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Water Scarcity in China: Left out to Dry?

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Abstract

Threatening its socio-economic development and long-term sustainability, China has increasingly been facing severe water scarcity. Its scarcity is characterized by insufficient local water resources as well as reduced water quality, both of which critically impacts upon its society and environment. The three main factors contributing to China's water scarcity are (1) uneven spatial distribution of water resources; (2) rapid economic development and urbanization; and (3) poor water resource management. This EIAS Policy Brief will outline the effects of these contributing factors and emphasize the importance of improving water resource management as a cost-effective option to alleviate China's water vulnerabilities. Then, it will discuss potential cooperation opportunities with the European Union, a 'green leader' that can offer support to guide China in the process of optimizing its water management mechanisms. There are three main potential channels of collaboration: (1) political agreements between the EU and Chinese governments and the creation of dialogue platforms such as the China-Europe Water Platform; (2) joint academic research projects involving Chinese and European researchers and meetings such as the EU-China Water Policy Dialogue to exchange scientific views and information on water management methods; and (3) business deals among European and Chinese companies to buy water management technology from each other, work on joint programs, and launch public-private partnerships with EU and Chinese institutions that can fund these projects.

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I. Causes of Scarcity

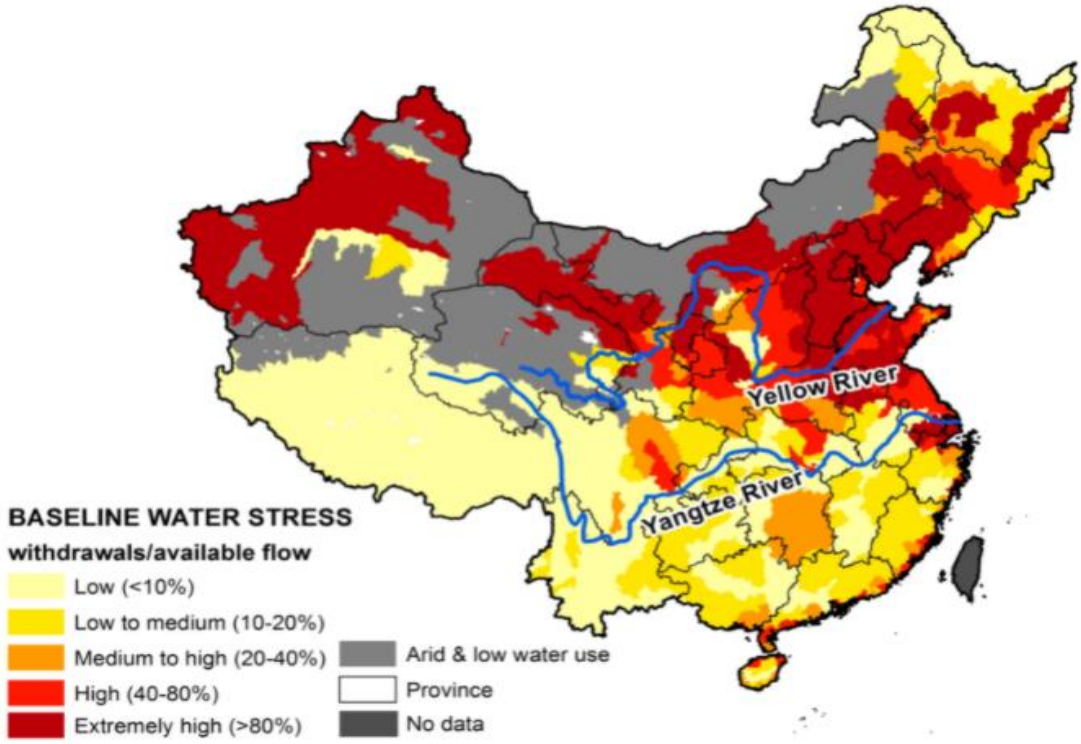

Illustration 1: Image from Water Resource Institute (WRI, 2017)

a) North-South Divide

China's water stress stems from the **disparity between the country's North and South**. Demarcating the Yangtze River as a dividing line between the two, one can compare China's northern and southern parts for a clearer understanding of their socio-economic environment, as well as their contrasting water needs and climate. Both regions claim a similar proportion of China's industry, population, and wealth. Northern China accounts for ~45% of the country's population, ~40% of GDP, and ~40% of industrial output (Jiang, 2015). However, despite this, the North only possesses 19% of the total **freshwater resource**s. This unfortunate distribution is intensified by the fact that 65% of the country's **arable land** is located in the North, as well as over 93.6% of China's **coal reserves** - its primary source of energy, and one which is extremely water-intensive to extract (Tu, 2011).

