WATER GOVERNANCE MAPPING REPORT: TEXTILE INDUSTRY WATER USE IN CHINA

Case Study of Zhejiang Province

Prof. Ma, Zhejiang University
Phillia Restiani, Stockholm International Water Institute
Frank Zhang, Stockholm International Water Institute
Chinese Academy of Environmental Planning

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SWEDEN TEXTILE WATER INITIATIVE

Executive Summary

Context and Aim of the Report

China's textile industry contribution to global markets is changing in line with its industrial transformation and increasing pressure to manage water related challenges. China's textile industry is the largest in the world with a production output of 5.8 billion meters of clothing in 2015 and contributed to 38.6% of the global exports/imports markets in 2014. Along with China's rapid growth, its industrial sector including textile sector experiences a massive restructuring and transformation. At the same time, China's per capita water availability is only a quarter of the world's average. Increasing water pollution from the textile industry exacerbates China's long term problems of water shortages, public health and deteriorating ecosystem. Experts believe that the main challenge in China's water resource management lies within its water governance and how China can establish effective institutional and policy framework that requires a broad and deep reform of the current system.

This report seeks to mapping existing water governance landscape in managing water risks related to the textile industry. To have a more comprehensive and contextual mapping and analysis of water governance, this report focuses on Zhejiang Province due to its importance for China's textile industry in terms of both productions and its policy responses to the industry's substantial pollution problems. Since the governance structure is often similar at the same administrative level across the country, the approach and insights of the analysis at the provincial level are also applicable to other provinces. In particular, this report aims to: 1) assess physical and regulatory water risks that determine long term viability of the textile industry in Zhejiang Province; 2) Investigate water governance landscape in relation to the textile industry in Zhejiang Province; and 3) Provide policy recommendations on priority areas for capacity building in sustainable water management in the textile industry in Zhejiang Province, China.

Zhejiang Textile Industry Contribution and Outlook

Zhejiang textile industry contributes significantly to output value and employment at the provincial and national level. In 2013 the industry generated a revenue of RMB 6,380 billion (US$ 944 billion) that accounts for 16.91% of Zhejiang economy and 18.86% of China's total output value from textile industry as well as a major share of 23.13% of national export revenues at RMB 76.13 billion (US$11,25 billion). The industry provided employment for 730,000 people or 19.60% of Zhejiang industrial sector within 8917 enterprises beyond the designated scale that represented 22.54% of total textile enterprises in China. The contributions of output values and employment from the industry have declining trends in recent years due to financial crisis, industrial structure adjustment and technological progress.

Zhejiang province is taking the lead to transform China into a world class manufacturing power by enhancing industry's capacity with regard to textile technology, brands, sustainable development and skills. This strategy is in line with China's two main strategy in textile industry development as stated in the 13th five-year planning and *Made in China 2025*, i.e. increasing hi-tech fiber market share and developing a replacement for natural fiber. This is an immense challenge considering textile industry, especially the dyeing and printing sector, is currently one of the most polluting industries in China, accounting for 10% (2.15 billion tonnes) of the total industrial wastewater in 2013, contributing to degrading water quality in the coastal bays around the factories, such as the Hangzhou Bay. Beyond water pollution, the industry is also highly consumptive and China's textile water use efficiency still lags behind advance countries, with 3-4 times higher freshwater consumption and 2-3 times more emissions generation. These challenges are even greater for small enterprises, which are not covered by national statistics.

Water Resource Management in China

China water resource management challenge is characterized by severe water scarcity, low water use efficiency, and lack of incompatibility between regions with most available water sources (Southern District) and those with more intensive development activities and water use (Northern District). China's per capita annual runoff is 2,670 m^3 or a quarter of the world average and it is mostly available in the Southern District 4 (79.3%). Groundwater resources are located mostly in the mountaneous regions in the North. Water resource development mostly take place for surface water (81%) and in the Southern District 4. The country's total water use is 618.34 billion m^3, comprising of 12.1% domestic use, 22.8% industrial use, 63.4% agriculture use, and 1.7%

of ecological use. National water productivity has 23.9% efficiency equivalent to 456 m^3 per capita per yuan GDP (current prices) and the Eastern region has the highest water use productivity.

Declining water quality in China's water bodies is observed in both surface and underground water resources as shown by fairly high proportion of water bodies in low quality (class IV and V). Nationally, the water quality of 31.4% of the rivers, 66.1% of the lakes, 18.6% of the reservoirs and 42,3% of water function areas, are poor (class IV, V or inferior V). For groundwater resources, while the majority 77.1% could only be used for other purposes outside drinking in class IV-V. In 2013, the State Council issued the implementation of "the most stringent water management system assessment methods" to address water management challenges and achieved encouraging results.

Climate change has little effect on the amount of precipitation in China, but it had a great influence on the distribution of rainfall across time and space. In the past 50 years, the overall rainfall has been increasing in Xinjiang and the Yangtze River basin and southern parts of China. However, the Southwest to the northeast region experience a reduced rainfall. Decreased precipitation in upstream areas has caused reduced natural recharge of the rivers with the implications of increased competition for downstream water users. Increased precipitation can also cause increased risk of disaster from snowmelt flood. Increased water scarcity from reduced precipitation also brings about negative implications, such as salt water intrusion in coastal areas, deterioration of wetlands, and desertification (conversion of lakes into the grass field and from grass fields to desert).

Physical Water Risks Pertaining to Zhejiang's Textile Industry

Despite its higher water scarcity comparative its output value, Zhejiang province has managed to continuously improve its water use efficiency, water conservation and reuse although it still lags behind those from advanced production countries. With merely 3.7% of the national water availability while contributing the largest share of national output, Zhejiang's textile industry faces a greater pressure of water scarcity at the provincial and district level. Through its comprehensive water management policy "a total of five water management", water use efficiency is improving from 33.07 m^3 per RMB 10,000 of industrial added value (0.022 m^3/US$) in 2010 to 19.29 billion m^3 (0.013 m^3/US$) in 2014 or 30.8% reduction in water use, which exceeded the national target of 22% decrease. Water conservation and reuse had also been improved by reducing freshwater use per one hundred-meter dyeing cloth in the textile industry from 4 to 1.8 tons of water and increasing reuse rate from 7% to over 35% from the 11th Five-Year Plan to the 12th Five-Year Plan.

Water quality of rivers in Zhejiang is lower than some other textile production provinces due mainly to high wastewater discharge rate and heavy pollution load from dyeing and printing units, and thus this sector has been the main target for structural pollution reduction strategy. Zhejiang's textile wastewater discharge rate has shown a slightly decreasing trend to the national level, while the COD loading contribution shows an increasing trend in recent years. This means that wastewater discharge in Zhejiang lags behind the national average. However, industry upgrade and development, comprehensive environmental management methods, as well as constant innovation and improvement of wastewater treatment technologies, have increased standard effluent discharge.

Key water management issues within the industry is water pollution, the ecological damage from wastewater discharge, and further improvement of water use efficiency. In spite of improvement in wastewater discharge rate, the total amount of pollution load is still increasing with increased production. In Shaoxing, which has a high concentration of dyeing and printing units, total pollution load from the industry could account for up to 87.9% of total municipal wastewater. Discharge of hazardous material pose threats to long terms human health and environmental safety. In recent years, Hangzhou Bay has started to receive industrial wastewater discharge from Shaoxing and other areas, posing greater pressure on its offshore water environment. Despite major improvements in water use efficiency, a large number of companies, especially SMEs, still run production processes and create products with lower added values and low water performances.

The stakeholders have a fairly good understanding of the short term and long term implications of the industry's physical water risks. In the short run, water shortage will further tighten existing water use permits

and increase monitoring on water use efficiency, while improvements in water management will lead to higher production costs. Water quality issues will also impact product quality as well as the performance of textile machine and equipment. In the long run, water pollution problem can tip ecological balance and threaten human wellbeing. Stakeholders understand that China's industrial transformation will take some time and provinces with lower environmental and water requlations are losing valuable time to shift to resource efficient productions and face long term risks from increasing environmental requirements at the national and international level.

Water Governance Landscape Pertaining to the Textile Industry in Zhejiang

To address persistent water resource shortage and increasing water pollution, government administration at all levels in Zhejiang puts water conservation and water treatment at a high priority as reflected in the involvement of actors beyond the traditional water-related portfolio ministries (water resources and environment) in the governance of textile water; thus ensuring a greater harmony between water, industrial and economic development policy. Using various approaches, such as technical innovation, closed-loop of water use, sectoral restructurisation, reform of water institutions and supervision of law enforcement, the government has achieved positive results. Nevertheless, the textile industry still face difficulties in meeting sustainable development challenges and managing regulatory water risks. The current water governance landscape in Zhejiang Province, as presented in the following, is well coordinated with economic-related agencies, such as the Commission of Economy and Information, Department of Finance, Development and Reform Commission, and Department of Technology. As usual, the Water Resource Bureau is a leading organisation with regard to value chains pertaining to water resources management, while the Environmental Protection Bureau is leading the value chains pertaining to water pollution control and water environment.

Key actor	Water Resource Bureau Development and Reform Commission Commission of Economy and Information (CEI)	Administration of commodity prices Water Resource Bureau Development and Reform Commission Department of Justice/Department of finance	Commission of Economy and Information (CEI) Water Resource Bureau Taxation department Department of Finance Development and Reform Commission	Environmental Protection bureau Development and Reform Commission Department of Technology Commission of Economy and Information Public security department Supervision department Public affairs department Department of Justice Department of Finance Human resource department Water Resource Bureau State-owned Assets Supervision and Administration Commission Taxation department Industrial and commercial bureau Statistic Department Bureau for Press and Publications	Water Resource Bureau Commission of Economy and Information (CEI) Department of Technology	Department of housing and urban and rural development Environmental Protection Bureau

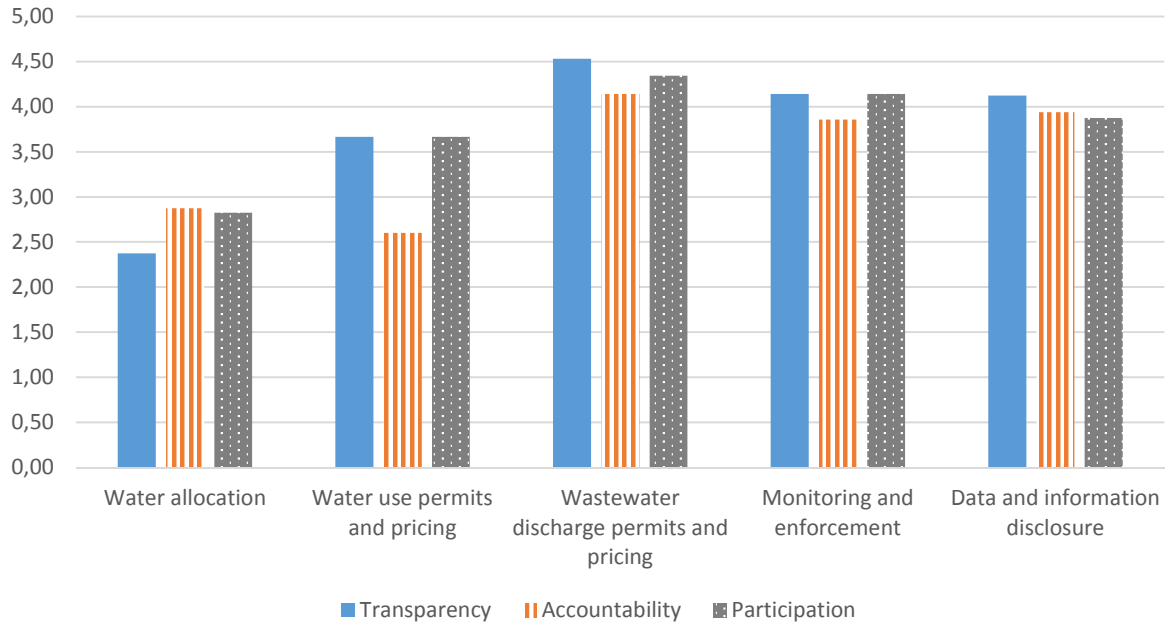
Water Governance Value Chain Pertaining to the Textile Industry in Zhejiang Province

As a role model for China's Water Ten policy, Zhejiang industrial water strategy has entailed a broad range and long list of regulations in water conservation and pollution control, which consists of both command-and-control as well as market-based approaches. While following the national policies, Zhejiang province has inspired the formulation of the national policy and thus taking the lead of textile water management in China. By targeting DP industry as the most serious pollution problem in the textile industry, Zhejiang has put a priority on facilitating industrial "renovation and promotion" by promulgating a series of policy documents connected with industry access, technical innovation and renovation and promotion.

Zhejiang textile industry face regulatory water risks at the enterprise and sectoral level. At the enterprise level, these risks materialize in terms of: 1) frequently changed standard adjustments that still lacks coordination across relevant government agencies; 2) limited access to appropriate and cost-effective production technologies; 3) uneven environmental regulatory requirements across provinces in China creating additional economic costs in

the short run; and 4) low demand for green products and limited green supply chain provide lower motivation toward more sustainable practices. Regulatory water risks at the sectoral level are: 1) unclear, overlapping and often contradictory responsibilities among government agencies; 2) Undervaluation of water despite water price reform; 3) Zhejiang province has a net output in virtual water trade and yet water-quality induced water shortages are on the rise; 4) The industrial transfer of China's textile industry from the eastern coast to the central and western regions; and 5) low capacities for environmental monitoring, especially toward the SMEs.

The results of the scoping assessment of good water governance pertaining to textile water use by the stakeholders show that Zhejiang government has performed the highest in terms of wastewater discharge permits and pricing and the lowest in water allocation. The scoping assessment was based on stakeholders' review of the performance of each value chain of industrial water use with regard to the three principles of good water governance: transparency, accountability, and participation (TAP). The rating was conducted on a scale of 1-5, in which the scale of 1 represents very low performance and 5 represents very high performance. The results show that in overall the stakeholders gave very high ratings for TAP in wastewater discharge permits and pricing (4.53; 4.14; 4.34 out of 5, for TAP respectively). Two focus areas with the lowest scores of good water governance are water allocation as well as water use permits and pricing.



Scoping Assessment of Good Water Governance Pertaining to Textile Water Use.

Recommended Priority Areas for Capacity Building

In line with the green development strategy, Zhejiang government has identified six priority capacity building areas that enable the shift to sustainable textile industry. These areas are development of green products, promotion of green enterprises, construction of green parks, optimization of green supply chain, formulation of green standards and undertaking green management reform based on realities in practice.

Based on the capacity building workshop, the participants that consisted of the policy makers, researchers, company leaders and other presenters agreed on that the most urgent water-related issues in the textile industry in Zhejiang are:

1. Low water efficiency in textile production. In general, the textile manufacturing industry in Zhejiang are 3 times less efficient in terms of the amount of water consumed for production of same amount of product compared to the more developed countries.
2. High water pollution discharge from textile production. The textile industry is the 6th biggest industrial water polluter in China and similar to the water efficiency issue, the small and medium sized manufacturers tend to be the biggest concern as they are more difficult to monitor and less financially capable of investing in more environmentally superior technologies.

3. Lack of awareness of environmental issues in general at all levels of manufacturing companies. It was emphasized that environmental awareness has to be built at all levels within a company, from company owners to frontline workers.

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Chapter 1 Introduction

1.1. Background

Textile industry has been a key manufacturing sector in China since the ancient times with the evidence of the first textile fragments found in 4000 BC.[1] Currently, China's textile industry is the largest in the world, with a production output of 5.8 billion meters of clothing in 2015[2] and contributed to 38.6% of the global exports/imports markets in 2014.[3] Since China has grown rapidly as the second largest economic powerhouse in the world, its industrial sector has expanded drastically and led the country to become the most competitive manufacturing country. Accordingly, its textile industry is experiencing a massive restructuring and transformation within the framework of China's macroeconomic structure.

China's per capita water availability is only a quarter of the world's average. The increasing water pollution from the textile industry exacerbates China's long term problems of water shortages, drinking water safety, public health and deteriorating ecosystem. To address the issues, Chinese government has released a number of policies. For instance, the Ministry of Environmental Protection has introduced the *Discharge Standards of Water Pollutants for Dyeing and Finishing of Textile Industry* in 2014 and announced the Water Ten policy in 2015. Experts believe that the main challenge in China's water resource management lies within its water governance and how China can establish effective institutional and policy framework that requires a broad and deep reform of the current system.[4]

In line with that perspective, this report seeks to map the landscape of water governance for industrial water use, especially in relation to the textile industry. This report looks at the background context of water risks for the textile industry, identification of various stakeholders across the value chain of water governance for textile water in order to assess the capacity building needs of the stakeholder to improve their effectiveness in good water governance.

1.2. Objective

This report aims to:

a) Assess physical water risks pertaining that determine long term viability of the textile industry in China, especially in Zhejiang Province.
b) Investigate water governance landscape and governance related (regulatory) water risks in relation to the textile industry in China, with a focus on Zhejiang Province.
c) Provide policy recommendations on priority areas for capacity building in sustainable water management in the textile industry in Zhejiang Province, China.

1.3. Methodology

The information, analysis and recommendation in this report are built on:

a) Comprehensive desk research and data review of international and local sources.
b) Interviews with a number of stakeholders which include public actors - government agencies, researchers, experts, and civil societies – as well as private actors – business associations and companies.
c) Inputs from the stakeholders gathered during a capacity building workshop onn 13 January 2017.

