

## Environmental Impact of Fashion

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**Annotation:** The fashion industry represent an important part of our economies, with a value of more than 2.5 trillion USD and employing over 75 million people worldwide. The sector has seen spectacular growth over the past decades, as clothing production doubled between 2000 and 2014. While people bought 60% more garments in 2014 than in 2000, they only kept the clothes for half as long. While the fashion sector is booming, increasing attention has been brought to the impressive range of negative environmental impacts that the industry is responsible for. Fashion production makes up 10% of humanity's carbon emissions, dries up water sources, and pollutes rivers and streams. What's more, 85% of all textiles go to the dump each year. Fast fashion also has a human cost: textile workers, primarily women in developing countries, are often paid derisory wages and forced to work long hours in appalling conditions .In many places, these conditions create infringements on human rights (Human Rights Watch). Use of chemicals in clothes production also raise serious health concerns, both for the workers in the industry and consumers. Additional impacts on health also arise from the pollution described previously.

**Keywords:** fashion, industry, environment, sustainability, impact, human rights, textile, sector.

### Introduction

After the Second World War, the development of synthetic textiles, such as polyester and nylon, transformed the fashion industry. From only a few thousand tonnes in 1940, global consumption of synthetic fibres rose to more than 60 million tonnes in 2018. Since the late 1990s, polyester is the most commonly used fibre in textiles. Today, an estimated 60% of clothing and 70 % of household textiles are made of synthetic fibres. These plastic-based textiles have a significant impact on the environment and climate throughout their life cycle due to emissions of greenhouse gases and pollutants. The textile sector is a growing contributor to the climate crisis, with about 1% of crude oil production used to produce synthetic fibres. The sector is also an important source of plastic leakage into the environment. With between 200 000 and 500 000 tonnes of microplastics from textiles enter the marine environment each year, the textile industry amount for 35% of microplastics pollution in the ocean. Consideration of the textile sector will thus be important for tackling the ongoing plastic crisis. Plastic pollution is one of the major environmental crises of our times, and efforts from various actors are underway to address it. This includes negotiations towards an international legally-binding agreement on plastic pollution, initiated by the resolution adopted at the UN Environment Assembly in March 2022. Learn more about the plastic pollution crisis, governance processes to address it and the work of Geneva-based organizations on the matter in our Plastics and the Environment series.

Launched at COP24 in 2021, the Fashion Industry Charter for Climate Change serves as a roadmap to achieve net-zero emissions by future within the textile, clothing and fashion industries. Signatories and Supporting Organizations under the Charter work within Working Groups aiming to identify and amplify best practices, strengthen existing efforts, identify and address gaps, facilitate and strengthen collaboration among relevant stakeholders join resources and share tools to enable the sector to achieve its climate targets. Cotton is one of the most common fabrics used for clothes. Producing cotton sustains the livelihood of 28.67 million people and provides benefits to over 100 million families across the globe .Recognizing the critical role of cotton for

economic development, international trade, and poverty alleviation, the UN General Assembly decided to proclaim World Cotton Day on 7 October. For its first edition, the day aims to highlight the importance of sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all in the cotton sector. Many actors in Geneva are involved in promoting sustainable production and consumption patterns in the cotton industry. Cotton production can have consequent impacts on the planet due to the use of pesticides, high water consumption, and the conversion of habitat to agricultural use. Conventional production practices can result in soil erosion and degradation, water contamination, and other forms of pollution. The fashion industry is one of the largest polluters in the world, just after the petroleum industry.<sup>[1]</sup> The environmental damage the fashion industry causes increases as the industry grows. Less than one percent of clothing is recycled to make new clothes and the production of green house gas emissions continues to increase everyday.<sup>[2]</sup> The industry produces an estimated 10% of all greenhouse gas emissions.<sup>[3]</sup> The production and distribution of the crops, fibers, and garments used in fashion all contribute to differing forms of environmental pollution, including water, air, and soil degradation. The textile industry is the second greatest polluter of local freshwater in the world,<sup>[4]</sup> and is culpable for roughly one-fifth of all industrial water pollution.<sup>[5]</sup> Some of the main factors that contribute to this industrial caused pollution are the vast overproduction of fashion items,<sup>[6]</sup> the use of synthetic fibers, the agriculture pollution of fashion crops,<sup>[7]</sup> and the proliferation of microfibers across global water sources.<sup>[2]</sup> Fast fashion is defined as "an approach to the design, creation, and marketing of clothing fashions that emphasizes making fashion trends quickly and cheaply available to consumers."<sup>[8]</sup> The amount of new garments bought by Americans has tripled since the 1960s. Globalization has encouraged the rapid growth of the fast fashion industry. Global retail sales of apparel in 2019 reached 1.9 trillion U.S dollars, a new high – this number is expected to double to three trillion U.S. dollars by the year future. The world consumes more than 80 billion items of clothing annually.<sup>[9]</sup> One concern with fast fashion is the clothes waste it produces. According to the Environmental Protection Agency,<sup>[10]</sup> 15.1 million tons of textile clothing waste was produced in 2013 alone.<sup>[11]</sup> In the United States, 64.5% of textile waste is discarded in landfills, 19.3% is incinerated with energy recovery, only 16.2% is recycled.<sup>[12]</sup> When textile clothing ends up in landfills, chemicals on the clothes such as the dye can leech into the ground and cause environmental damage. When unsold clothing is burned,<sup>[13]</sup> it releases CO<sub>2</sub><sup>[14]</sup> into the atmosphere. According to a World Resources Institute report, the fashion industry releases 1.2 billion tons of CO<sub>2</sub> into the atmosphere per year. In 2019, France announced that it was making an effort to prevent companies from this practice of burning unsold fashion items.<sup>[15][16]</sup> Chile has long been a hub for unsold clothing, that was made in China or Bangladesh and passing through Europe, Asia or the United States before arriving in Chile, where clothing merchants then resell it around the continent. Clothing from all over the world arrive at the Iquique port in the Alto Hospicio free zone in northern Chile each year, an important center for trade in South America. What is not sold around South America or sent to other countries to be sold, stays in the Alto Hospicio free zone. If no one pays the necessary tariffs to take it away, it is then dumped in the Atacama Desert.