As a result, **water availability** in Northern China is ~900m^3 per capita per year, compared to ~3,300m^3 in the South, while the world average freshwater availability per capita per year is ~8,000m^3 (Li et al., 2014). In comparison, a country is said to be experiencing 'water stress' if the amount of its freshwater resources falls below 1,700m^3 (UN, 2014). Below 1,000m^3, the country is labelled as experiencing 'water scarcity', and below 500m^3 as 'absolute water scarcity' or 'acute scarcity' (UN, 2014). With these definitions we can identify Northern China to be experiencing 'water scarcity'. However, the situation is more complex than this figure suggests,

as (like with China overall) regional disparities reflect the extent of the supply problem. In the Hai River basin, for instance, water availability is only 315m^3 per capita, with Beijing only having access to 162m^3 of water per person, per year (Jiang, 2015). This places the region (as well as nine other Northern provinces) in the same acute scarcity category as Oman and Saudi Arabia (WRI, 2019).

However, not all water included in these freshwater availability statistics can be utilised sufficiently for consumption or even industry. For example, the South receives over 2,000mm of annual rainfall compared to <400mm in the North (WMO, 2019). Yet, often the water rich South receives much of this annual rainfall all at once (within a few weeks) resulting in mass flooding and little utility. As well as this, variations in **groundwater quality** further restrict the utility of China's water resources. Data from the State Environmental Protection Administration (SEPA) highlights how the majority of groundwater can no longer be treated for human consumption, in part due to unsustainable levels of groundwater extractions as well as surface water eutrophication and nitrate contamination from fertilizer and pesticide **pollution** (Ma et al., 2020).

b) Urbanization and Industrialisation

While regional disparities may have caused shortages in certain areas, China's rapid urbanization and industrialization over recent decades has created an ever-increasing demand for water resources while simultaneously overexploiting supply. China's industrialising, export-led economic growth has come with an extensive but inefficient use of natural resources. As an example, by 2004, China contributed less than 4% of the global GDP, however its world natural resources consumption was 15% for water, 28% for steel, 25% for aluminium, and 50% for cement (D'Aquino, 2005). High industrialization coupled with an increasing population has led to vast overexploitation of water resources, with the use rate of some river basins in the North being as high as 91% (Hai River basin) (Jiang, 2009). Such excessive water resources division reduces instream flows from rivers and has negatively impacted aquatic ecosystems. **Environmental degradation** has led to the extinction of the Yangtze River Dolphin and more frequent sandstorms in Beijing (Jiang et al., 2018). As well as this, overexploitation has resulted in over 28,000 rivers in China being permanently dried up, and the discharge of the Yellow River into the sea is now less than half what it was in the 1950s, making it more susceptible to natural hazards and droughts as was seen in 1997, when the lower reach of the Yellow River had no flow for 226 consecutive days over 700km from the river mouth (Yang, 2016).

c) Water Resource Management

With such limited and spatially distributed resources in China, there has been a drastic need for effective management over these available water resources. However, management has been lagging behind, leading to increases in severe water shortages. Economically, water is a common-pool resource. This means people have no incentive to save or use water efficiently, so effective management to deal with the externalities of water use and market failure is needed. Involving multiple government agencies at different levels, China's institutional system of water resource management is fragmented, and thereby often lacking in effective coordination and cooperation. One example is with river basin management. The river basin commissions

under the Ministry of Water Resources (MWR) are responsible for watershed-wide water allocation among provinces. Yet, issuing permits for water withdrawals is left to local governments and their water resources bureaus that have no representation in the basin commissions (Jiang, 2015). This results in frequent water withdrawals far beyond the allocated water quotas for each river basin. As well as this, the lack of a clear water rights system undermines much of the efforts to mitigate water resource losses through inefficiencies. For example, agriculture accounts for over 60% of China's annual water consumption. However, according to the World Bank, only 45% of groundwater withdrawn for agriculture was actually used for crops (World Bank, 2009). Much of this inefficiency is due to unclear water rights for farmers. One key feature of traditional water rights is outlining the amount of water that one is entitled to, yet lack of volumetric metering for water use at the agricultural level makes the water rights of individual farmers unclear. Moreover, during water shortages, farmers' irrigation demands are often forced to yield to domestic or industrial use without compensation (Khan and Liu, 2008). In addition, decisions about irrigation water delivery, including volume and timing, are largely made by irrigation districts rather than farmers. With an irrigation water charge tied to the acreage of irrigated land rather than actual water consumption, farmers have few incentives to save water and consume efficiently (Jiang, 2015).

