Alleviating water scarcity in Northern China: balancing options and policies among Chinese decision-makers

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Abstract Water scarcity is mostly a man-made problem that increasingly affects people’s lives and questions economic output in Northern China. Policy options addressing the serious water shortages in the region include conservation and water management reform, which is unpopular; grain imports and the downsizing of agriculture; derivation of Yangze water; derivation of the Amur and other international rivers. All solutions present major difficulties, whether domestic or international, for the Chinese authorities. While major decisions have not yet been taken, evidence shows major works such as water transfers from the Yangze or water pricing are not only unavoidable, but will not be enough to meet the growing demand for water in the region.

Keywords Arbitration; China; water pricing; water scarcity; water transfers

Theoretical aspect
Water-scarcity disputes are as much a domestic problem as an increasingly discussed feature of international relations. Prospects of aggravated crises abound as correlations are often established between population increase, limited water resources, global warming and development constraints.

However, scarcity of resources does not lead to conflict, whether international or domestic, in a mechanistic way. The reaction of governments and societies to a situation of scarcity depends on a whole set of variables such as the geographic setting, regional and domestic politics, societal issues both within a country and affecting a region, development levels and, above all, perceptions or representations – the images societies and governments have of the seriousness of the scarcity and its possible solutions.

Water disputes are in fact not just a question of mere water volumes: spatial, economic and political representations, as much as geographic constraints, shape a state’s response to water scarcity.

A worsening man-made scarcity
China’s rapid economic growth, industrialization, and urbanization, compounded by inadequate infrastructure investment, have all contributed to widespread problems of water scarcity and water pollution throughout the country.

Average water availability in China does not suggest a real shortage: with 2,500 m³ per person, water is relatively abundant in China. But the geography of water also shows strong regional discrepancies: the south-east of China (Guangxi, Guangdong, Fujian) boasts a huge 20,000 m³ per person while availability in the Huanghe basin averages 500 m³ per person, a figure close to the extreme scarcity level as defined by the United Nations.

It is not that water is scarce in Northern China: major rivers, such as the Huanghe and the Heilongjiang/Amur carry large volumes and aquifers were, before being overexploited, safe and abundant reservoirs of water. Present-day water problems are, to be fair, partly compounded by a long dry period dating back to the 1950s, with real droughts spanning several years (Tianxin and Kang, 1997). They are largely man-made, and their solution,
beyond the water transfer schemes that will be discussed below, imply profound reforms in
the development strategy in China and drastic arbitration measures by the Chinese leadership
that could prove very unpopular.

The Huanghe River showed a flow of about 40 billion m$^2$ during the 1980s, but ran dry
for longer and longer periods of time, on larger and larger parts of its course. Beginning in
1972, these episodes have become recurrent. In 1980, the river went dry on 150 km for
7 days; on 300 km for 53 days in 1990; on 704 km for 226 days in 1997 and 280 days in 1998
(Lasserre, 2002).

A scarcity that compels reform in the Chinese development scheme

A dangerous reliance on groundwater

Irrigation, as in most developing countries and also in several developed countries, is
responsible for most of the water consumption. Dependence on groundwater for irrigation
is particularly high in the 3H basins, for climatic and geomorphologic reasons. Climatic
reasons: precipitation is very concentrated, in Northern China, during the summer (June to
August); rain during that time amounts to between 60 and 70% of the annual total. Besides,
the Huanghe displays a very variable regime. Its flow varies from 22,000 m$^3$ per second
during floods at Zhengzhou in Henan, to as little as 250 m$^3$, the winter minimum, while the
mean annual discharge at the mouth – when the river does not run dry – is 1,600 m$^3$ per
second (Smil, 1984). Less than 1,500 m$^3$ of water runoff are available for each hectare of
land in the Huanghe basin, compared to 6,000 m$^3$ per hectare (ha) in the Yangze basin
(Smil, 1993). Geomorphologic reasons: the Huanghe carries a large sedimentary charge
that requires a large amount of the river water to be used for flushing and limits its avail-
ability lest it becomes clogged with sediments and flood-prone (Smil, 1984; Guangwei,
1998); siltation also hampers the construction of extensive river-fed irrigation canals
(Nickum, 1998). These natural constraints led to the intensive use of groundwater for irri-
gation, particularly when compared to Southern China. In 1997, 63.8% of irrigation in the
North China plain relied on well irrigation (Yang and Zehnder, 2001). In the Hai, Huai and
Huang basins, groundwater represents 48, 38 and 35% of total water resources compared to
19% for the rest of China (Ministry of Water Resources (MWR), World Bank, AusAID,
2001); but about 70% of China’s groundwater reserves are located in Southern China.