Polyester was one of the most popular fibers used in fashion in 2017, found in about 60% of garments in retail stores and equalling about 21.3 million tons of polyester fiber.<sup>[17]</sup> There was a 157% increase of polyester clothing consumption from 2000 to 2015.<sup>[17]</sup> Synthetic polyester is made from a chemical reaction of coal, petroleum, air, and water,<sup>[18]</sup> two of which are fossil fuels. When coal is burned it creates heavy amounts of air pollution containing carbon dioxide. When petroleum is used it creates several air pollutants such as particulate matter, nitrogen oxides, carbon monoxide, hydrogen sulfide, and sulfur dioxide.<sup>[19]</sup> The creation of polyester creates pollution, in addition to waste from the finished product at the end of its life cycle. Polyester is non-biodegradable<sup>[20]</sup> meaning it can never be converted by bacteria to a state that will not damage the environment. Washing polyester clothing leads to shedding of microfiber plastics which enter water systems, including oceans.<sup>[21][22]</sup> Cotton is the most common crop in the world aside from food.<sup>[23]</sup> Half of all textiles produced are made of the fiber.<sup>[23]</sup> Cotton is a water-intensive crop, requiring 3644 cubic meters of water to grow one ton of

fiber, or 347 gallons per pound.<sup>[24]</sup> Growing cotton requires 25% of insecticides and 10-16% of pesticides of what is used globally every year.<sup>[25][24]</sup> Half of the top pesticides used in growing cotton in the US are deemed likely to be carcinogenic by the United States Environmental Protection Agency.<sup>[24]</sup> Cotton production degrades the quality of the soil, leading to exhausted fields and expansion into new areas.<sup>[23]</sup> Expansion into new areas leads to the destruction of local habitats and the associated pollution affects biodiversity.<sup>[23]</sup> Animal-based fibers such as wool and leather were responsible for 14.5% of global greenhouse gas emissions in 2005.<sup>[26]</sup>

**Discussion**

Cattle have digestive systems that use a process known as foregut fermentation, which creates the greenhouse gas methane as a byproduct. In addition to the CH<sub>4</sub> released from the ruminants, CO<sub>2</sub> and N<sub>2</sub>O are released into the atmosphere as byproducts of raising the animals. In total, 44% of emissions caused by livestock are from enteric fermentation, 41% comes from the feed needed to raise the livestock, 10% comes from manure, and 5% comes from energy consumption.<sup>[27]</sup>

Fiber	MJ of energy/kg of textile	liters of water/kg of textile
nylon	250 <sup>[28]</sup>	---
acrylic	175 <sup>[28]</sup>	---
polyester	125 <sup>[28]</sup>	50,690-71,409 <sup>[29]</sup>
polypropylene	115 <sup>[28]</sup>	---
viscose	100 <sup>[28]</sup>	3,000 <sup>[29]</sup>
wool	63 <sup>[28]</sup>	500 <sup>[30]</sup>
cotton	55 <sup>[28]</sup>	10,000-20,000 <sup>[2]</sup>

Energy use here is measured in megajoules needed to produce one kilogram of the given textile. Water use here is measured in liters of water needed to produce one kilogram of the given textile. Improperly disposing of clothing can harm the environment, especially through wastewater. Chemicals from decomposing clothing can leach into the air and into the ground, affecting both groundwater and surface water. Aside from plastic pollution, textiles also contributes significantly to marine pollution. Unlike plastic, textile pollution's impact on marine life occurs in its various supply chain processes.<sup>[31]</sup> Pollutants like pesticides and clothing manufacturing chemicals cling to particles that accumulate in the waters ecosystem and consequently enter into human food chains.<sup>[32]</sup> Plastic and synthetic textile are both created from a chemical structure called polymer. The Merriam-Webster dictionary defines polymer as “a chemical compound or mixture of compounds formed by polymerization and consisting essentially of repeating structural units.” For plastic, the common polymer found is PET, polyethylene (PE), or polypropylene (PP), whereas for textile, the polymer found the most abundant in the collection of waste is polyester and nylon textiles.<sup>[33]</sup>

