The Impact of Water Scarcity and Pollution on the Textile Industry: A Case Study from Turkey

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Section I – Introduction

Water scarcity is becoming a global concern. Although the amount of water on Earth has remained the same for over a million years, freshwater sources are being depleted at alarming rates. Freshwater sources are being consumed at a faster rate than they can be replenished due to increases in population and an increase in industrialization. An increase in population places stress on local freshwater sources and the water available per capita of the region is decreased.

An increase of industrialization reduces freshwater sources because of the large amounts of water required by manufacturing facilities and because pollutants from manufacturing processes pollute the remaining freshwater sources. The large quantity of water usage and pollution relates to the manufacturing of textiles.

Textile manufacturing in Turkey has been affected by water scarcity. Although Turkey has quite a vast amount of freshwater sources, industrialization is beginning to threaten these sources. Textile facilities began to move to different locations in the country in order to secure their own water sources which could meet the facilities quantity and quality demands. The facilities are also beginning to build their own wastewater treatment plants in order to treat their effluent and remove any pollutants before the water is disposed of into the municipal water system or a water source within the country. Textile companies within Turkey are also importing new technology into their facilities to process goods in a manner that would not require water at all. Textile manufacturing in Turkey is just an example of how water scarcity and pollution is affecting textile manufacturing globally. Water scarcity and pollution are becoming major global trends that will continue to rise in the years to come. The textile industry foresees the impact of this trend and it is creating new technology to reduce water consumption and lower pollution; industries in Turkey are already experiencing water scarcity and began to lower pollution and water use.

Section II – Global Trend

With water covering more than 70 percent of the Earth's surface, it is commonly viewed by many people as a limitless resource (Thomas). This view, however, is quickly changing. The number of countries that are experiencing water scarcity issues is rising (Thomas), and the amount of freshwater that is currently available is decreasing due to pollution from manufacturing industries in the world (World Water Assessment Programme). Through the increase of water usage and pollution, water scarcity is becoming a problem in which manufacturing industries play a vital role in consumption and pollution.

The Earth's surface water has a volume of 335 million cubic miles, but the water that is

available for human use is considerably smaller. Only 2.5 percent of water on the Earth is freshwater. Seventy percent of this freshwater is frozen in glaciers and another 29 percent is contained in underground reservoirs that are currently inaccessible. The remaining 1 percent of freshwater is surface water; examples would be lakes, rivers and aquifers, which are places where water is stored underground in permeable soils and rocks. Areas of the world that are desperate for freshwater are using a process called desalination to obtain more freshwater. Desalination is a process where salts are removed from sea or ocean water in order to create freshwater (Thomas).

The amount of water on Earth has remained relatively the same for over a million years (NASA). As the amount of water on Earth has remained the same, water use has been increasing at alarming rates. In 1995, the world withdrew 3,790 cubic kilometers of freshwater; in 2000, this number had increased to 4,430 cubic kilometers. This number is expected to increase 10 to 15 percent every 10 years in the future ("Vital Water Graphics"). The increase in demand is leading to water scarcity because freshwater sources cannot supply this demand and remain renewable.

The renewable time, which is how long it will take a water source to replenish the water that it contains, for an aquifer, on average, is 1,400 years; it would take 17 years for a lake to replenish, and 16 days for a river to be replenished. An aquifer is a nonrenewable source of water due to the large amount of time required to replace the water it contains. Desalination plants may seem to be an adequate source of freshwater, but they are not. There are over 12,500 desalination plants in the world, but they only produce 4 billion gallons of water per day, which is 0.25 percent of the world's water need (Thomas).

Water scarcity is becoming a reality for many people around the world. Freshwater is becoming a finite resource for many nations in the world. The United Nations expects that by the year 2025, 3 billion people in 52 countries will be affected by water scarcity and they will not have enough water to drink, for sanitation, or for household use. It is also projected that in 2025, the world's water sources will need to be enhanced and manipulated by 22 percent to meet the needs of society (Thomas). Examples of the many countries that are currently facing water scarcity are Yemen and China.

In Yemen, aquifers are being depleted at a faster rate than they can be replenished. On average, the water level in aquifers is dropping at a rate of 3 meters a year. The World Bank estimates that some of the rural economies of the country will change within a generation due to water shortages and water scarcity. The country is currently drilling for new aquifers, up to 2 kilometers into the Earth's surface, but no new water sources have been found. The country is faced with the decision to either import water to its capital or to just relocate the city. The aquifer that the capital is using will be depleted by the end of this century (Brown).

