals Agency	Campaign aimed at spreading knowledge about the environmental effects of textile consumption and how to consume in a more sustainable manner. Main communication channel is Instagram where short films and posts are shared using a common language in an interactive and easy spirit. The outcome of the project will be summarized and presented in February 2021. https://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Konsumtion-och-produktion/Hallbara-textilier/Textilsmart/	Consumers	Consumption
Clevercare GINETEX (International association for textile care labelling), in collaboration with brand ambassadors	Care symbol, website and communication campaign for consumers to consider the environment when washing and caring for garments. https://www.clevercare.info/en	Consumers	Use
IPrefer30 degrees A.I.S.E.	International Association for Soaps, Detergents and Maintenance Products (A.I.S.E.) campaign with a focus on saving energy through low temperature washing. https://www.iprefer30.eu/	Consumers	Use
Love your Clothes WRAP UK	Campaign aiming at raising awareness of the value of clothes and encouraging people to make the most out of the clothes they already have. https://www.loveyourclothes.org.uk	Consumers	Use and end-of-life
Campaign for Wool	Global endeavour to raise awareness amongst consumers about the unique, natural, renewable and biodegradable benefits offered by wool. http://www.campaignforwool.org	Consumers	Use and end-of-life
Canopy Style Initiative Canopy	Initiative to transform unsustainable wood supply chain by adopting sustainable sourcing policies and producing fabrics and textiles derived from lower impact fibres such as straw and recycled fabrics. https://canopyplanet.org/	Consumers, brands, retailers	Fibre, yarn, fabric and textile production
Clean Clothes Campaign Garment industry alliance (Europe)	Campaign to improve the working conditions and support the empowerment of workers in the global garment and sportswear industries. https://cleanclothes.org/	Consumers, manufacturers, brands, governments	Yarn, fabric and textile production
Detox my Fashion Greenpeace International	Long-standing campaign to eliminate hazardous chemicals from textiles. Helped trigger policy changes in Europe and Asia. https://www.greenpeace.org/international/act/detox/	Consumers, manufacturers, brands, governments	Yarn, fabric and textile production
Good on you Ethical Consumers Australia	Brand directory and app that provides information and news about sustainable and ethical fashion choices. https://goodonyou.eco/about/	Consumers	Textile production

Name	What it is about	Stakeholder targeted	Value chain stage
Anatomy of Action UNEP, One Planet network Sustainable Lifestyles and Education Programme	In the Anatomy of Action campaign's media tool kit Fashion slow-down is a core action that asks people to buy better and avoid fast fashion that mass produces at the cost of environmental and human justice. https://anatomyofaction.org/stuff/	Consumers	Use and end-of-life

Table A4: Technological innovations in the textile sector

Name	What it is about	Stakeholder targeted	Value chain stage
DyeCoo	CO dyeing technology that provides a water-free and process chemical-free textile processing solution. Uses reclaimed CO2 in a closed loop process, offering low costs due to high energy efficiency, efficient dye use and no water treatment costs. http://www.dyecoo.com/	Brands, retailers, yarn and fabric producers	Yarn, fabric and textile production
Fibersort	Technology that automatically sorts large volumes of mixed post-consumer textiles by material composition; implementation project in North-West Europe. http://www.nweurope.eu/projects/project-search/bringing-the-fibersort-technology-to-the-market/	Recyclers and waste managers	End-of-life
Guppy Friend Stop! MicroWaste	The Guppyfriend washing bag, made from a micro-filter material, filters out microfibres released from textiles during washing. http://guppyfriend.com/en/so-gehts	Consumers	Use
Haelixa	Start-up which offers a product marking technology based on DNA that allows to trace material from producer to retail supporting claims related to sustainability. https://www.haelixa.com/	Brands, retailers, consumers	Value chain
Made from Malai	Biocomposite material made from organic bacterial cellulose, grown on agricultural waste sourced from the coconut industry in Southern India. Close collaboration with local farmers and processing units to collect waste coconut water. http://made-from-malai.com/	Brands, retailers, yarn and fabric producers	Fibre production
NuCycl Evrnu	Fibre with performance and environmental advantages made from discarded clothing. https://www.evrnu.com/nucycl	Brands, retailers, yarn and fabric producers	Fibre production; end-of-life
Repreve Unifi	High performance fibre made from recycled bottles used to make athletic and fashion apparel. https://repreve.com/	Brands, retailers, yarn and fabric producers	Fibre production
Seaqual Textil Santanderina	Polyester yarn made from recycled materials including post-consumer plastic bottles and recycled cotton textiles. https://textilsantanderina.com/seaqual/	Brands, retailers, yarn and fabric producers	Fibre production; end-of-life