1.4 Focus of the Report

This report has a specific focus on water governance pertaining to the textile industry in the Zhejiang province, although it also has an overview on the same issue at the national level. This focus allows us to have a more comprehensive, contextual and detailed mapping and analysis of water governance for a strategically selected area, which accounts for a major share of the textile industry in China. The approach and the insights of the analysis at the provincial level are also applicable to other provinces, considering that the governance structure is often similar at the same administrative level across the country. Zhejiang Province was chosen as the focus of the report due to its importance for China's textile industry in terms of both productions and how it addresses the industry's pollution problems.

Located at the industrial eastern region of China, Zhejiang province accounted for 20% of the total national production value and had the largest contribution (24%) to the national total export value in 2011. The province's total production of printed and dyed fabrics in 2014 was 32.4 billion meters, accounting for 61% of the total national production. (Ma Zhifang, 2015). Furthermore, 30% of the top 100 textile companies in China are located in Zhejiang, representing the largest cluster in the country. Textile products from Zhejiang have large market shares in China, i.e. 44.22% for synthetic fibres, 54% for dyed and printed fabrics; 40% for silk, and 17.12% for clothing.

When it comes to environmental issues, the industrial wastewater discharge in 2013 was 1.75 billion cubic meter (BCM) or 42% of the total wastewater discharge in Zhejiang province and the fourth largest in China. Textile, paper and chemical industry together contribute to 65% of total industrial wastewater discharge while their contribution to total industrial production value was only 18%.

In the first half of 2013, more than 400 dyeing and printing (DP) factories in Zhejiang did not meet the national standards for water pollution discharge and this accounted to 92% of total factories of all industries that did not meet the standards.[5] DP processes are obviously the most water consumptive and water polluting process in the textile industry. The production capacity of DP units in Zhejiang accounts for about 60% of the national capacity (Zhejiang Industrial Economy Research Institute). Shaoxing municipality in Zhejiang has 30% of the national capacity in DP.

High concentration of DP units and increasing water treatment requirement have led to a larger amount of sludge, while the lack of sufficient governance mechanism and capacity for proper sludge treatment are severe in Zhejiang.[6] These contribute to degrading quality of the coastal water in the Hangzhou Bay in the province, which is the worst among nine major coastal areas in China. Water quality in this coastal area is rated "worse than grade 4", which is the worst grade as the water body has lost all its functions.[7] The Hangzhou Bay receives water discharge directly from two of the biggest textile industrial parks in Zhejiang.

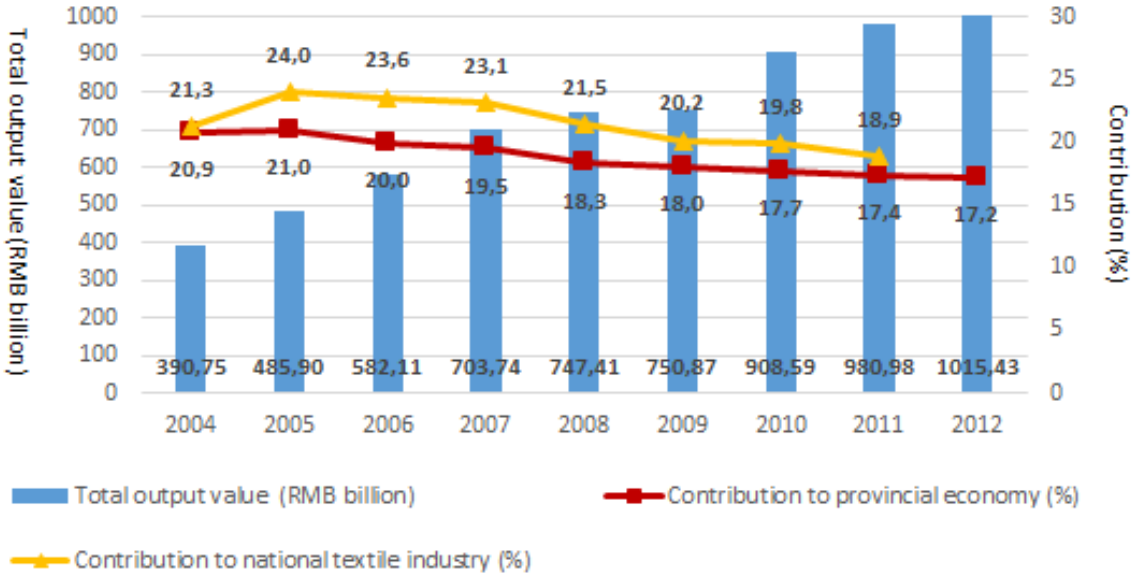
Chapter 2 Textile Industry in Zhejiang

2.1 Economic status of Zhejiang textile industry

Zhejiang Province ranks first on textile production in China. The industry is also a major pillar of light manufacturing industry of the whole province, making great contribution to the national economic development through output, export and employment.

2.1.1 Contribution to the Economy

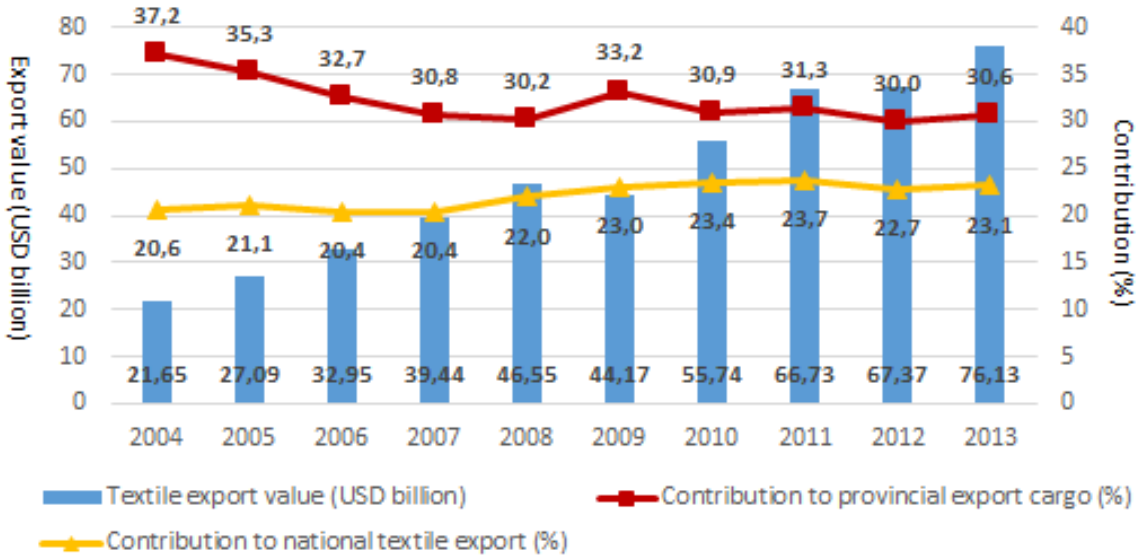
Revenues of major businesses in the textile industry in 2013 reached RMB 6,380 billion, up more than 11% from 2012. The profits reached RMB 350.6 billion, up 15.78% year on year. From 2004 to 2013, the total output value of Zhejiang textile industry above the designated size had increased continuously at an average annual rate of 10.55%, from RMB 390.75 billion in 2004 to RMB 1,065.31 billion in 2013 (Figure 1), which accounted for 16.91% of Zhejiang economy. This growth also represented a significant contribution of 18.86% of the total output value of China's textile industry in 2011. Due to structural adjustment and technology transfer of Zhejiang textile industry, its contribution to Zhejiang economy and China's textile industry had decreased in the same period.



Source: China Statistical Yearbook and 2005-2014 Zhejiang Statistical Yearbook.
Note: Since 2012, the contribution of Zhejiang textile industry to the national level changed because the statistical standard of *China Statistical Yearbook* had been changed.

Figure 1 Total Output Value of Zhejiang Textile Industry Above Designated Size in 2004-2013

The textile industry also has an important contribution to export values, with an increasing trend of growth at 13.40% annually in 2004-2013 (Figure 2). There was a dip in 2009 due to the financial crisis. The export value in 2004 was USD 21.65 billion, accounting for 37.23% of Zhejiang total export for cargo and 20.59% of China's textile export. In 2013, Zhejiang Textile Export value reached RMB 76.13 billion with an increased contribution of 30.61% to provincial export cargo and a moderated contribution of 23.13% of China's textile export.

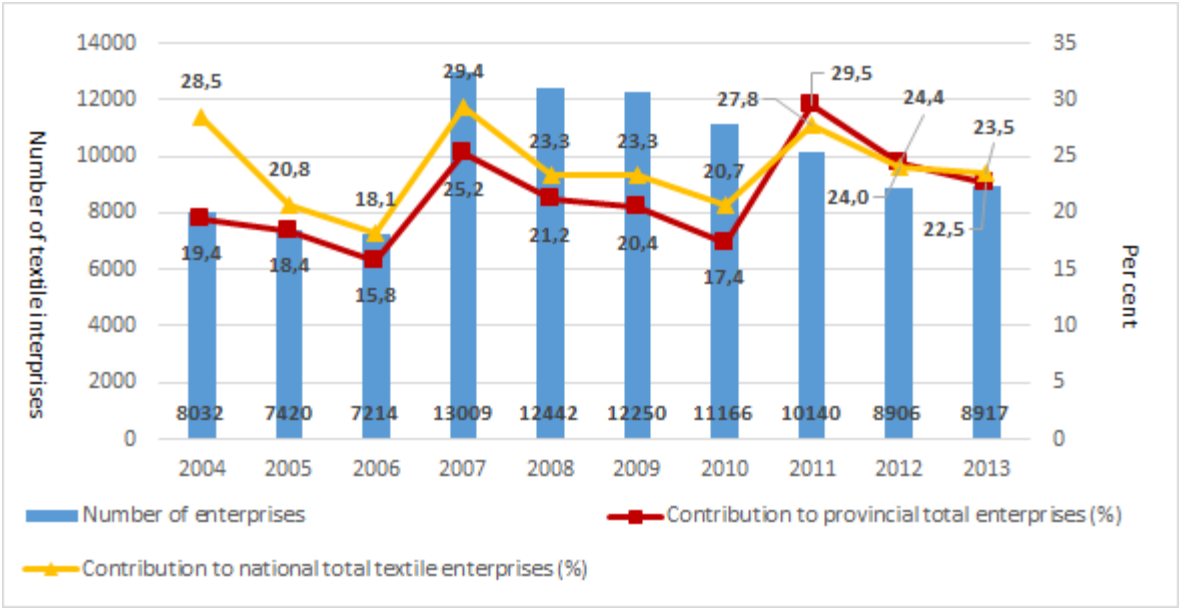


Source: China Statistical Yearbook and 2005-2014 and Zhejiang Statistical Yearbook.

Figure 2 Zhejiang Textile Export Value in 2004-2013

2.1.3 Contribution to employment

From 2004 to 2013, the number of textile enterprises above designated size, i.e. those with annual revenues above RMB 5 million, in Zhejiang had undergone a process of growth and consolidation (Figure 3).



Source: China Statistical Yearbook and 2005-2014 and Zhejiang Statistical Yearbook.

Figure 3 Number of Zhejiang Textile Enterprises Above Designated Size in 2004-2013

On Phase I (2004-2006), the number of textile enterprises gradually decreased from 8032 enterprises to 7214 enterprises because some enterprises that could not meet international trade rules closed down after China joined WTO. In 2006-2007, the industry size almost doubled to 13009 enterprises due to better adjustments of Chinese enterprises to international trade rules. On the third phase (2008-

2013), the effects of financial crisis, industrial structure adjustment and technological progress, had rendered a consolidation of the textile industry with 8917 enterprises, which represented 22.54% of total textile enterprises above designated size in China and 23.5 % of total enterprises above designated size in Zhejiang.

In the same period, the number of employees of textile enterprises above designated size in Zhejiang had also increased and decreased reflecting the growth and changes in structural economy and technological advances (Figure 4). The number of employees of textile enterprises above designated size reached the highest record in 2008 with 837 300 people. Afterwards the numbers kept declining slightly until 2013 in which 730 000 people were employed, approximately 19.60% of employment within Zhejiang industrial sector.

Source: *China Statistical Yearbook* and *Zhejiang Statistical Yearbook.*
Note: The statistical standard of *China Statistical Yearbook* changed after 2012.

Figure 4 Number of Employees within Zhejiang Textile Enterprises Above Designated Size in 2004-2013

2.2 Regional distribution and expected growth of Zhejiang textile industry

Despite its rapid economic development, Zhejiang textile industry also accelerates its transformation in product and regional structure, while increasing its market share continuously. The province boasts a complete supply chain of the textile industry, including: chemical-fiber weaving industry of Shaoxing and Xiaoshan; garment industry of Ningbo, Wenzhou and Hangzhou; shirt and sock knitting industry of Zhuji and Yiwu; tie industry of Shengzhou; knitting industry of Xiangshan; warp knitting industry of Haining; and decorative cloth industry of Yuhang and Haining.

In terms of output value, Shaoxing textile industry has the highest contribution of 32.51% to the province, followed by Hangzhou at 18.56% and Jiaxing at 16.70% (Table 1). For printing and dyeing, which is an important link in the textile industry, in Zhejiang, Shaoxing boasts the most textile printing and dyeing enterprises, followed by Jiaxing and then Hangzhou. The specific cotton and linen and chemical fiber and blending printing and dyeing enterprises are mainly distributed in Shaoxing, Jiaxing and Hangzhou; knitting and yarn printing and dyeing enterprises are mainly distributed in Jinhua, Shaoxing and Jiaxing; silk printing and dyeing enterprises are mainly distributed in Hangzhou, Jiaxing and Huzhou.

Table 1 Total Output Value of Textile Industry Above Designated Size by District in 2013

District	Total output value of textile industry (RMB100 million)	Contribution to provincial textile industry (%)	Ranking
Shaoxing	3463.05	32.51	1
Hangzhou	1977.69	18.56	2
Jiaxing	1778.69	16.70	3
Ningbo	1149.49	10.79	4
Jinhua	845.12	7.93	5
Huzhou	718.26	6.74	6
Wenzhou	417.71	3.92	7
Taizhou	112.42	1.06	8
Quzhou	77.56	0.73	9
Lishui	64.21	0.60	10
Zhoushan	48.86	0.46	11
Zhejiang Province	***10653.05***	***100.00***	***n.a.***

Source: 2014 Zhejiang Statistical Yearbook.

2.3. The Outlook for Zhejiang Textile Industry

In China's 13th five-year planning, there are two main directions of its textile industry. The first direction is to increase hi-tech fiber market share of large-carbon fiber, aramid fiber, high-strength and high-modulus polyethylene, and polyphenylene sulfide. The second direction is related to common fiber, mainly to develop a replacement for natural fiber. Industrial textile has taken up about 50% of China's textile market. Chinese industrial textile market scale will expand continuously at the following stage, enhancing its share in the whole textile industry. Zhejiang is taking the lead in the industrial textile development in China.

The 13th five-year is a key period for China to build itself as a powerful textile nation. Zhejiang textile industry follow the strategic goals and implementation paths of *Made in China 2025*, which is a 10 year action plan to transform China into a world class manufacturing power. In line with this, Zhejiang textile industry will actively adapt to new trends of economic development and allow market role in allocating resources. On one hand, this will accelerate industry transformation and upgrade and build its core competitiveness. On the other hand, the government needs to better manage the interactions and trade-offs between industry and society, ecology and consumption so that the plan can enhance Zhejiang's capacity with regard to textile technology, brands, sustainable development and talents.

2.4. Textile Water Use Impacts on the Environment

2.4.1. Water Quality

There are over 50,000 textile and apparel factories above designated size, which are therefore covered by the national statistics in China[8]. They are mainly concentrated in the economically developed eastern coastal regions, especially some areas of Zhejiang, Jiangsu, Guangdong, Fujian and Shandong provinces. The presence of the industry has exerted immense water environmental issues, due to its location in regions with already high pressure on the water environment in terms of qualitative water scarcity and increasingly dense population. Textile industry together with paper and chemical industry are considered to be the most polluting industries in China, all of which contributed to 65% of total national industrial wastewater discharge; even though their contribution to the total industrial production value was only 18%. Textile manufacturing discharged 10% (2.15 billion tonnes) of the total

industrial wastewater in 2013. With a possibility of underreporting, the actual wastewater discharge could be much higher than the available data.[9]

The part of the industry's value chain with the most intensive use of water and largest rate of wastewater discharge is the dyeing and printing sector, which accounts for about 80% of textile industry's water discharge in China[10]. The volume of printed and dyed fabric produced in those industrial concentration areas has risen from 89.89% of the national total in 2005 to 91.37% by 2010.[11] This has contributed to degrading water quality in the coastal bays around the factories, such as the Hangzhou Bay in Zhejiang province, which was rated extremely poor[12] and classified as category IV. In addition to the traditional pollutants such as Chemical Oxygen Demand (COD), China is also facing challenges to detect and reduce discharge of toxic chemicals into the water environment. This is particularly important considering that 25% of the global total production of chemicals is used for the textile industry and 42% of them is used by textile production in China.

2.4.2. Water Quantity

In addition to being a major source of industrial water pollution, the textile industry is also one of the most water consuming industries. This often leads to conflicts between different water uses in areas that lack water, but also in the coastal areas in which water shortages have caused deteriorating water quality. The overall water use efficiency within the industry is still far behind the countries with more advanced textile industries.

