Impending Water Crisis in China

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“Water is the most ubiquitously needed resource. It is needed for industry, for agriculture and by every living being. We face an energy crisis but we can work on alternative and renewable energy resources. When it comes to the water crisis, there is no alternative for water.” -- Professor Liu Changming, Director of the United Research Centre for Water Problems (URCWP)[1]

Introduction

71% of the Earth is covered in water but only 2.5% is freshwater. 70% of that freshwater is trapped in polar ice caps or underground, leaving approximately 1% in easy to access rivers and lakes.[2] Fresh water is an extremely undervalued and scarce resource. Currently 1.1 billion people lack access to safe, clean drinking water globally[3] and this number could increase to 2.3 billion by 2025.[4]

China has less than 7% of the world’s arable land with which to feed its enormous population of 1.3 billion people.[5] Growing water scarcity is one of the most pressing issues currently facing China, given its burgeoning industry and huge population. Against the backdrop of rapid population and economic growth China’s water resources are getting scarcer. As China continues along its path of industrialization and urbanization, more and more of the available water will be rendered useless for drinking, irrigation, and hydro-power purposes.

Growing water pressures are coming from the following factors: highly uneven distribution of water and agriculture between the North and the South, urbanization, population increase, degradation of the environment and rapidly rising demands for energy, irrigation, and drinking water. There are clear implications for both China and the world if China cannot sustainably manage its resources. In order to broadly understand the Chinese water scarcity issue, it is necessary to understand the available water supply, the sources of demand, the factors contributing to the developing crisis, and the policy solutions being implemented to mitigate the problems.

Water Supply

China’s water supply comes from glaciers, surface water, and groundwater. However, it is not the lack of water, but the uneven distribution of water that makes China’s current situation so dire. China is in the unique position of being both water rich and water poor. Water is extremely scarce in the North but abundant in the South.

1.1 Glaciers
The Qinghai-Tibetan Plateau, located in Western China, is comprised of over 35,000 glaciers with an area of approximately 50,000 km². Seasonal melting typically keeps China’s rivers flowing during the dry season. This seasonal behavior is unfortunately being disrupted by warming due to climate change (to be discussed later). The Qinghai-Tibetan plateau is the origin of two of China’s most important rivers, the Yangtze and Mekong, as well as rivers that run through other countries such as the Indus, Mekong, Salween, and Tarim Rivers.

1.2 Surface Water

Total annual runoff for China’s rivers in 2005 was 2.7 trillion m³, ranking 6th in the world for total runoff. China’s surface water supply is replenished by glacier melting and precipitation. As of 2006, both China’s lakes and rivers were replenished by annual precipitation of 620 mm.

The Yangtze River is the longest river in China and carries more water than any other river in China, with an annual runoff accounting for 52% of the national total. The Yellow River, considered to be the cradle of Chinese civilization, is China’s second largest river with an annual runoff that comprises only 2% of the total runoff. The Yangtze, Yellow, Heilong, Pearl, Liao, Hai and Huai rivers flow east and empty into the Pacific Ocean.

The lower reaches of the Yellow, Huai, and Hai rivers supply the North China Plain, which is home to some of the country’s largest urban and industrial concentrations and most intensive irrigated agriculture, such as Beijing and Tianjin. The North China Plain contains 65% of the country’s agricultural land and therefore relies on vast irrigation systems and underground aquifers to support its agriculture.

China also possesses approximately 2,800 lakes, which cover over 80,000 square kilometers. China’s freshwater lakes, including the Tai Hu, Chao Hu, and Dian Chi, home to numerous species of aquatic plants and animals are not only an important source of water, but are also a critical food resource. China used to be home to 4,077 lakes, half of which have disappeared over the past several decades due to increased demand, consumption, global warming, and conversion of lakes to rice paddies.

Figure 1: China’s Rivers and Lakes
1.3 Groundwater

As rivers flow across the plains, water seeps through the ground to become groundwater. Groundwater provides potable water for nearly 70% of China’s population and irrigation for some 40% of its agricultural land.\cite{15} Underground aquifers are especially important for supplying the arid North with water for irrigation. Almost half of Northern China’s water comes from groundwater aquifers (See Figure 1.2).\cite{16} Of the irrigated land in Northern China approximately 60% is irrigated with groundwater.

