

## Power shortages, a hidden water crisis, and a hard landing in China

### Key findings:

- China's economy is structurally deficient in water resources and electric power
- Profound impacts on global supply chains as China's economy struggles to adjust
- Structural deficiency raises risks of a near term economic hard landing in China, and seriously jeopardizes the prospects of China hitting its 2060 carbon neutrality goals
- Timeframe to resolve the twin water/power crisis is likely measured in years; cooperation and transparency key to finding solutions

*Special acknowledgement to Charlie Parton for his in-depth piece from 2018, "China's Looming Water Crisis"*

### Introduction

With sustained, coordinated central bank policy support since the Global Financial Crisis of 2008, it has been comfortable to assume that macroeconomic challenges can be managed by central banks in some fashion or other.

In this piece, I propose that we are already in the midst of an economic crisis—a crisis for which there is no central bank remedy.

China is structurally deficient in water resources and electric power to maintain its economy. This is not a theoretical, two-decades-out problem. It is happening right now. And it will impact every single person on the planet.

This research is not intended with malice towards the people of China; Americans on average consume nearly 3x more water per capita than a citizen of China<sup>i</sup>.

### Background

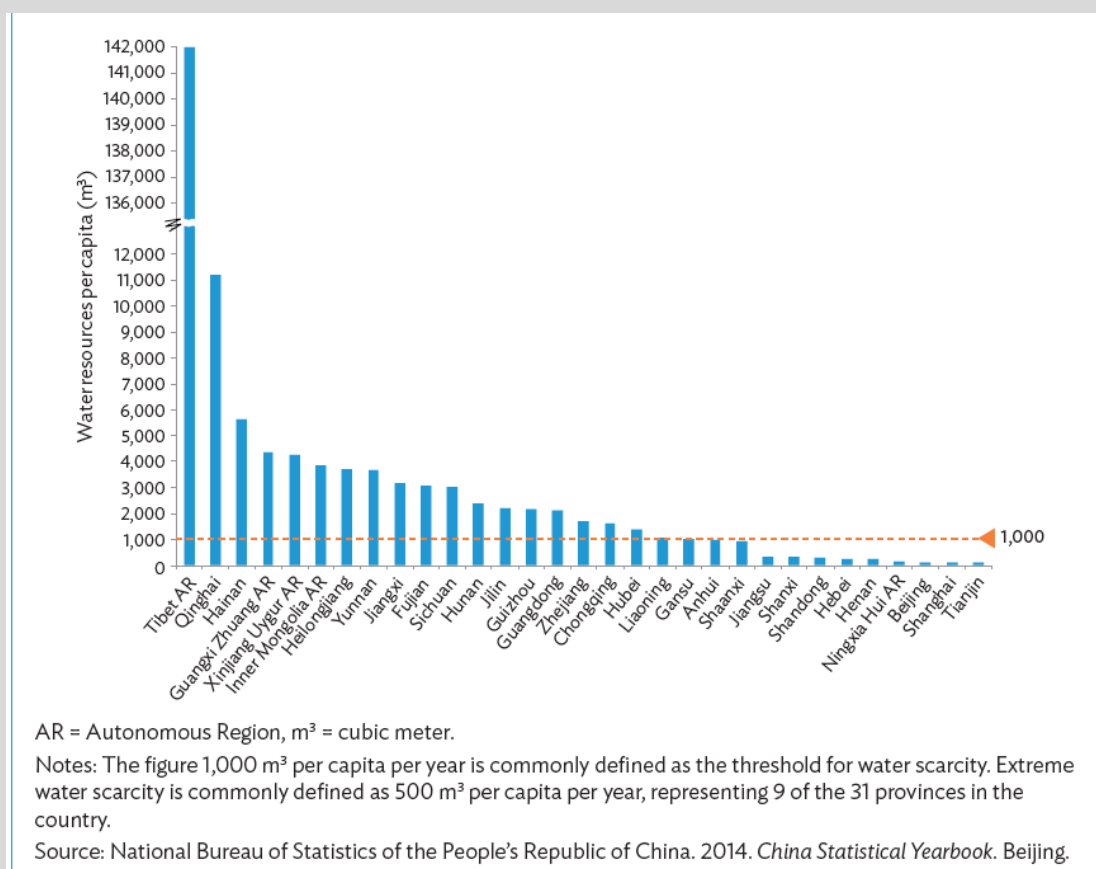
As widely cited, China has 20% of the world's population but only 7% of the world's freshwater resources<sup>ii</sup>. Regional differences make the water issue even more challenging: North China (12 provinces north of the Yangtze River) accounts for more than 60% of China's agricultural land and 40% of China's population, while possessing only 20% of the nation's freshwater resources<sup>ii</sup>.