According to the national pollution prevention and control report for key industries[13], water consumption for producing identical textile products in China is 3-4 times more than that in more advanced countries. Likewise, water discharge from dyeing and printing processes in China in average contains 2-3 times more emissions compared to that more advanced countries. The enormous amount of water discharge also generates challenging issues in terms of sludge treatment.

Within the textile industry, a significant number of small businesses, many of which are not covered by the national statistics, is still using outdated production methods associated with a low resource efficiency and high environmental impacts. The regulation and monitoring of such businesses has been and remain to be a major challenge.

Chapter 3 Water Resources Management in China

3.1. Introduction

China has a land area of 9.6 million square kilometer and the sixth highest total annual runoff in the world, equivalent to an annual precipitation of 628 mm, which is 114 mm higher than the Asian average. Per capita annual runoff is 2,670 m^3 or a quarter of the world average; while the average annual runoff per m^2 of arable land is 1800 m^3 or about two third of the world average.

Some areas more in China are prone to severe rainstorm and flash flood disasters; while others are vulnerable to seasonal droughts. There are 14 typhoons affect China: nine in the southeast coastal areas, two or even three typhoon more storms, tidal flood intertwined affected. Other parts of China, especially the Southwest and Northwest, experience winter drought; while the southern and southwestern parts experience severe summer drought. State Flood Control and Drought Relief Headquarters under the Ministry of Water Resources is required to seriously implement scientific prevention and effective response for flood and drought control. As a result, the death toll from floods has been reduced by 5 percent since 2000. Irrigation to reduce agricultural drought has been expanded by 3.7 million mu (0.25 million ha), and drinking water access has been further improved for additional 20.07 million rural residents.

3.2. Total Water Resources

The national average of annual precipitation in 2013 was 661.9mm, equivalent to the total amount of precipitation 6.27 trillion m^3. The annual precipitation varied across regions, with the lowest average in Northern Area 6 (the Songhua River, Liaohe River, Haihe River, Yellow River, Huaihe River with 362.4mm and the highest one in South Zone 4 (Yangtze River that includes Zhejiang province and Taihu lake basin, southeast Rivers, Pearl River) with 1193.3mm, close to the perennial values. From the administrative boundary, the eastern 11 provincial-level administrative regions (the eastern region) had the highest average precipitation with 1178.4mm; and the west 12 provincial-level administrative regions (the Western Region) had merely 517.8mm.

Total national water resources in 2013 was 2.8 trillion m^3 of water. Non-renewable groundwater and surface water resources amounted to 111.84 billion m^3 (covering 13.8 percent of total water resources, while about 86.2% were renewable resources. Roughly 23.3 percent of these total water resources (650.8 billion m^3) was located in Northern 6th district; while the rest 76.7% (2.14 trillion m^3) was located in the South. By the administrative division, the eastern part accounts for 21.9 percent (613.03 billion m^3), 24.2 % (674.83 billion m^3) in the central region, and 53.9% (1.51 trillion m^3) in the western region. Water yield per unit area was approximately 295 thousand m^3/km^2.

Since surface water and groundwater can transform into each other under certain conditions, the total water resources is not the sum of river runoff and groundwater recharge. Considering the conversion between the two water resources, the total renewable water was 732 billion m^3.

3.2.1 Total Surface Water Resources

Surface water resources in the country in 2013 amounted to 2.68 trillion m^3, equivalent to annual runoff of 283.4 mm. The northern area 6 contributed approximately 20.7% (553.82 billion m^3) while the Southern District 4 constituted most of them at 79.3% (2.13013 trillion m^3). By administrative region, the eastern part contributed 21.5% of the resources (575.17 billion m^3); 23.3% in Central Region

(625.44 billion m^3), and the remaining 55.2% in western region (1.48 trillion m^3).

Water inflow from outside China's territory was trivial at 21.49 billion m^3, while the outflow amounted to 528.22 billion m^3, in which 229.91 billion m^3 flowed into the transboundary rivers. The rest 1.56 trillion m^3 of water flowed into the sea.

3.2.2 Total groundwater resources

Groundwater resources with a salinity level of less than or equal 2g/L amounted to 808.11 billion m^3, in which 178.21 billion m^3 of those were located in plain area; 661.07 billion m^3 in mountainous areas; and 31.17 billion m^3 were located in both mountainous and plain area (*double counting amount*). North District 6 covered roughly 19% of those groundwater supply (153.97 billion m^3).

3.2.3 Dynamic Water Storage

The 2013 statistics showed that China had 588 large reservoirs and 3271medium-sized reservoirs with a total outflow of 340.07 billion m^3 at the end of water reservoirs, which was 24 billion m^3 less compared to the beginning of impoundment. Total volume at the end of the large storage reservoirs was 300.54 billion m^3 or 23.29 billion m^3 less than the inflow; while for the medium-sized reservoir total storage capacity was 39.53 billion m^3 or 710 million m^3 less than the inflow. North Area 6 storage capacity was 9.97 billion m^3, out of which 5 billion m^3 and 2.38 billion m^3 flowed to the Yellow River and Huaihe River District area consecutively. The south end zone 4 reservoir had a storage capacity of 14.03 billion m^3, out of which 11.72 billion m^3 flowed to Yangtze River area. By the provincial administrative area, Guangdong, Hainan and Yunnan and other 10 provinces (autonomous regions and municipalities) had an increased reservoir storage capacity of 5.88 billion m^3; while Hubei, Zhejiang, Qinghai and Jilin and other 19 provinces (autonomous regions and municipalities) consumed 29.88 billion m^3 of water.

3.2.4 Shallow Groundwater Dynamic Northern Plains Region

The 17 provincial administrative regions of the Northern Plains possesed 1.68 billion m^3 of shallow groundwater storage over 690,000 km^2 area in 2013. The consumptions of these shallow groundwater resources amounted to 3.67 billion m^3 in the Huaihe River area, 530 million m^3 in the Yellow River area, 130 million m^3 in the Northwest and 90 million m^3 in the Haihe River area. The Songhua River and Liaohe area increased the storage capacity by 2.64 billion m^3 and 90 million m^3 consecutively. By provincial administrative region, the shallow groundwater storage capacity was increased in seven provinces, where the Heilongjiang and Jilin contributed to 1.84 billion m^3 and 960 million m^3; while storage capacity reduction took place in 10 provinces, such as by 2.51 billion m^3 in Henan and 940 million m^3 in Jiangsu.

3.2.5 Water Resources Development and Utilization

Total water supply development in 2013 was 618.34 billion m^3 or 22.1 % of total water resources of the year. Out of this, 81% was surface water, 18.2% was groundwater, and the rest from other sources. For the surface water supply, water storage accounted for 31.6% of the projects, 32.6 % was diversion works, 32.2% was clean water projects, and the remaining were water diversion. For the groundwater supply development, 84.8 % was shallow groundwater, 14.9% was deep confined water and the rest was saline water.

Water resource development took place mostly in the Southern District 4 with 336.14 billion m^3, (54.4%) and the rest in the Northern District with 282.2 billion m^3. Surface water supply in the southern

provinces accounted for more than 88%, while in the northern provinces groundwater supply quantity made up more than half of the total water supply water supply.

In addition, 69.27 billion m^3 of seawater was also used, mainly as cooling water for thermal (nuclear) power, out of which 27.04 billion m^3 in Guangdong, 20.4 billion m^3 in Zhejiang, 5.84 billion m^3 in Fujian and 5.59 billion m^3 in Shandong.

3.3. Total Water Use

In 2013 the country's total water use was 618.34 billion m^3, comprising of 12.1% domestic use, 22.8% industrial use, 63.4% agriculture use, and 1.7% of ecological use. Based on distribution of the 6 water districts, Northern District used 6282.2 billion m^3 of water (45.6%); while the South Zone 4 made up 336.14 billion m^3 of water use (54.4%). Contribution of regional districts for each sectoral water use is illustrated in the figure below.

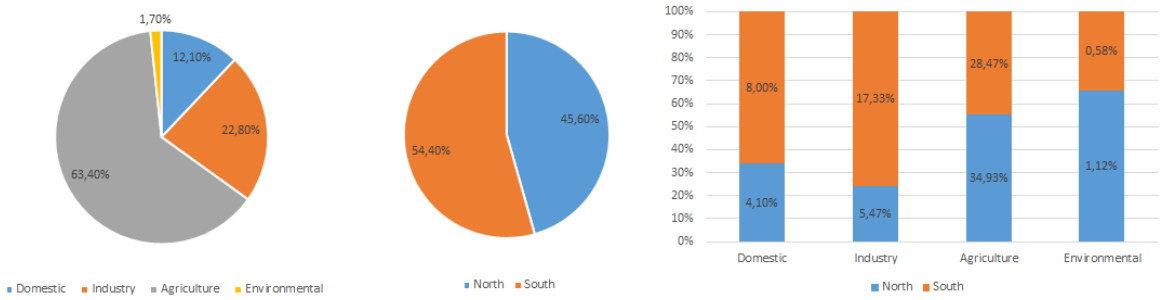


Figure 5 Water Use By Sector Across Regions in China in 2013

3.3.1 Total water consumption

Water consumption is the total amount of water consumed out of the total water abstracted or used. National water consumption in 2013 was 326.34 billion m^3 or 53% of total water use. Water consumption rate of various users vary greatly across sector: 65% in agriculture; 23% in industry; 43% for domestic; and 80% for environmental purposes. The national total wastewater discharge was 77.5 billion m^3, which included discharges from industrial water users, tertiary industry and urban life, but did not include the thermal power cooling water emissions and pit displacement.

3.3.2 Water use index

The national water productivity as defined by water use was 456 m^3 per capita per yuan GDP (current prices), which was equivalent with 109 m^3 of water consumption (23.9% efficiency). Actual irrigation water productivity was 418 m^3 per mu (27.87 m^3/ha) and average irrigation efficiency was 52,3%[i]. Water productivity for industrial use was 67 m^3 per yuan of industrial added value (current prices). For domestic water consumption (including public water), per capita water productivity was 212L/day for urban area and 80L/day for rural area.

Water productivity across sectors and regions is elaborated in Table 2. The Eastern region had the highest water use productivity in terms of low overall water use and consumption as well as agricultural and industrial water use; while the Western region had the lowest water productivity.

[i] 1 ha = 15 mu.

Table 2 Water Productivity at the National and Regional Level

Region	Water Productivity				
	Overall water use, m^3/capita/yuan GDP	Water consumption, m^3/capita/yuan GDP	Effective water use rate, %	Agriculture, m^3/mu (m^3/ha)	Industry, m^3/yuan added value
Eastern	393	63	16.03	379 (25.27)	44
Central	468	129	27.56	378 (25.20)	70
West	545	158	28.99	512 (34.13)	54
National	456	109	23.90	418 (27.87)	67

Source: National statistics, 2013.

3.4 Water quality

3.4.1 River water quality

The 2013 water quality evaluation of the country's 208,000 km river showed that all year long 4.8% of the river length was in class Ⅰ (good quality), 42.5% in class Ⅱ, 21.3% in class Ⅲ, 10.8% in class Ⅳ, 5.7% in class Ⅴ, and 14.9% in inferior class Ⅴ. Nationally, 68.6% of the river was in the Ⅰ - Ⅲ class (fairly good quality). In terms of river basin areas, the Southwest River area had excellent water quality. The Northwest River District, Pearl River, and Southeast Rivers area also had good water quality. However, water quality in the Yangtze River area, the Songhua River of the Yellow River area, Liaohe River area, and Huaihe River area are poor. The Haihe River area water quality was deteriorating.

3.4.2 Lake water quality

The country conducted water quality evaluation in 2013 for 119 major lakes that covered 29,000 km2 of water surface area. Throughout the year, 38 lakes (31.9%) were in Ⅰ-Ⅲ class, 50 lakes (42.0%) in Ⅳ-Ⅴ class, and 31 lakes (26.1%) in inferior Ⅴ class. The main indicators evaluated were total phosphorus, BOD and ammonia nitrogen. These lakes were also evaluated for eutrophication issues and there results showed that most lakes or 69.8% (83) were eutrophic, 29.4% (35) were of high nutrient content, and only 0.8% (1) were oligotrophic 1.

3.4.3 Reservoir water quality

A water quality assessment was conducted to 667 major reservoirs in 2013, comprising of 262 large reservoirs, 381 medium-sized reservoirs and 24 small reservoirs. 4.7% (31) of them met class Ⅰ water quality, 45.1% (301) were in class Ⅱ,31.6% (211) under class Ⅲ category, 9.9% (66) were in class Ⅳ, 3.7% (25) were in class Ⅴ, and the remaining 5.0% (33) were in inferior classs Ⅴ. Regarding the nutrient content, 375 out of 646 or 58.1% evaluated reservoirs had high nutrient content, 214 (33.1%) had slight eutrophication problems, 55 (8.5%) had moderate eutrophic problems, and 2 (0.3%) had severe eutrophication problems.

3.4.4 Water quality of the water function area

The National Assessment of Water Ribbon evaluated 2538 (49.4%) of 5134 water function areas and showed that 57.7% of the evaluated areas meet their functional objectives. The compliance rate of the 2999 evaluated major rivers and lakes to the water pollutant thresholds for functional areas,was 63.0%.

3.4.5 Water quality of provincial transboundary rivers

The 2013 monitoring and evaluation of 512 important provincial transboundary rivers showed that 62.3% of the rivers were in class Ⅰ~Ⅲ, 18.2% were in class Ⅴ, and class Ⅳ~, worse than Grade Ⅴ cross-section rates were, and 19.5%. Water level in each area, Southwest River District, trans-boundary water quality of the rivers in the southeast area is excellent, the Yangtze River region, trans-boundary water quality in the Pearl River area is good, trans-boundary water quality of the Songhua River area is the area of the Yellow River, Huaihe River District trans-boundary water quality is poor, Haihe River area, Liaohe region trans-boundary water quality deteriorated.

3.4.5 Groundwater quality

According to water quality monitoring data of 1229 well in Beijing, Liaoning, Jilin, Heilongjiang, Henan, Shanghai, Jiangsu, Anhui, Hainan, Guangdong, 10 provinces (autonomous regions and municipalities), 2.4% of the wells are suitable for a variety of purposes class Ⅰ-Ⅱ, 20.5% were suitable for drinking water sources, agricultural and industrial purposes in class Ⅲ, while the majority 77.1% could only be used for other purposes outside drinking in class Ⅳ-Ⅴ.

3.5 Most strict water management system

In 2013, the State Council issued the implementation of "the most stringent water management system assessment methods" and it achieved remarkable results. The government established 31 provinces (autonomous regions and municipalities) for the overall responsibility of the most stringent water management system, together with the State Ministry of Water Resources, 10 Sector Development and Reform Commission and other formation evaluation working group.

The Ministry of Water Resources Administration of Quality Supervision, Inspection and Quarantine advocate for water-saving products and quality improvement actions, together with the Ministry of Industry and Information Technology, Government Offices Administration of the State Ministry of Education. Water licenses management and supervision of sewage discharge into the river will strengthen groundwater management and protection. The system started 46 pilots of the national water ecological civilization city development that included emergency water regulation and proper disposal of Zhuozhang water effluents. Seven River Basin Integrated Planning (revision) by the State Council approved continued implementation of water planning system. The first national investigation on water was completed and the results were widely used.

3.6 The impact of climate change on China's water resources system

China's average surface air temperature increased at an average of 0.29℃ every 10 years, during 1961-2011 period. The average annual rainfall in 2011 was 556.8 mm, which was 62.7 mm less than normal years and the lowest since 1961. In early 2009, China's northern winter wheat region suffered a severe drought, in which Hebei Province received the least rainfall since 1951. The Southwest region experienced a rare drought in 2010 with the worst record drought in Yunnan, equivalent to a drought return period of more than 80 years to 100 years. Severe drought was also experienced in the Yangtze River region Sharp in June 2011.

Climate change has little effect on the amount of precipitation in China, but it had a great influence on the distribution of rainfall across time and space. In the past 50 years, the overall rainfall has been increasing in Xinjiang and the Yangtze River basin, and southern parts of China. However, the Southwest to the northeast region experience a reduced rainfall, as in some part of North China. This is caused by uneven distribution of precipitation as well as the combined less precipitation and increased evaporation in some upper stream of major rivers. These major rivers run from west to east, while the

population is concentrated in the eastern parts, resulting in high water use in all sectors (domestic, industrial, and agricultural) in those parts. However, decreased precipitation in upstream areas has caused reduced natural recharge of the rivers. Therefore, the competition for downstream water use will be significantly increased.

In addition, increase precipitation in some parts can replenish freshwater resources to some extent, but also cause increased risk of disaster from snowmelt flood, such as those that happened in Xinjiang. For Yangtze River basin, flood has caused major ecological and socio-economic damages.

Increase water scarcity from reduced precipitation also brings negative effects, such as salt water intrusion in coastal areas, deterioration of wetlands, and desertification (conversion of lakes into the grass field and from grass fields to desert).