d) Water Security and Safety

Since 2001, the Chinese government has launched several successful national policies to increase water security. The most recent efforts include the 2015 Water Pollution Prevention and Control Action Plan, the 2018 revision of the Water Pollution Prevention and Control Law (China Water Risk, 2018), and the five-year plan approved in January 2020, which limits farming near major rivers to reduce water pollution caused by agriculture (Xu, 2020). Besides, one of the most ambitious projects of the Chinese administration is the Disease Management and Control in Chinese Aquaculture (Food and Agriculture Organization of the United Nations, 2020). This strategy stops the expansion of pathogens among fish, restricts the breeding scale of specific species and maintains a positive breeding environment by ensuring water quality. By using a national disease surveillance system that provides early warnings and self-diagnosis services, it shares national expert resources and offers online technological services for farmers. Thus, all these policies constitute a top-to-bottom approach to control and monitor water use and supply at all local, regional and national levels in China.

II. Ineffective solutions

a) Engineering Supply

With per capita freshwater supply falling and demand rising, China is truly faced with a pressing dilemma, one which it has sought to solve through for example large scale infrastructure projects. One of these initiatives, the South-North Water Transfer Project (SNWTP), consists of 4,300 kilometres of artificial waterways and canals to move water from the South to the North across its three main routes: the Western, Central, and Eastern ones. At a cost of over USD 62 billion and the displacement of over 300,000 people (Wilson et al., 2017), all combined water projects only provide 4.5 billion cubic meters of the annual water

supply compared to the 133 billion cubic meters demanded for northern China (Rogers et al., 2019). In addition, many of these water transfer projects require more water (through energy usage) than they can provide, essentially trading high amounts of lower quality industrial water for lower amounts of marginally better-quality water. Another drawback is the increased relative price of transferred water, one which many farmers cannot afford, resulting in a considerably greater exploitation of groundwater resources. Undeniably, more must be done to address these challenges, mitigate the risks and alleviate their burden, but perhaps the solution is not to be found in engineering the supply side, but rather addressing demands.

b) Reducing Demand

Despite the prevalence of water scarcity in China, the price of water both for commercial and residential use is among the cheapest in the world at only ~ USD 1 per cubic meter compared to USD 3 in the US, USD 4 in the UK, and USD 5.5 in Germany (Jiang, 2015). In other words, compared with the United States, China has four times less freshwater available per person, but charges half the price for businesses and one-fourth the price for most urban households. This might appear reasonable, given that commodity prices in general are lower in China. However, the percentage of disposable income spent on water is three times lower in China than in developed countries (Rogers et al., 2019). In the face of such regional disparities and water shortages, it may appear strange that China has maintained such low relative prices. Much of the reason is due to government subsidies in order to maintain high agricultural yields. Policymakers are also concerned that raising water prices will exacerbate income inequality as water consumption represents a higher share of income for low-income households (such as farmers).

However, China has not been idle in its demand-side water initiatives. In the 13th Five-Year Plan, it unveiled an introduction of tiered pricing for urban households. In Beijing, for example, households using more than 260m^3 per year will now pay three times more to utilities. Yet, the National Development and Reform Commission (NDRC) has stated that prices should be at least three times higher universally, as domestic consumption only accounts for 12% of freshwater usage and the greatest forms of inefficiency come from industrial and agricultural consumption (CWR, 2014).

China has the potential to achieve water security in the long run, however, doing so will require a holistic, systematic, and integrated approach with joint effort across sectors of management. One of the most fundamental shifts must come from the engineering-based water management which currently dominates scarcity policy towards alternative demand side solutions. Shifting some of the water intensive functions of the capital city from the North to the South might be a better solution than water transfer projects. As well as this, desalination projects may present themselves as a more cost effective solution, as has been demonstrated in the previously water-stressed Israel. However, given the fragmented structures of China's water management and the vast amount of scarcity agitated by agricultural and industrial inefficiencies, the primary reform should come from the government in order to develop modern water laws and clear mandates on water management between provinces and water bureaus within river basins while encouraging more participation from citizens, NGOs, and businesses. Water management implementations should be monitored, accounted for, and incorporated in the

evaluation of water managers and government leaders in relation to their responsibilities. Rigorous policy analysis and integrated assessment with reliable data is a key component of institutional resilience with adaptive capacity, and must be dramatically improved to play a bigger role in policy and decision-making.