Textiles shed microfibers at every stage of their life cycle, from production, to use, to end of life disposal.<sup>[2]</sup> These fibers end up in the soil, air, lakes, and oceans.<sup>[2]</sup> Microfiber pollution has existed as long as the textile industry has, but only recently has it come under public scrutiny.<sup>[2]</sup> The Ocean Wise Conservation Association produced a study discussing the textile waste. For polyester, it stated that on average, humans shed around 20 to 800 mg micro polyester waste for every kg textile washed. A smaller amount for nylon is found; for every kg of fabrics washed, we shed around 11 to 63 mg nylon microfiber waste to the waters.<sup>[34]</sup> Washing synthetic textiles releases microplastics and microfibers into the oceans.<sup>[35]</sup> This type of waste is most commonly found from washing machine cycles, where fibers of clothes fall loose during the tumbling process.<sup>[35]</sup> An individual domestic load of laundry can shed up to 700,000 microfibers.<sup>[2]</sup>

The Association also released a study stating that on average, households in the United States and Canada produce around 135 grams of microfibers, which is equivalent to 22 kilotons of microfibers released to the wastewater

annually. These wastewater will go through various waste water treatment plants, however, around 878 tons of those 22 kilotons were left untreated and hence, thrown into the ocean. For comparison, 878 tons of waste is equivalent to around 9 - 10 blue whales in the ocean. This is how much we pollute just from textile.<sup>[36]</sup>

Textiles are the main source of microfibers in the environment.<sup>[2]</sup> Thirty five percent of the microplastics that are found in marine ecosystems, such as shorelines, are from synthetic microfibers and nanofibers.<sup>[2]</sup> Such microfibers affect marine life in that fish or other species in the marine ecosystems consume them, which end up in the intestine and harm the animals.<sup>[37]</sup> Microfibers have been found in the digestive tracts of widely consumed fish and shellfish.<sup>[2]</sup> These fish are then consumed by humans, which leads to the absorption of micro pollutants in the fish in a process called bio magnification.<sup>[38]</sup> Predators of the affected marine individuals are also harmed, as they consume their prey who now contain the microfibers.<sup>[37]</sup> The yearly shellfish consumption of microplastics was found to be 11,000 pieces, and microfibers were found in eighty three percent of fish caught in one lake in Brazil.<sup>[37]</sup> Further, about two thirds of synthetic fibers from clothing production will be found in the ocean from 2015 to future.<sup>[39]</sup> In one study, the food consumption rates decreased in crabs who were eating food with plastic microfibers, which further lead to the available energy for growth to also decrease.<sup>[40]</sup>

Techniques to address the environmental impacts of the fashion industry include a marine algal bioabsorbent, which could be used for dye removal through rich algal surface chemistry through heteroatom containing functional groups.<sup>[41]</sup> Many techniques or potential solutions are difficult in their implementation, for instance the accuracy of marine sediment techniques to detect microplastics is not sufficiently tested among different soil samples or sources.<sup>[42]</sup>

Clothing often contains non-organic, excessively farmed cotton which is grown with chemicals that are known to cause eutrophication. Eutrophication is a process in which fresh water sources such as lakes and rivers become overly enriched with nutrients. This causes a dense growth of plant life that is harmful to the ecosystem, which can eventually kill all living things in the local ecosystem.<sup>[43]</sup> Two of the main ingredients in pesticides are nitrates and phosphates. When the pesticides leak into stream systems surrounding the cropland, the nitrates and phosphates contribute to water eutrophication. The fashion industry consumes a large amount of water to produce fabrics and manufacture garments every year. The global fashion industry uses 93 billion cubic meters of water per year, or 20 trillion gallons.<sup>[2][44]</sup> This is four percent of all freshwater withdrawal globally.<sup>[32]</sup> This amount is set to double by future if it follows the current trend.<sup>[45]</sup> According to the United Nations Environment Programme, the fashion industry is responsible for 20 percent of global wastewater.<sup>[46]</sup> Manufacturing a single pair of Levi jeans, will on average, consume about 3,781 liters of water to make.<sup>[47]</sup> On average, to produce one kilogram of textiles will require 200 liters of water.<sup>[24]</sup>

The consumer use phase in the life cycle of clothing and other textiles is a significant area of impact yet it is often overlooked.<sup>[48]</sup> While there is minimal research into energy efficient washers and dryers as a method of reducing impact on the consumer side,<sup>[48]</sup> wearing garments for 9 months longer could cut overall waste by 22% and water use by 33%.<sup>[44]</sup> On the producer side, choosing to make garments in popular colors and designs that consumers are more likely to buy is both a financially and environmentally responsible choice.<sup>[48]</sup> Designing clothing that is more likely to be purchased can reduce waste on the production side. In 2018 the fashion retailer H&M ended up with \$4.3 billion of unsold merchandise.<sup>[44]</sup>

## Results

Sustainable fashion (also known as eco-fashion) is a term describing products, processes, activities, and people (policymakers, brands, consumers) that aim to achieve a carbon-neutral fashion industry built on equality, social justice, animal welfare, and ecological integrity.<sup>[1]</sup> Sustainable fashion concerns more than fashion textiles or products, rather addressing the entire process in which clothing is produced, consumed and disposed of. The

movement looks to combat the large carbon footprint that the fast fashion industry has created by reducing the environmental impact such as air pollution, water pollution and climate change.