Chapter 4 Physical Water Risk Outlook of the Zhejiang Textile Industry

4.1 Water resources situations at the Zhejiang Province

4.1.1 Total Water Resources of Zhejiang Province

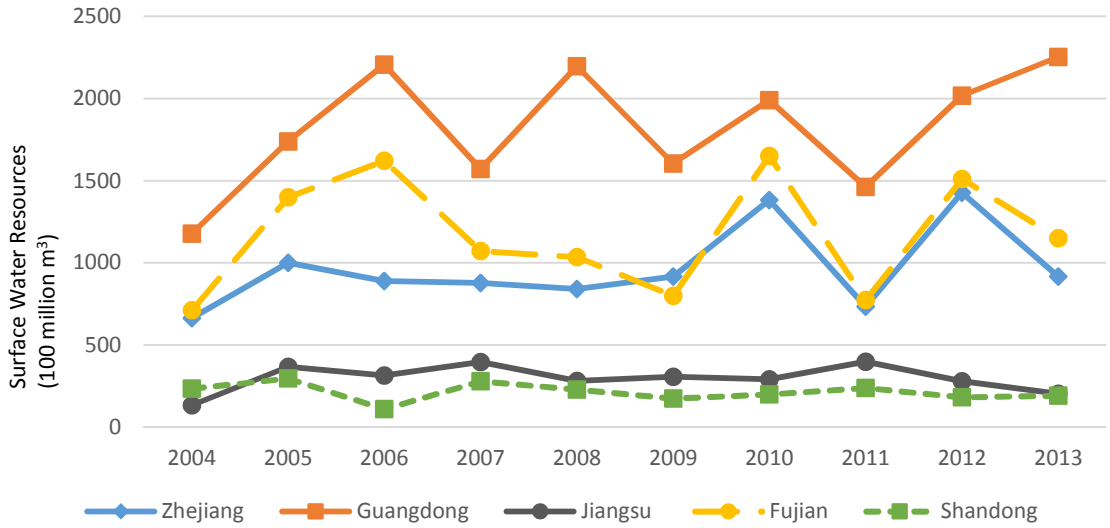
The total amount of water resources of Zhejiang remains at 95.541 billion m^3 all year round, while per capita availability is only 2,126 m^3, lower than that of the national average value of 2,340 m^3 and only a quarter of the world average. Compared with other main textile industry provinces, Zhejiang does not have rich surface water resources as shown in Table 3 and Figure 6. The total surface water resources in Zhejiang accounts for 3.7% of the national total or approximate 52.9% of Guangdong's. Meanwhile, the total output value of the textile industry of Zhejiang accounts for about 21% of the national output value and 23.53% of textile enterprises are located in Zhejiang. With its low surface water availability and high water demand of textile industry, in Zhejiang faces a greater pressure of textile water use than Guangdong and Fujian.

Nevertheless, a comprehensive management of water resources in Zhejiang through "a total of five water management", innovations within heavily-polluting and high energy-consumptive industries, and a general improvement of enterprise technical level in recent years, water use efficiency of Zhejiang textile enterprises has been improved continuously. In 2014, the actual total water consumption was 19.287 billion m^3, which was lower than the national target of 21.7 billion m^3. Water consumption per RMB 10,000 of industrial added value in Zhejiang was 33.07 m^3, which was 30.8% lower than that of 2010 and far less than the national target of 22% decrease.

Table 3 Total Surface Water Resources of Main Textile Industry Provinces in 100 million m^3

Year	National	Zhejiang		Guangdong		Jiangsu		Fujian		Shandong	
		Total	% of nat. level	Total	% of nat. level	Total	% of nat. level	Total	% of nat. level	Total	% of nat. level
2004	23126,4	662,2	2,9%	1177,8	5,1%	132,4	0,6%	711,0	3,1%	234,5	1,0%
2005	26982,4	999,4	3,7%	1738,5	6,4%	366,4	1,4%	1400,0	5,2%	295,9	1,1%
2006	24358,1	889,4	3,7%	2206,5	9,1%	314,7	1,3%	1622,3	6,7%	109,6	0,5%
2007	24242,5	876,7	3,6%	1571,8	6,5%	395,7	1,6%	1071,7	4,4%	280,2	1,2%
2008	26377,0	839,9	3,2%	2197,3	8,3%	280,9	1,1%	1035,7	3,9%	229,0	0,9%
2009	23125,2	917,4	4,0%	1604,1	6,9%	306,1	1,3%	799,6	3,5%	173,8	0,8%
2010	29797,6	1382,9	4,6%	1989,5	6,7%	291,2	1,0%	1651,5	5,5%	199,1	0,7%
2011	22213,6	733,3	3,3%	1461,3	6,6%	399,0	1,8%	773,5	3,5%	237,5	1,1%
2012	28371,4	1427,2	5,0%	2017,5	7,1%	279,1	1,0%	1510,1	5,3%	182,2	0,6%
2013	26839,5	917,3	3,4%	2253,8	8,4%	202,3	0,8%	1150,7	4,3%	191,1	0,7%

Note: The data is excerpted from *China Statistical Yearbook*.



Note: The data is excerpted from *China Statistical Yearbook*.

Figure 6 Surface Water Availability Across Main Textile Provinces

4.1.2 The regional distribution of water resources in Zhejiang Province

The regional distribution of available water resources across districts in Zhejiang is quite uneven from southwest to northeast, with an overall declining trend at the province that does not match the water consumption and population growth (Table 4 and Figure 7). The mountainous areas in southwestern part with a small population and a low economic output account for 80% of the total available water resources, while the coastal plain along the eastern Zhejiang with a large population and great demand for water only accounts for 20% of the total water resources.

Table 4 Total Surface Water Resources across Districts in Zhejiang in 2014

Region	Total surface water resources (100 million m³)	Proportion to the provincial level (%)	Ranking
Hangzhou	163.01	14.42	2
Ningbo	85.06	7.52	7
Wenzhou	159.01	14.06	3
Jiaxing	23.52	2.08	10
Huzhou	39.45	3.49	9
Shaoxing	72.40	6.40	8
Jinhua	115.13	10.18	5
Quzhou	120.27	10.64	4
Zhoushan	7.94	0.70	11
Taizhou	112.31	9.93	6
Lishui	232.59	20.57	1
The whole province	1130.69	100.00%	-

Notes: The data is excerpted from *2014 Zhejiang Water Resources Communique*.

Available water resources in cities with a high concentration of textile industries like Hangzhou, Shaoxing, Jiaxing and Huzhou only account for approximately 25%. Shaoxing, which is home to most dyeing and printing (DP) enterprises of the province, accounts for only 6.40% (eighth rank) of available

water resources at the province; while Jiaxing, which takes the second place in terms of the number of DP enterprises in Zhejiang, only accounts for 2.08% (tenth rank) in the province.

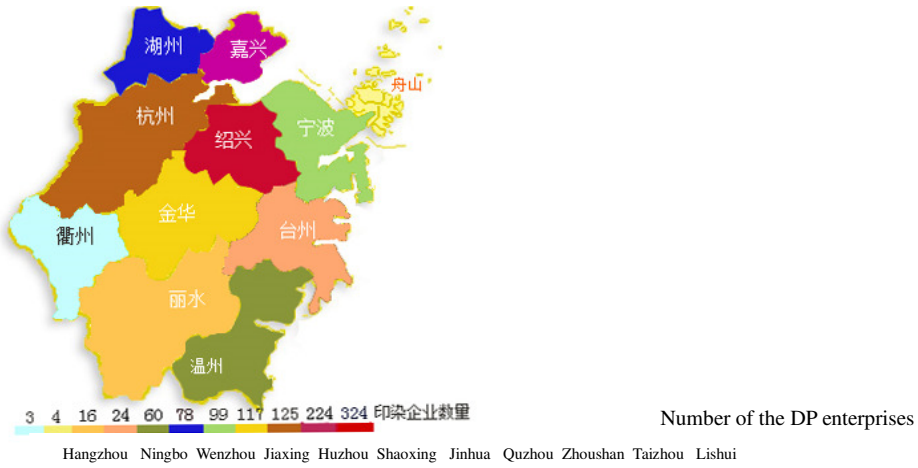


Figure 7 Distribution of textile and dyeing and printing enterprises in Zhejiang Province

4.1.3 Water quality in Zhejiang Province

According to water quality monitoring of river cross sections controlled by Zhejiang province (Table 5 and Figure 8), the proportion of Class Ⅰ, Ⅱ and Ⅲ is only 63.8%, which is lower than those in Shandong and Jiangsu as the other main textile industry provinces. Effluent of the DP enterprises is one of the main sources for water pollution of Zhejiang province. These enterprises are highly concentrated in Shaoxing, with an annual output value of DP sector there accounts for about 60% of provincial output value and about 36% of China's in the long term. Shaoxing's DP effluent contributed to 83% of COD and 76.5% of ammonia-nitrogenous pollution. Therefore, the DP industry has become one of the main industries for structural pollution reduction and comprehensive water treatment of Shaoxing and even Zhejiang province.

Table 5 River Water Quality of River in Main Textile Industry Provinces in 2014

Category	Class I,II,II	Class IV	Class V	Inferior class V
The state	72.8%	10.8%	4.7%	11.7%
Zhejiang	63.8%	17.7%	8.1%	10.4%
Guangdong	77.4%	12.1%	2.4%	8.1%
Jiangsu	45.8%	37.3%	15.7%	1.2%
Fujian	94.7%	2.2%	2.3%	0.7%
Shandong	50.0%	20.3%	19.5%	10.2%

Notes: The data is excerpted from *China Statistical Yearbook*.

The coastal area Hangzhou Bay wherein Zhejiang and Shaoxing DP enterprises are mainly located, especially around Cao'e River, Puyang River and water system of Jianhu Lake, feed into Qiantang River in the area. The river basin covers an area of 1,539 km^2 or about 3.05%, out of which the plain water area is 131.17 km^2 (8.5% o the basin) with water resource use of 91.4%. In 2014, there were 1,317

textile and DP enterprises above designated size in Shjaoxing, of which 87 enterprises were listed as 2015 Key Monitoring Units of Pollution Discharge. After strict treatment and monitored discharge, their effluent can be discharged to the downstream of Cao'e River and finally feed into Hangzhou Bay and then the sea.

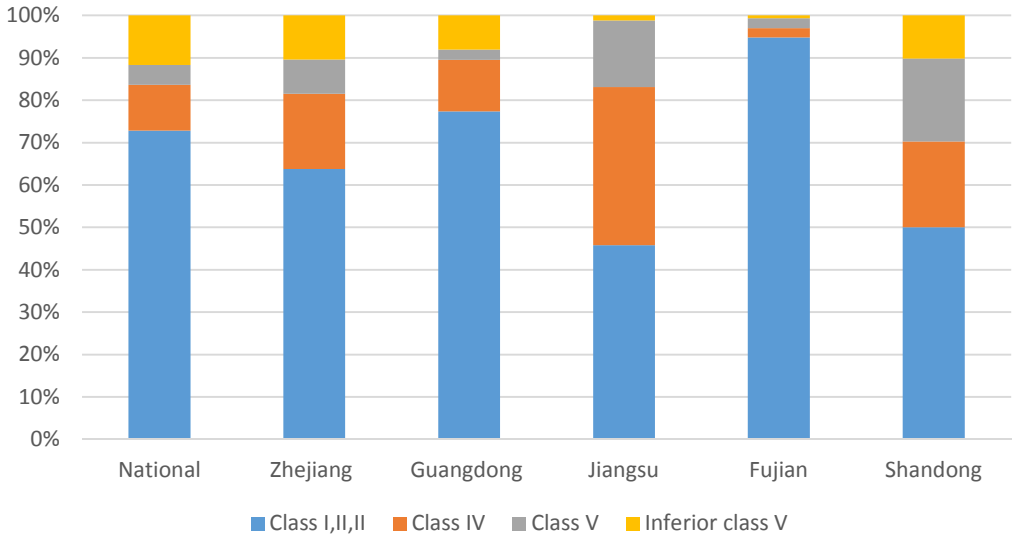


Figure 8 River Water Quality of Main Textile Industry Provinces of China in 2014

4.1.4 The Influence of Climate Change on Hydrology and Water Use

Zhejiang province is under the influence of subtropical humid monsoon climate zone and encounters typhoon almost every year. The annual rainfall is in the range of 1000 to 2600 mm. Combining strong wind with rainstorm and storm tide, Zhejiang is prone to flood disasters in summer. Precipitations are low in autumn and winter since 75.9% of annual precipitation is concentrated in April to September and only 1% in winter. The differences in precipitation across regions in Zhejiang are significant. In general, precipitations plunge from west to east and from south to north; while precipitations in mountain and coastal areas are higher than those of the plains and inland basins.

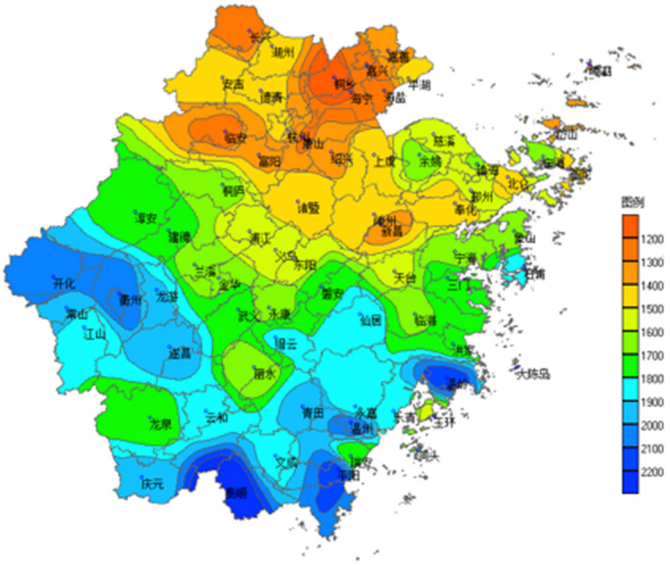


Figure 9 Precipitation Distribution of Zhejiang in 2014

This precipitation feature is largely responsible for the unbalanced distribution of water resources across time and space. The annual rainfall capacity of the key textile industry sites like Shaoxing, Hangzhou and Huzhou is relatively low, leading to low availability of water resources. During the textile production peak season in September to November, the immense water demand takes place at a time when the province experiences a serious seasonal drought. This mismatch between the low precipitation period and high textile water demand aggravates water stress issue of the region.

With climate change, extreme climate events will increase. In the past five decades in Zhejiang, the increase in summer precipitations have an ambiguous relationship to temperature increase; while the decline in autumn precipitations is significantly related to temperature rise. Drought frequency in autumn has also increased continuously for a long time. Climate change has aggravated water resource shortage in Zhejiang, which in turn will seriously affect water risk of its textile industry. Due to climate change, stricter requirements have been imposed for water resource planning and sustainable development of the textile industry in Zhejiang and even at the national level.

4.2 Zhejiang textile industry water use

4.2.1 Water consumption and efficiency of Zhejiang textile industry

In line with intensified national efforts for sustainable development, a gradual increase in energy conservation and emission reduction, as well as increased investments for environmental protection and cleaner technologies, water consumption efficiency of Zhejiang textile industry has increased annually (Table 6).

Table 6 Water Efficiency of Zhejiang Textile Industry in 2004-2013

Year	Economic output		Water efficiency of China's textile industry
	Textile industry (10,000 yuan)	Proportion to the national level (%)	
2004	3907.53	21.33	0.0239
2005	4858.96	23.99	0.0230
2006	5821.11	23.59	0.0289
2007	7037.42	23.11	0.0323
2008	7474.11	21.48	0.0375
2009	7508.71	20.16	0.0403
2010	9085.88	19.84	0.0484
2011	9809.76	18.86	0.0670
2012	10154.31	-	-
2013	10653.05	-	-

Note: WP = V/WF, where WP refers to water productivity, indicated by Yuan/ton; V refers to economic output, in terms of total industrial output value in 10,000 Yuan/Year; WF refers to annual water consumption, indicated by 10,000 ton/Year. Data source: *China Statistical Yearbook* and *Zhejiang Statistical Yearbook.* After 2012, the statistical caliber of *China Statistical Yearbook* has been changed.

In the past ten years, industrial water conservation in Zhejiang has made outstanding achievements. During the 11th Five-Year Plan, freshwater use per one hundred-meter dyeing cloth in the textile industry has decreased from 4.0 tons to 2.5 tons and the rate of water reuse has been improved from 7% to 15%, indicating evident improved water conservation efficiency. During the 12th Five-Year Plan,

with the upgrade and development of Zhejiang key industries, a large number of energy-saving and cleaner technologies of textile industry have been extensively applied, reducing fresh water use per one hundred-meter dyeing cloth in the textile industry from 2.5 tons to 1.8 tons and improving the rate of water reuse from 15% to over 35%. Water reuse rate for non-cotton items in particular has been higher than 50%, reaching the level of water use in countries with advanced textile industry.

4.2.2 The wastewater discharge and disposal by Zhejiang textile industry

Wastewater discharge of Zhejiang textile industry.

During 2008 to 2013, wastewater discharge of Zhejiang textile industry shows an increasing trend at the beginning before declining by 2013 (Table 7, Figure 10). Wastewater discharge of the industry in 2008 accounted for 36.84% of the national level and reached its peak in 2011 at 42.67% of the national level. This effluent discharge declined by 2013 to 40.22% of the national level. Despite the provincial contribution to the national total output value in 2013 was merely 16.91%, effluent discharge and COD pollution load contribution were 40.22% and 43.82% respectively. Meanwhile, the high proportion of printing and dyeing industry in the textile industry chain of Zhejiang contributes to the higher wastewater discharge.