Thus, groundwater represents the main source of water for the region, but it has been
overpumped for several decades now and already shows signs of depletion. In 1981, with-
drawals in aquifers in the North China plain were estimated at 54%; in 1997 they reached
101%, breaking the renewal limit. In the Hai basin, pumping was taking place at a 70% rate
in 1981, reaching an unsustainable 158% rate in 1997 (Smil, 1984; MWR et al., 2001). New
wells now have to be drilled down to 1,000 metres to reach water in the Beijing area. In
1999, the aquifer level under China’s capital fell by 3.5 m in the west and southwest of the
city and by 2 m on average.

A pollution that stems from development, but could also kill it

Of the 640 major cities in China, more than 300 face water shortages with about 100 facing
severe scarcities. Water availability for cities is further limited by the impact of rural,
industrial and urban pollution. Poor pollution management led to the scarcity of clean
water, water being so polluted at times as to kill crops, notably in Shaanxi. Estimated crop
losses, converted to grain equivalents, were set at 3.9 million tons in 1990 (Nickum, 1998).
The impact of China’s dual problem of water scarcity and water pollution exacts a costly
toll on productivity – water not meeting basic quality standards for industrial use – and on
water supply management – poor supply forcing municipalities to increase pumping in
already severely depleted aquifers.
The increasing water scarcity in the Huai, Hai and Huanghe, or Yellow River basins (3-H) in Northern China had the Chinese leadership facing the dilemma of having to implement a policy concerning this ever acute problem. As in most developing countries, most water withdrawals and consumptive use stems from the agrifood sector, but industrial and domestic demands are increasing fast. Unlike agricultural users, industries and city dwellers usually have the means to pay for higher prices and offer a higher economic return on the amount of water they withdraw and consume. Enacting tougher pollution control measures, the policy the government is now implementing, could force several firms out of business, especially poorly competitive companies in central China, a region already desperate to see economic growth take off like those of the coastal provinces.

Strategic policy choices are now unavoidable

China has 49 million hectares of irrigated land, more than any other country. This compares with some 46 million hectares in India and 20 million in the United States, these countries ranking second and third in irrigated area. Far more important to China than to these two nations, irrigation covers roughly half of the total cropland area and accounts for nearly four-fifths of the all-important grain harvest. The 3-H basins account for about 50% of major cereal production. With most aquifers being depleted, China is now reconsidering its options for re-establishing a balance between water use and supply, since the destruction of these very aquifers would cause a severe blow to agriculture in this region, given its dependence on groundwater.

The Chinese Ministry of Water Resources estimates show that expanding resource exploitation in the North China plain is not an option: even with increased aquifer pumping, total supply would, under a 95% probability, increase from 122 billion m\(^3\) in 1997 to 133.3 billion m\(^3\) in 2050, an increase of 9.1%. On the other hand, demand change, taking into account a 10% efficiency improvement in agriculture and industry, a strong price increase and the development of water reuse, would, in the 95% probability scenario, jump from 190.6 billion m\(^3\) in 1997 to 207.8 billion m\(^3\), also a 9% increase. Thus, these measures would merely slow down the demand increase to a similar pace as water supply, without closing a widening gap of 68.6 billion m\(^3\) in 1997 and 74.5 billion m\(^3\) in 2050 (MWR et al., 2001).

Four possible initiatives stand out: pressure applied against water consumption by the agricultural sector, including agricultural reform; strong water conservation within the North China plain basins; domestic diversion of water from the south to the north; grain imports and diversions from border rivers like the Amur/Heilongjiang.

Reduced agricultural consumption and agricultural reform

Gradual pressure is being applied on officials to transfer irrigation water to urban and industrial users. The Statistical Bureau of the Ministry of Water Resources did a planning exercise from 1991 to 1995 and came to the conclusion that about 40% of the water gap in Northern China could be met by transferring water from agriculture (Nickum, 1998). China’s leaders have stated a general principle that urban and industrial water users will have priority over agricultural water use and that the share of water allocated for agriculture would decrease over the coming decades. The share of withdrawals for irrigation is dropping significantly as a result of pressures from other sectors for the scarcer resource, down from 84% in 1980 to 73% in 1998. But this phenomenon is also causing intense disputes between local political entities, provinces, irrigation districts, and villages (MWR et al., 2001).