Agriculture accounts for approximately 60% of China's water consumption with power generation/manufacturing consuming another 20%; Chinese household consumption accounts for most of the remainder<sup>i</sup>.

About the author: Gopal Reddy is the founder of Ready for Climate, a research platform focused on the national security and economics risks from climate change. Previously, Gopal was the founder of Chakra Capital Partners, a Boston-based hedge fund, and also spent 14 years at Fidelity Investments as an analyst and portfolio manager. Gopal attained a BA in Economics from Stanford University in 2001.

Water scarcity is defined by the UN as freshwater availability below 1,000 cubic meters(m<sup>3</sup>) per capita per year, with acute scarcity below 500 m<sup>3</sup> per capita per year. As of 2013, average water resource in North China was 300 m<sup>3</sup>; at one point in 2012, Beijing had available per capita water supplies of under 120 m<sup>3</sup><sup>ii</sup>. For reference, Egypt, a country often mentioned as at high risk of water scarcity, had per capita resources of 570 m<sup>3</sup> as of 2019<sup>iii</sup>.

Water Scarcity Threshold and Water Resources per Capita per Year by Province in the People's Republic of China, 2014



Asian Development Bank, "Addressing Water Security in The People's Republic of China", *Asian Development Bank*, 2016

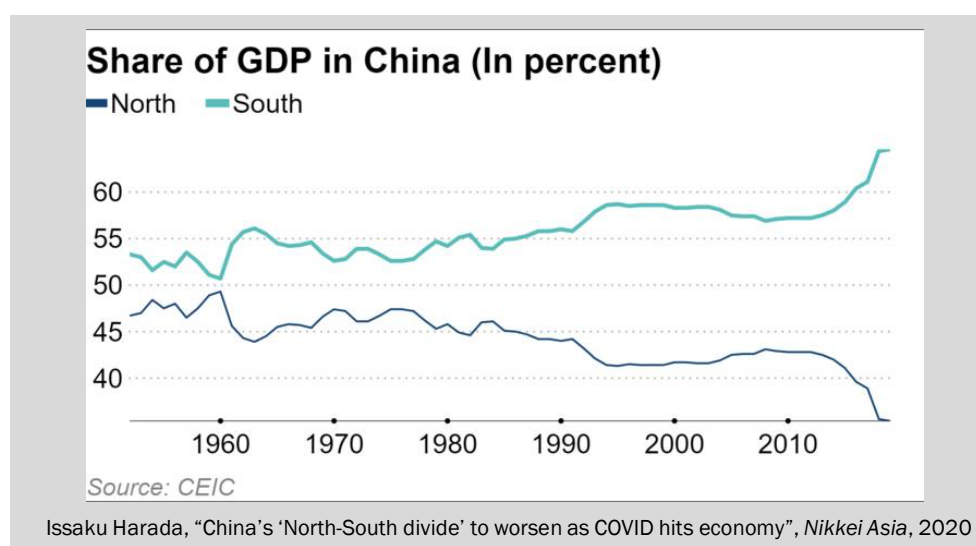
China draws heavily on groundwater resources to maintain its economy, particularly in North China. Years of groundwater depletion are causing the land above to subside; parts of Beijing are currently subsiding by 14 centimeters per year<sup>iv</sup>, with more than 50 other cities in China<sup>ii</sup> also seeing subsidence.

China's government is well aware of the need to address the structural water shortage; in 2005, Chinese Premier Wen Jiabao remarked that water shortages threatened the "survival of the Chinese nation". To the government's credit, significant steps have been taken to improve water efficiency across the economy, with water use/\$ of local GDP improving by 30% since 2015<sup>vi</sup>.

More ambitious efforts to increase local water supply include the \$60 billion project to transfer water from South China to North China, which temporarily alleviated the shortages in Beijing and surrounding areas.

More recently, China has announced plans to use cloud seeding (atmospheric interventions to increase rainfall/snowfall) across 50% of its landmass<sup>vii</sup>.

Structural water shortages may also account for North China's collapsing share of national GDP; it is worth highlighting the significant fall since 2013<sup>viii</sup>.



### China's power shortfalls and structural water shortage are intimately linked

Coal, hydro, and nuclear power generation all require significant water resources in order to maintain output. Combined, these three sources comprise more than 80% of China's power capacity<sup>ix,x</sup>.