Table 7 Wastewater Discharge of Zhejiang Textile Industry in 2008-2013

Year	Wastewater discharge of Zhejiang textile industry		COD pollution load of textile industry		Direct discharge to the sea (10,000 tons)	Standard Effluent (10,000 tons)
	Effluent discharge (10,000 tons)	Proportion to the national level (%)	COD load (ton)	Proportion to the national level (%)		
2008	64513.60	36.84	77812.34	37.68	5756.90	60494.90
2009	66789.21	36.86	75582.29	37.56	5270.81	63874.89
2010	69064.41	36.87	73352.23	37.43	4784.71	67254.87
2011	69523.87	42.67	66050.55	41.00		
2012	62915.55	40.67	68399.22	42.77		
2013	58386.95	40.22	63848.37	43.82		

Note: The data comes from Zhejiang Statistical Yearbook of Natural Resources and Environment as the official data is not publicly available. The value of 2009 adopts the average value of 2008 and 2010 (interpolation). As the statistical definition of the Zhejiang Statistical Yearbook of Natural Resources and Environment changed after 2011, the value of direct discharge to the sea and the effluent standard are absent.

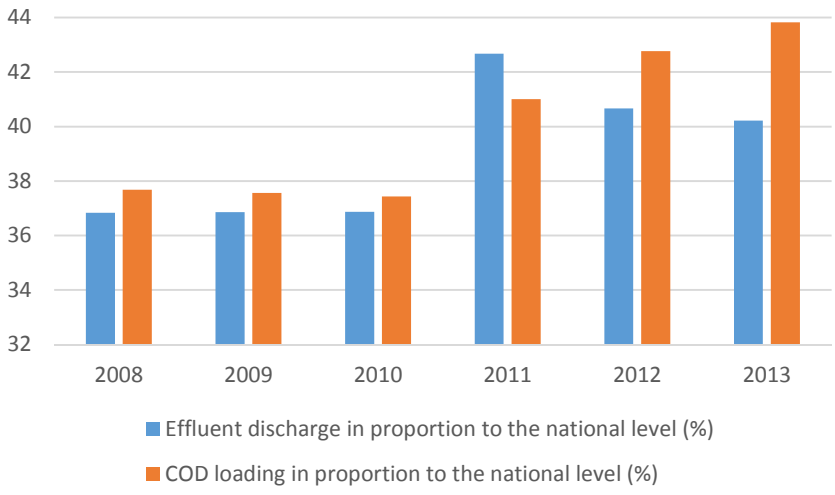


Figure 10 Wastewater Discharge of Zhejiang Textile Industry in 2008-2013

Wastewater Disposal of Zhejiang Textile Industry

Since the 12th five-year plan, Wastewater discharge of the textile industry in Zhejiang has gradually decreased through agglomeration and integration, elimination of laggards (inefficient firms) and technological reform. As a result, the absolute magnitude of COD loading of the industry decreased by 18% in 2008-2013. Nevertheless, the proportion of COD loading to the national level has increased at 6.14% from 37.56 % in 2008 to 43.82 % in 2013. This means that wastewater discharge in Zhejiang is lagging compared to the national average level. The good news is upgrade and development of the textile industry, comprehensive environmental management methods, as well as constant innovation and improvement of wastewater treatment technologies, have increased standard effluent discharge from 604.95 million tons in 2008 to 672.55 million tons in 2010.

4.3 Physical water risks faced by Zhejiang textile industry

4.3.1 Key water management issues within the industry

a) Water pollution of the textile industry.

In general, the textile water pollution management in Zhejiang has been improved relatively rapidly as indicated by lower discharge flow of water pollution compared to the national mean. While for the stock parameter, total water pollution load increases with production aggregate. For the relatively developed areas of the DP industry in Zhejiang, pollution load of the effluent in many districts of Shaoxing reached 492,000 m^3 each day, accounting for 87.9% of total discharge of the whole city. Failure of timely effective effluent treatment will lead to water quality problems of the rivers and lakes of the region.

b) The damage to the ecological environment by the textile industry.

Textile effluent largely damages self-cleaning capacities of the local environment. Discharge of hazardous material pose threats to long terms human health and environmental safety. Some toxic and hazardous materials pose problems to the endocrine system of human and wildlife, while some other substances are carcinogenic or have reproductive toxicity. In recent years, Hangzhou Bay has started to receive industrial wastewater discharge from Shaoxing and other areas, posing greater pressure on its offshore water environment.

c) Water use efficiency of the textile industry needs to be further improved.

In spite of the overall improvement of water use efficiency in Zhejiang, a large number of companies with a higher of unit water consumption and low water use efficiency needs to be further improved. The low water performance of these companies are due to the fact that they are part of many small and medium enterprises (SMEs) that feature various production processes and levels with low-grade products of lower added values.

4.3.2 Perceptions on Physical Water Risks Faced by the Industry

a) The main implication of water resources shortage is the restriction to the industrial development, especially for primary and secondary industry.

   As the textile industry presents essential and substantial demand for meeting the standards of water resources, both quantitative and qualitative shortage of water resources present essential and substantial demand for water from the industry and further affect the operation of the whole industry. According to the interviewed government authorities, the maximum number of water use

permits and water use per unit production in Zhejiang, especially for textile industry, is expected to be further tightened in the future. All factories of a significant scale will be increasingly monitored and need to improve their water use efficiency in order to avoid being closed down or face production constraints from water use limitations.

b) Water quality damage brings immense adverse impacts to textile product quality as well as machine and equipment.

   For example, DP plants are steam and water-consuming units, while water use of pre-treatment processes accounts for a higher proportion of the entire DP process. The statistics show that the production of 1km DP cotton fabric consumes nearly 20 ton of water, out of which the pre-treatment accounts for 50%. Water quality will not only affect pre-treatment and other-processes that determine product quality but also the amount of consumed dyestuff and auxiliaries. With low water quality, pollutants pose damage risks to pre-treatment equipment (such as inner wall of closed trough, valves and guide roller) and hinders normal operation.

c) In the short run, the decline in good quality water resources will lead to higher production costs, in terms of higher pre-treatment costs, higher industrial water price, higher water reuse cost, higher wastewater treatment, higher costal water price, and higher machine and equipment costs.

d) Long-term risk from water crisis.

   Lack of harmony between water issues and human development in the long run will render depletion of water resources and aggravated pollution problems that can tip the balance of ecological environment and threaten human wellbeing.

e) As China is only at the beginning of its industrial transformation, heavily water-consumptive and water-polluting productions have been and will continue to be the main target for such structural industrial transformations and upgrades for a long period ahead.

   Companies with no ambitions, resources or capacities to improve their water efficiencies and treatments will be increasingly threatened by growing pressures from the government and customers. According to the representatives from relevant industrial associations, one of the obstacles for the companies to fully engage in meeting such challenge is all the varying environmental standards and requirements in different provinces, which cause unequal conditions of competition at the national level. At the same time, provinces that have lower environmental requirements on water compared to Zhejiang are losing valuable time for upgrading their inefficient resource-consuming productions that will be a long term risk as the national and international requirements will only be stricter over time.

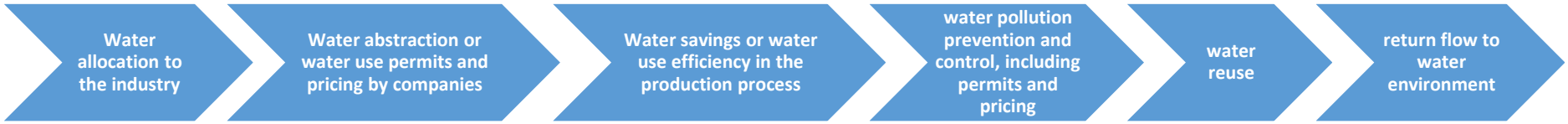
Chapter 5 Water Governance Landscape Pertaining to the Textile Industry in Zhejiang

High water consumption and pollution characteristics of textile sub-sector, such as DP and chemical fibers, require systematic coordination between textile development and water management toward sustainable textile industry. Under persistent water resource shortage and increasing pollution of water environment, government administration at all levels in Zhejiang puts water conservation and water treatment at a high priority. With various approaches, such as technical innovation, closed-loop of water use, sectoral restructurisation, reform of water institutions and supervision of law enforcement, the government has continuously explored options for water conservation and pollution control, and achieved positive results. The textile industry, however, is still beset with difficulties in meeting sustainable development challenges and faces numerous regulatory water risks.

5.1 Mapping of Textile Water Governance Value Chain

5.1.1 Key Actors and Responsibilities

Based on the responses from the interviews with relevant stakeholders, a value chain for the water governance pertaining to the textile industry in Zhejiang is presented in this section. In order to more clearly map out the structure, the textile industry is divided into six major water-related components including water allocation for industrial use, especially textile; water use permits and pricing for industrial use; industrial water saving and efficiency; water pollution prevention and control; water reuse; and return flow to the water environment. For each of the component, a number of critical stakeholders at provincial level are identified and their main responsibilities clarified. The objective of the mapping is to provide an overview of the main stakeholders involved and their responsibilities in each critical component of the water governance pertaining to the textile industry in Zhejiang.



Key actor	Water Resource Bureau Development and Reform Commission Commission of Economy and Information (CEI)	Administration of commodity prices Water Resource Bureau Development and Reform Commission Department of Justice/Department of finance	Commission of Economy and Information (CEI) Water Resource Bureau Taxation department Department of Finance Development and Reform Commission	Environmental Protection bureau Development and Reform Commission Department of Technology Commission of Economy and Information Public security department Supervision department Public affairs department Department of Justice Department of Finance Human resource department Water Resource Bureau State-owned Assets Supervision and Administration Commission Taxation department Industrial and commercial bureau Statistic Department Bureau for Press and Publications	Water Resource Bureau Commission of Economy and Information (CEI) Department of Technology	Department of housing and urban and rural development Environmental Protection Bureau

Figure 11 Water Governance Value Chain Pertaining to the Textile Industry in Zhejiang Province

Main institutions for water allocation for industrial use

- **Water Resource Bureau:** It is responsible for determining water function zones in the province and water allocation plan and monitoring the implementation of such plan. It is also the leading authority for the implementation of the "most strict water resource management" in the province, which contains goals and measures for total water use, water efficiency and total water discharge. The Bureau also organizes and supervises water resource assessment for industries that abstract water directly from natural water bodies for which water abstraction permit would be required. The scale of high water-consuming industries in the province should be limited by the bureau's strict enforcement of relevant regulations and standards.
- **Development and Reform Commission:** it is responsible for setting up goals and policies for strategic transformation of industrial structure and development of key industries, including textile industry, particularly regarding the design and implementation of development strategies for industrial zones. The commission also integrates the "most strict water resource management" into the provincial socioeconomic development plans, which significantly influences the overall strategic development of the textile industry. Together with the Water Resource Bureau, it participates and supports water allocation work at the basin level and the enforcement of regulations and standards to limit the scale of water-intensive industries.
- **Commission of Economy and Information:** Together with other relevant authorities, it is responsible for the enforcement of regulations and standards to limit the scale of water-intensive industries.

Main institutions for water use permits and pricing for industrial use

- **Administration of commodity prices:** The authority organizes and implement water pricing reforms for improved water saving incentives. It also determines the range of water resource fee, as part of water price, and makes adjustments of the fee when needed.
- **Water Resource Bureau**: it provides supports and recommendations for water pricing and approves water use permits.
- **Development and Reform Commission:** it promotes and supervises reforms of resource pricing mechanism. The commission also participates and promotes "water resource assessment" mechanism.
- **Commission of Economy and Information:** it establishes and upgrades the standards and requirements for maximum water use permit for businesses in key industries, including textile industry.
- **Department of Justice/Department of finance:** it drafts and updates the management guidelines for the collection and usage of water resource fees.

Main institutions for industrial water saving and water efficiency, including water reuse

- **Commission of Economy and Information (CEI):** The Commission of Economy and Information is responsible to organize the work of drafting and implementing development plan, policies and technical standards for each industry. CEI is also leading authority for making policies and develop plans for strategic transformation and optimisation of the industrial structure, and eliminating outdated production capacities. In addition, policy making, planning and supervision of implementing circular economy and clean production is also led by CEI. Specialized government funding is distributed by CEI for structural transformations within key

industries. As an important part of transforming the heavily energy consuming and polluting industries, CEI is responsible to promote and support the development of industrial parks and it is also overall responsible for industrial water saving/efficiency, such as providing recommendations for water saving technologies and other industrial water-saving policies and measures. Each key industry, including the textile industry, also has to adopt the resource efficiency standards released by CEI as requirement for entering the industry.

- **Water Resource Bureau:** Provincial water resource bureaus is responsible to lead the implementation of the "Three Red Lines" policies and goals covering total water use, water productivity and total pollution discharge load. It is overall responsible for water saving work, including drafting of policies, standards, action plans, and so forth as well as supervision and monitoring of the implementation and work towards a "water saving society". It contributes to the drafting of water productivity/efficiency requirement/standard for each industry and it examines and approves the submitted water use quota per unit production from CEI. [ii]

- **Taxation department:** It implements suitable tax policies for resource saving and reuse, and pollution reduction

- **Development and Reform Commission:** The commission drafts regulations, strategies and implementation plans for development of circular economy with better resource productivity and is also responsible for evaluation of the implementation. The commission also leads the local government and companies in organizing and participating in circular economy initiatives. It organizes data collection and analysis of resource productivity and circular economy development. The Commission's work of provincial socioeconomic development planning should also incorporated the "Most strict water resource management mechanism". The Commission also drafts technology catalogues for promoting circular economy and implements national circular economy special subsidies projects.

Main stakeholder for water pollution prevention and control

- **Environmental Protection Bureau:** The bureau is in charge of: 1) Action plans for pollution prevention and control; 2) Monitoring governments and authorities at lower levels in terms of pollution control; 3) The set up, supervision and improvement of the mechanisms for discharge permits, environmental impact assessment, pollution discharge fee, control of total pollutants load, pollution reduction, and accountability mechanism for environmental protection goals; 4) Environmental law enforcement; 5) Environmental risk management, quality monitoring and information disclosure; 6) Draft and implement action plan for environmental disaster response; 7) Participate in drafting economic policies, technology policies and industrial policies that are related to environmental protection; 8) Organize and supervise usage and trade of pollution discharge permits; 9) Establish Environmental Credibility Assessment mechanism; 10) Promote development of environmental technologies; 11) Supervision and monitoring of key companies' environmental information disclosure; and 12) together with the Bureau of Water Resource, approve of discharge outlets into rivers.

- **Development and Reform Commission:** The Commission is responsible for: 1) Coordination of resource saving and pollution reduction work; 2) Collaborate with Environmental authorities to draft and implement measures for total pollutant discharge; 3) Fund raising (from government budget) for resource saving and environmental protection projects; and 4)

[ii] ww.ywsfx.com/index.php?option=com_content&view=article&id=1036:2015-07-04-10-24-32&catid=34:shengjiguizhang&Itemid=517

Integrate "Most strict water resource management mechanism" into socioeconomic development planning.

- **Water Resources Bureau:** The responsibilities of the Bureau are: 1) Control and monitoring of water pollution load in water function zones; 2) Measure pollution recipient capacity of water bodies and recommend limitations for total pollution discharge; and 3) Together with local EPB, approval of discharge outlets into rivers.
- **Commission of Economy and Informatization:** Its responsibilities are: 1) Draft and implement plans for eliminating outdated production capacities; 2) Monitoring of industries to implement industrial structural transformations and pollution prevention and control measures; and 3) Organize industries to implement technical upgrades, promote clean production and circular economy by using new technologies, processes, products.

Main stakeholder for return flow to the water environment

- **Environmental Protection Bureau:** The bureau drafts discharge standards for municipal wastewater treatment plants and conducts the supervision and monitoring of their compliance and environmental information disclosure.

5.1.2 Key Water Related Policies pertaining to the textile industry of Zhejiang

A. Main national policies for water management in the textile industry

Since the beginning of this century, the government of China has introduced a suite of laws and regulations as well as management policies in relation to water conservation and emission reduction of the textile industry and has achieved good results, which have effectively boosted the energy conservation and emission reduction of the textile industry and the development of green growth in China. The following tables provide an overview of the most significant and relevant national policies and regulations that have been implemented for water conservation (Table 8) and water pollution control (Table 9) during the last decades.

B. Main provincial policies for water management in the textile industry in Zhejiang

On one hand, Zhejiang manages industrial water conservation and pollution of the textile industry based on national policies on water conservation and pollution control. On the other hand, a number of systematic and complete policies on water conservation and pollution control have been issued according to the provincial situation and the industrial features (Table 10 and Table 11), gradually forming a management system of laws and regulations and policies of its own, and taking the lead of textile water management in China. It should be especially pointed out that by targeting DP industry as the most serious pollution problem in the textile industry, Zhejiang has put a priority on facilitating industrial “renovation and promotion” by promulgating a series of policy documents connected with industry access, technical innovation and renovation and promotion.