However, this theoretical position collides head on with a strategic principle the Chinese leadership has consistently kept since the foundation of the PRC: food security policies.
Agricultural staples such as cereals are still considered by the Chinese leadership as strategic products for which the country cannot rely on too large an import share lest the very security of the country be challenged. Policy debates hint at a reconsidering of the paramount political principle of food security, but so far the Chinese leadership has consistently resisted this route (Dadao, 1993; Crook and Diao, 2000; Yang and Zehnder, 2001; Lasserre, 2002). The very policy of food security, focusing on staples such as cereals, contradicts both the reallocation of water principle and the pricing policy, since having farmers pay much more for their irrigation water will drive many to switch to more profitable crops. To counter a faster growing urban demand, officials have already opted for quotas to be implemented in 2002 (Far Eastern Economic Review, 2001).

Another reason that strongly militates against too rapid a demise of the agricultural sector is that the government fears it would fuel a massive rush to cities already struggling with inadequate infrastructure, housing, transportation, water distribution and treatment after use.

**Use water more rationally**

Conservation policies within the Huanghe catchment have also been put in place. They include, among other things, raising water prices, heightening efficiency in water use, recycling of sewage water, utilizing brackish water, and so on. Less water-demanding crops, as mentioned above, will reportedly be encouraged. An investment, comparable to the estimated cost of the Yangze diversion, in more water-efficient industrial practices, more water-efficient household appliances and above all, the use of more efficient irrigation practices would likely yield more water, since it would alter the structure of withdrawal and consumption. Efforts at water saving have already shown results. Water withdrawals for agriculture increased little from 1980 to 1998, from 358 billion m³ to 369 billion m³, for a surface area that went from 44.96 million ha to 52.3 million ha, indicating a decrease of water use per hectare (Yang and Zehnder, 2001).

But fee levels tend to remain set by provincial governments at very low uniform rates, with little adjustment for inflation or investments, despite the State’s Council decision that water prices, even for agriculture, should be calculated to reflect the real economic cost of extraction, delivery and management. Collection rates also tend to be lower than for industrial and urban uses. This low level of financial return on agricultural use is a strong incentive for cash-starved water management bodies to switch from supplying irrigation water to meeting the growing needs of cities and industries (Nickum, 1998).

Implementing such resource management policies also demands a restructuring of the administrative setting of water management bodies toward a greater centralization. If fully enforced, these political changes imply future battles between the central government and provincial authorities.

The Water Law of 1988 provides for a series of measures to rationalize water management, especially in water-short regions and stresses the need for restrictions on urban, industrial and agricultural consumption as well as the need to implement water-saving techniques in agriculture. In reality, the mechanisms set forth by the law can hardly be effective inasmuch as water management remains split among a number of different agencies. The Ministry of Urban Construction claims the right to supervise urban water uses, the Ministry of Agriculture wants to keep an eye on irrigation, the Ministry of Geology wants to remain in charge of rural groundwater extraction. The State Environment Planning Agency (SEPA) also claims responsibility for water quality monitoring, but there is hardly any coordination between SEPA and the Ministry of Water Resources, since the two bodies seem to nurture a competitive relationship (World Bank, 2001).

Besides, the basin management agencies are not really autonomous, but are indeed
branches of the Ministry of Water Resources (MWR). They therefore appear as mere emanations of the central government to local authorities, thus making arbitration and negotiations more tense when claims to the resource compete.

Since March 1999, Huanghe River waters have been subjected to central planning and allocation, a drastic measure the government opted for so as to try and find a solution to the recurrent episodes of drying up of the river. This decision was very unpopular among provincial governments, but the central authorities boast over the fact that the Huanghe River did not run dry in 2000, reportedly because of central management practices (China Daily, 2001).

Water transfer within China
The severe drought that has struck China for the past 5 years has lent urgency to the 46-year-old plan to bring water to Northern China from the Yangze River. Government planners are also well aware of the fact that improved water management techniques, pricing and recycling, besides being costly, are also slow in showing large-scale effects.

The gigantic engineering project diverting water from the upper, middle and lower reaches of the Yangze would alleviate to a certain extent water scarcity in the north, especially in the short term. However, some officials have hinted at the idea that it is the acuteness of the drought crisis that had the government give the green light, in November 2001, to a costly and controversial project. The government decision seems irreversible nevertheless, if only because almost all forecasts show water deficits would be unbearable in Northern China without the water transfer scheme.