Coal power in particular requires large amounts of water at every stage, including mining, washing, and cooling during the thermal power cycle. Coal resources are mismatched with water resources; as of 2015, 67% of China's coal plants were in regions considered water-stressed or highly water-stressed<sup>xi</sup>.

As referenced below, this issue is most pressing in North China.

*"Risks are greatest in the north of the country where we have found that 35% to 60% of its regional coal-fired power capacity is threatened by cooling water shortage during months of low flow from December to June. In contrast, although water resources are abundant in the southern grids (south, central, and east), power plants still face water shortage risks at certain months of the year because they often use open-loop cooling systems that require significant volumes of water*

*withdrawal.<sup>xii</sup>* The same report also notes: “There are inevitable uncertainties in estimates of water consumption and withdrawal because data are often not measured or published.<sup>xii</sup>”

To its credit, China has taken steps to improve the water efficiency of its coal generation, but more than half of China’s coal power capacity is older, less efficient subcritical technology with low water efficiency<sup>xiii,xiv</sup>.

The challenges of water availability mean that seasonal power demand shifts or weather disruptions can bring China’s electric grid down quickly. This summer, a combination of reduced output from hydropower dams and increased electric demand for air conditioning resulted in disruptions across the country; similar disruptions occurred last winter as heating demand increased.



### Profound supply chain impacts across the globe— including the USA

When power capacity is constrained, Chinese officials are forced to make rationing decisions about which parts of its economy will be impacted; power rationing thus far seems to be focused on the industrial sector, which directly impacts the availability of products on shelves across the globe as manufacturing plants are idled.

Reports of supply chain challenges are broadly circulating in the media; the following excerpt from Bloomberg News in September 2021 reveals that China's power shortages are hitting a wide swathe of its manufacturing base:

*"The crackdown on power consumption is being driven by rising demand for electricity and surging coal and gas prices as well as strict targets from Beijing to cut emissions. It's coming first to the country's mammoth manufacturing industries: from aluminum smelters to textiles producers and soybean processing plants, factories are being ordered to curb activity or – in some instances – shut altogether..."*

*...A number of smaller companies are also starting to inform the stock exchange they've been ordered to curb or halt activity. While they may be overlooked by major foreign investors that don't cover these firms, the end result could be a shortage of everything from textiles to electronics components that could snarl supply chains and eat into the profits of a host of multinational companies.<sup>xv</sup>"*

While the article notes China's desire to "cut emissions" as a reason for the power shortfall, numerous other outlets have also cited falling hydropower reservoir levels as a major culprit<sup>xvi</sup>.

The power cuts are severe enough that even top tier manufacturers like Apple are seeing impacts to their supply chains.

*"iPhone assembly operations in China are beginning to reduce their energy consumption because of a sudden power crunch in the country, which has triggered government-imposed curbs on a range of businesses. Pegatron Corp., a key partner for Apple Inc. and one of the assemblers of its iPhone, said on Monday that it's taking energy-saving measures to comply with local government policies. Still, the firms responsible for producing the Apple handset have avoided drastic cutbacks in production so far and appear to be getting preferential access to energy in order to keep operations going, according to people familiar with the situation<sup>xvii</sup>."*

One can only wonder how companies without "preferential access" to electricity will manage. That same article also includes a statement from Pegatron that mentions both energy AND water conservation efforts. It is worth noting that the typical smartphone requires 3,000 gallons of water to produce.

*"Pegatron has been adopting energy- and water-saving measures over the past few years and there is a comprehensive response program for the current situation to reduce the impact on our operations and production capacity.<sup>xviii</sup>"*

### Even crypto-currency may have had a role in this story

Crypto-mining consumes large amounts of electricity; at one point in 2020, crypto-mining accounted for more than 1% of China's total power consumption<sup>xviii</sup>. More worryingly, forecasts in early 2021 suggested crypto-mining would consume nearly 4% of China's annual electricity output by 2024<sup>xix</sup>.

That kind of demand load on an already-strained electric grid was likely a factor in why Chinese authorities banned cryptocurrency mining in June. Seasonally, the timing of the crypto ban provided immediate relief for an electric grid about to be hit with seasonal air conditioning demand. China further tightened restrictions on cryptocurrency by adding a transaction ban this past September.