In 2020, it was found that voluntary self-directed reform of textile manufacturing supply chains by large companies to reduce the environmental impact was largely unsuccessful.<sup>[2][3]</sup> Measures to reform fashion production beyond green washing requires policies for the creation and enforcement of standardized certificates, along with related import controls, subsidies,<sup>[4]</sup> and interventions such as eco-tariffs.<sup>[5][6][7]</sup>

The origin of sustainable fashion movement is intertwined with the modern environmental movement, with the publication in 1962 of the book *Silent Spring* by American biologist Rachel Carson.<sup>[8]</sup> Carson's book exposed the serious and widespread pollution associated with the use of agricultural chemicals, a theme still relevant to the environmental and social impact of fashion today. The decades which followed saw humans' impact on the environment more systematically investigated, notably the effects of industrial activity. New concepts were introduced for discussing these effects, such as sustainable development, a term coined in 1987 by the Brundtland Report.<sup>[9]</sup>

In the early 1990s, roughly coinciding with the 1992 United Nations Conference on Environment and Development, popularly known as the Rio Earth Summit, 'green issues' (as they were called at the time) made their way into fashion and textiles publications.<sup>[10][11]</sup> These publications featured well-known companies such as Patagonia and ESPRIT, whose founders Yvon Chouinard and Doug Tompkins, were outdoorsmen who witnessed the environmental harm of overproduction and overconsumption. Doug Tompkins and Yvon Chouinard were early to note that exponential growth and consumption are not sustainable.<sup>[12]</sup> In the late 1980s, they brought environmental concerns into their business models, commissioning research into the impact of fibres used in their respective companies. For Patagonia, this resulted in a lifecycle assessment of four fibres: cotton, wool, nylon, and polyester. For ESPRIT, the focus was on cotton—representing 90% of their production at the time—and finding better alternatives to it. A primary focus on materials' provenance, impact and selection, fibre and fabric processing is still the norm in sustainable fashion 30 years on.<sup>[13]</sup>

The principles of 'green' or 'eco' fashion, was based on the philosophy of the deep ecologists Arne Næss, Fritjof Capra, and Ernest Callenbach, and design theorist Victor Papanek.<sup>[14]</sup> This imperative is also linked to a feminist understanding of human-nature relationships, interconnectedness and “ethics of care” as advocated by Carolyn Merchant,<sup>[15]</sup> Suzi Gablik,<sup>[16]</sup> Vandana Shiva,<sup>[17]</sup> and Carol Gilligan.<sup>[18]</sup>

The legacy of the early work of Patagonia and ESPRIT continues to shape the conversation around fashion sustainability today. In 1990, ESPRIT placed an ad in *Utne Reader* making a plea for responsible consumption, and ESPRIT and Patagonia co-funded the first organic cotton conference held in 1991 in Visalia, California, aimed at broadening the movement to include many fashion brands.

In 1992, the ESPRIT e-collection based on the Eco Audit guide by the Elmwood Institute, was developed by head designer Lynda Grose<sup>[19]</sup> and launched at retail. In 2011 the brand Patagonia ran an ad and a PR campaign called "Don't Buy This Jacket" with a picture of Patagonia merchandise. This message was intended to encourage people to consider the effect that consumption has on the environment, to purchase only what they need.<sup>[20]</sup>

In parallel with industry, research around sustainable fashion has been in development since the early 1990s, with the field now having its own history, dynamics, politics, practices, sub-movements and evolution of analytical and critical language.<sup>[21][22][23][24][25][26]</sup> The field is broad in scope, including technical projects that seek to improve the resource efficiency of existing operations,<sup>[27]</sup> the consideration of brands and designers working within currently understood frameworks<sup>[28]</sup> as well as those which look to fundamentally re-imagine the fashion industry, including the growth logic.<sup>[29]</sup>

In 2019, a group of researchers formed the Union for Concerned Researchers in Fashion (UCRF) to advocate for radical and coordinated research activity commensurate with the challenges of biodiversity loss and climate change.<sup>[30]</sup> In the fall of 2019, the UCRF received the North Star Award at the Green Carpet Fashion Awards during Milan Fashion Week.<sup>[31]</sup>

Fashion industry followers believe the business sector can act more sustainably by pursuing profit and growth. This is done while adding increased value and wealth to society and the global economy. The goal of sustainable fashion is to create flourishing ecosystems and communities through its activity.<sup>[28]</sup> The movement believes that clothing companies ought to place environmental, social, and ethical improvements on management's agenda.<sup>[32][33]</sup> This may include: increasing the value of local production and products; prolonging the lifecycle of materials; increasing the value of timeless garments; reducing the amount of waste; and reducing the harm to the environment as a result of production and consumption. Another goal is to educate people to practice environmentally friendly consumption by promoting the "green consumer", which can allow for the company itself to gain more support and a larger following.<sup>[34][35]</sup>

Consumption geared towards saving money, lowering utility bills, lowering greenhouse gas emissions, and meeting the country's energy needs is described as green consumerism. In recent years there has been an increase in research centered around consumer reactions to the advent of green products within fast fashion.<sup>[36]</sup> Critics doubt the effectiveness that this has, but companies have already begun slowly transitioning their business models to fit a more eco-friendly and sustainable future. Thus the industry has to change its basic premise for profit, yet this is slow coming as it requires a large shift in business practices, models and tools for assessment.<sup>[37]</sup> This became apparent in the discussions following the Burberry report of the brand burning unsold goods worth around £28.6m (about \$37.8 million) in 2018,<sup>[38]</sup> exposing not only overproduction and subsequent destruction of unsold stock as a normal business practice, but behavior amongst brands that actively undermine a sustainable fashion agenda.<sup>[39]</sup>