III. Collaboration Opportunities with the EU

The European situation is slightly different from the Chinese one because the EU case is an example of collaboration among member states. Today the main EU "water law" is the 2000 Water Framework Directive (WFD), an environmental policy that sets particular standards for chemical and biological characteristics of water, pollutant sources, and flood management, among others, of all water bodies across Member States territories. The most remarkable advantages of this framework are that it analyses and monitors the evolution of these water bodies and uses the pricing of water as an economic tool to protect this energy resource. Thus, EU water legislation, unlike the Chinese one, gives EU Member States a certain level of autonomy to create national policies concerning water supply and use but sets minimum standards to be achieved.

Both regions have confronted water insecurity but have chosen different approaches; China using a more centralized regulation than the EU. However, there are potential solutions to water scarcity and insecurity that can only be obtained through multilateralism and considering the differences between these water management models.

a) Political Dialogue

i. Advancements made to date

China and the European Union met at the 8th High Level Dialogue Conference on water resources via video link in Beijing from the 21st to the 22nd January 2021. This conference was titled "Strengthening Water Ecological Protection and Promoting Water System Management", and it aimed at discussing policies and measures to increase the quality of the ecosystem, and ensure the critical and coordinated administration of natural resources (Global Times, 2021). Over 300 representatives from governments, enterprises and research centres originating from over 18 countries attended this meeting. China's Minister of Water Resources, Li Guoying, highlighted that China is fully committed to improve the quality of water bodies and its supervision. Li also called for further EU-China research and business collaboration to help water conservancy enterprises to spread to overseas markets, and for government authorities to continue working towards the water-related goals of the 2030 Agenda for Sustainable Development. On the other hand, the EU confirmed that the discussions at the forum were pragmatic and honest, and that both parties reached consensus on several topics: (1) they compromised to increase efforts to tackle climate change, (2) agreed that **the China-Europe Water Platform** had become a model for international cooperation but it should continue becoming more efficient in offering water infrastructure services like water supply and sewage

management, and (3) agreed that there should be more policy dialogues, private sector discussions and joint scientific research between the EU and China.

The China Europe Water Platform was created in 2012. It is a platform that promotes EU-China dialogue between policymakers, researchers and businesses in the field of water. Nearly 20 European countries and more than 1,000 water government officials, business representatives and scientific researchers from China and the EU work through this platform. China still confronts environmental issues concerning water security and, according to some experts, the progress made to counter these may not be sufficient (Yifan Yang, 2016). On the other hand, the EU is still considered a green leader considering the European Green Deal launched in December 2020. This is a set of policies proposed by the European Commission with the aim of making Europe climate neutral in 2050. China still needs to solve vital problems regarding water security and safety, and learning from the EU experiences may be beneficial for the country and to expand cooperation plans to fight together other environmental problems that transcend national borders and affect both parties (Yifan Yang, 2016). This way, mutual interests would be satisfied, and diplomatic relations smoothened.

In this context, the China Europe Water Platform is a dialogue space of vital importance because it allows Chinese and European policy-makers to reach a consensus on water management and accelerates bilateral programmes and initiatives to share responsibilities, coordinate efforts and agree on common norms in this field. For this reason, this platform is economically supported by the EU to solve problems concerning integrated water resources management, water disaster mitigation, adaptation to climate change, protection of water ecosystems and water policies in general, and collaboration on joint programmes on applied research and business cooperation. This is financed through a EUR 6 million Partnership Instrument launched by the European Commission.

Moreover, China is also included in the EUR 9 million Commission action launched in May 2019 by the European Commission to decrease plastic waste and litter in the East and Southeast Asian oceans (European Commission, 2019). This initiative also aims at cooperating with certain EU countries on projects to ensure the sustainable consumption and production of plastic and finance the transition towards a more circular economy, in sync with the EU Circular Economy Action Plan and the EU Plastic Strategy.

The EU-China Strategic Outlook, published in May 2019, also mentions the EU's interest in monitoring and assisting in decreasing China's environmental impact, supervising that Chinese products that enter the EU respect the environmental standards imposed by the EU, which also includes the use and treatment of water resources in the production process of these goods.