Source: [http://depts.washington.edu](http://depts.washington.edu)
Sources of Demand

China’s demand for water is divided between domestic, agricultural, and industrial use. More and more water is being allocated to industrial and urban demand than ever before (See Figure 2.1). The challenge now facing the Chinese government is how to meet the soaring water needs of its swelling urban population and industrial sector without compromising either its agriculture sector or food security.
2.1 Domestic Use

China’s population is currently 1.3 billion people making it the most populous in the world. The population is expected to swell to 1.5 billion by 2030, according to UN demographers.[19] The increase in domestic water use will be determined by population growth and the amount of per capita water use. The latter is positively correlated to the level of income and the rate of urbanization; high income, urban dwelling, people tend to lead more water intensive lives. In addition, as affluence increases, people tend to introduce more meat, fruits, and vegetables into their diets. It takes significantly more water to produce these luxury agriculture goods than to produce grain, which will exact a serious toll on future supply.

The migration from rural to urban areas contributes partly to the increase in demand. By 2030 it is estimated that over 50% of China’s population will be living in cities.[20] As China's population urbanizes, hundreds of millions will change their primary water source from the village well to water intensive indoor plumbing with showers and flush toilets. [21] The World Bank estimated that between 2000 and 2010, China’s urban water demand will increase by 60%[22], making water scarcity a serious threat.

2.2 Agricultural Use

Within the agricultural sector water is used for farmland irrigation, forestry, breeding livestock and maintaining fisheries.[23] Currently 67% of China's water is used for agriculture, a sector responsible for only 13.2% of GDP. In the agricultural sector, demand for irrigation water is currently roughly 400 billion m3. It is expected to reach 665 billion m3 in 2030.[24]

Rice, wheat, maize and cotton are the four most water-demanding crops in Southeast China. Rice accounts for more than 90 % of water use despite occupying only 70 % of land area.[25] China’s grain production has improved dramatically over the last 50 years due in large part to the expansion of irrigation, but many observers are beginning to question whether irrigated agriculture is sustainable given China’s growing water scarcity. Doubts about China’s ability to continue to produce high agricultural yields have only increased in recent years as China’s agricultural production has fallen.

The dry North China Plain includes many of the country’s most important agricultural provinces, such as Hebei and Shandong. The North China Plain is supplied by the Haihe, Launhe, and Yellow Rivers. There are approximately 20 billion m3 per year of surface water available in this region.[26] Over the last few decades farmers have been relying more and more heavily on groundwater aquifer resources, as rivers dry up before reaching the North China Plain. Unfortunately, this has led to the overexploitation and rapid decline of groundwater resources, which poses serious consequences for the future of China’s water supply.

2.3 Industrial Use
China’s economy has expanded rapidly over the past few decades. In 2006 the World Bank estimated that the economy would grow approximately 9.6% in 2007. Industrial demand for water already makes up 22% of China’s total demand and the World Bank estimates this demand will increase by 62% from 2000 to 2010. The major industrial water consumers are metallurgy, timber processing, paper and pulp, petroleum and chemical industries.[27]

Industrial output is increasingly much more profitable than agricultural output, meaning that overtime greater water resources will be transferred to industrial needs. A thousand tons of water can produce one ton of wheat worth $200, whereas the same amount of water used in industry yields an estimated $14,000 of output.[28] As water becomes an increasingly scarce and more expensive resource, the agricultural sector will lose out to the industrial sector because industry is simply much more profitable.

As agriculture loses out to industry, China will be forced to become a net importer of food, rather than a net exporter, which is a serious departure from the current position. Such a dramatic change has dangerous implications for world grain prices. Furthermore, as more water is being used for industry, which is responsible for a great deal of pollution, China’s dwindling water sources will become more heavily polluted.

**Figure 2.1: Changes in Domestic, Agricultural, and Industrial Demand from 1978 to 2004**

![Pie chart](source: Groundwater in China Development and Response²³)

**Factors Contributing to Water Crisis**

The main factors contributing to the impending water crisis in China are increasing demand, specifically domestic and industrial, inefficient use of water resources, pollution, and climate change.

Each of these factors adds a layer of complexity onto the issue of water in China, but feedback mechanisms also exist amplifying the effects of all of these aspects. As China’s surface water becomes polluted to the extent that it cannot be used for industrial purposes,
China will be forced to overexploit its underground aquifers beyond their ability to recharge. As the climate warms, lowering precipitation rates in China, the aquifers will recharge at much slower paces.