The challenge for making fashion more sustainable often requires systematic reinvention, and this call for action is not new. The UCRF has argued that the industry focus remains the same ideas originally mooted in the late 1980s and early 1990s. The Union observes, "so far, the mission of sustainable fashion has been an utter failure and all small and incremental changes have been drowned by an explosive economy of extraction, consumption, waste and continuous labor abuse."<sup>[40]</sup>

A frequently concern of those working in the area of sustainable fashion is whether the field itself is an oxymoron.<sup>[41]</sup> This reflects the seemingly irreconcilable possibility of bringing together fashion (understood as constant change, and tied to business models based on continuous replacement of goods) and sustainability (understood as continuity and resourcefulness).<sup>[13]</sup> The apparent paradox dissolves if fashion is seen more broadly, as a process not only aligned to expansionist business models<sup>[42][43]</sup> and consumption, but instead as mechanism that leads to more engaged ways of living.<sup>[44][29]</sup>

Fashion is, per definition, a phenomenon related to time: a popular expression in a certain time and context. This also affects the perception of what is and should be made more sustainable – if fashion should be "fast" or "slow"—or if it should be more exclusive or inclusive.<sup>[45][46]</sup> Like much other designs, the objects of fashion exist in the inter-zone between desire and discard along a temporal axis, between the shimmering urge towards life and the thermodynamic fate of death. As noted by cultural theorist Brian Thill, "waste is every object, plus time."<sup>[47]</sup>

When it comes down to the garments themselves, their durability depends on their use and "metabolism"—certain garments are made to withstand long use (ex. outdoor and hiking wear, winter jackets) whereas other garments have a quicker turn-around (ex. a party top). This means some garments have properties and a use-life that could be made more durable, whereas others should be compostable or recyclable for quicker disintegration.<sup>[48]</sup> Clothing

that aren't sold in markets become solid waste clogging areas of water and ultimately creating "the potential for additional environmental health hazards in LMICs lacking robust municipal waste systems"<sup>[49]</sup> Some garments age well and acquire a patina and a romantic enchantment not unlike the wonder, fascination and grandeur of historical ruins, whereas the derelict and discarded rags of last season is an eyesore and nuisance; the first connotes a majesty of taste, whereas the second is the underclass of waste.

### Implications

One of the most apparent reasons for the current unsustainable condition of the fashion system is related to the temporal aspects of fashion; the continuous stream of new goods onto the market, or what is popularly called "fast fashion." The term fast fashion is used to refer to the fast paced production of goods at an unethical level which often has a negative impact on the environment. As a way to conform to the latest fashion styles and keep consumers wanting new garments, current fast fashion trends pre-suppose selling clothing in large quantities.<sup>[50]</sup> Due to fast fashion being affordable and able to keep up with the trends, there has been an increase in apparel consumption. Consumption has risen to 62 million tonnes annually and is projected to reach 102 million tonnes by future.<sup>[51]</sup> This type of fashion is produced in vast quantities with low-quality materials and are sold through chains such as H&M, Zara, Forever21, Shein, etc. Fast-fashion retailer Shein is one of the most visited fast-fashion websites in the world and ships to 220 countries, however, there are questions about Shein's ethics and sustainability as it was responsible for about 706 billion kilograms of greenhouse gases in 2015 from the production of polyester textiles and uses up hundreds of gallons of water per garment.<sup>[52]</sup> Additionally, leaving an aftermath of 6.3 million tons of carbon dioxide while missing 45% of the UN's goal to reduce carbon emissions by future.<sup>[53]</sup> In January 2021, Shein offered over 121,000 garments made from polyester, making up 61% of their clothing total.<sup>[54]</sup> The fashion industry has a value of three trillion dollars. It is two percent of the world's gross domestic product (GDP) - the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period.<sup>[55]</sup> Out of the three trillion dollars, the majority is made of fast fashion.

However, the "fast" aspect of consumption is primarily a problem for the environment when done on a massive scale. As long as fast conspicuous consumption was reserved to the rich, the global impact was not reaching public attention or seen as a problem. That is, "fast" shopping sprees of haute couture is not seen as a problem, rather it is celebrated (for example in movies such as *Pretty Woman*), whereas when people with less means shop fast fashion, it is seen as unethical and a problem. Today, the speed of fast fashion is common across the whole industry as exclusive fashion replicates the fast fashion chains with continuous releases of collections and product drops: the quality of a garment does not necessarily translate to a slower pace of consumption and waste.<sup>[56]</sup> These releases are only exasperated by the acceleration of fashion trends. As micro-trends are only lasting an average of 3 years, the demand for clothes has also accelerated.<sup>[57]</sup>

In addition to its negative environmental impact, fast fashion is unethical. Keeping up with fashion trends causes clothing to be produced in a harmful manner. "Fast" clothing is made with synthetic fibers as opposed to natural fibers. The synthetic fibers are made using the Earth's fossil fuels. Almost sixty percent of clothes are made this way.<sup>[58]</sup> Since people spend so much money on these types of clothes and purchase them so frequently, landfills are filling up quickly. Over sixty percent of clothes made every year end up in landfills as consumer waste, and almost twenty percent of the world's waste is constituted by fashion products.<sup>[59]</sup> Therefore, because fast fashion frequently introduces new collections, consumer consumption increases. Consequently, leading consumers to view low-cost apparel as disposable since there are continuous releases of products.<sup>[59]</sup> Production of these types of clothing is also commonly exploitative, with most factories that produce "fast" clothing employing workers on low wages in exploitative environments. Workers from Shein reported making as little as 35 cents per garment produced, as well as operating on 18-hour workdays with 1 day off per month.<sup>[60]</sup> Exploitative fast fashion

production is prevalent in countries like China, Bangladesh and Vietnam.<sup>[61]</sup> Hard labor was always around in the fashion industry dating back to when slave labor helped factories gather their materials. People making these clothes today suffer from harsh working conditions, low wages, and risks to health and safety.