Finally, the most important political agreement including water-related compromises was **the EU-China 2020 Strategic Agenda for Cooperation** (European Commission, 2013), signed at the 16th China-EU Summit, from 20th to 21st November 2013. This document set the bases of collaboration between the two parties in the fields of 'peace and security', 'prosperity', 'sustainable development', and 'people-to-people exchanges'. In it, we find two important statements concerning water management. Firstly, it stresses the importance of

funding joint research and innovation initiatives on water administration, as well as combining efforts in tackling water pollution. Secondly, it highlights the importance of the CEWP.

ii. Limitations of existing policies and solutions

There are several challenges to establishing political agreements between the EU and China in this field. Firstly, the physical distance between both partners makes policies such as the transfer of water between both regions to assist each other during water scarcity periods too costly or inefficient. Secondly, any EU-China political accord should be approved by the European Commission, the European Parliament and Council of the EU, which is a long legislative process.

The China Europe Water Platform has one main limitation: it serves as a policy dialogue platform, but it is not an active bilateral programme including actual compromises between both regions. **It would be efficient to set up bilateral programmes between the EU and China with binding clauses and detailed policy frameworks and clear targets.** These legal resources would force the EU and Chinese political leaders to follow joint policy objectives and would make them more accountable. Policies such as diffusing common criteria and standards to determine water scarcity and assess water security would be a plausible working objective that could be done remotely, which has become the norm since the beginning of the Covid-19 pandemic.

Secondly, **EU-China collaboration can also involve bilateral discussions among individual Member States and China**. For instance, this is what the Rijkswaterstaat (Dutch Ministry of Infrastructure and the Environment) and the Chinese Ministry of Water Resources (MWR) have been working on for over 10 years. More EU Member States should engage in bilateral discussions with China because many of them face common challenges that could be resolved more easily if technical knowledge is shared between both parties on a regular basis. For example, the IJsselmeer lake and Lake Tai both need to be monitored on wave measurements, water quality/algae blooms, and the Huai River and the Rhine both need flood prevention systems and operational crises management (Ministerie van Buitenlandse Zaken, 2017). Thus, European countries suffering the same issues as China could create more extensive joint policy programs with Chinese policymakers to learn from different water management methods. Furthermore, the more bilateral discussions are launched between EU Member States and China, the more likely these dialogues will be expanded at the EU level.

b) Scientific and Academic Research

The most promising channel through which EU-China cooperation could be expanded is joint scientific research and academic collaboration and considerable advancements have been made during the past few years.

In 2019, the first meeting of **the EU-China Water Policy Dialogue** was held to exchange information on water management techniques and to boost political cooperation through **the China-Europe Water Platform**. This dialogue was based on the EU-China River Basin Management Program (2006-2012) and a Dialogue on Groundwater Policy, Legislation and Standards developed by the CEWP Focus Area on Rural Water and Food Security in 2016. The

outputs of this meeting were five analysis reports, three strategy documents and one summary report. Both Chinese and EU representatives highlighted that strategic knowledge exchange was key in developing a common position and understanding (Martin Griffiths and Liu Dengwei, 2012). Thus, it is very likely that Chinese policymakers will continue learning from the EU example in the following years and vice versa and bilateral programs such as this one will be further developed.

Aside from having these fora for scientific discussions and deliberation, it is also essential to **create joint research projects and other scientific works with mixed European and Chinese researchers teams**. These projects would rely on massive databases about European and Chinese environments and water management techniques and include mixed research methods that the European and Chinese teams implemented in their domestic research projects. The two main advantages of joint research would be that (1) a more significant amount of scientific evidence would be collected from the study, and (2) the outcome could offer solutions to water scarcity or security issues that could be applied in different regions around the world. Nonetheless, these would also require trust between the European and Chinese research teams (especially given that they would have to work remotely and communicate online due to the physical distance between the research spots). Furthermore, these European and Chinese teams would need to split or share the funding of these projects equitably and communicate and update each other on their findings regularly.

Finally, it is also important that Chinese and European experts launch meetings through international organizations such as **the Food and Agriculture Organization (FAO)** at the UN level. There are major advantages of expanding dialogue through this type of platform: both parties learn from exchanging information on successful policies applied in other countries, they can receive advice from private entities such as water management companies that also share their findings or provide advice to countries, and the progress they make in these bilateral studies can be monitored by third parties that can also highlight shortcomings or limitations that the primary investigators may not spot during their research.

c) Business Deals

The 'circular economy' concept seems to best satisfy the EU and Chinese companies' and policymakers' interests (Al-Saidi et al., 2021). This is a crucial policy objective influencing water access and safety because reducing the impact of the consumption society on water resources or, in other words, avoiding the exhaustion of water around the world, is a key requirement to achieve circular economies. Therefore, there are already policies in place in both regions, namely the EU 2015 Action Plan for the Circular Economy and China's 2009 Circular Economy Promotion Law (McDowall et al., 2017).