3.1 Increasing Demand

China’s population is expected to reach 1.5 million by 2030, with almost half living in cities. Due to amenities such as indoor plumbing, urban populations generally live more water intensive lives than rural people. The evidence of water shortages is overwhelming. Experts estimate that by 2030 per capita water resources will drop to 1,760 m3, which is barely above 1,700 m3 considered to be then benchmark for water crisis.[30] Farmers are pumping groundwater from deeper and deeper levels thereby exploiting underground aquifers beyond the possibility of replenishment. “The U.S. embassy in Beijing reports that wheat farmers in some areas are now pumping from a depth of 300 meters, or nearly 1,000 feet. Pumping water from this far deep in the earth raises pumping costs so high that farmers are often forced to abandon irrigation and return to less productive dryland farming.”[31] Much of this increased demand and consumption clearly comes from China’s fast growing economy. China’s economy is expected to continue growing at around 9% per year, which will subsequently increase industrial demand for water, the affluence of the population, the migration to cities by people looking for better jobs, per capita water use – all of which portend a serious supply shortage.

3.2 Inefficient Use

Management of China’s water resources has been extremely inefficient, leading to extensive water loss. Water is highly subsidized by the central government, making it practically free for users thereby leaving no incentive to save water. The general attitude towards water use is to use as much as possible as fast as possible. China’s irrigation system, choice of water intensive crops, obsession with dams, and overexploitation of surface and groundwater resources have all contributed to the highly inefficient use and management of water resources.

The irrigation system is “less than 50% efficient which can mean that 8.5 % of the world’s water is being wasted.”[32] Much of the water in open channel irrigation systems leaks back into the ground before it can be utilized, although unfortunately not fast enough to replenish groundwater resources. According to China’s Ministry of Construction, inefficient irrigation has led to a loss of 400 million cubic meters of water every year.[33]

In addition to an inefficient irrigation system, many crops that China grows are impractically water-intensive, such as wheat and rice. Many will have to leave grain production altogether, or at least stop planting of rice, wheat and other water-intensive crops. For decades farmers and politicians have ignored all warnings and done practically nothing to fix the system.
The government also relies on dams to manage the water resources and to reach its stated goal of becoming the largest producer of hydroelectric power in the world. Not only are many of these dams poorly constructed, but there has been a move away from the use of large dams after the 2000 World Commission on Dams issued a critical report. The report announced that many “large dam projects had fallen far short of their physical and economic targets, resulting in huge losses of forest lands, wildlife habitat, and aquatic biodiversity. All existing dams should be reviewed and no more should be built without the agreement of the people likely to be affected by them.” Dams destroy fish runs, flood agriculture lands, displace local communities, dry up and pollute downstream wetlands, and are extremely inefficient because significant amounts of water are lost due to evaporation. In spite of this report and the resulting shift by many developed countries away from dams, China now openly boasts of owning over half of the world’s dams.

China is also overexploiting both its surface water and groundwater resources significantly faster than they are being replenished by rain. According to the Ministry of Water Resources, the utilization rate of water resources is around 60% for a number of rivers, including the Huai, Liao, and Yellow, and as high as 90% for the Hai River. These numbers are all notably above international standards, which are set with the intention of conserving water, of 30-40%.

As rivers become increasingly polluted and run dry and lakes disappear with escalating pace, China will be forced to rely even more heavily on its underground aquifers, unfortunately using up today what should be tomorrow’s water. Although increasing the efficiency of water use will not solve the underlying problem of water scarcity in China, it will buy them considerable time to tackle the bigger aspects of this issue.

3.3 Pollution

China’s rapid economic growth has brought with it steady increase in the production of industrial wastewater. The high levels of pollution are seen by many as the result of lax environmental codes that are rarely enforced and easily avoided by bribing corrupt officials. Pollution of China’s surface water has reached a distressing point at which much of the water is unsuitable for drinking, irrigation, industrial use, or even electricity generation in dams. According to the World Resources Institute, about half of China's population consumes drinking water contaminated with waste that exceeds the applicable maximum permissible levels. Liver and stomach cancers in China are caused in part by water pollution. In addition, pollution is causing the collapse of numerous aquatic species, biodiversity loss, and many illnesses.