As with the power disruptions to manufacturers, the Chinese government has emphasized its desire to reduce carbon emissions as the reason for the mining ban; it is difficult to reconcile this with China's plans to add nearly 250 gigawatts of new coal generation—or “six times Germany's entire coal-fired capacity.”<sup>xx</sup>

### Huge impact on commodity markets as portions of China's economy lose easy access to water

China imports more than \$100 billion a year in food products<sup>xxi</sup>. If China's groundwater resources in North China are compromised, China may be forced to significantly increase imports of agricultural products just as key exporters like Argentina and Brazil struggle with their own logistical/climate challenges.

**“Brazil's crops have been scorched, frozen and then dried out by the worst drought in a century, upending global commodity markets.**

*Bloomberg* September 28, 2021

**“Dying crops, spiking energy bills, showers once a week. In South America, the climate future has arrived.”**

*Washington Post* September 24, 2021

More recently, large scale purchases of agricultural commodities by China call into question the true level of grain reserves in the country.

*“Analysts think China's mountain of corn may be more like a molehill. The United States Department of Agriculture estimates the country is sitting on a stockpile of 198 million tonnes, or 7.8 billion bushels, of the crop.*

*“There is no way they have a 7.8 billion bushel surplus,” said Todd Hultman, lead analyst with DTN. He said it simply doesn't make sense that China is going to import one billion bushels of corn in 2020-21 if its own stockpile was that plentiful. It also doesn't add up that corn prices on China's Dalian Commodity Exchange have been astronomical all year long, trading at around US\$11 per bu (bushel) as of May 19.*

*Other organizations are starting to drastically cut their China stocks estimates. In February, the Food and Agriculture Organization of the United Nations made a massive reduction to its number. Its new estimate is 139 million tonnes or 5.5 billion bushels, a 28 percent drop from its December number.<sup>xxii</sup>*

Nor is it just Western news outlets raising questions about grain reserves. China's central government raised this very issue with its provinces in December of 2020.

*"China published a new draft law on management of its grain reserves on Thursday to include oversight of stocks in regions and provinces as it seeks to bolster its food security. Previous rules governing grain reserves only applied to its central state stockpiles but Beijing has this year heightened its focus on risks to food supply.*

*The law was drawn up as "new situations and questions have risen regarding grains reserves security administration, posing severe challenges to China's grains stockpile security," the National Development and Reform Commission said in a statement on its website.*

*The document also encourages urban and rural residents to stockpile grains in a reasonable way.<sup>xxiii</sup>*

Beyond agriculture, China's power/water shortages are affecting a wide range of commodities, including base metals like aluminum and steel (large power consumers), as well as coal and natural gas as China seeks overseas supply to offset domestic shortfalls.

It is worth noting that natural gas demand is likely to rise, as it is the only quick way for China to add baseload power capacity without further stressing water resources (natural gas power generation requires at least 50% less water than coal-fired generation<sup>xxiv</sup>). Rising natural gas prices have had a major impact in the US and abroad.

### **No quick fix for China's power grid—or the water problem**

There are few options for China to add power capacity without further straining its water resources.

Wind and solar (combined app. 9% of China's generating capacity<sup>xxv</sup>) do not require water as part of their generation process, but also do NOT provide reliable, baseload electricity that industrial customers need to maintain operations. The power output from these sources is simply too variable over the course of a day/month without large scale energy storage to manage supply.

Nuclear power is often mentioned as a baseload power alternative to coal, but requires nearly as much water as coal generation during its process. Moreover, the timeframes involved in completing nuclear facilities makes it an untenable near-term (3-5 year) solution.

It is not clear that there is consensus even within China's government about how to balance the tradeoffs between water consumption, power reliability, and moving towards low carbon energy



sources. Readers should consider the inherent conflict between these two statements, less than four months apart in 2021, both coming from the same government agency in China:

*“Because renewable energy (sources such as) wind and solar power are intermittent and unstable, we must rely on a stable power source,” said Su Wei, Deputy Secretary-General of the National Development and Reform Commission. “We have no other choice. For a period of time, we may need to use coal power as a point of flexible adjustment.”<sup>xxvi</sup>*

*“China's state planner, the National Development and Reform Commission, on Friday said it would encourage [aluminium] smelters in the country to increase their use of non-hydropower forms of renewable energy, such as wind and solar power. Some Chinese regions have faced electricity shortages in recent months as severe drought hit their availability to generate hydropower, leading to curbs on metal smelters' power usage.”<sup>xxvii</sup>*

### “Manufacturing” water not a real option

As Charlie Parton succinctly put it, “China can print money, but it cannot print water.”<sup>ii</sup>

As far back as 2016, the Chinese government was encouraging citizens to make consumption changes, like swapping rice (high water intensity) for potatoes (lower water intensity). Whether effective or not, the need for such messaging suggests the water issue has been viewed as critical by the Central Party for some time<sup>xxviii</sup>.