Slow fashion can be seen as an alternative approach against fast fashion, based on principles of the slow food movement.<sup>[62][63]</sup> Characteristics of sustainable fashion match the philosophies of "slow fashion" in that emotional, ecological and ethical qualities are favored over uniform and bland convenience with minimal friction. It requires a changed infrastructure and a reduced through-put of goods. Categorically, slow fashion is neither business-as-usual nor just involving design classics. Nor is it production-as-usual but with long lead times. Slow fashion is a vision of the fashion sector built from a different starting point.<sup>[64]</sup> Slow fashion is a fashion concept that reflects a perspective, which respects human living conditions, biological, cultural diversity and scarce global resources and creates unique, personalized products.

The term Slow Fashion came about quite organically. It was coined by Kate Fletcher of the Centre for Sustainable Fashion, following the phenomena of the slow food movement.<sup>[65]</sup> As with the slow food movement, Fletcher saw a need for a slower pace in the fashion industry.<sup>[66]</sup>

Slow fashion challenges growth fashion's obsession with mass-production and globalized style. It becomes a guardian of diversity and changes the power relations between fashion creators and consumers, therefore forging new relationships and trust that are only possible at smaller scales. It fosters a heightened state of awareness of the design process and its impacts on resource flows, workers, communities, and ecosystems.<sup>[67]</sup>

A slow-fashion garment often consists of durable materials, traditional production techniques, or design concepts that are seasonless or will last for more than a season. Several points of the production chain are affected by slowness. Textile workers in developing countries earn higher wages because of slow fashion. For end-users, slow fashion means that the goods are designed and manufactured with greater care and high-quality products. From an environmental point of view, it means that there are less clothing and industrial waste that is removed from use following transient trends.<sup>[68]</sup> Throughout the process, durability is considered; emotionally, materially, aesthetically, or by including services that extend the garment's life. Additionally, creative ideas and product innovations constantly redefine slow fashion, so using a static, single definition would ignore the evolving nature of the concept.

Examples of stability of expression over long times are abundant in the history of dress, not least in ethnic or folk dress, ritual or coronation robes, clerical dress, or the uniforms of the Vatican Guard.<sup>[69]</sup> The emphasis on slowness in branding is thus an approach that is specific for a niche in the market (such as Western-educated middle-class) that has since the 1990s become dominated by "fast" models. One of the earliest brands that gained global fame with an explicit focus on slow fashion, the Anglo-Japanese brand People Tree, embraces the concept of ethical trade, manufactures all products in accordance with ethical commerce standards, and supports local producers and craftsmen in developing countries. The People Tree brand is known as the first fashion company to receive the World Fair Trade Organization product label in 2013, demonstrating their dedication to fair trade and the environment.<sup>[70]</sup>

The concept of slow fashion is however not without its controversies, as the imperative of slowness is a mandate emerging from a position of privilege. To stop consuming "fast fashion" strikes against low-income consumers whose only means to access trends is through cheap and accessible goods. Those who are already having a high position in society can afford to slow down and cement their status and position, while those on their way up resent being told to stay at the lower rungs of the status hierarchy.<sup>[71]</sup> "The prestige of slowness allows a cultural signifier for those already have social positions to preserve, and have time and money to take it easy and enjoy the pleasures of reflection and meditate over their moral superiority."<sup>[72]</sup>



The environmental impact of fashion also depends on how much and how long a garment is used. With the fast fashion trend, garments tend to be used half as much as compared to 15 years ago. It has been estimated that each year around \$172 million worth of garments is expected to be discarded, many of them after being worn only once.<sup>[73]</sup> There has been a 7.1 kg increase in global per-capita textile production from 1975-2018. This would not only an increase in textiles but an increase in the amount of water pollution from dyeing and treating the textiles. The increase can be contributed to the need for consumers to keep up with the latest fashion trends and the quick disposal of clothing.<sup>[74]</sup> This is due to the inferior quality of fabrics used but also a result of a significant increase in collections that are being released by the fashion industry. To combat this issue at hand, longer lasting materials and products are being promoted to increase sustainability.<sup>[75]</sup>

Typically, a garment used daily over years has less impact than a garment used once to then be quickly discarded. Studies have shown that the washing and drying process for a pair of classic jeans is responsible for almost two-thirds of the energy consumed through the whole of the jeans' life, and for underwear about 80% of total energy use comes from laundry processes.<sup>[13]</sup> The dyeing process also contributes close to 15%-20% of wastewater. For this reason, innovative techniques are being introduced to reduce energy and water consumption, such as utilizing CO<sub>2</sub><sup>[59]</sup> in the dyeing process where heat and pressure turns liquid CO<sub>2</sub> into dye used for various garments.<sup>[76]</sup> Thus, use and wear practices affect the lifecycles of garments and needs to be addressed for larger systemic impact.<sup>[77]</sup>

However, there is a significant difference between making a product last from making a long-lasting product. The quality of the product must reflect the appropriate fit into its lifecycle. Certain garments of quality can be repaired and cultivated with emotional durability. Low-quality products that deteriorate rapidly are not as suitable to be "enchanted" with emotional bonds between user and product.<sup>[78]</sup> It is important to notice that choosing and promoting "emotional bonds" with consumer objects is an endeavor more easily done under circumstances of excess, as the needy have no other option than to keep and care for their belongings.