Name	What it is about	Stakeholder targeted	Value chain stage
Smart Textiles	New technologies for a sustainable textile production process: for example, printing without water; textiles made from 100% paper, recycling jeans and redesigning fabrics to avoid waste https://smarttextiles.se/en/	Fibre, yarn, fabric and textile producers, academia, recyclers and waste managers	Fibre, yarn, fabric and textile production, end-of-life
SpinDye	Technically innovative and precise colouring process for polyester yarns and fabrics using little water and no toxins. https://spindye.com/	Brands, retailers, yarn and fabric producers	Yarn, fabric and textile production
Tandem Repeat	Eco-friendly process where self-healing properties in squid genes are used to create a fibre that is biodegradable, long lasting and 100% recyclable. http://www.tandemrepeat.com/	Brands, retailers, yarn and fabric producers	Fibre production; end-of-life
Texloop and Agraloop Circular Systems	Materials science company transforming agricultural wastes and textile waste into fibre, yarn, and fabrics for the fashion industry. https://www.circular-systems.com/agraloop	Brands, retailers, yarn and fabric producers	Fibre production; end-of-life
Upcycling the Oceans Ecoalf Foundation	Project collecting marine debris and turning it into quality yarn. https://circulareconomy.europa.eu/platform/en/good-practices/upcycling-oceans-collects-marine-trash-and-turns-it-quality-yarn	Brands, retailers, yarn and fabric producers	Fibre production

Table A5: Initiatives with a focus on social sustainability in textiles

Name	What it is about	Stakeholder targeted	Value chain stage
Better Work International Labour Organization (ILO)	Brings diverse groups together – governments, global brands, factory owners, and unions and workers – to improve working conditions in the garment industry and make the sector more competitive. https://betterwork.org/	Brands, retailers, manufacturers and governments	Fibre, yarn, fabric and textile production
Ethical Fashion Initiative International Trade Centre	Connects marginalized artisans from the developing world – the majority of them women – to international fashion houses for mutual benefit. https://ethicalfashioninitiative.org/	Brands and retailers	Textile production
Ethical Trading Initiative Norwegian, Danish and British governments	Focuses on particular supply chains where there are good opportunities to improve working conditions through collaboration https://www.ethicaltrade.org/programmes	Textile producers	Textile production
Fair Wear Foundation	Works with brands on labour conditions in their supply chain and with companies and factories to improve labour conditions for garment workers. https://www.fairwear.org/	Brands, retailers, textile producers	Textile production
FairTrade International	Works with farmers who have formed small producer organizations, as well as contract production organizations in the process of forming independent cooperatives. https://www.fairtrade.net/product/cotton#	Cotton farmers	Fibre production (cotton cultivation)

Fashionomics Africa Digital Marketplace and Mobile App African Development Bank	Pan-African B2B and B2C platform intending to stimulate inter-and-intra African trade; provide access to market intelligence to increase transparency in the sector; and connect the various players of the fashion supply chain from entrepreneurs, buyers and sellers to manufacturers, distributors and customers https://fashionomicsafrica.org/	Investors, brands, retailers	Textile production
Initiative for Compliance and Sustainability (ICS)	International sectoral initiative that aims to enhance working conditions along the global supply chains of its member retailers and brands. https://ics-asso.org/	Brands, retailers and manufacturers	Textile production

