The of the consumption of the ‘new’ and

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The majority of the world’s pollution is thought to come from coal power plants, strip-mined mountaintops, raw sewage piped into our waterways and various garbage disposal. Often, we don’t think, nor do we realize that its coming from the fabric that’s covering our bodies; with our clothing (Kozlowski et al., 2012; Sweeny, 2015). When it comes to the fashion industry, it has been put under the spotlight as being a significant contributor to both; social and global environmental issues (Ditty, 2015; Kozlowski et al., 2012).

The social issues of most clothing are that they’re being manufactured in sweatshops which has been highly publicized, however the environmental impact has hardly been brought up. This is a disturbing fact, as the fashion industry is in fact the second largest polluter after the oil industry. Be it high fashion or for the everyday person, the fashion industry is subject to change through trends. These trends usually changed with the seasons or were inspired by high fashion, however is it now influenced by trends that are changing at faster rate and the need for a quick turnaround.

The industry has also become more globalized, with industries being spread out around the world with the raw materials travelling further to reach there, in addition to global consumerism (Muthu, 2014; Palamutcu, 2015). The current ideology surrounding the fashion industry is one of the consumption of the ‘ new’ and the discard of the ‘ old’. Considering this, and the ever-changing trends, has seen an emergence of the business model of ‘ fast fashion’; which has increased the introduction of even more trends this leading to premature product replacement and fashion undesirability (Bhardwaj and Fairhurst, 2010; Caniato et al.

, 2012; Palamutcu, 2015). The phrase “ fast fashion” refers to low-cost clothing collections that mimic current luxury fashion trends. In order to provide this low costing clothing, the production has shifted to developing nations, not only due to the low cost of labour but also the lax standards and regulations regarding the social and environmental issues (Joy et al., 2012). Just like fast food which isn’t good for you, fast fashion might be good for your wallet in the short term but it isn’t in the long term. This is partly due to the clothing not being designed to last very long, with quantity being valued over quality. Reuse and recycle could be used is certain cases, however the low-quality merchandise sometimes doesn’t even make it to those steps. More often than not, the clothes are thrown away, ending up in landfills (Caniato et al.

, 2012; Joy et al., 2012). Disturbingly, when it comes to the fashion industry it is one industry, where throughout the manufacturing process there is a high amount of environmental impacts and natural resources being used. It involves a long and varied supply chains of production, raw material, textile manufacture, clothing construction, shipping, retail, use and ultimately disposal of the garment (Figure 1 & 2) (Claudio, 2007). In a 2017 paper by Iran and Schrader, they also mention that around 60% of the total environmental cost can be accounted for during the consumption phase i.

e shop-wash-throwaway. Moreover, depending on the type of apparel that is being produced could see various environmental impacts. In the book Assessing the Environmental Impact of Textiles and the Clothing Supply Chain, it describes the various inputs throughout the lifecycle that

corresponds to each of the production steps within the lifecycle (Muthu, 2014). With both the input and the production step also having varying impacts on the environment. Figure 1 Lifecycle assessment (LCA) Diagram of natural textiles(BSR, 2009) Figure 2 Lifecycle assessment (LCA) Diagram of synthetic textiles (BSR, 2009) MaterialsWith the rise of fast fashion, most of what is used by companies are cheap and versatile fabrics. Broadly, these fabrics can be broken down into two categories; natural and synthetic.

Furthermore, natural fibers can be classified as being cellulose or protein fibres. Nevertheless, whether the raw material is harvested from the crops, sheered from the animal or even produced chemically there are still many impacts to the environment (Muthu, 2015, 2014; R Ananthashankar, 2013). SyntheticOne of the largest environmental impacts connected with the fashion industry, is the use of synthetic fibers. Synthetic fibers such as polyester, nylon, spandex, acetate, acrylic and polypropylene, are predominately used in the industry (R Ananthashankar, 2013). With the high cost of this fibre coming from the fact that is it essentially a nonbiodegradable product. Muthu (2014), briefly described the various environmental impacts that are associated with synthetic fibers. With the main one being that it is sourced from a non-renewable resource, moreover, the amount of energy that is required to extract this resource and that which is used during the production stage are relatively high.

During the manufacturing stage, not only does it require a large energy input, but this industrial phase emits high amounts of greenhouse gases. Moreover, there is a chemical component in the manufacturing phase, where

the amount that is used being high. Not only is there a high amount of greenhouse gases that is being emitted during each stage of the life cycle, but there are other toxic pollutants that are released through different mediums throughout the life cycle (Muthu, 2015, 2014).