Table 8 Main National Policies for Water Conservation in the Textile Industry

S/N	Document Name	Issued by	Time of Issuance/ Implementation
1	*Opinions on Enhancing Industrial Water Conservation*	The State Economic and Trade Commission and the Ministry of Water Resources of the P.R.C.	October 25, 2000
2	*Water Law of the People's Republic of China*	The NPC Standing Committee	October 1, 2002
3	*Notice on Promoting Water Conservation and Water Resource Protection by Water Price Reform by the General Office of the State Council*	The General Office of the State Council	April 19, 2004
4	*Control Regulations on Water Drawing Permit and Charge for Water Resources*	The State Council	April 15, 2006
5	*Circular Economy Promotion Law of the People's Republic of China*	The NPC Standing Committee	January 1, 2009
6	*Outline of China's Water Conservation Technology Policy*	NDRC, the Ministry of Science and Technology and the Ministry of Water Resources	March 3, 2010
7	*Opinions on Further Strengthening g Industrial Water Conservation by the Ministry of Industry and Information Technology*	The Ministry of Industry and Information Technology	May 4, 2010
8	*Decisions on Accelerating Water Conservancy Reform and Development by the Central Committee of the Communist Party of China and the State Council*	The Central Committee of the Communist Party of China and the State Council	December 31, 2010
9	The "12th Five-Year" Plan on Constructing a Water-conserving Society	The Ministry of Water Resources	January 20, 2012
10	*Opinions on Implementing the Strictest Water Resource Management System by the State Council*	The State Council	January 20, 2012
11	Notice on Printing and Distributing the Assessment Method of the Strictest Water Resource Management System by the General Office of the State Council	The General Office of the State Council	January 2, 2013
12	Notice on Printing and Distributing *Made in China 2025* by the State Council	The State Council	May 8, 2015

Table 9 Main National Policies for Water Pollution Control in the Textile Industry

S/N	Document Name	Issued by	Time of Issuance/ Implementation
1	*Water Pollution Prevention and Control Law of the People's Republic of China*	The NPC Standing Committee	June 1, 2008
2	*Enforcement Regulations on Water Pollution Prevention and Control Law of the People's Republic of China*	The NPC Standing Committee	March 20, 2009
3	*Notice on Further Eliminating Outdated Capacity*	The State Council	February 6, 2010
4	*Access Conditions of Printing and Dyeing Industry*	The Ministry of Industry and Information Technology	June 1, 2010
5	*The "12th Five-Year" Planfor Printing and Dyeing Industry*	China Dyeing and Printing Association	January 20, 2012
6	*Promotion Law on Cleaner Production of the People's Republic of China*	The NPC Standing Committee	July 1, 2012
7	*Water Pollution Discharge Standard of Textile Dyeing and Finishing Industry*	The Ministry of Environmental Protection and the General Administration of Quality Supervision, Inspection and Quarantine	January 1, 2013
8	*Interpretations on Laws Applicable to Environmental Pollution Criminal Cases*	The Supreme People's Court and the Supreme People's Procuratorate	June 8, 2013
9	*Notice on Enhancing Checking and Inspection of Total Quantity Emission reduction of Papermaking and Printing and Dyeing Industry*	The Ministry of Environmental Protection	November 27, 2013
10	Instructions on Advancing Paid Use and Trading Pilot Work of Discharge Right	The General Office of the State Council	August 6, 2014
11	*Environmental Protection Law of the People's Republic of China*	The NPC Standing Committee	January 1, 2015
12	*Plan on Water Pollution Prevention and Control* (Ten Regulations)	The Ministry of Environmental Protection	April 2, 2015
13	*Interim Procedures on Revenue Management of Discharge Right Transfer*	The Ministry of Finance, NDRC and the Ministry of Environmental Protection	October 1, 2015
14	*Management Method of National Ecological Industry Demonstration Park*	The Ministry of Environmental Protection	December 17, 2015

Table 10 Main Policies on Water Conservation of the Textile Industry in Zhejiang

S/N	Document Name	Issued by	Time of Issuance/ Implementation
1	*Notice on Enhancing Industrial Water Conservation by the General Office of Zhejiang Provincial Government*	The General Office of Zhejiang Provincial Government	July 12, 2005
2	*Enforcement Regulations on Water Drawing Permit System of Zhejiang*	Zhejiang Provincial Government	October 28, 2005
3	*Method of Water Conservation of Zhejiang*	Zhejiang Provincial Government	October 1, 2007
4	*Management Method of Water Resources Charge of Zhejiang*	Zhejiang Provincial Government	October 1, 2007
5	*Opinions on Furthering the Development of Industrial Cycle Economy*	The General Office of Zhejiang Provincial Government	May 30, 2009
6	*Control Regulations on Water Resources of Zhejiang*	The Standing Committee of Zhejiang Provincial People's Congress	November 27, 2009
7	*Interim Procedures on Assessment of Industrial Cycle Economy Demonstration Park (Enterprise) of Zhejiang*	Zhejiang Provincial Economic and Information Commission	August 13, 2010
8	*The "12th Five-Year" Plan on Water Conservancy Development of Zhejiang*	Zhejiang Provincial Government	October 20, 2011
9	*The "12th Five-Year" Plan on Cyclic Economy Development of Zhejiang*	Zhejiang Provincial Government	October 20, 2011
10	*"991" Action Plan of Cyclic Economy of Zhejiang (2011—2015)*	Zhejiang Provincial Government	December 27, 2011
12	*Interim Procedures on Cumulative Water Charge Raise of Overrun Water in Zhejiang*	Zhejiang Provincial Department of Finance and Zhejiang Provincial Bureau of Price	May 1, 2012
13	*The "12th Five-Year" Plan on Water Resources Utilization and Development Protection of Zhejiang*	Zhejiang Provincial Government	October 19, 2012
14	*Opinions on Advancing the Construction of Water-Conserving Society by Implementing the Strictest Water Resources Management System*	Zhejiang Provincial Government	December 31, 2012
15	*Decision Deployment of "A Total of Five Water Treatment"*	Zhejiang Provincial People's Congress	November 28, 2013
16	*Opinions on Accelerating Industrial Transformation and Upgrading by Implementing the Decision Deployment of "A Total of Five Water Treatment" of Zhejiang Provincial Party Committee and Government*	Zhejiang Provincial Economic and Information Commission	February 13, 2014
17	*Work Program on Emphasizing Water Conservation of Zhejiang*	The Department of Housing and Urban-Rural Construction Development of Zhejiang Province	April 24, 2014
18	*Catalogue on Promotional Orientation of Industrial Water Conservation Process, Technologies and Equipment in Zhejiang (First Batch)*	Zhejiang Provincial Economic and Information Commission	July 24, 2014

Table 11 Main Policies on Water Pollution Control of the Textile Industry in Zhejiang

S/N	Document Name	Issued by	Time of Issuance/ Implementation
1	*Interim Procedures on Cleaner Production Audit of Zhejiang*	Economic and Trade Commission of Zhejiang Province and Provincial Environmental Protection Bureau	October 31, 2003
2	《*Method of Creating Green Enterprises (Advanced Cleaner Production Enterprise) in Zhejiang (Tentative)*	Economic and Trade Commission of Zhejiang Province and Provincial Environmental Protection Bureau	2003
3	*Interim Procedures on Management of Cleaner Production Audit Organization of Zhejiang*	Economic and Trade Commission of Zhejiang Province and Provincial Environmental Protection Bureau	June 10, 2008
4	*Regulations on Water Pollution Control of Zhejiang*	The Standing Committee of Zhejiang Provincial People's Congress	January 1, 2009
5	*Instructions on Environmental Admittance of Printing and Dyeing Industry in Zhejiang*	Zhejiang Provincial Environmental Protection Bureau	February 25, 2009
6	*Interim Procedures on Paid Use and Trading Pilot Work of Discharge Right in Zhejiang*	The General Office of Zhejiang Provincial Government	October 9, 2010
7	*Implementation Opinions on Advancing Green Credit*	Department of Environmental Protection of Zhejiang Province	April 27, 2011
8	*Embodiment on Total Quantity Emission reduction of Main Pollutants in Zhejiang during the "12th Five-Year" Plan (2011 — 2015)*	Department of Environmental Protection of Zhejiang Province	November 23, 2011
9	*Regulations on Investment Management of Printing and Dyeing Projects*	Zhejiang Provincial Economic and Information Commission	December 27, 2011
10	*Instructions on Further Renovating and Promoting Heavy-Pollution and High Energy-Consuming Industries during the "12th Five-Year" Plan*	Zhejiang Provincial Government	December 29, 2011
11	*Regulations on Boosting Comprehensive Utilization of Resources in Zhejiang*	The Standing Committee of Zhejiang Provincial People's Congress	January 1, 2012
12	*Work Plan on Clean Water Source Action of Zhejiang in 2012*	Zhejiang Provincial Government	June 13, 2012
13	*Notice on Printing and Distributing Renovating and Lifting Scheme of Printing and Dyeing, Papermaking, Tanning and Chemical Industries in Zhejiang*	Department of Environmental Protection of Zhejiang Province and Zhejiang Provincial Economic and Information Commission	July 6, 2012
14	*Program on Technical Innovation Comprehensive Pilot of Intelligent Textile Printing and Dyeing Equipment Industry and Transformation Development Pilot of Provincial High-tech Zone*	Zhejiang Province Economic and Information Commission	December 10, 2012
15	*Plan on Total Quantity Emission Reduction of Main Pollutants in Zhejiang*	Zhejiang Provincial Government	Continuously published in 2013, 2014 and 2015
16	*Plan on Eliminating Outdated Capacity of Zhejiang (2013-2017)*	Coordination Group of Outdated Capacity Elimination of Zhejiang	April 16, 2013

Table 11 Main Policies on Water Pollution Control of the Textile Industry in Zhejiang (cont'd)

S/N	Document Name	Issued by	Time of Issuance/ Implementation
17	*Action Plan on Cleaner Production of Zhejiang (2013-2017)*	Zhejiang Provincial Economic and Information Commission, Department of Environmental Protection of Zhejiang Province and Science Technology Department of Zhejiang Province	June 9, 2013
18	*Notice on Advancing Renovation and Promotion of Printing by GoodDyeing Industry Planning*	Zhejiang Provincial Economic and Information Commission and Department of Environmental Protection of Zhejiang Province	August 5, 2013
19	*Decision Deployment of "A Total of Five Water Treatment"*	Zhejiang Provincial People's Congress	November 28, 2013
20	*Regulations on Water Pollution Control of Zhejiang*	The Standing Committee of Zhejiang Provincial People's Congress	December 19, 2013
21	*Notice on Demonstration Pilot Park of Cleaner Production*	Zhejiang Provincial Economic and Information Commission and Department of Environmental Protection of Zhejiang Province	March 19, 2014
22	*Notice on Printing and Distributing Embodiment of Sewage Control of Zhejiang (2014-2017)*	Department of Environmental Protection of Zhejiang Province	April 30, 2014
23	*Regulations on Comprehensive Water Control of Zhejiang*	Zhejiang Provincial Government	December 31, 2014
24	*Development Plan of Energy Conservation and Environmental Protection Industry in Zhejiang (2015-2020)*	Zhejiang Provincial Development and Reform Commission, Zhejiang Provincial Economic and Information Commission and Department of Environmental Protection of Zhejiang Province	December 8, 2015

In recent years, Zhejiang has facilitated water conservation and water management by means of technical innovation, restructuring, the development of circular economy, boosting water management reform and reinforcing the supervision of law enforcement and other measures.

a) Technical innovation and restructuring

Zhejiang encourages industrial water conservation and pollution control via technical innovation, i.e. advanced process and equipment as well as cleaner production, and emphasizes water consumption reduction and improvement of water resource efficiency. For instance, in July 2005, the General Office of Zhejiang Provincial People's Government released the *Notice on Enhancing Industrial Water Conservation*, which involves accelerating the readjustment of industrial structure and distribution, elimination of high water consumption process, equipment and products by law; strengthening the management of industrial water conservation source; stricter market access of water appliance; overall practice of cleaner production; and promotion of water conservation technical progress. The *Notice* highlights "technical innovation" in water conservation and mentions "readjustment of industrial structure and distribution". In July 2014, Zhejiang Provincial Economic and Information Commission published the *Catalogue on Promotional Orientation of Industrial Water Conservation Process, Technologies and Equipment in Zhejiang (First Batch)*, including 13 new water conservation technologies for textile industry and 8 advanced equipment in industrial water conservation.

b) Develop circular economy

Zhejiang implements the development of circular economy, which saves water and reduces discharge by constructing and driving circular economy in factories, parks and industries. In February 2005, the General Office of Zhejiang Provincial Government issued *Opinions on Accelerating the Development of Industrial Circular Economy*, which clearly points out the need to "accelerate circular economy, promote the circular use of resources and realize the coordinated development of industrial economy and the environment". In May 2009, the Zhejiang Provincial Government issued *Opinions on Furthering the Development of Industrial Cyclic Economy*, proposing to "boost regional industrial ecology". In August 2010, Zhejiang Provincial Economic and Information Commission promulgated the *Interim Procedures on Assessment of Industrial Circular Economy Demonstration Park and Enterprises of Zhejiang*, which requires the assessment and setting of 30 demonstration parks and 300 demonstration enterprises by stages and in groups. The goals of these initiatives are to boost the development of industrial circular economy, to display the leading and supporting role of circular economy to industrial transformation and upgrade, to achieve a high relevance of industrial chain, to improve public services (e.g. in centralized heating, reuse of reclaimed water and sewage treatment), and to further cycle and utilize the resources. In October and December 2011, Zhejiang Provincial Government introduced the *"12th Five-Year Plan on Circular Economy Development of Zhejiang"* and "*991 Action Plan of Circular Economy of Zhejiang (2011—2015)"* in succession to promote the development of circular economy in textile DP industry.

c) Advance water management reform

Zhejiang advances water conservation and emission reduction in practice through market-oriented approaches. The most prominent work is water management reform that includes the promotion of water price reform, water right trading, total water quantity control, water pollution right trading and the control of total water pollution right trading. In October 2005, Zhejiang released *Enforcement Regulations on Water Abstraction Permit in Zhejiang,* emphasizing the water abstraction permit. Combined with the first water right trading pilot in China, Zhejiang has taken the lead in water resource management. *The Method of Water Conservation in Zhejiang* was enforced in October 2007 to put forward the measures of promoting water conservation, including: classified pricing, ladder water price to establish a price mechanism stimulating water conservation; water resource fee or water charge paid as metered by water users; total water quantity control; and water price reform. In the same year, Zhejiang carried out the *Management Method of Water Resources Charge in Zhejiang*, specifying that "part of water consumption by the user that exceeds the approved water abstraction amount shall be charged as per excess cumulative price markup".

d) Enhance supervision of law enforcement.

In water conservation and emission reduction management, Zhejiang reinforces supervision of law enforcement through administrative and legal institutional approaches, actively encourages supervision and emission reduction, eliminates outdated capacity, put a constrain on industrial clusters, and implements reward and punishment mechanism. In November 2009, Zhejiang Provincial People's Congress passed the amended *Control Regulations on Water Resources of Zhejiang*, which emphasizes to "set out and publish the list of outdated processes, equipment and products, with high water consumption, and to eliminate them within the deadline according to state regulations". The producers, sellers or users in production and management should stop producing, selling or using the processes, equipment and products

in the elimination list within the time limit." In February 2014, Zhejiang Provincial Economic and Information Commission issued the *Opinions on Accelerating Industrial Transformation and Upgrade by Implementing the Decision Deployment of "A Total of Five Water Treatment" of Zhejiang Provincial Party Committee and Government*. The regulation supervises and guides pilot units to formulate the standard of shutting down and eliminating low-end and outdated massive industries, integrating them into parks, and the specification improvement so that outdated DP capacity of 3 billion meters will be eliminated by 2017. The rate of reuse water of DP enterprises shall reach over 40% by 2017 through technical transformation and process improvement.

Based on recent policy development and the responses from interviewees, the prevention and control of water pollution in the textile industry seems to be more important than water conservation for the textile industry in Zhejiang. Zhejiang has already advanced textile water pollution control through technical innovation, resource recycling, structural adjustment, water management reform and enhanced supervision of law enforcement.

a) Technical innovation.

In October 2003, Economic and Trade Commission of Zhejiang Province (currently known as Zhejiang Provincial Economic and Information Commission) and the Provincial Environmental Protection Bureau (currently the Department of Environmental Protection of Zhejiang Province) jointly issued the *Interim Procedures on Cleaner Production Audit of Zhejiang*. In January 2006, Zhejiang Provincial Economic and Information Commission promulgated the *Method of Creating Green Enterprises (Advanced Cleaner Production Enterprise) in Zhejiang (Tentative)*, highlighting the comprehensive implementation of cleaner production by the enterprises through technological improvement and the shift from prevention and control of industrial pollution to prevention first. In order to specify cleaner production audit and enhance the management of cleaner production audit organizations, in June 2008 Zhejiang Provincial Economic and Information Commission and the Department of Environmental Protection of Zhejiang Province issued the *Interim Procedures on Management of Cleaner Production Audit Organization of Zhejiang*. In June 2012, Zhejiang Provincial Government released the *Work Plan on Clean Water Source Action of Zhejiang*. In June 2013, six departments, including Zhejiang Provincial Economic and Information Commission and the Department of Environmental Protection of Zhejiang Province, jointly introduced the *Action Plan on Cleaner Production of Zhejiang (2013-2017)*.

b) Resources recycling.

In January 2012, Zhejiang started to execute the *Regulations on Boosting Comprehensive Utilization of Resources in Zhejiang*, pointing out to "plan regional economic distribution; define key industries, trades and enterprises of comprehensive utilization of natural resources; improve the industrial scale and further adjust industrial structure boost enterprise cooperation in comprehensive utilization of resources; and realize the efficient utilization and recycle of resources".

c) Structural adjustment.