China is also experiencing water scarcity. The current annual per capita water supply is 2,200 cubic meters. This number is expected by drop to 1,700 cubic meters per person in 2030. In the same amount of time, China's water demand will increase from 120 billion tons a year to 400 billion tons a year; this is more than triple the current amount (Pocha). China is facing serious water problems. As the population increases, the water supply that is available per person is decreasing on-top of the increasing demand for water itself as a resource. The Chinese government estimates that over 50 percent of the cities in the country are currently facing some form of water scarcity. Certain areas of the country are

experiencing aquifer water levels dropping 5 feet in just the last 5 years, and people in China are seeing lakes turn into vast sand pits due to the over-withdrawal of water for society (Pocha). A contributing factor to water scarcity is water pollution. Every day, 2 million tons of waste is dumped into water sources around the world and 1,500 cubic kilometers of wastewater is produced throughout the world. The amount of contaminated water quickly rises due to this pollution because 1 liter of wastewater will pollute 8 liters of freshwater (World Water Assessment Programme 10). Water pollution is decreasing the available freshwater sources. In India, 14 percent of the rivers are severely polluted, 19 percent are moderately polluted, and 67 percent are moderately clean (Parsai). Groundwater in Russia is becoming more polluted with over 2,700 sources of freshwater being classified as polluted (Global Environment Outlook 3). In the United States, 40 percent of freshwater is identified as being unsafe for human consumption or recreation (Pimentel). These water sources, clean or polluted, are being used in different ways throughout the world. Water use in the world is divided between agricultural, industrial and domestic; of which each sector holds a percent of the total water used throughout the world, 70%, 22%, and 8% respectively. In high-income countries, the water use by industries is 59 percent of total water usage; and in low- and middle-income countries, water use by industries is 10 percent of the total water usage. The industrial sector of water usage is expected to increase from 752 cubic kilometers a year to 1,170 cubic kilometers a year in 2025. Currently, industries dump 300 to 500 million tons of heavy metals, solvents, toxic sludge and other wastes every year into water source. Of all the industrial waste that is created in developing countries, 70 percent is dumped untreated into water that will pollute the usable water supply ("Water and Industry"). The industrial sector of the world is creating massive amounts of wastes and the majority of it is polluting the world's water sources.

In order to address the pollution of water sources and water scarcity, many non-governmental and governmental organizations have been created. Over 90 governmental organizations exist in the world; some pertain to just certain countries such as South Africa, Norway, India, and Mexico; other organizations are regional, international, or even global in scope. There are also over 80 non-governmental organizations that deal with water related issues. These organizations focus on dams, sewer systems, heavy metal concentrations, desalinization, and water allocation. Water scarcity, allocation, and pollution are receiving global attention by not just civil societies but also by the governmental bodies of the Earth ("The World's Water"). Manufacturing industries require large amounts of high quality water as a key raw material. The use of this raw material will increase as the developing world becomes more and more industrialized. Water usage in the industrial sector of a country increases as the per capita income rises within a country (Dupont 413). Water is a crucial issue in manufacturing because large amounts are needed and used, but once the water is used, the wastewater is of poor quality and it threatens the water sources that the wastewater is disposed into. The wastewater can be treated, this is a costly undertaking, but the treated water is seldom at the quality it was before it was used in manufacturing. Water treatment is also not done by all manufacturing industries. An increase in training, education and technology transfer can reduce water usage and pollution. Many countries have polluter pays laws, which state that when pollution does occur, the polluter must pay for the clean-up; many also have laws that make pollution illegal, but countries lack the sources to monitor or

enforce these laws or they may look the other way as to not hinder economic progress. This is combined with many people in low- or middle-income countries within the industry not knowing how water is used in their processes and the use of obsolete, inefficient technology (World Water Assessment Programme 20). In the textile industry, water scarcity and pollution have been the driving forces in creating new technology and the use of new chemicals during processing.

Section III – Impact on My Profession

In order to produce marketable goods, the textile industry consumes large amounts of water (Menezes). These large amounts of water are often taken from freshwater sources, used, pollutants are added, and then it is dumped into treatment facilities or other freshwater sources. It is the large consumption of water by the textile industry that has fueled the creation of new technology and created a change in conventional chemical processes.