Current Party policy seems to be to maximize in-country water resources, regardless of the impact on neighbors. As noted earlier, China is moving to widescale implementation of atmospheric interventions to boost precipitation. The long-term impact of these interventions is unclear; extreme weather events were a major reason for hydropower disruptions in China this past year.

It is also worth highlighting that Taiwan (Republic of China) is downwind of the jet stream patterns over China. This raises the question of whether the recent increase in rainfall in China might be coming at the expense of its neighbor, now in the midst of a serious drought<sup>xxix</sup>.



Nor is cloud seeding the only action China is taking regarding water resources that is impacting its neighbors. Flows on rivers feeding into the key Mekong River Delta are now being diverted such that downstream countries like Thailand are seeing significant changes to normal seasonal patterns.





*“The report’s most significant finding is that for most of 2019 much of China’s portion of the upper Mekong received high to average levels of precipitation, yet its dams blocked or restricted more water than ever as downstream countries suffered through an unprecedented wet season drought. The restriction came after China’s upstream dams released nearly all of their water between January and June 2019 to produce an unprecedented amount of hydropower for sale to markets in China. The amount of rainfall and snowmelt in China was enough to keep water levels in much of the Lower Mekong above average between June 2019 and March 2020 if China’s dams were not restricting that water.”<sup>xxx</sup>*

### Desalination is utterly unfeasible at the scale China requires

The desalination process requires significant amounts of electric power, which in turn would put further strain on China’s electric grid and diminishing water resources. Net water yielded from the desalination process can be reduced by half or more when factoring in water consumption for electricity<sup>ii</sup>; this begs the question of where China will find the power (and the water to generate the power) to generate water.

Moreover, the costs involved in desalination and transport of water across thousands of miles to the dry, interior regions of China are simply too high to be viable for agriculture or industry.

### Macroeconomic reverberations to be felt for years

The global economy’s high reliance on China for everything from apparel to chemicals to industrial components means that power and water shortages in China will constrain economic growth across the globe.

As an example, 40% of the clothing and 70% of the shoes sold in the US are sourced from China<sup>xxxi</sup>. Given the scale of the disruption to China’s manufacturing base, this is likely to result in a combination of lower global economic activity at higher costs- a perfect recipe for “stagflation.”

Moreover, the physical constraints of water and power mean that additional fiscal stimulus or a restart of property/infrastructure cycles in China would only further stress the country’s electric grid and water supplies.

Chinese corporate profitability is at risk as manufacturers idle capacity due to power shortages; the Chinese banking system is also at risk from loan loss provisions as unproductive capacity is written down. Further, it is unclear how much residential real estate will be worth in regions where water supplies are stretched to the point where economic activity is impacted.

Finally, the time frames involved in building large quantities of new power generation capacity, even while China grapples with its existing infrastructure losing access to water, mean that resolving structural shortfalls will take years, possibly decades.

### China's shift towards a low carbon economy at significant risk

China's most pressing need is to find ways to generate low carbon, low water intensity, high reliability power. Until this is accomplished, any plans to decarbonize the global economy are pure fantasy.

China has pledged to achieve carbon neutrality by 2060; less has been said about the specific path China can follow to achieve this. Recent moves like stopping the construction of new coal plants overseas via the Belt and Road Initiative are helpful gestures, but the fact remains that China will need to rely on coal-fired generation for decades to come.

In the interim, the only palatable option for decarbonizing China's electric grid may be to capture carbon emissions directly from coal power plants using carbon capture and storage (CCS) technology. This is no easy solution; some CCS technologies require large additional water consumption as part of their process, and very little has been tested at the scale China would require. In addition, there is no current mechanism for Chinese companies to get paid for the costs associated with carbon capture.

China's strained electric grid also calls into question just how quickly the country can shift its transportation fleet over to electric vehicle (EV) technology. China has made EV development a national priority, with more than 300 local manufacturers fighting for market share. It is unclear how the additional power demand from mass EV adoption will be met in the near future, and likely extends the timeframe for decarbonizing China's ground transportation fleet.

### Cooperation and transparency the key to resolving this crisis

I want to emphasize two personal views:

1. Given the globe's reliance on China as a trading partner, we are all in this together
2. The rest of the world is going to need the same solutions China needs, eventually

There are a number of potential technology solutions to address industrial water efficiency, water loss to irrigation, and energy storage in development right now. However, current tensions between China and the US on everything from trade policy to intellectual property rights to COVID origins is an impediment to cooperation.