As highlighted in the research of Irene Maldini, slowing down (in the sense of keeping garments longer) does not necessarily translate into lower volumes of purchased units.<sup>[79]</sup> Maldini's studies expose how slow fashion, in the sense of long-lasting use phase of garments, tends to indicate that garments stay in the wardrobe longer, stored or hoarded, but does not mean fewer resources are used in producing garments. Thus, slowness comes to mean wardrobes with more lasting products, but the consumption volume and in-flow into the wardrobe/storage stay the same.<sup>[80]</sup> The fashion industry has a disastrous impact on the environment. In fact, it is the second largest polluter in the world, just after the oil industry. And, the environmental damage is increasing as the industry grows.<sup>[81]</sup> The textiles and fashion industries are amongst the leading industries that affect the environment negatively. One of the industries that greatly jeopardize environmental sustainability is the textiles and fashion industry, which thus also bears great responsibilities. Globalization has made it possible to produce clothing at increasingly lower prices, prices so low, and collections shifting so fast, that many consumers consider fashion to be disposable.<sup>[22]</sup> However, fast, and thus disposable, fashion adds to pollution and generates environmental hazards, in production, use, and disposal. The globalization of the textile and fashion industry has also contributed to the uneven distribution of such environmental hazards and consequences. Developing countries who typically produce the textile and clothing bear the burden for developed countries who largely consume the products.<sup>[82]</sup>

Putting the environmental perspective at the center, rather than the logic of the industry, is thus an urgent concern if fashion is to become more sustainable. The Earth Logic fashion research action plan argues for "putting the health and survival of our planet earth and consequently the future security and health of all species including humans, before industry, business, and economic growth."<sup>[83]</sup> In making this argument the Earth Logic plan explicitly connects the global fashion system with the 2018 Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5 °C.

Furthermore, the Earth Logic fashion research action plan sets out a range of possible areas for work in a sustainable fashion that scientific and research evidence suggests are the most likely to deliver a change of the scale and pace needed to respond to challenges like climate change. Earth Logic's point of departure is that the planet, and its people, must be put first, before profit. It replaces the logic of economic growth, which is arguably the single largest factor limiting change towards sustainable fashion, with the logic that puts earth at its center.<sup>[84]</sup>

The clothing industry has one of the highest impacts on the planet. Cotton requires approximately 15,000 liters of water to grow for a pair of jeans.<sup>[85]</sup> High water usage, pollution from chemical treatments used in dyeing and preparation and the disposal of large amounts of unsold clothing through incineration or landfill deposits are hazardous to the environment.<sup>[86]</sup> There is a growing water scarcity, the current usage level of fashion materials (79 billion cubic meters annually) is very concerning because textile production mostly takes place in areas of fresh water stress.<sup>[87]</sup> Only around 20% of clothing is recycled or reused, huge amounts of fashion product end up as waste in landfills or are incinerated.<sup>[87]</sup> It has been estimated that in the UK alone around 350,000 tons of clothing ends up as landfill every year. According to Earth Pledge, a non-profit organization committed to promoting and supporting sustainable development, "At least 8,000 chemicals are used to turn raw materials into textiles and 25% of the world's pesticides are used to grow non-organic cotton. This causes irreversible damage to people and the environment, and still two thirds of a garment's carbon footprint will occur after it is purchased."<sup>[88]</sup> The average American throws away nearly 70 pounds of clothing per year.<sup>[89]</sup> Around 5% of the total waste worldwide stems from the textile industry, the clothing section of the textile industry has elevated the amount of waste contributing to global waste.<sup>[90]</sup>

There is increasing concern that microfibers from synthetic and cellulosic fabrics are polluting the earth's waters through the process of laundering. Microfibers are tiny threads that are shed from fabric. These microfibers are too small to be captured in wastewater treatment plants filtration systems and they end up entering our natural water systems and as a result, contaminating our food chain.<sup>[91]</sup> One study found that 34.8% of Microplastics found in oceans come from the textile and clothing industry and the majority of them were made of polyester, polyethylene, acrylic, and elastane;<sup>[92]</sup> but a study off the coast of the UK and US by the Plymouth Marine Laboratory in May 2020 suggested there are at least double the number of particles as previously thought.<sup>[93]</sup> Eliminating synthetic materials used in clothing products can prevent harmful synthetics and microfibers from ending up in the natural environment. While some clothing companies and NGOs support the use of washing bags to filter out microfibers in washing machines and thus reduce microfiber release, microfibers are also shed during wear and disposal.<sup>[94]</sup> Plastic debris covers the surface of the whole ocean. If no progress is made to reverse the damage, it is calculated that there will be an increase of 850 Mts of plastic debris in the ocean by future.<sup>[95]</sup> In February 2021, Changing Markets Foundation released a report on the fashion industry's dependence on oil extraction. The report analyses the current production model across the fashion industry is dependent on massive fossil-fuel extraction to fuel the production of fibers.<sup>[96]</sup> The report spotlights how the production of the most popular fibers, primarily polyester, is reliant on oil extraction. Production of polyester has grown ninefold since the 1970s, and is the fastest growing component in fashion production. The popularity of polyester is due to its low price, but also the fiber's flexibility as a material. The report suggests, synthetic fibers in the textile industry currently accounts for 1.35% of global oil consumption, and this is projected to more than double in the coming years: "BP's energy scenario presumes plastic production will account for 95% of future growth in demand for oil demand, while the International Energy Agency (IEA) predicts petrochemicals will represent up to 50% of growth in oil demand by future and 4% in the projected growth of gas demand. Open-source content has become a popular reference with designers sharing patterns and designs, connecting to the success of the open-source software movement. By sharing designs freely, using digital technology, the aim is to make consumers more engaged in the design, production, and lifetime use of the garment.<sup>[151]</sup> While the terminology is new, the concept builds on the sharing of patterns across European courts in 16th century (such as Kleidungsbüchlein or Trachtenbuch (usually translated as