Table A6: Platforms and networks addressing sustainability in textile production

Name	What it is about	Stakeholder targeted	Value chain stage
Alliance for Sustainable Fashion UN	Works to support coordination between UN bodies working in fashion and promoting projects and policies that ensure that the fashion value chain contributes to the achievement of the SDG targets; scope extends from the production of raw materials and the manufacturing of garments, accessories and footwear, to their distribution, consumption, and disposal. https://unfashionalliance.org/	Brands, retailers, manufacturers, consumers and governments	Value chain
Clean by Design Natural Resource Defense Council (NRDC)	Innovative programme to use the buying power of multinational corporations as a lever to reduce the environmental impacts of their suppliers abroad; focuses on improving process efficiency to reduce waste and emissions and improve the environment. https://www.nrdc.org/resources/clean-design-apparel-manufacturing-and-pollution	Brands, retailers, textile producers	Textile production
Common Objective	Global business network aiming to connect members with each other and the solutions for sustainable fashion business. https://www.commonobjective.co	Brands, retailers and textile producers	Fibre, yarn, fabric and textile production
European Clothing Action Plan European Commission	Project whose approach encompasses sustainable design, production, consumption, public procurement, collection, recycling and reprocessing. http://www.ecap.eu.com/	Brands, retailers, consumers, governments, fibre, yarn, fabric and textile producers	Value chain
Framework initiative on transparency and traceability of sustainable value chains UNECE and UN/CEFACT	EU-funded project aimed at setting up a multi-stakeholder platform and developing policy recommendations, traceability standards and implementation guidelines, pilots and capacity-building activities for sustainable textile and leather value chains. https://www.unece.org/tradewelcome/outreach-and-support-for-trade-facilitation/traceability-for-sustainable-value-chains-textile-and-leather-sector.html	Brands, retailers, fibre, yarn, fabric and textile producers, governments	Value chain
Global Fashion Agenda	Leadership forum and advocacy for industry collaboration on sustainability in fashion. https://www.globalfashionagenda.com	Brands, retailers and textile producers	Value chain

Name	What it is about	Stakeholder targeted	Value chain stage
LIVA Accredited Partner Forum (LAPF) Aditya Birla	National drive in India to bring all textile stakeholders onto a single platform and promote innovation and quality, and make India the world's leading cloth manufacturing hub. https://www.adityabirla.com/media/events/aditya-birla-group-to-scale-up-liva	Brands, retailers, fibre, yarn, fabric and textile producers	Fibre, yarn, fabric and textile production
Nordic Initiative Clean & Ethical (NICE) Nordic Fashion Association	Platform for cooperation between the Nordic countries; involved in projects that have addressed global sustainability issues. http://nordicfashionassociation.com/projects/a-nice-future/	Brands, retailers and manufacturers	Fibre, yarn, fabric and textile production
Outdoor Industry Microfibre Consortium	The Outdoor Industry Microfibre Consortium facilitates the development of practical solutions for the textile industry to minimize fibre fragmentation and release into the environment from textile manufacturing and product life cycle. With broad membership, the consortium works collaboratively to improve industry understanding of the challenges that microfibres present and find sustainable solutions; engaging with policy makers and the media. https://www.microfibreconsortium.com/about	Brands, retailers and textile producers	Textile production and use
Partnership for sustainable textiles	Global multi-stakeholder platform (German Government, NGOs, unions, standards organizations) to improve the social and ecological performance of the textile supply chain; members set targets, pursue them and gradually raise their level of ambition; they regularly share knowledge, experience and information. https://en.textilbuendnis.com/en/	Fibre, yarn, fabric and textile producers	Fibre, yarn, fabric and textile production
Platform for Transformative Technologies (P4TT)	The Platform for Transformative Technologies (P4TT) is a collaborative platform, organized by the private sector. It identifies and brings to market innovative and integrated technological solutions that can contribute substantially to the achievements of specific SDGs if deployed at scale. The platform spans the whole life cycle from innovation to business development and enabling policy setting for selected industrial sectors.	Fibre, yarn, fabric and textile producers, brands, retailers, academia, governments	Value chain
REBus	EU Life+ funded project that enables companies to transform their strategies into profitable, resilient and more resource efficient business models. http://www.rebus.eu.com/	Fibre, yarn, fabric and textile producers, brands, retailers, recyclers	Fibre, yarn, fabric and textile production, consumption