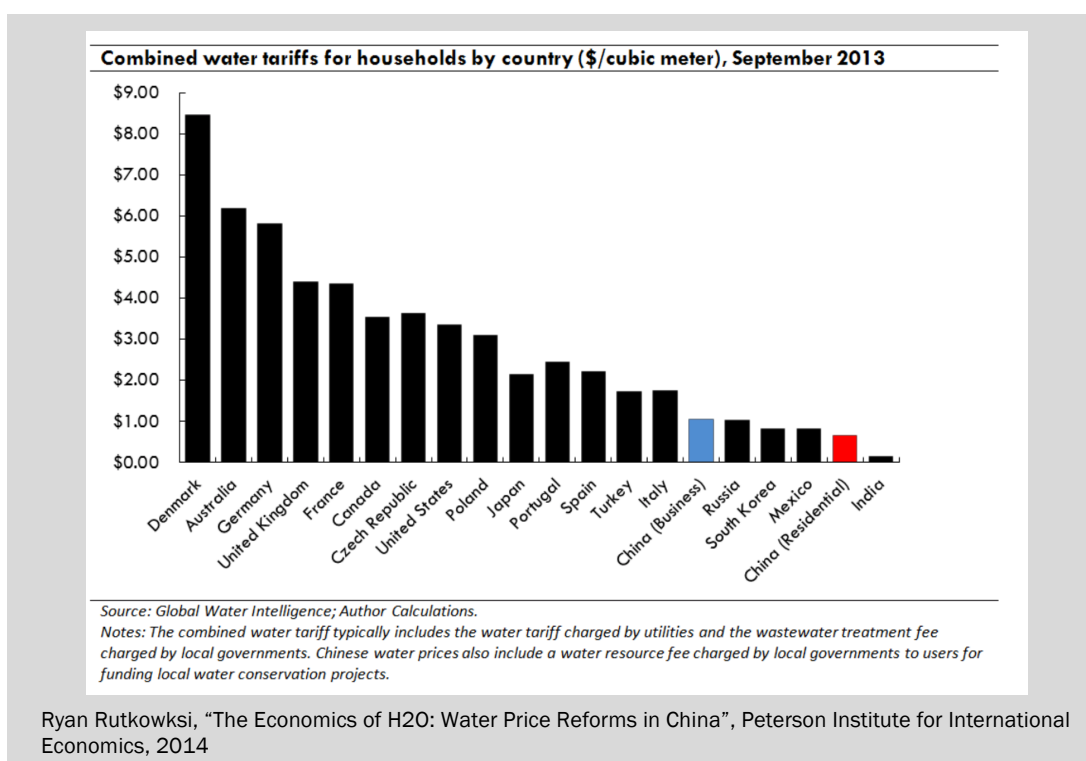
Whatever our differences, international cooperation is in everyone's interests. Parts of the Western US are already in severe distress due to drought, and methods to help China save water will likely be in very high demand domestically.

Not to mention the fact that nearly half the world's population *already* struggles with water scarcity at least one month out of the year<sup>xxxii</sup>. Water shortages may be a key trigger for mass migrations out of the Middle East and Central America; it would seem prudent to find ways to allow locals to remain in their homes.

Greater levels of transparency in China regarding water availability and usage are vital. Resolving the twin power/water crisis is in the interests of the Chinese people, the Chinese Communist Party, and the rest of the world.

The challenge is implementing policy at the provincial and local level, where water conservation may involve painful decisions to shutter or relocate industrial capacity. Politically, it is difficult for local officials to sign off on policies that hurt economic growth, but it may be unavoidable.

Water prices in China are also well below most other developed economies, despite the long term supply challenge. China has taken modest steps in recent years to increase prices to end users, but significant work remains.



### Concluding thoughts

"According to Wang Shucheng, China's former minister of water resources, at current rates of water extraction, many cities in northern China—including Beijing, home to more than 20 million people—will run out of water in 15 years. Wang said this 11 years ago."<sup>v</sup>

That excerpt is from an article written in 2016; five years later, Wang Shucheng certainly deserves credit for his prescient warning.

Americans (and the rest of the world) do not have the option of pretending that China's water issues are not our problem; our economies are simply too interlinked.

And perhaps, when doing due diligence on an investment, it may be wise to verify whether said investment has access to enough water to bear fruit.

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