Polyethylene terephthalate (PET) or Polyester, along with nylon, are the most widely used synthetic fibres, with it accounting for 60% of today’s clothing. Besides it being versatile and cheap, the use of polyester is also favoured due it having a low moisture absorption and being stretch resistant with thermal stability (Cherrett et al., 2005). The fact that these fibers are nonbiodegradable is related to it essentially being a plastic product. This is due to the raw material being produced from a polymer solution that is gained from a by-product of fossil fuels (Chen and Burns, 2006; Cherrett et al., 2005). With the use of fossil fuels there is the obvious aspect of it being a non-renewable resource, therefore the Moreover, the requirement of the fossil fuels is directly related to the carbon footprint of the fibre, such as the amount of energy used to extract the resource in addition to the varying pollution impacts. Besides the high amount of CO2 being released, which is the norm with industrial processes, there are also a large number of particulates that is generated and emitted into the air and water systems.

Atmospheric emissions, along with CO2, are that of carbon monoxide, hydrocarbons, sulphur oxides and nitrogen oxides; with some of these being carcinogens and/or greenhouse gases. Other organic compounds such as dioxins and acetaldehydes are also emitted during the production process, which impact the ozone layer and pose a threat to human health (Muthu,

2014). While the wastewater effluents related to the polyester manufacturing process could contain iron, ammonia, acids and dissolved solids, that can have a multitude of effects on the environment and surrounding populations (Cherrett et al.

, 2005). In terms of the energy needed, it has been reported that the amount of energy required to produce a kilogram of fibre is 125MJ, this means that it is not only an environmentally costly production but also an economically expensive one (Muthu, 2015, 2014). While when it comes to the amount of harmful gas that is emitted, to produce 1kg of polyester it is estimated that there are 18. 2g of carbon monoxide and 19.

4g of nitrogen oxides along with the 2. 31kg of CO2 (Kalliala and Nousiainen, 1999; Muthu, 2014). Due to the fragmented yet globalized nature of the fashion industry, the manufacturing step can occur virtually anywhere in the world. One might think that these large-scale productions would take place in more first world countries, however, most of what is produced is occurring in countries such as China, Indonesia and Bangladesh (Kalliala and Nousiainen, 1999). There is a call for concern regarding productions in these ‘ third’ world countries, mainly due to their lax environmental regulations and laws; where they are either implemented and there is no compliance or they are not implemented at all. This is worrisome as this usually leads to high levels of air and water pollution, with harmful chemicals being released into both systems and wastewater being left untreated before discharge (Kalliala and Nousiainen, 1999; Muthu, 2014).

Solid waste is also a problem when it comes to polyester (Muthu, 2015). This doesn’t necessarily mean just actual garments, but also the threads. Large amount of threads from the cutting room floor are being thrown away during the production stage, with this problem continuing after it is purchased as well. Threads are easily released during the washing process, with is being predicted that more than 700 000 microscopic plastic fibres into the environment during each cycle of a washing machine (Williams, 2016). A study done at Plymouth University in the UK, washed various synthetic garments (polyester, acrylic and polyester-cotton) at 30? C and 40? C using various combinations of detergent and softeners.

From the waste effluent, the fibers were extracted and examined, this found that washing an average washing load of 6kg could release an estimated 137, 951 fibres from polyester-cotton blend fabric, 496, 030 fibres from polyester and 728, 789 from acrylic. The range of impacts of this type of microplastic is not fully understood, but some of the known impacts include; possible poisoning of the food chain through bioaccumulation of chemicals leached from the fibers and the build-up of these fibers could disrupt the breathing and digestive system of both marine and terrestrial animals. Natural Despite the high carbon footprint that is associated with synthetic fibers, using natural fibers for clothing production isn’t necessarily the answer. This is partly due to the farming land needed and the subsequent issues surrounding the farming step/ production steps. These are mainly broken-down by the amount of chemicals used (pesticides/ fertilizers), amount of water used and the amount of energy used (Muthu, 2014). Some points to consider when assessing the impacts on the

environment by these fibers are linked to the LCA (Figure 1); amount of chemicals (pesticides, fertilizers, dyes etc.

) used, amount of water used and the source, the amount of energy used throughout the production/ manufacturing stage and the source of the energy, carbon footprint regarding the energy and transport, land use and the waste produced during the various stages and the subsequent pollutants (Muthu, 2015, 2014). CelluloseCotton is a natural cellulose fibre that accounts for 40% of the fibre that is used in the production of clothing, with about 20 million tons being produced each year. With the production being spread over about 90 countries around the world, with China, United States, India, Pakistan, Uzbekistan and West Africa (Figure 3) account for over 75% of global production (Baffes, 2005; Cherrett et al., 2005; Eyhorn et al., 2005). Perceived as the better choice due to the raw material being picked off a renewable resource and the product being biodegradable. However, what it takes to produce the fibre, the large inputs and the damaging outputs are usually overlooked (Cherrett et al.