The textile industry is a leading consumer of water. In order for a manufacturing plant to process and produce one kilogram of cotton fabric, the plant must consume 250-350 kilograms of water. These numbers do not include the water needed to apply a dye or finish to the fabric, so even more water is needed to produce a finished fabric (Arun 184). Textile plants that dye and finish textile goods can consume over 200 cubic meters a day in regular processing techniques ("The Dry-to-Dry Route"). The water used in textile processing is used in two ways, one as a solvent for the application of chemicals to the textile, and secondly as a washing or rinsing medium. In order to ensure a quality product is produced, quality water must be used in the processing stages. Quality water must therefore be obtained, and it is often from freshwater sources; rivers, lakes and underground aquifers. However, the massive amount of water that is needed in processing has depleted these sources which have lead to water scarcity around textile facilities. The water scarcity has then resulted in deteriorating water quality of the remaining sources due to the wastewater discharge and effluents from the processing facilities. Pollutants in wastewater are often non-biodegradable and can include oils, dyes, lubricants, hydrogen peroxide, chlorine compounds, acids, bases, nitrites, water softeners, and low molecular polymers. In order to protect the environment, almost all of the countries in the world have regulations on the condition of effluents that can be disposed into sewer systems, lakes or rivers.

These demands on the quality of effluents and water scarcity have lead to new technology and the use of new chemicals (Arun 184-5). It is for these reasons that water conservation in textile processing will be the driving force in new technology (Menezes 40). New technology in textile manufacturing is focused on reducing the amount of water needed to perform processing techniques while maintaining the quality of finish on the product. Ultrasonic waves are being researched in order to replace processes that require water or to decrease the amount of reagents in the effluent. The ultrasonic waves can produce effects on textiles that are similar to current physical and chemical techniques with the advantage of not using water. Instead of chemicals or machinery that require water during processing, researchers are allowing the fast impulses of the ultrasonic waves to do the work. The waves also increase the dye absorption into a textile product so less dye will be in the effluent at the end of the process (Gandhi).

Another form of new technology is the foam application of reagents on fabrics for dyeing and finishing. This application process is being looked to as the future of textile wet processing.

Research is being done on using foam to replace the conventional padding system. In the padding system, the reagent is diluted in water which is then impregnated into the textile by running the textile through the diluted solution and then through two rollers that squeeze the excess solution off the textile. During the foam application method, air replaces water as the transport medium between the reagent and textile. This system does not require water to apply a dye or finish to textiles and less waste is produced when compared to the conventional padding method because not all of the reagent is impregnated into the textile during padding (Elbadawi 40).

An Italian based company, Sperrotto Rimar, has begun the production and sale of a closed washing system that creates an effluent of pure water which can be reused. An average washing system that uses water consumes 8 cubic meters of water an hour; which becomes an effluent that needs to be treated and released into the environment. The Sperrotto Rimar washing system uses 23 cubic meters of water an hour, of which 100 percent is recoverable and unpolluted. Although the new technology uses more water initially, it is able to recover all the water it uses and it is unpolluted. Since the water is unpolluted, the same water that is coming out of the system can be used at the beginning of the system. The Sperrotto Rimar washing system would save a processing facility 169 cubic meters of water a day, which it would no longer need to remove from freshwater sources or treat to remove pollutants before disposing it in other water sources ("The Dry-to-Dry Route").

New chemicals are being used in textile processing that are replacing conventional chemicals in order to reduce pollution in the effluent. Enzymes are currently being used in desizing applications in a vast majority of textile processing facilities. Enzymes are naturally occurring mechanisms that have the intrinsic properties of degrading specialized compounds.

They are also easily destroyed under certain obtainable conditions of temperature or pH, with no adverse effects to the environment. Enzymes are now beginning to be marketed for applications in bio-polishing, the change in hand of a textile, the reduction of pilling, the removal of print thickeners used during printing textiles, and the production of a 'worn look' on a fabric. All of these processes conventionally use chemicals to obtain the desired finish, which would produce a polluted effluent. Now all of these finishing techniques can be done through the use of enzymes
(Gandhi). Currently, there are alternative chemicals that can be substituted for conventional chemicals that would produce a 50 percent reduction of pollution in the effluent. Acetic acid can be substituted with formic acid, non-ionic detergent can be substituted with Ginasol 6836, and hydro can be substituted with thiourea dioxide (Gandhi).