In November 2011, the Department of Environmental Protection of Zhejiang Province printed and distributed the *Embodiment on Total Quantity Emission reduction of Main Pollutants in Zhejiang during the "12th Five-Year" Plan (2011—2015)*, making a positive demand on increasing industrial restructuring of enterprises, in which, textile, DP and chemical fiber

enterprises account for a large proportion. Additionally, Zhejiang Provincial Government in 2013, 2014 and 2015 have unveiled the *Plan on Total Quantity Emission reduction of Main Pollutants in Zhejiang* for consecutively three years, all stressing the structure emission reduction, the forced function of energy conservation and emission reduction, acceleration of eliminating high energy consumption and pollution capacities and technologies. Meanwhile, specific emission reduction indices have been created for the DP industry, assessment and supervision will be conducted for all cities with districts once half a year, and regions and enterprises poorly implemented will be notified.

d) Water management reform.

In January 2006, Zhejiang published the *Method of Creating Green Enterprises (Advanced Cleaner Production Enterprise) in Zhejiang (Tentative)*, which proposes to "gradually practice discharge trading system, and environmental protection loan and interest subsidy, which may be preferentially routed as per the right to manage environmental protection fund". This is the rudiment of water pollution right trading and green finance. In September 2008, the Standing Committee of Zhejiang Provincial People's Congress passed the *Regulations on Water Pollution Control of Zhejiang*, raising a total requirement on setting standard sewage draining exit pursuant to national and provincial regulations, implementing total quantity control system and apply system of pollution discharge permit for key water pollutants. The regulation gradually advances the paid use and transfer of total water pollutant discharge permit indices, undertakes the collection of pollutant charge and double pollutant charge for the discharge capacity exceeding the approved amount. In October 2010, the General Office of Zhejiang Provincial Government issued the *Interim Procedures on Paid Use and Trading Pilot Project of Discharge Right in Zhejiang*, prescribing the "approval, distribution and paid use principle of initial discharge permit indices", and pointing out that "if areas conduct paid use and trading pilot project of discharge permit and the newly-built, reconstructed and extended projects and discharging units need to add the discharge permit indices, these permits should be obtained via the platform of discharge trading organizations" according to the market regulation of the discharge trading price.

e) Supervision of emission reduction.

In February 2009, the Department of Environmental Protection of Zhejiang Province published the *Instructions on Environment Admittance of Printing and Dyeing Industry in Zhejiang*, stipulating that DP units should be built in industrial blocks with appropriate infrastructure, such as centralized heating and centralized sewage treatment plant. In August 2013, Zhejiang Provincial Economic and Information Commission and the Department of Environmental Protection of Zhejiang Province jointly issued the *Notice on Advancing Renovation and Promotion of Printing by Good Dyeing Industry Planning*, pointing out the principle of "shutting down and eliminating a batch, integrating one batch into park, and standardizing and improving one batch" to renovate and promote the DP industry. In April 2013, Coordination Group of Outdated Capacity Elimination of Zhejiang released the *Plan on Eliminating Outdated Capacity of Zhejiang (2013-2017)*, requesting the DP industry to: 1) mainly eliminate outdated capacities with long term, backward process and high pollution, making way to the development and integration into parks; and 2) intensively develop the large scale water-efficient and water-less DP units with advanced technology; so as to achieve green and sustainable development of the DP industry.

5.1.3. New trends of water conservation and pollution prevention and control policies in textile industry in Zhejiang

In December 2013, the 4th session of the 13th plenary meeting of Zhejiang Provincial Party Committee proposed the significant decision on "a total of five water treatment" to transform and upgrade water management by controlling sewage, preventing flood, draining flooded fields, guaranteeing water supply and emphasizing water conservation. Since the strategy implementation over the past two years, the water conservation and emission reduction of textile industry in Zhejiang has witnessed great progress. To support the implementation, the departments and bureaus of Zhejiang Provincial Government have published a series of rules and regulations. The Department of Environmental Protection of Zhejiang Province has issued the *Notice on Printing and Distributing Embodiment of Sewage Control of Zhejiang (2014-2017)*. The Department of Water Resources of Zhejiang Province has introduced the *Implementation on Water Guarantee and Supply of "A Total of Five Water Treatment" in Zhejiang*. The Department of Housing and Urban-Rural Development of Zhejiang Province has published the *Implementation on "Emphasizing Water Conservation" in Zhejiang*. On December 31, 2014, Zhejiang Provincial Government promulgated the *Regulations on Comprehensive Water Control of Zhejiang* (from February 1, 2015), which marks the arrival of "comprehensive treatment" era. Furthermore, the government speeds up the formulation of "one standard for one water", improves the standard of sewage control, boosts compatibility between sewage discharge standard system and environmental capacity standard system, optimizes mandatory local standard structure, drives transformation of energy conservation technology with advanced standard, accelerates elimination of production process and high energy consumption with stricter emission standard than national standard, chiefly improves the pollution control of water, gas and solid waste.

In general, Zhejiang has taken the lead in water conservation and pollution control of textile industry nationwide. The industrial water management has realized five transformations: (1) transforming administrative approach to market approach; (2) transforming "end-of-pipe elimination" to "prevention or strict access" and to constrained sustainable development; (3) transforming "control first, supported by prevention" to "integrated prevention and control"; (4) transforming "pure elimination" to "promoting transformation"; (5) transforming "single consideration of water conservation and water pollution control" to "comprehensive water treatment".

5.2. Regulatory water risks faced by Zhejiang textile industry

In recent years, the administrative departments at all levels of Zhejiang have made excellent progress in industrial water conservation and pollution control, making Zhejiang in the front rank of national textile industrial water conservation and pollution control. Although Zhejiang's textile industry water is faced with relatively less regulatory water risks; challenges and opportunities will coexist for a long period due to the outdated production capacity and improved standard in pollutant emission reduction, as well as multiple pressures from capital shortage, insufficient technical support, increased composite cost and reconstruction of global value chain. The main regulatory water risks identified in this study were also raised during the interviews with various stakeholders. These risks are elaborated at the factory level and at the sectoral level.

5.2.1 Regulatory water risks at the enterprise level

a) Frequently changed standard adjustments that still lacks coordination across relevant government agencies.

Many textile enterprises have performed well in compliance with the new standards in pollution

control and made investments to boost the transformation and upgrade of the industry. Nevertheless, they are exposed to the risk of any discrepancies between the national and provincial standards and frequent regulatory changes.

For example, on October 19, 2012, the Ministry of Environmental Protection and the General Administration of Quality Supervision, Inspection and Quarantine, unveiled the new *Water Pollution Discharge Standard of Textile Dyeing and Finishing Industry* (GB 4287-2012), replacing the previous standard GB 4287-92 on indirect COD discharge index, which is no more than 500mg/L for DP cluster enterprises. Instead, the new standard states that the direct COD discharge shall be decreased to 100mg/L or less and the indirect discharge shall be no more than 200mg/L. The new standard, however, has not considered the difference in technical features and cost effectiveness in pollution control methods between the industrial park and individual enterprises. It was frequently mentioned by a number of interviewees at the provincial level that the new standard was very challenging to be applied in Shaoxing industrial parks in Zhejiang province, which has a cluster of DP enterprises. Many of these enterprises are confronted with shutdown and even bankruptcy. Soon afterwards, Zhejiang Printing and Dyeing Association together with other provincial departments filed an application on standard modification to the Ministry of Environmental Protection. In June 2015, the Ministry of Environmental Protection, based on the ground truth of textile parks and the need of adjusting indirect discharge control of water pollutants, postponed the implementation of partial indices and returned the COD concentration discharge from wastewater pipelines in park enterprises to 500mg/L again.

b) Limited access to appropriate and cost-effective production technologies.

Water use efficiency and recycling rate as well as wastewater treatment level in Zhejiang is generally higher than the national average, but they still lag behind the global advance level. Enterprises are interested in improving their production process technology through innovation, R&D in resource utilization and environmental economics, and boosting the industry's sustainability with higher efficiency of resource use and lower pollution. Nevertheless, promotion of uniform technology domestically limits the range of diverse textile technologies and products. Furthermore, some advanced technologies need to be imported and they are not adjusted to the contexts in Zhejiang or even China, creating barriers to technology transformation. Some interviewees also mentioned that sustaining an efficient operation and maintenance of these imported equipment and technologies at the factories would be as challenging as having the outdated equipment and technologies.

c) Uneven environmental regulatory requirements across provinces in China creating additional economic costs in the short run.

This risk was frequently mentioned, in particular by respondents, which represented local textile associations or individual businesses. To be compliant, enterprises need to invest substantially in technical R&D, equipment innovation, production process adjustment and sewage treatment. In recent years, textile enterprises in Zhejiang have experienced declining revenues due to sharply increased operation costs, which render efforts for environmental protection more challenging to undertake. At the same time, the government constantly improves the requirements and standards of water control, and frequently conducts production restriction and shutdown to the enterprises in a short period. These government's actions will induce economic risks, such as industrial move, capital withdrawal, bankruptcy and early investment sinking, which limit textile development. More seriously, the risks will affect the economic and social development of the whole province and country, restricting technical progress and partially causing unemployment. The standard of

textile wastewater discharge of Zhejiang was once higher than the national average, which on the one hand can accelerate enterprise transformation, but on the other hand, it will result in cost difference in environmental protection across provinces. A number of respondents claimed that strengthening provincial standards might, in the long term, improve the competitiveness of the textile industry in the province. In the short term, the businesses in Zhejiang might suffer from unfair competition with other regions with less costly environmental pressure.

d) Low demand for green products and limited green supply chain provide lower motivation toward more sustainable practices.

At present, most garment consumers have low consciousness in green consumption. As the demand for green supply is low, the environmental incentive for textile manufacturers is limited. An appropriate green supply chain management and a green purchasing system are urgently needed to motivate environmental behaviors of the manufacturers. With enhanced environmental consciousness of consumers and buyers, the textile DP enterprises will be forced to cast about green production and cleaner production, reduce blue water footprints and grey water footprints of products.

5.2.2 Regulatory water risks at the sectoral level

a) Unclear, overlapping and often contradictory responsibilities among government agencies.

The lack of clarity of the responsibilities and overlapping functions of relevant departments will lower supervision efficiency and further influence the overall effect of textile water management. For instance: (i) the environmental protection department and the water conservancy department often mutually make excuses on water environment and water quality monitoring, control objective of total pollution discharge quantity and restricted total discharge within the water area; (ii) the water conservancy department and industry information department have unclear responsibilities and lack of coordination in total water conservation quantity and water distribution; and (iii) the water conservancy and housing and construction department have overlapping functions of industrial water supply, water conservation, drainage and sewage treatment and recycling. It is critical to have a good coordination of organizational interrelations and rationalize the distribution of authority and responsibilities to each department.

Another important issue is that vertical management has not yet been carried out in environmental protection department. Therefore, it is hard to supervise local government and relevant departments; solve the intervention on environmental monitoring, supervision and law enforcement due to local protectionism; adapt to the new requirements on resolving cross-regional and cross-basin environmental problems; and standardize and reinforce the capacities of local environmental protection organizations.

b) Undervaluation of water despite water price reform.

Water price as a crucial economic means has the function of regulating water resource supply and demand. If water price reflects the development and utilization costs of water resources as well as the social and economic development, then water price can well display its economic role, restrict water resource waste and further boost water conservation. Even though each area of Zhejiang has conducted water price reform with some degree of success, underpricing still hinders the improvement of industrial water conservation and efficient water use, causing inefficient allocation of water resources. For example, the difference in value between industrial water price and reclaimed water reuse. If industrial water price is higher than that of the reclaimed water, then the

enterprises will actively take part in water conservation and wastewater treatment.

c) Zhejiang province has a net output in virtual water trade and yet water-quality induced water shortages are on the rise.

China is a great power in textile and garment products export and Zhejiang contributes significantly to this position. Virtual water export of Zhejiang focuses on light industries, such as textile industry, garments, shoes and hats, leather and down and their product industries, as well as partial heavy industries, such as machinery manufacturing and equipment manufacturing. Zhejiang has always been one of the provinces in China with abundant water yield and it is at the state of net output in virtual water trade. Due to this Zhejiang contributes to solving water resource shortage of water scarce areas to some extent and help addressing China's uneven distribution of water resources. In essence, Zhejiang has a substantial discrepancy between water resources supply and demand, while quality-induced water shortage is on the rise. To boost water conservation beyond the periods of water shortage, Zhejiang should also consider industrial water conservation and virtual water trade of its industries.

d) The industrial transfer of China's textile industry from the eastern coast to the central and western regions.

Industrial transfer is a major trend and performance of optimization and upgrading of industrial structure. The industrial transfer of China's textile industry is currently characterized by a shift of industrial distribution, from the eastern coast to the central and western regions. Nonetheless, the capacities transferred from developed area in most cases are still technically backward, highly water-consumptive and polluting, which cause certain harm to water resources and ecological environment of the industrial areas. Meanwhile, the large number of industrial transfer will also cause numerous post drains from eastern coast to the central and western regions, resulting in unemployment issues in the eastern coast.

e) Low capacities for environmental monitoring, especially toward the SMEs.

The textile industry generates substantial amount of wastewater pollutants. Currently, Zhejiang has merely monitored PH value, COD concentration and ammonia nitrogen indices. The monitoring and supervision level of water pollutants need to be improved. Besides, the vast majority of textile enterprises are small and medium enterprises (SMEs), which are characterized with a large number of enterprises and complex processes. Relevant departments have difficulties in supervising these SMEs. For instance, one industrial park in Zhejiang has nearly 200 textile DP enterprises while there are only 11 employees in the environmental protection and safety monitoring departments of management committee, including one leader, five workers responsible for safe production of enterprises, and the remaining five workers are in charge of monitoring and managing environmental indices. The short-staffed condition has exerted heavy pressure on environmental monitoring. Moreover, public awareness on participation in environmental monitoring needs to be enhanced. The multi-actors monitoring mechanism has not taken place yet.

5.3 Scoping Assessment on Good Water Governance for Industrial Water Use

The scoping assessment looked at three principles of good water governance:

1. *Transparency*, which is the level of openness of governance processes and access to information.
2. *Accountability*, defined as sets of control, counterweights and modes of supervision that make officials and institutions in the public and private sector answerable for their actions.
3. *Participation* refers to the possibility for citizens to provide informed, timely and meaningful input

and to influence decisions at various levels.

To have a baseline on stakeholder's perspectives regarding good water governance pertaining to textile water use, a scoping assessment was conducted focusing on five areas of industrial water use:

1. Water allocation.
2. Water use permits and pricing.
3. Wastewater discharge permits and pricing.
4. Monitoring and enforcement.
5. Data and information disclosure.

The performance of the five focus areas of industrial water use were reviewed by stakeholders in terms of the three principles of good water governance (TAP) on a scale of 1-5 in which the scale of 1 represents very low performance and 5 represents very high performance. The stakeholders were also asked to provide further comments pertaining to their rating.

In practice, this scoping assessment through performance rating was found to be quite challenging for some stakeholders. For example, some stakeholders felt that they could not assess water governance areas beyond their own particular roles and responsibilities. Some stakeholders also pointed out the difference in performance between those from public and private actors. With regard to data and information disclosure, for instance, some stakeholders viewed that there was higher level of transparency by the government agencies than the businesses.

The results of the scoping assessment are presented in the following figure. Eventhough the figure presents the average score, the ratings from various stakeholders were in fact very convergent across all five focus areas. Overall, the stakeholders gave very high ratings for TAP in wastewater discharge permits and pricing (4.53; 4.14; 4.34 out of 5, for TAP respectively). This is highly reasonable considering that water pollution prevention and control receives the highest priority by the Chinese government. Stakeholders also mentioned that there was a mechanism in place to ensure that public could submit inputs and complaints on water issues. Nevertheless, it is yet clear how this information from the public affects the decision making. In terms of participation, public can also join random inspections from the authorities to the factories. Nevertheless, the level of public participation varies depending on the size of municipality as well as the level of awareness and understanding on environmental issues.

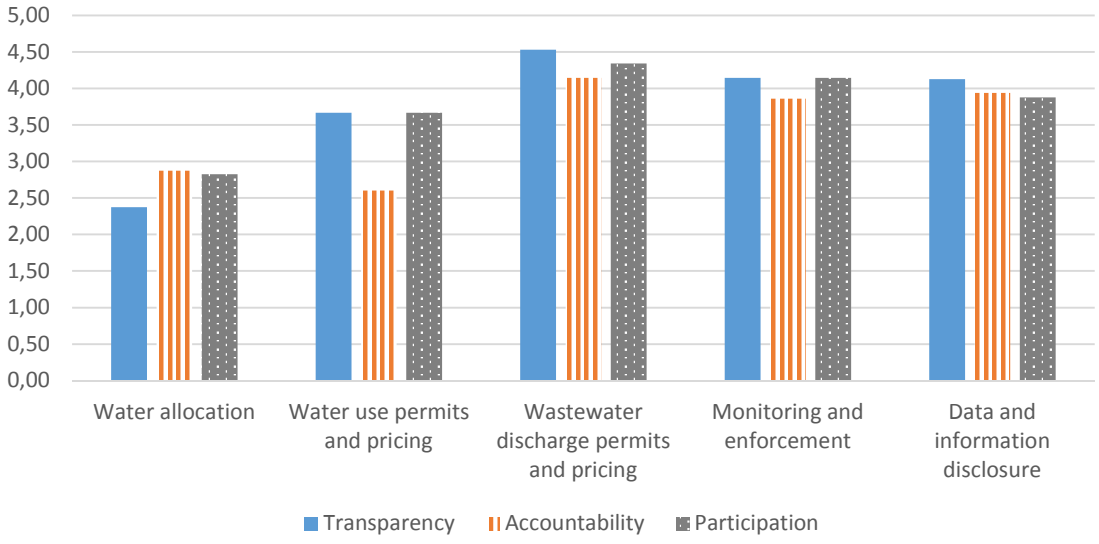


Figure 12 Scoping Assessment of Good Water Governance Pertaining to Textile Water Use.