Name	What it is about	Stakeholder targeted	Value chain stage
Responsible Supply Chains in the Garment and Footwear Sector OECD	Guidance and forum with representatives from government, business, workers and civil society to discuss key issues and risks related to due diligence in global garment and footwear supply chains, focusing on solutions; supports alignment across governments and industry initiatives. https://mneguidelines.oecd.org/forum-on-due-diligence-in-the-garment-and-footwear-sector.htm	Brands, retailers, manufacturers	Yarn, fabric, textile and apparel production
Shaping Fashion World Economic Forum	A global initiative to scale sustainable transformations in the fashion industry through the Global Shapers network. https://www.weforum.org/projects/shaping-fashion	Brands, retailers and manufacturers	Fibre, yarn, fabric and textile production
Sustainable Apparel Coalition	Industry alliance with members from NGOs, governments, manufacturers and retailers, committed to making transformational change; driving social and environmental improvements in the industry through scaling the Higg Index globally. https://apparelcoalition.org/	Brands, retailers, fibre, yarn, fabric and textile producers	Fibre, yarn, fabric, textile and apparel production
Swedish Fashion Council	Independent organization that aims to promote, educate, inspire and digitize the Swedish fashion industry to become competitive and sustainable in all areas. http://www.swedishfashioncouncil.se	Brands, retailers and textile producers	Textile production
Swedish Textile Initiative for Climate Action Sustainable Fashion Academy	Initiative to provide a neutral, non-competitive platform for companies and organizations to learn about sustainable practices. https://www.sustainablefashionacademy.org/STICA	Brands, retailers, fibre, yarn, fabric and textile producers	Value chain
Swedish Textile Water Initiative	Member network (Stockholm International Water institute and Swedish textile brands) that helps textile companies and factories reduce water, energy and chemical use in their supply chains. http://stwi.se	Brands, retailers and textile producers	Textile production
Textile and Cotton Programmes Solidaridad	Training, network meetings and on-site and off-site technical support covering a wide range of thematic aspects including resource efficiency (energy and water), sound waste management (including effluent), chemical management and awareness of social aspects. https://www.solidaridadnetwork.org/supply-chains/textiles	Textile producers	Textile production
Textile and Fashion 2030 Swedish government assignment, hosted by Smart Textiles and the Swedish School of Textiles	National platform that challenges, educates and offers activities for the transition to a more sustainable textile and fashion industry. A developed progress model is used as a tool and together with companies joining, the model is used to measure the development of their sustainability work. https://textileandfashion2030.se/en/textile-challenge/	Brands, retailers and textile producers; governments; researchers/academics, students; consumers and influencers	Value chain

Name	What it is about	Stakeholder targeted	Value chain stage
UNEP Circularity Platform	The UNEP Circularity Platform provides an understanding of the circularity concept, its scope and how it contributes to promoting sustainable consumption and production patterns. It also offers a wide range of useful resources and features stories illustrating how various stakeholders have successfully adopted circular approaches in the textile value chain. https://www.unenvironment.org/circularity	Brands, retailers, textile producers, governments, civil society	Value chain
UNEP expert community (textile value chain)	Expert community convened by UNEP to share existing and jointly develop new knowledge and solutions to advance towards sustainable and more circular textile value chains (such as this report) and provide leadership. https://www.oneplanetnetwork.org/unep-textile-value-chain	Brands, retailers, textile producers, governments, international organizations, NGOs	Value chain
Textile Exchange	Works with its members to drive industry transformation in preferred fibres, integrity and standards and responsible supply networks; partners with organizations wanting to advance their sustainability efforts; helped to establish best practices and fair business models for the entire supply network, from farm to retail. https://textileexchange.org/	Brands, retailers, fibre, yarn, fabric and textile producers	Fibre, yarn, fabric and textile production
WEAR (World Ethical Apparel Roundtable) Fashion Takes Action	Provides a platform to share examples of local and global leadership, best practices and innovative solutions. https://wear.fashiontakesaction.com/	Brands, retailers and manufacturers	Fibre, yarn, fabric and textile production

Table A7: Initiatives addressing the use of hazardous chemicals in textile production

Name	What it is about	Stakeholder targetedt	Value chain stage
Restricted Substances List American Apparel and Footwear Association (AAFA)	Practical tool to help textile, apparel and footwear companies become aware of regulations and laws that restrict or ban certain chemicals and substances in finished home textile, apparel, and footwear products around the world. https://www.aafaglobal.org/AAFA/Solutions_Pages/Restricted_Substance_List.aspx	Manufacturers, suppliers	Textile production
Textile Guide ChemSec (International Chemical Secretariat)	Helps small and medium-sized textile companies identify and replace hazardous chemicals present in their processes and products. http://textileguide.chemsec.org/	Manufacturers	Textile production
Zero Discharge of harmful Chemicals (ZDHC) Roadmap to Zero Programme ZDHC Foundation	Coalition of brands, manufacturers etc. aiming to empower the global textile, leather, apparel and footwear value chain to substitute hazardous chemicals with safer ones in the production process. https://www.roadmaptozero.com/	Brands, retailers, textile producers	Textile production