The Sperrotto Rimar washing system uses a solvent instead of water as the main medium during the process cycle. This new chemical solvent reduces the effluent of a washing system from 16 kilograms an hour to zero. In the conventional washing system, 16 kilograms an hour of detergent would be produced in the effluent leaving the system; the Sperrotto Rimar does not even use detergent so no effluent is leaving the system. Pollution is decreased because there is no effluent that needs to be treated and released

into water sources. The system is a closed loop system so the solvent is recovered at the end of the process and reused ("The Dry-to-Dry Route" 32-3).
A Netherlands based company, Bayer-Sybron, has introduced a new chemical, Tanex GEO, which promises to increase the whitening affect of textiles without adding pollution to the effluent. Tanex GEO is based on a naturally occurring mineral that aids in the bleaching of textiles by acting as a stabilizer for peroxide compounds. Tanex GEO has the ability to produce a whiter textile without adding pollution to the effluent of the whitening process; unlike the conventional whitening enhancers. Bayer-Sybron also produces Alkafto, which is a buffer solution used during reactive dyeing. Alkafto is used as a substitute for soda ash, but less Alkafto needs to be used to achieve the same effectiveness of the soda ash. During processing, the amount of Alkafto needed is equal to only one tenth of the amount of soda ash that is required. Since fewer chemicals are used to produce the same results, less pollution is added to the effluent and so less pollution will need to be treated and released into the environment ("Supertex-Sarex" 97-98).

Section IV – Case Study

Turkey has an abundant water supply which will be threatened in the future. Each year Turkey uses 110 billion cubic meters of water; extraction from surface water sources account for 98 billion cubic meters and water from aquifers account for the remaining 12 billion cubic meters ("Water in Turkey"). Although the amount of water usage seems large, it is only 17 percent of the total freshwater sources in Turkey. Turkey contains 48 lakes, has over 30,000 kilometers of riverbeds, and has 1149 dams, which create lakes with areas summing over 32,500 square kilometers ("Turkey Environmental Profile"). The country is currently working on the Southeastern Anatolia Project (GAP). The GAP is a plan to build 22 dams and 19 hydroelectric plants on the Tigris and Euphrates rivers. The project is currently in construction and massive amounts of water will become available to Turkey once the project is complete. The dams will hold water in man-made lakes that will cover an area larger than Belgium and the Netherlands combined. The project is being implemented to meet the power and water needs of the country.
The total water withdrawals in Turkey are expected to rise by 140 percent within the next 10 years (Juhasz). This increase in water withdrawals, along with water pollution, will put a strain on the water sources in the country.
Water pollution is one of the major environmental concerns within Turkey. The major sources of water pollution are chemicals and detergents ("Turkey Environmental Issues"). Only 55 percent of water consumers in Turkey are serviced with a sewer system and only 11 percent of water consumers are connected to a wastewater treatment facility (Okumus). This means that 89 percent of water consumers in Turkey dispose of wastewater directly into the environment without treatment or the removal of pollutants. Therefore, this water is polluting the sources of freshwater in Turkey and so water scarcity is likely to increase due to the minimization of freshwater sources due to pollution and the expected rise in water withdrawals in the next 10 years.
In order to reduce pollution, Turkey created a National Ministry of Environment (NME) in 1991. The NME create the National Environmental Action Plan which consists of documents that set levels on pollution and emissions in the public sector. This document, however, only

serves as a guideline for the private sector ("Freshwater Country Profile: Turkey"). Turkey also has over 50 laws and regulations that are applicable to the environment, but the lack of communication and responsibilities between industries and the government have decreased the effectiveness of these laws and regulations within the country (Oner). The current government in Turkey is quickly adopting new legislation concerning the environment in preparation of the country entering the European Union. Turkey must meet the environmental directives set by the Union before the country is allowed to join. The major sources of environmental risks are wastewaters, untreated sewer disposal and solid wastes ("Environment Market in Turkey").