, 2005; Muthu, 2014). When it comes to cotton, there are two types; organic cotton and the conventional kind. Figure 3 2015/2016 World Statistics of global cotton production (https://www. statista. com/statistics/263055/cotton-production-worldwide-by-top-countries/) Like other organic crops, organic cotton is favoured due to the seemingly low impact materials and methods used during the farming. They are grown without the use of synthetic chemicals, such as; fertilizers and pesticides/herbicides. Instead of using fertilizers, the soil fertility is manually

maintained through practices such as crop rotation, use of animal manure and compost and natural pesticides and fertilizers are used as a way of reducing the use of pesticides that are not only toxic but persist in the environment (Cherrett et al.

, 2005; Hustvedt and Dickson, 2009). Despite the decrease in its chemical output, organic cotton is still a cotton plant and cotton is known to be a crop that require large amounts of water. In general, for both types of cotton, the largest environmental cost comes from the use of water.

The crop might be drought tolerant, but it does require large amounts of water during specific points of its growth cycle. Just to produce about 1kg of cotton, about 20 000 litres of water is needed. As a natural resource, freshwater is a globally scarce one. Despite this, about 69% of the resource is used for the global agricultural sector! Now when it comes to the use for cotton crops, these crops can be divided into those that is rain-fed and those under irrigated field, respectively only 27% of cotton is rain-fed while 73% are produced in irrigated fields (Bärlocher, 1999; Bevilacqua et al.

, 2014). Traditionally, irrigated systems have used the flooding technique whereby freshwater is pumped into an open canal system from surface water areas- lakes, rivers and reservoirs. This technique typically works; however, it is region selective to those areas that can access the surface water. In many cases around the world, there has seen a loss of wetlands due to the abstraction of water for irrigation purposes. Moreover, in areas that are typically dry or do not have access to local surface water, farmers have made use of the ground water. Bärlocher (1999), refered to two such

cases where 31% of the irrigated water in Pakistan was pumped from ground water. While China, which proportionally produces the largest amount of cotton, has seen a major fall in their water table due to the extensive use of the resource. The uncertainity surrounding rainfall has moved for more areas to use irrigation as their primary source, however, the global effiency of this practice is less than 40% which is partly due to water losses through evapouration, seepage and the lack of maintance (Bevilacqua et al.

, 2014). The use of the large amounts of water is not the only impact, in dry climates being exposed to long periods of irrigation could lead to the salinisation of the soil making it inhospitable for the crops (Bärlocher, 1999). Of the two types, the obvious choice to have the largest environmental impact is that of the conventional cotton. This is wholly due to the amount of chemicals that is used. As a crop, cotton covers about 2. 5% of the global farmland, this however, does not compete with the 16% of insecticides and 6. 8% of herbicides used worldwide (Muthu, 2014). The amount used it not as unexpected, due to the cotton plant being prone to attack by insects and fungi.

In addition to the amount used globally, what insecticides are used is also a call of concern. Of the ten most widely used chemical for cotton production, three of them are Parathion, Aldicarb and Methamidopho were classified as the most harmful to human health by The World Health Organization (WHO). Aldicarb is rightfully classified as being highly dangerous; this is due to reports stating that a single drop exposed to human skin has the ability to kill them. The other seven might not be of the most harmful, but WHO have

them classified as moderate to highly harmful. When it comes to the pesticides used, Environmental Protection Agency in the USA classified seven (diuron, dichloropropene, tribufos, trifluralin, fluometuron and pendimethalin) of the most used pesticides as being probable human carcinogens.

Other than the direct effect of these chemicals when it comes into contact with human skin, fertilizers, pesticides and insecticides eventually leach into the soil and water systems. These pollutants add excess nutrients, heavy metals etc, to the environment, with them having a direct impact on the biodiversity of freshwater systems (Kalliala and Nousiainen, 1999; Muthu, 2015, 2014). This partly due to the toxicity of the chemicals but also certain chemicals have the ability to persist in the environment and can bioaccumulate in the system thus increasing the reach and destruction of the chemicals. Despite the known threats that these chemicals pose to the health of humans and the environment, they are still used and is done in large amounts.

There lies the problem, as this could lead to the targets becoming resistant to the chemicals, leading to the use of more harmful ones (Kalliala and Nousiainen, 1999) Protein Despite the production of fibers such as wool, angora, mohair, cashmere and silk consuming far less water than the farming of cellulose fibers, it having a lower carbon footprint and with it coming from a renewable resource; fibers gained from animals do not come without their own problems and environmental impacts(Chen and Burns, 2006). The large grazing areas needed for the animals, means a possible loss of natural habitats and overgrazing could see an increase in soil erosion

(Muthu, 2014). One aspect of protein fibers regards its host, the animal, and the manure produced. This aspect can be taken as an advantageous one as there would be not cost incurred as it is naturally produced on the land. However, poor management could lead to the possible contamination of any water sources in the area. With the processing of the fibers, there comes in an aspect of processing it. Often overlooked, but the cleaning process includes the use of chemicals and large amounts of water.