As polluted water leaks into the ground due to inefficient irrigation systems, it puts toxins into the ground, affecting fertility of agricultural lands and resulting in food with high levels of toxins. “According to the SEPA [State Environmental Protection Administration], 70 per cent of China's rivers and lakes are polluted to some degree; the water of 28 per cent is unsuitable even for irrigation. Moreover, 90 per cent of the groundwater in the cities is too polluted to drink. As a result, several hundred million Chinese lack access to safe water.”
There are approximately 21,000 chemical companies along the Yangtze and Yellow river, as well as numerous paper, steel, textile, and power plants, which are responsible for a considerable amount of pollution. In 2006 alone, over 26 billion tons of wastewater was dumped into the Yangtze River.[40] The Yellow and Yangtze Rivers are the main source of water for many important agricultural, industrial, and urban provinces and therefore expose large percentages of the population to polluted water. Analysts contend that 80% of the water flowing in China’s rivers is unable to sustain fish life,[41] which is another way, in addition to grain shortages, that water scarcity will affect China’s food supply.

A recent example of the magnitude to which pollution can affect China’s supply of water is the chemical spill in the Jilin province in 2005. According to the International Herald Tribune, “an explosion on Nov. 13 at a plant run by the China National Petroleum Corp., known as CNPC, in Jilin Province, 380 kilometers, or 235 miles, upriver from Harbin, spewed an estimated 100 tons of benzene compounds into the river.”[42] A 50 mile stretch of polluted water ran down the river Songhuan, threatening the main source of freshwater for the nine million inhabitants of Harbin, the biggest city in Jilin province. The price of drinking water doubled within hours, people immediately started migrating, and there were local fights for water.[43] This event is a microcosm for what could happen on a very large-scale in China if the central government, corporations, and individuals continue to disregard environmental codes.

3.4 Climate Change

Climate change poses a serious threat to ecosystems around the world. Many aspects of climate change and its role in the water scarcity issue for China are still ambiguous and being studied. However, global warming has had an undeniable effect on the Qinghai-Tibetan Plateau, which is the source of water for the Yangtze and Yellow Rivers. MSNBC reported in 2006 that, “glaciers covering China’s Qinghai-Tibet plateau are shrinking by 7 % a year due to global warming and the environmental consequences may be dire.”[44] According to the IPCC, global temperatures have warmed by .76 Celsius over the last 100 years.[45] The glacier’s seasonal melting keeps the rivers flowing during the dry season, but as the glacier retreats by more and more every year, there will be less water during the dry season. In addition, the melting could cause massive flooding, followed by severe drought and an ultimate long-term decrease in water supply that is irreplaceable. This warming has not only caused glacial retreat but also the drying up of numerous lakes that feed the region’s rivers.

According to a study on glaciers released by the World Wildlife Fund in 2005, “over the past 15 years, river and lake areas have been shrinking. Lake shrinkage mainly occurred in the Yangtze River source region, a total decrease of 114.81 km2, accounting for 10.64% of the total lake area in the Yangtze River source region and for 58.4% of the total decreased area in the combined region. The source lake for the Yellow River source lake has decreased by 5.28 %.”[46] The decrease in rainfall is also causing desertification across China, increasing the percentage of land that is unusable for agriculture. It is still unclear whether global warming will increase or decrease precipitation in the long run for China, but the past several years have seen significant drops in rainfall across several
provinces. The Ministry of Water Resources reported drops in precipitation in the Songliao Plain, Yellow River Basin, Huai River Basin, and the Hai, River Basin, by at least 10% and in some provinces by almost 40%. The average yearly river runoff is likely to decrease in already arid Northern provinces while it may increase in the already water-abundant southern provinces. This could cause an increase of flood and drought events due to climate change.

Warming also causes higher levels of evaporation, which is decreasing the level of water available in China’s numerous dams, resulting in reduced river flows, and desertification. Over the past decade, Chinese deserts expanded at a rate of 950 square miles a year. As the world’s biggest emitter of greenhouse gases, as of 2006, China will hopefully take a more active role in reducing its contribution to climate change if not simply for the sake of the environment, but for the sake of its people and economy.

**Consequences of Water Scarcity**

If China continues to overexploit its scarce water resources a serious water crisis looms in its future, which could even set off consequences for the rest of the world. As the North continues to rely more heavily on water that comes from the South, regionally conflicts over water could erupt. In addition, competition between sectors for water supply could develop into something more violent and cause serious civil unrest. The Qinghai-Tibetan Plateau is the source of rivers that reach India, Bangladesh, Burma, Bhutan, Nepal, Cambodia, Pakistan, Laos, Thailand, and Vietnam. When China begins to run out of water, it may try to hoard the remaining water supply for its own people, thereby diverting water that would have reached these countries in South and Southeast Asia. Many of these countries, specifically India, are already facing their own severe water crises, which will only be exacerbated if China diverts rivers that would have delivered much needed water.