The South-North Water Transfer Project (SNWTP) may appear to be unavoidable given the widening water deficit in Northern China, but it will not solve the water scarcity issues in the region. A study by Sandia National Laboratories show that, should the consumptive patterns in Northern China remain the same, water deficits should return to 2002 levels in 2025 in the Hai basin, even with the Yangze derivation (Sandia National Laboratories, 1999). According to another study – assuming, as the Ministry of Water Resources does, that water transfers from the Yangze would amount to 12 billion m$^3$ in 2010 and 19.4 billion m$^3$ in 2020 – the global water deficit, under a 75% probability, would still be 33.6 billion m$^3$ in 2010 and 30 billion m$^3$ in 2050 (MWR et al., 2001).

Government planners have selected three routes; most were envisioned as early as the 1950s. The eastern route, first approved as early as 1983, calls for the widening and deepening of the Grand Canal from the Shanghai region north to Beijing. This route would transfer between 19 and 21 billion m$^3$ per year “in the long term” (Changming and Dajun, 1995).

The middle route, the current priority, would transfer water from the Danjiangkou reservoir on the Han River to supply Hubei, Henan, Hebei and then continue on to Beijing and Tianjin with a tunnel under the Huanghe. Long term projects also include the derivation of water from the Three Gorges Reservoir into the Danjiangkou, raising the derivation capacity from 13.8 to 23 billion m$^3$ (Chunhuai, 1995; Nickum, 1998).

The western route requires massive works such as 410-metre high dams, tunnels between 30 and 210 km, 2 pumping stations lifting water 495 m and 485 m, and all for a total derivation that would not exceed 20 billion m$^3$ (Changming and Dajun, 1995; Xiande, 1995). Some authors strongly suggest that the western route is utterly unrealistic (Smil, 1984; Far Eastern Economic Review, February 2000), while others insist China cannot do without it in the medium to long term, given the water deficit that will develop in Northern China.

International watercourses derivation: confronting wary neighbours?
As regards water-rich but human-poor Siberia, China is for now keen on maintaining
good relations with Russia for international relations purposes, but mistrust is entrenched between the two neighbours. Once a political tool against the Soviet Union during the 1970s, the idea of tapping into Siberia’s water resources could resurface in China, frightening Russia. Projects such as the damming of the Heilongjiang tributaries have already surfaced both within Russia and China as droughts and fast economic development, especially on the Chinese side, indicate a rapidly growing water demand. The sheer scope of the western route envisioned for the Yangze derivation had Chinese scientists underline its poor feasibility or economic rationality, pointing to more practical derivation schemes in Northeastern China, especially in the Amur/Heilongjiang basin.

Projects of derivation from Northeastern China in the Heilongjiang Basin, include derivation from tributaries of the Songhua (Sunggari) River, a major tributary of the Heilongjiang, as well as from the Ussuri; from the Yalu River marking the border between China and North Korea (Nickum, 1998); from various Heilongjiang tributaries (Tianxin and Kang, 1997); from the Ili (the main Lake Balkash tributary) and Ertis (Irtych, a major Ob tributary) in northern Xinjiang, major rivers that flow into Kazakhstan and Russia (Beijing Information, 2000).

Besides being a potentially explosive issue with Kazakhstan and a China-wary Russia, water issues are becoming sensitive in Northeastern China and Siberia as well, with rivers running with less and less water and reservoirs drying up (China Daily, September 2000; Pravda, June 2001). It is not sure that the Heilongjiang basin provinces would agree to let their water go when they themselves begin to feel the pinch of water scarcity.

**Conclusion**

The equilibrium between supply and demand is still very much a matter of national-scale policy in China. With domestic agricultural output still considered strategic, imports and substitution policies or drastic arbitration against small and/or ineffective farmers are usually disregarded at the national level, though pricing is no longer considered an impossible option. Drastic conservation policies such as sharp price increases have so far been the fate of industries and cities, with the adverse effect that these customers, being able to pay, tend to grab water away from farmers.

Massive investment in efficient irrigation could have been an option. Instead, the government opted for a diversion scheme that seems extremely expensive and technically far more difficult than diverting water from border rivers in the north. Moreover, the south-north water transfers would not be enough, given the volumes that could be diverted, to avoid the return of the problem without further investments in either conservation or other derivation works. It then appears the Chinese government opted for the Yangze derivation so as to achieve a precarious equilibrium between domestic and international constraints.

**References**

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