"Book of Clothes") of Melchior Lorck, and the wide range of sewing magazines, such as Burda Style, in the early 20th century. By making garments more open and adaptable across their lifecycle, the hope is that "garments can be multi-functional, beyond simply clothing our bodies; that fashion should be both useful and inventive; and that what we wear should relate to the world around us."<sup>[151]</sup> Examples of open-source fashion range from freely available patterns and production techniques, platforms for exchanging materials and patterns, and maker spaces.<sup>[152]</sup>

## Conclusions

Sustainable clothing refers to fabrics derived from eco-friendly resources, such as sustainably grown fiber crops or recycled materials. Sustainable clothing includes the use of second-hand retail repair and often utilizes upcycling and recycling of clothing.<sup>[155]</sup> It also refers to how these fabrics are made. Historically, being environmentally conscious towards clothing meant (1), making clothes last long by caring for them, repairing and patching them, (2) inheriting and using hand-me-downs within ones expanded family and community, (3) buying clothes from thrift stores or any shops that sell second-hand clothing, or (4) donating used clothes to shops previously mentioned, for reuse or resale. In modern times, with a prominent trend towards sustainability and being 'green', sustainable clothing has expanded towards (5) reducing the amount of clothing overproduced, incinerated or discarded to landfills, and (6) decreasing the environmental impact of agrochemicals in producing conventional fiber crops (e.g. cotton). Under the accordance of sustainability, recycled clothing upholds the principle of the "Three R's of the Environment": Reduce, Reuse, and Recycle, as well as the "Three Legs of Sustainability": Economics, Ecology, and Social Equity.

Through the utilization of recycled material for the manufacturing of clothing, provides an additional realm of economic world profit. Sustainable Clothing will provide a new market for additional job opportunities, the continuous net flow of money in the global economy, and the consumption reduction of raw materials and virgin resources. Source reduction or reducing the use of raw materials and virgin resources can ultimately reduce carbon emissions during the manufacturing process as well as the resources and carbon emissions that are related to the transportation process. This also prevents the unsustainable usage of extracting materials from the Earth by making use of what has already been used (i.e. recycling).

Sustainable clothing has many benefits. Some being that it uses less water, it reduces toxic waste, it reduces the amount of pesticides released into the environment, and the quality is higher.

Recycled or reclaimed fibers are recovered from either pre or post-consumer sources. Those falling into the category of 'pre-consumer' are unworn/unused textile wastes from all the various stages of manufacture. Post-consumer textile waste could be any product that has been worn/used and has (typically) been discarded or donated to charities. Once sorted for quality and color, they can be shredded (pulled, UK, or picked, US) into a fibrous state. According to the specification and end-use, these fibers can be blended together or with 'new' fiber.

While most textiles can be recycled, they are mainly downgraded almost immediately into low-quality end-uses, such as filling materials. The limited range of recycled materials available reflects the market dominance of cheap virgin fibers and the lack of technological innovation in the recycling industry. For over 200 years recycling technology has stayed the same; fibers are extracted from used fabric by mechanically tearing the fabric apart using carding machines. The process breaks the fibers, producing much shorter lengths that tend to result in a low-quality yarn. Textiles made from synthetic fibers can also be recycled chemically in a process that involves breaking down the fiber at the molecular level and then depolymerizing the feedstock. While chemical recycling is more energy-intensive than mechanical pulling, the resulting fiber tends to be of more predictable quality. The most commonly available recycled synthetic fibre is polyester made from plastic bottles, although recycled nylon is also available.<sup>[156]</sup> In addition to promoting a sounder environment by producing newer clothing made with

sustainable, innovative materials, clothing can also be donated to charities, sold into consignment shops, or recycled into other materials. These methods reduce the amount of landfill space occupied by discarded clothes. According to the United States Environmental Protection Agency's 2008 Report on Municipal Solid Waste (MSW), Generation, Recycling, and Disposal in the United States defines clothing as non-durable – generally lasts less than three years – textiles. In 2008, approximately 8.78 millions of tons of textiles were generated, 1.45 millions of tons were recovered and saved from landfills resulting in a rate of almost 17%. The EPA report also states that the amount of MSW being "Discarded" is 54%, "Recovered" is 33%, and "Combusted with Energy recovery" is 13%.<sup>[157]</sup> Approximately two-thirds of clothing materials are sent to landfills, making it the fastest-growing component of waste in the household waste stream. As of 2009, textiles disposed of in landfill sites have risen from 7% to 30% within the last five years

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