Having extensively contaminated its own major rivers through unbridled industrialization, China now threatens the ecological viability of river systems tied to South and Southeast Asia in its bid to meet its thirst for water and energy. Both diverting water that would have flowed to other countries and allowing increasingly polluted water to run through other countries has already angered neighboring countries and will continue to do so. Political relations could be further strained by massive migration of people from regions facing severe water shortages that could spill over into other countries. In fact, many analysts argue that the oil wars of the 20th century will be replaced by water wars in the 21st century.

Polluted water has been linked to the spread of numerous diseases, including cancers. Increasing levels of pollution could lead to more serious and widespread health problems, dehydration, and the increased prevalence of cancer in Chinese people. Because China’s rivers run through so many different countries in the region, disease could rapidly spread to large numbers of people.
China’s food supply is incredibly vulnerable to water shortages. Rapid industrialization inevitably leads to a heavy loss of cropland, which can override any increase in land productivity and lead to an absolute decline in food production. China’s grain harvests have already fallen short of demand for the past several years, causing China to import their grain. According to Lester Brown of the Worldwatch Institute, consumption outstrips production by over 45 million tons a year. It is very possible that in the near future China will become the largest importer of agricultural goods, which could shock the world’s grain markets and trigger higher food prices around the world.

Possible Water Management Solutions

5.1 Three Gorges Dam

The idea for the Three Gorges Dam, first proposed by Dr. Sun Yat-sen in 1919, is currently on the road to completion. The Three Gorges Dam, China’s most ambitious dam project, is on the Yangtze River. It is one and a half miles wide, more than 600 feet high, and will create a reservoir hundreds of feet deep and nearly 400 miles long. The dam is intended to be a symbol of China’s power and prestige. The purpose of the Three Gorges Dam is to solve the flooding issues that have plagued China throughout its history, to allow large ships to sail directly to the interior, and to generate enough energy to reduce coal usage. The dam is expected to produce 18.2 million kilowatts of energy, which is one ninth of China’s total output. The Three Gorges Dam is the subject of much controversy, both national and international. Some people hail it as the solution to much of China’s water and energy problems, while others criticize it as an “anachronistic relic of the state-directed Maoist economy” that threatens to further degrade the environment and displace millions of people. Regardless of the debate, construction of the dam is expected to be finished by 2009.

5.2 South-North Water Diversion Project

The South-North Water Diversion (SNWD) Project was first conceived by Mao Zedong in 1952 when he realized the irony that most of China’s water was in the South, while most of the agriculture was in the North. SNWD, which is not expected to be completed until at least 2050, will eventually divert 44.8 billion m³, or 8% of China’s total water, of water annually to the drier north. The complete project is expected to cost $62 billion, which is more than twice as much as the Three Gorges Dam. There are three routes of the SNWD project: the eastern, which will supply the Shandong Province and the Huang-Huai-Hai Plain, the central, which will supply the Henan and Hebei Provinces, and the northern, which will bring water to northwest China. This project has also sparked environmental concerns about pollution and worries over displacing huge populations. It is yet to be seen if this project comes to fruition.

Conclusion

China is currently at a crossroads where many different interest groups have overlapping needs for resources but diverging ideas for how to manage them. China’s biggest
challenge will be balancing region and sector demands: dry North, growing industry, and an inefficient agriculture system, all compounded by a rapidly growing consumer middle class. The Yangtze and Yellow Rivers have been drying up earlier than ever and now rarely reach the Pacific Ocean during the dry season. All of China’s water sources are becoming scarcer, while sources of demand are increasing. Rivers and lakes are drying up, what water is left is increasingly polluted, glaciers are melting, groundwater is being over-pumped beyond recharging limits, and precipitation has been dwindling. Global climate change has already had a recorded impact on China’s water resources and threatens to worsen the plight. All of these problems overlap and amplify the effects of each other, putting even greater stress on water resources. China is one of the world’s biggest powers, increasingly connected to the rest of the globe, which means that water scarcity, which has traditionally been a local issue, will become the world problem and China may have to address the divergence between its own interests and that of the world. The immediate solution is to use water more conservatively, but ultimately China will have to face the underlying problem that too many people are using too few resources far too quickly.

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