Table A8: Organizations and initiatives addressing the re-use and recycling of textiles

Name	What it is about	Stakeholder targeted	Value chain stage
Eco TLC	Extended Producer Responsibility (EPR) organization aiming for 100% re-use and recycling of clothing, home textiles and footwear; accredited by the French government. https://www.ecotlc.fr/page-297-information-in-english.html	Textile manufacturers, distributors and importers	Textile and apparel production, collection, sorting, re-use and recycling
Garment Collecting Initiative H&M and I:CO	Initiative to increase the re-use and recycling of apparel by providing collection bins in stores and a discount to customers; textiles are sorted for repurposing, re-use (turning into other products), recycling (shredding) or recovery (incinerated for energy). https://hmgroup.com/media/Our-stories/fromthrowawaytoheretostay.html	Consumers	End-of-life
Jeans Redesign Guidelines Ellen MacArthur Foundation	Guidelines to tackle waste and pollution in jeans production including minimum requirements on garment durability, material health, recyclability and traceability. https://www.ellenmacarthurfoundation.org/our-work/activities/make-fashion-circular/projects/the-jeans-redesign	Manufacturers, brands, retailers	Textile production
Nuw	Platform to borrow or swap rarely worn clothes. https://www.thenuwardrobe.com/nujourney	Consumers	Use
Phinix	Filipino textile recycling centre that collects textile wastes and transforms them into higher value products such as footwear and fashion accessories. The brand also supports social inclusion and fair working conditions by employing local Filipino shoe artisans and persons with disabilities https://www.facebook.com/madebyphinix/about/?ref=page_internal	Brands, retailers, consumers	Fibre, yarn, fabric and textile production, end-of-life
Re-Spun Marine Layer	Recycling programme whereby people donate old t-shirts and get store credit. T-shirts are broken down to a fibre level and used to make "new" t-shirts. https://recyclenation.com	Consumers	End-of-life
Refazenda	Brazilian fashion brand that uses fabric scraps and relies on handmade production and social work to create new clothes. The brand educates consumers about re-using and repurposing clothes. https://www.vivarefazenda.com.br/?fbclid=IwAR2Fl4tyu-RRQqytJB56kBZQ2_LBUdkutzk_sXy85DhCs3rklW9o2u1zRxw	Brands, retailers consumers	Textile production, consumption, end-of-life
Re:newcell	Swedish company that developed a unique process for industrial scale textile recycling. Re:newcell's recycling technology can transform old clothes into a virgin quality natural material called Circulose. https://renewcell.com/	Brands, retailers, textile producers	Fibre, yarn and fabric and textile production, end-of-life
Recover Brands	Outdoor apparel company sourcing fibre from recycled plastic bottles and with a t-shirt recycling initiative. https://recoverbrands.com	Consumers	End-of-life

Name	What it is about	Stakeholder targeted	Value chain stage
ShareMyBag	International fashion sharing website launched in 2018. The concept of the platform aims to connect consumers with other consumers in order to share fashion while extending the use-phase of products. https://www.isharemybag.com/	Consumers	Use
TexAid European organisation	Works with local municipalities, charities and other organizations to ensure that used textiles in Europe are kept in the value-added chain for as long as possible. https://www.texaid.ch/en/	Recyclers and waste management	End-of-life (collection, sorting, re-use and recycling)
Textile Recycling Association	UK's trade association for collectors, sorters, processors and exporters of used clothing and textiles. www.textile-recycling.org.uk	Recyclers and waste management	End-of-life (collection, sorting, re-use and recycling)
Worn Wear Patagonia	Provides resources for responsible care, repair, re-use and resale, and recycling at the end of a Patagonian garment's life. https://wornwear.patagonia.com	Consumers	End-of-life