Taking into account this 'circular economy' policy objective, commerce would be the ultimate solution to incentivize Sino-European collaboration. For instance, the EU could be interested in buying the technology implemented by the Chinese government in the national disease surveillance system of the **Disease Management and Control in Chinese Aquaculture strategy**, a successful policy explored above. At the same time, China could be interested in learning from the **Common Implementation Strategy (CIS)** adopted by the EU and

Norway to provide Member States with guidelines and policy directives on how to respect the Water Framework Directive.

Private companies based in the EU and China can also boost the collaboration of both regions through joint water management programs. Looking again at the Sino-Dutch collaboration on water management, one observes that Dutch businesses work in countries all over the world to solve water-related problems such as irrigation, safe riverbanks and clean drinking water. For example, a Dutch enterprise called Cytobuoy that measures water contamination caused by blue-green algae developed a new technique named CytoSense to analyze water particles. Thanks to this technique, instead of extracting water samples every time using boats and bringing them back to the laboratory, the composition of the algae can be measured every 10 minutes to see how it evolves. This technique has been tested since 2016 in the Tai Lake near Shanghai and in the Ijsselmeer in the Netherlands due to their similar size and depth, which makes them easy to compare. The reason why this technique is tested both in the Netherlands and China is that it provides scientific evidence on how efficient it truly is and allows investigators to determine if it can be implemented in different countries or regions. According to researchers, using it in Tai Lake will help cut public health risks and allows companies to work more efficiently with limited water resources. Suppose European companies follow this example and boost EU-China collaborations in the private sector. In that case, enterprises in both regions could optimize their production chains, reduce their environmental impact, contribute to the transition towards a more circular economy and ultimately benefit society as a whole.

Finally, another option that should be further explored are **public-private partnerships**. The European Commission offers a wide range of funding opportunities for companies and, more specifically, for small and medium businesses or organizations that launch projects that promote the interests of the EU or facilitate the application of an EU programme or policy. European companies working on water management initiatives that focus, for example, on developing more sustainable uses of water resources for agricultural production could apply for funding from the European Agricultural Fund for Rural Development through the Ministry of Agriculture of their own country. Furthermore, if they work on reducing water pollution in the ocean, they may apply for funding from the European Maritime Fisheries Fund. Finally, Horizon Europe is a specific fund that supports research and innovation programs that help reach the UN's Sustainable Development Goals (SDGs), increase the EU's competitiveness and growth, and promote the implementation of EU policies while solving major global challenges. Therefore, any Chinese companies working in joint initiatives with European business can indirectly benefit from EU funding if their projects satisfy the criteria outlined above.

Concluding Remarks

Overall, it appears neither China's supply nor demand side policies have gone far enough to address the growing pressure on its freshwater resources. However, although more action is required, there may be some hope for more 'natural' changes in China's future. Occupational transitions from primary and secondary jobs to an expansion in tertiary work will naturally reduce the problem and increase relative supply. As well as this, greater reliance on renewable (or at least less water intensive) forms of energy and China's projected population decline (by

2030) will further reduce demand to more sustainable levels. However, these are only possible (future) alleviations, not outright solutions. For now, China must implement more stringent reforms or face greater scarcity and further degradation at the expense of its environment, its people, and its international reputation.

Additionally, China can continue learning from the EU's progress and experience in water management, and EU-China collaboration initiatives should be further developed. Chinese and EU authorities made a significant contribution by creating the CEWP as a dialogue platform for scientists and policy-makers. Nonetheless, they should also sign formal political agreements to harmonize standards and criteria to measure water scarcity. Individual member states must also engage in discussions with China to develop bilateral agreements that can pave the way for EU-level policy accords. Secondly, aside from meeting at the EU-China Water Policy Dialogue every year, European and Chinese scientists should work in joint research projects where technical and strategic knowledge is exchanged and seek additional advice and insights from the Food and Agriculture Organization. Finally, European and Chinese businesses should trade water management technology and work on joint projects like the Dutch company Cytobuoy tested its technology in Tai Lake. These joint projects involving EU and Chinese companies could qualify for EU funding through programs like Horizon Europe and result in public-private partnerships. While there is still much work to be done, there is hope on the horizon for China's water management experts to learn from their European colleagues and improve the water quality and satisfy the growing water demands of their citizens.

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