Monitoring and enforcement as well as data and information disclosure were also deemed by the stakeholders to have rather high good water governance with TAP scores range from 3.86 to 4.14 out of 5. With regard to monitoring and enforcement, there are already very good equipment in Zhejiang province. Better operation of these equipment in certain areas is needed. Better accountability in monitoring and enforcement is implemented presently by holding the officers responsible for their actions, programme and policies even after they move to a different post.

Data and information disclosure by the businesses is more challenging due to the anticipated risks of negative consequence or perception from public. Some stakeholders highlighted the need for better education to the public in understanding different kinds of environmental data to avoid misinterpretation of these data. They think that government should find a good model to obtain information from the market, rather than only from the government itself and the public. This model should define what kind of information to obtain from the market, which market actors can provide this information, and how government can use and share this information to the public. The stakeholders believed that trust building among government, civil society and the businesses would be the key to find a better model for information sharing.

Two focus areas with the lowest scores of good water governance compared to others are water allocation as well as water use permits and pricing. In general, stakeholders viewed that there was not much transparency and accountability with regard to water allocation to the textile and leather industry. This decision is made at the national level and usually it does not involve public or local governments. At the provincial level, experts and large commercial water users are normally invited to give their inputs.

Regarding water use permits and pricing, accountability was perceived to be quite low (score of 2.6 out of 5). Factories are encouraged to undertake water savings and they have the opportunity to give inputs on this issue through workshops. To improve water use efficiency by the industries, water savings progress is evaluated annually at the provincial level. However this evaluation is not elaborated further into each industrial sector.

Chapter 6 Capacity Building Workshop

6.1. Workshop Organisation

In early 2016, Stockholm International Water Institute (STWI) established collaboration with the Zhejiang Institute of Industry and Information Technology (ZIIIT), as a local partner in China, to conduct joint research, workshops and other activities under the Water Governance component of the Sweden Textile Water Initiative (STWI). The different joint activities related to water governance were mainly focused on the Zhejiang province of China which is province previously famous for its severe water quality degradation problems but, during the past years, frequently promoted as an example of efficient and innovative water management policies and practices at provincial level.

As a spin-off of the collaboration on the water governance component of STWI between the two organizations, SIWI also became a formal European partner in the Switch-Asia Sustainable Printing and Dyeing industry programme led by the ZIIIT. SIWI's role in this program, as the European partner, is to bring the European perspective into the programme in terms of the European water-related standards and regulations and other best practices for a more sustainable textile industry in EU. The priority is to share such insights and knowledge with all relevant stakeholders in China and generate sustainable and long term impacts beyond the time frame of the programme.

In conjunction with the closing event of the Switch-Asia Sustainable Printing and Dyeing industry programme in Zhejiang on the 13th January, SIWI presented the Water Governance report and led

discussions together with a number of local experts who contributed to the report at different levels. Based on the recently much more tightened policy environment, a number of representatives from local government, Industrial associations and textile companies also, from each of their unique perspectives, presented their research, work and views on the sustainable development of the textile industry in Zhejiang province.

6.2. Inputs from the Workshop

The Zhejiang government representatives emphasized a number of challenges for the local textile industry including increasing production costs, decelerating economic growth, increasingly prominent social and environmental crisis and hardening international and regional competition. In order to survive and come out stronger from the ongoing constraints, the Zhejiang government will continue to prioritize and intensify their efforts to transform the current textile industry to a pillar industry recognized by its high added value, high resource efficiency and world-leading technologies and quality.

In terms of environmental policy, the Zhejiang local government will continue its very aggressive approach, including its well-know “five-water management” initiative, which include very strict environmental requirements on textile industry and other heavily polluting industries in Zhejiang in order to speed up the industrial transformation.

In summary, the policy makers, researchers, company leaders and other presenters agreed on that the most urgent water-related issues in the textile industry in Zhejiang are:

1. Low water efficiency in textile production. In general, the textile manufacturing industry in Zhejiang are 3 times less efficient in terms of the amount of water consumed for production of same amount of product compared to the more developed countries.
2. High water pollution discharge from textile production. The textile industry is the 6th biggest industrial water polluter in China and similar to the water efficiency issue, the small and medium sized manufacturers tend to be the biggest concern as they are more difficult to

monitor and less financially capable of investing in more environmentally superior technologies.

3. Lack of awareness of environmental issues in general at all levels of manufacturing companies. It was emphasized that environmental awareness has to be built at all levels within a company, from company owners to frontline workers.

In total, about 50 textile manufacturing companies were invited to the workshop. A number of company representatives shared their experiences and practices in order to reduce their environmental impacts and strengthen their capacities for more sustainable development. A significant part of their improvements was through internal training of staff, investment on new technical solutions and transition into a more high-end product portfolio. However, the company representatives also discussed some of their most common challenges with the policy makers, association representatives and financial institutes, including limited access to qualified workers, rapidly changing environmental policies and standards, lack of financing for environmentally superior technologies.

The representatives from local textile associations used significant part of the event to discuss the local textile industrial associations' role in the sustainable development of the textile industry in Zhejiang. It was concluded that the associations should be more active and better aware of its important role to represent local textile businesses and help them to better prepare and adapt themselves to the textile industry's intensifying transition to a more sustainable growth and the strengthening policy environment in Zhejiang.

During SIWI's conversation with the Zhejiang Institute of Industry and Information Technology (ZIIIT), it was discussed how the Water Governance report should be used in the process of providing concrete policy recommendations to the local government in Zhejiang province, especially when it comes to facing the different water challenges in the province. The policy recommendations will be submitted in form of a policy report to a number of critical government bodies by ZIIIT who has the right entry points

considering its role as advisor for government decision making.

During the workshop, SIWI also presented the plans to maintain long-term collaboration with ZIIIT which would generate sustainable impacts even after the completion of the Water Governance component of the STWI programme. Two of the ideas that have already been putting into action are to jointly arrange an International textile and water conference in 2017 and also to establish an inter-city collaboration between Keqiao in Zhejiang and Borås from Sweden considering that both of them are heavily linked with textile industry and therefore a lot of experiences and practices worth sharing and jointly developing further.

Key Presenters:

EU delegation in China
Zhejiang Provincial Dyeing and Printing Association
Keqiao District Dyeing and printing association
Zhejiang Provincial Economic and Information Commission
Zhejiang university
Wanshili Group
Zhejiang RGB textile and dyeing ltd.
Switch-Asia project implementation office
Stockholm International Water Institute

Chapter 7 Recommendations on Areas for Capacity Building

Considering the potential of Zhejiang textile industry, the government has formulated a strategy of "green development", which needs to be carried out by the 18th session of the 5th plenary meeting of Communist Party of China, practically boosts sustainable development of Zhejiang's textile industry and motivates industrial green reform by developing green products, establishing green enterprises, building green parks, optimizing green supply chain, formulating green standards and conducting green management reform based on realities in practice. The strategy identifies priority areas for capacity building to enable Zhejiang textile industry to further promote green and cleaner production, improve water resource productivity and contribute to the sustainability of the regional textile industry. Finally Zhejiang textile industry can be the leader and provide examples of China sustainable textile industry and advanced industrial water conservation and treatment.

7.1 Develop green textile products, propel structural water management

Zhejiang vigorously develops green textile products, introduces natural color fiber materials and vegetable sizing agents, adopts environmental-friendly dyes and processing agents, develops natural degradable vegetable dyes, reduces the cost of advanced digital printing technology, employs green finishing agent and biological treatment technology, quickens breeding of key R&D and production base of high-end intelligent textile printing and dyeing equipment. Furthermore, it improves product water consumption standard, supports enterprises in researching and producing production equipment and products with environmental mark, energy conservation and water conservation. According to the regional resource endowment and industrial base, it adjusts the proportion of fiber consumption for garments, home textiles and industrial terminal products, and increases the overall percentage of industrial textiles. Also the fashion industry is encouraged to guide some textile industries transforming to the tertiary industry via design, brand and e-commerce, and vigorously develop silk industry. It leads the product planning adjustment of chemical fiber industrial clusters in Shaoxing, Xiaoshan and Jiaxing, and breaks the intensified homogeneous competition of conventional products.

7.2 Construct green textile enterprises, promote water management performance

It promotes "four changes and three well-known" among textile enterprises, i.e. strive to develop industries with high added value, low energy consumption and low pollution; advances manpower changed by machine, achieving downsized staff (slim organization) and improved efficiency; improving effective land use through land conservation; propels market changed by e-commerce and rapidly develop e-commerce; and underscores cultivation of well-known enterprises, brands and entrepreneurs to be the industrial leader. Meanwhile, it should take active participation in water balance test of plants, strengthens water recycling, wastewater recycling and reuse of reclaimed water in textile industry, and the R&D and utilization of other key common technologies and processing equipment during green development, gradually eliminating outdated processes with long flow, high energy consumption, large water consumption and high pollution. SMEs merger and reorganization is encouraged; while inefficient small enterprises will be "shut down, stopped, merged or transferred".

7.3 Forge green textile parks, boost the efficiency of circular water management

It orderly boosts mandatory audit of cleaner production of key DP and chemical fiber parks, continues to construct cleaner production demonstration enterprises and pilots, demonstration parks of cyclic economy, reinforces process evaluation, and spot check. Furthermore, it moderately controls the park

scale, enhances circular transformation, propels waste recycling in and among enterprises and parks, boosts vertical extension and horizontal expansion of circular industrial chain, and positively explores recycling mode of industrial resources. It allows mutual assistance in wastewater pretreatment and renovating sludge in the parks, and optimizes the system of third party social capital into the field of pollution treatment.

7.4 Optimize green supply chain of textile, enhance the management capability of intensified water utilization

It emphasizes the full life circle control during production of textile products and vigorously carries out monitoring of green supply chain. Additionally, it improves energy conservation and emission reduction and resource utilization standard of full industrial chain from "breeding mulberry tree planting, silkworm breeding, filature, weaving, printing and dyeing, garments, home textiles and recycling", facilitates the implementation of supply chain standard, and inserts global green purchasing chain, so that the textiles quality, safety, energy conservation and environmental protection can meet international advanced standard. Moreover, it gives priority to products with China environmental mark certification and international green certification to promote green consumption. Also it focuses on labor safety of producers, reduces production and use of substances toxic and harmful to human body and environment, establishes waster fiber products recycling system, encouraging the establishment of enterprises involved in waste product recycling and reuse in textile garments.

7.5 Establish green development standard, innovate metering water management

It positively researches and formulates the evaluation standards and methods of green textile enterprises and products, establishes statistical standard for water use and drainage data, and enhances metering supervision for the water resource utilization of textile enterprises. Meanwhile, it sets out input-output table of water resources utilization, conducts water footprint evaluation for the green products of textile enterprises, studies the feasibility of water mark and water tag implementation and researches related specifications and standards, and cultivates water conservation demonstration enterprises. It carries out checking and tracing of virtual water, reduces virtual water crisis resulting from excessive output of textile garments with high water consumption, high discharge and low profit in international and regional trades.

7.6 Carry out green management reform, improve institutional water management service

It continues the strictest water resources management system, conducts differentiated industrial water price, total water quantity control, water right trading, total water pollution discharge control, water pollution right trading, liability insurance of environmental pollution, green finance (credit), moderate reform of systems including pool water treatment of sea and land, and probes into the trading system integrating both water right and pollution right. Furthermore, it strengthens information disclosure, and facilitates cooperation in water management right list disclosure and boundary work among functional government departments. Based on technical service organizations, it launches contract management pilot for water resources utilization of textile enterprises; enhances law popularization and enforcement, improves the role of public engagement in environmental supervision; displays the role of industrial association with the purpose of upgrading the water technology service and publicity and management of the textile industry.

Chapter 8 Conclusion

Zhejiang, as the largest province of textile industry in China, retains the first position of total output value and has made prominent contribution to the textiles export and employment reception. Although the water resources are distributed unevenly in each region of Zhejiang and the contradiction between industrial cluster development and regional environmental protection is complicated, over the past decade, water use efficiency and sewage control ability of textile industry have been promoted to a great extent. The textile industry of Zhejiang has witnessed outstanding results in sewage control. The industrial water governance is still under performing and needs improvement eventhough it has formed a model of policy management system that is referred to by other areas of China, powerfully boosting the textile transformation and upgrade and contributing to regional sustainable development.

(1) Zhejiang's textile industry has made great contribution to regional economic and social development. The gross industrial production of textile industry above designed size in Zhejiang has increased steadily from 2004 to 2013, with an annual growth 10.55%, reaching 1,065.305 billion CNY in 2013. It accounts for 16.91% of provincial GDP and 18.86% of China's textile industry. Zhejiang textile export contributes to 30.61% of total export cargo in Zhejiang. In the same period, Zhejiang's textile export has kept rising by 13.40% annually from 21.65 billion CNY to 76.13 billion CNY. The industry has had a slight decrease in employment after reaching a peak of 837,300 people in 2008. There are 8,917 textile enterprises with 6,756,900 employees in Zhejiang in 2013, accounting for 22.54% of industrial enterprises and 19.60% of labour employment.

(2) Relatively unbalanced water resources distribution and textile water use in Zhejiang. Water resources availability in the southwest mountain area of Zhejiang with a small population and economic aggregate contributes to 80% of the total quantity; while that of coastal plain regions of east Zhejiang with a large population, developed economy and high water demand only account for 20%. The textile industry mainly gathers in east and north Zhejiang like Hangzhou, Shaoxing, Jiaxing and Huzhou, whose total water resources are merely about 25% of the entire province. As to the water quality, only 63.8% of surface water in Zhejiang is of fairly good quality or more (class I, II and III), which is marginally superior to other major textile cluster provinces, such as Shandong and Jiangsu. In terms or rainfalls, it decreases progressively from the west to the east and from the south to the north. However, the textile industry in Zhejiang is predominantly in the east and north areas.

(3) Zhejiang's textile industry has accomplished significant achievements in water conservation and sewage control. For the past few years, Zhejiang has made considerable progress in industrial water conservation. During the "12th Five-Year" Plan, with the extensive application of energy conservation, consumption and emission reduction technology in the textile industry, the fresh water abstraction quantity for DP textile industry has dropped from 2.5 tons to below 1.8 tons per hectometer DP output, while the water reuse rate has improved from 15% to over 35%. The industrial wastewater discharge and COD discharge of the textile industry show decreasing trends. The wastewater discharge has declined from the peak of 695.24 million tons in 2011 to 583.87 million tons in 2013. The COD discharge has fallen from 77,812.34 tons in 2008 to 63,848.37 tons in 2013. Nevertheless, Zhejiang textile industry is still pressed by water use. The total output value of textile industry above designated size in Zhejiang in 2013 is 16.91% while its wastewater discharge and COD discharge account for 40.22% and 43.82% of the whole province.

(4) Zhejiang is leading in industrial water governance pertaining to textile industry compared to other parts of China but it still needs further improvement. Zhejiang textile industry always takes the lead in water management of China and has formed a policy management system, which becomes a role model in China. Targeting of the DP industry with the highest pollution problem in textile industry, Zhejiang has put a high priority to the industry's revitalisation and upgrade, by releasing a series of industrial access, technical innovation and revitalisation and upgrade policy documents, which has obtained favorable results. Water conservation and pollution control of Zhejiang textile industry have effectively facilitated the transformation and upgrade of the industry, and realized "five transformations" in industrial water management, namely: (1) transforming administrative approach to market approach; (2) transforming "end-of-pipe elimination" to "prevention or strict access" and to constrained sustainable development; (3) transforming "control first, supported by prevention" to "integrated prevention and control"; (4) transforming "pure elimination" to "promoting transformation"; (5) transforming "single consideration of water conservation and water pollution control" to "comprehensive water treatment". This is supported by stakeholders' review of good governance, which show very high ratings for transparency, accountability and participation in wastewater discharge permits and pricing. Nevertheless, two focus areas that need further improvement of good water governance are water allocation as well as water use permits and pricing.

Based on the capacity building workshop, the participants that consisted of the policy makers, researchers, company leaders and other presenters agreed on that the most urgent water-related issues in the textile industry in Zhejiang are:

4. Low water efficiency in textile production. In general, the textile manufacturing industry in Zhejiang are 3 times less efficient in terms of the amount of water consumed for production of same amount of product compared to the more developed countries.
5. High water pollution discharge from textile production. The textile industry is the 6th biggest industrial water polluter in China and similar to the water efficiency issue, the small and medium sized manufacturers tend to be the biggest concern as they are more difficult to monitor and less financially capable of investing in more environmentally superior technologies.
6. Lack of awareness of environmental issues in general at all levels of manufacturing companies. It was emphasized that environmental awareness has to be built at all levels within a company, from company owners to frontline workers.

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