Table A9: Initiatives advancing circularity in textiles

Name	What it is about	Stakeholder targeted	Value chain stage
Ban on the destruction of unsold textile products French Ministry for Ecological and Solidary Transition	New French law prohibiting the disposal of unsold non-food goods, including textiles. Applicable to sellers no later than 31 December 2021. Exemptions will apply only for some products for which recycling may lead to a negative environmental impact or if recycling is prohibited (because it poses a risk to the environment or human health) or for which no technical solution for re-use, recovery or recycling exists. https://www.ecologique-solidaire.gouv.fr/loi-anti-gaspillage-economie-circulaire-1	Retailers, brands, governments, recyclers	End-of-life
Circle Economy Textiles Programme	Works with businesses (multinationals, SMEs and innovative start-ups) to co-create practical and scalable solutions. Aims to produce the critical data, tools, and pilot projects needed to build the foundation for a circular textiles industry. https://www.circle-economy.com/textiles/#.XWTt2YpS_IU	Brands, retailers, recyclers, consumers, governments, textile producers	Value chain
Circular Apparel Innovation Factory	An industry-led platform with the mission to build the capabilities and the ecosystem to search, seed, support and scale circular textile and apparel innovations in India. https://www.circularapparel.co	Brands, retailers, textile producers, innovators	Textile production
Make Fashion Circular Ellen MacArthur Foundation	An initiative bringing together leaders from across the fashion industry, including brands, cities, philanthropists, NGOs, and innovators. Aims to stimulate the level of collaboration and innovation necessary to create a new textiles economy, aligned with the principles of the circular economy. https://www.ellenmacarthurfoundation.org/our-work/activities/make-fashion-circular	Brands, retailers, researchers, governments, fibre, yarn, fabric and textile producers	Value chain
Dutch Circular Textile Valley	Broad coalition of brands, retailers, manufacturers, their associations, knowledge institutes and government bodies that collaborate on moving to a more circular clothing and textiles value chain in the Netherlands. https://www.dutchcirculartextile.org	Brands, retailers, researchers., governments, fibre, yarn, fabric and textile producers	Value chain

Platform for Accelerating the Circular Economy (PACE) World Economic Forum, UNEP, others	Platform is intended to accelerate the transition to a circular economy by supporting and scaling up public – private partnerships and providing connections, learning and opportunities to pilot and scale best practices. PACE work is articulated around thematic areas, including one on Textile and Fashion. https://pacecircular.org/textiles-and-fashion-project	Brands, retailers, governments	Value chain
Policy Hub for Circular Economy Sustainable Apparel Coalition (lead), Global Fashion Agenda, Federation of the European Sporting Goods Industry	An effort to unite industry leaders behind policies that promote circular practices in the apparel, footwear and textile sectors. Supported by the C&A Foundation. Will also feature input from brands. https://apparelcoalition.org/press-releases/press-release-sac-launches-policy-hub/	Brands, retailers, textile producers, governments	Textile production and end-of-life
Switching Gear Circle Economy	A Laudes Foundation supported project that aims to accelerate circular business models in the industry by guiding four leading apparel brands toward the design and launch of a resale or rental pilot by 2021. Supported by strategic partner Fashion For Good. An Enabling Network, consisting of over 50 circular solution providers and innovators, frontrunning brands and relevant experts, https://www.circle-economy.com/programmes/textiles/switching-gear	Brands, retailers, textile producers	Textile production, consumption and end-of-life

Table A10: Private innovation funds promoting innovation in the textile sector

Name	What it is about	Stakeholder targeted	Value chain stage
Apparel Impact Institute	Aims to identify, fund, scale, and measure innovative programmes within the apparel and footwear industry to meet critical environmental and social needs. https://www.apparelimpactinstitute.org	Brands, retailers, textile producers	Textile production
Circular Design Challenge	Platform for young designers to showcase and win a prize for their innovative ideas and collections made by using materials from diverse waste sources. Launched in collaboration with Fashion for Earth by R|Elan™, UNEP and Lakmè Fashion Week. http://www.circulardesignchallenge.net/	Designers, entrepreneurs	Textile production
Fashion for Good	Global platform that supports innovative initiatives. https://fashionforgood.com/	Brands, retailers and manufacturers	Value chain
Global Change Award H&M Foundation	Innovation challenge aiming to make fashion circular. https://globalchangeaward.com/	Innovators	Value chain
Tommy Hilfiger Social Innovation Challenge	Aims to support entrepreneurial start-ups and scale-up businesses that are developing solutions that have a positive social impact on the fashion value chain. https://amsterdam.impacthub.net/tommy-hilfiger-social-innovation-challenge/	Innovators	Value chain

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