The cleaning process includes the use of an alkaline solution and soap to remove and impurities. In addition to that, is the use of chemicals to make the fibre more durable, thus making is resistant to stains, shrinkage and making it washable (Chen and Burns, 2006; Muthu,
2014). ChemicalsFertilizers, pesticides and those used in the processing of protein fibres, are not the only chemicals that are used during the life cycle. These include those used during the textile wet processing, which includes those used in the dyeing, printing and finishing sectors.

DyesDating back to 3500 BC, resources such as vegetables, flowers, fruits and certain insects and fish were used as natural dyes. These were commonly used up until the 1850s, when W. H. Perkins created synthetic dyes. This now allowed for fabrics to be dyed in a wider array of colours, which were not as dull as the natural dyes. Moreover, using synthetic dyes were far cheaper than natural dyes, easier to produce and sped up the dying process. Despite the advantages, the toxic nature of these synthetic dyes and some natural dyes cannot be overlooked (Carmen and Daniela, 2012; Kant, 2012).

The dyeing process (Figure 1 and 2), is broken down into three steps; preparation, dyeing and finishing. When it comes to dyes, one must take note that not all dyes dye all fabrics and not all fabrics can be dyes by one dye. Therefore, the type of dye that is used for a specific fabric will have a number of environmental impacts, which will differ with the change in dye and fabric.

Water Water, as a natural resource, is not only the most used resource throughout the manufacturing process, it is also one of the most polluted! Most industrial processes use water, however, during many of the steps within the lifecycle of an article of clothing, copious amounts of water are seen to be used or polluted. This is worrisome as freshwater is mainly being used, which is already a scarce global resource. Due to it being a globalized but fragmented industry, the freshwater consumption or availability might shift In addition to certain production processes occurring in regions where there is a lack in water resources. It has been estimated that the fashioned industry consumes about 79 billion cubic meters.

This is a disturbing amount considering that freshwater is a scarcity Besides the copious amounts of water that is used during the production of natural raw materials, the various steps within the wet process also require a large amount of water. Table 1 Total water consumed during wet process (R Ananthashankar, 2013) Table 2 Amount of water required during the wet process for the cotton industry (R Ananthashankar, 2013) Table 3 Amount of water required during the wet process for the synthetic industry (R Ananthashankar, 2013) (Ozturk et al., 2016) Most of the intermediate steps

within the lifecycle has been delegated to developing countries, these include most of the raw material, most of the wet processes and most of the sewing and assembly (Figure 1 & 2). This, however, allows for a lot of leeway when it comes to following laws and regulations, if there are even any.

Now regarding the availability of water, it is estimated that 40% of the population within developing counties don’t have access to proper sanitation facilities In addition to the runoff contamination from the farming of natural raw materials, that sees the introduction of excess nutrients amongst other chemicals, Production, Characterization and Treatment of Textile Effluents: A Critical Review CarbonThe carbon footprint of a specific piece of clothing can differ, by the material used, dye used, where it was produced etc. Overall, the carbon footprint of a Going back to globalization and consumerism, it is now easier than ever to get that article of clothing that you wanted. Before, one had to drive to the store to get it, but now with one push of a button you can have it delivered to your house from anywhere in the world. So now, the clothing isn’t just being shipped from the production factories to the stores, but from the stores (globally and locally) to your home. As far as carbon consumption goes, through the amount of energy needed, polyester on average has a 63% higher energy consumption than the production of cotton per 1 kg fibres (Kalliala and Nousiainen, 1999). WasteIn 2014 the worldwide consumption of clothing reached 73 million tonnes. Now because of the low quality of the products and the throwaway nature of the clothing, more of them are ending up in landfills. This is an invertibility, due to records showing that only 20% of these purchased clothes are being recycled globally.

Now this waste isn’t just linked to the post-consumer category but also the pre-consumer. This is because (Ditty, 2015). Low quality products that is linked to fast fashion Besides the’ throwaway’ culture that is linked to fast fashion and consumerism, a large chunk of textile waste can be seen on the cutting room floors of factories. Offcuts and thread, if not recycled/reused, usually end up in landfills. This is not the best place for clothing to end up, whether is natural fibers or synthetic if they’re dyed they have the ability to leach off chemicals into the landfill region. So, the synthetic fibre uses more carbon than natural fibres, but natural isn’t really the answer due to the amount of water needed to produce the cotton and the chemicals to manufacture the raw materials. What are the possible solutions? Solutions? The impacts have been set in stone, but there is change in the horizon.

various companies changing how the clothes are being produced For polyester, there is a recycling aspect that is being implemented by some sectors. This aspect is simple the use of PET bottles that are being broken down into pellets, which are then span into the polyester fibers. Notably, when one is shopping