With the textile industry in Turkey growing, water pollution and scarcity will become a problem. Turkey is ranked the sixth largest textile exporting country the world (Yontem). The textile industry has grown 10 percent in the last ten years (Yontem), and it is now over 20 percent of the industrial sector in Turkey (Baban). As the textile sector in Turkey continues to grow, the amount of water it will consume and dispose of will ultimately increase and pose a threat to the environmental directives that have been set by the government. In order to reduce pollution and water consumption, the textile industry in Turkey is buying new technology and building their own water treatment facilities. Turkey is currently one of the largest importers of Algelich dyeing machines. Algelich, a Spanish based company, focuses on the production of dyeing and finishing machines that consume less water and fewer chemicals during operation. One of the machines currently being imported by Turkish companies is the Airtint. The Airtint is a machine that uses air to transport the dye or finish to the textile instead of the conventional transport medium of water. The machine produces the same results as water transportation methods without the use of water. By using air to transport the chemicals, fewer chemicals are needed because there is a 100 percent chemical add on to the fabric, whereas in water transport methods, not all of the chemicals are add to the fabric, some remain in the effluent and are wasted. There is no effluent produces with the Airtint, so water is saved along with the reduction in pollution. The textile industry is reducing water usage and pollution by importing this new technology and using it within their facilities ("Innovation and Success" 54).

The Neuenkirchen clarification facility was built for a textile mill in Steinfurt, Turkey. The facility can treat between 1,300-1,500 cubic meters of effluent per day and it reduces the pollution level in the effluent leaving the textile mill by 50 percent when compared to the previous levels of pollution before the treatment facility was built. The treated levels are below the new limits set by the government and so the textile mill is able to remain in production. The Neuenkirchen clarification facility currently recycles 32 percent of the incoming effluent it receives from the textile mill and it is reused by the textile mill; the goal of effluent recycling is 40 percent for the facility. By this action of recycling the effluent, the treatment facility is saving water by reducing the amount of water the textile mill needs to pump from the aquifer that it uses as its water source. The reduction in the amount of water the mill needs to pump from the aquifer increases the mill's production capacity because the demand on the aquifer is reduced and therefore the water source will last for a longer period of time (Krull 72).

The Taner Triko Sanayi Ve Ticaret AS Company has recently built a new facility in Corlu, Turkey. Its previous location was 100 kilometers south in Istanbul. Pollution concerns and water quantity prompted the move out of Istanbul. The previous facility

has having difficulty obtaining the quantity of water it needed for its dyeing and finishing processes; the infrastructure of Istanbul and increased usage was reducing the available water to the facility. At the new location in Corlu, Taner Triko built the new facility on top of an aquifer with its own direct tap into the water source; this allows the new facility to no longer be reliant on anyone else for a water supply. The company also built its own effluent treatment facility. The previous facility was connected to the municipal water system and the pollution levels in the effluent from the facility were beginning to increase and become too high due to increased production. So the new facility was build with an effluent treatment facility in order to treat the effluent leaving the processing facility, and hence reduce the pollution it contained before it left the company premises ("Quality, Expansion" 8-9).

The role of water scarcity and water pollution has played an important role in the Turkish Textile Industry. As this sector of the economy continues to grow, more and more demands will be placed on the water supply of the country; at the same time, more and more pollutants will be entering the environment as the production of textile goods increases.

Section V – Implications for the Future

What was once thought of as an unlimited resource, freshwater is become a scarce commodity that is becoming ever increasingly hard to find. Many countries around the world are experiencing some form of water scarcity and more are going to experience it in the future. The demand on the fixed amount of water on Earth is increasing and it is used without considering how long it will last or what is being put into it. Industries around the world are dumping pollutants into the limited sources of freshwater in the world and they are decreasing the availability of an already scarce resource.

The textile industry has been affected by water scarcity and pollution. New technology is focusing on not using water at all for what was once water intensive production processes. There are now chemical alternatives that can be used to reduce the environmental impact of the textile industry by producing less pollution in the effluent that leaves the textile facilities. Examples of these measures are seen in textile production facilities in Turkey. The textile industry in Turkey has been relocating to different areas in order to find adequate freshwater sources. Companies are leaving cities in order to have an adequate and reliable water supply. These companies are also building their own wastewater treatment facilities in order to reduce the amount of pollution in their effluent. New technology is also being imported that will decrease the amount of water used during manufacturing.

Water scarcity is likely to increase in the future and the textile industry needs to adjust to a limited supply of freshwater. In order to maintain current production, textile facilities around the world will need to be able to process the same amount of products and goods at a lower water intake level. Otherwise, textile production will decrease in the coming years due to a lack of available freshwater. The textile industry is aware of the decrease in water sources and they are developing new technology and new chemical alternatives, but the challenge will lay in converting the technology in current textile facilities into the new technology that uses less water. Another challenge lays in changing the mindset of the current generations in the textile industry to use the new chemical alternatives instead

of the chemicals they have used in the past decades. This will be a slow process, but one that will need to happen in order for the textile
industry to maintain current production and grow in the future.

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