China Environment Forum

Woodrow Wilson International Center for Scholars

This brief is part of a series under the China Environment Forum's Cooperative Competitors: Building New Energy and Water Networks Initiative, made possible by support from the Blue Moon Fund, Rockefeller Brothers Fund, U.S. Agency for International Development, and Vermont Law School

Quenching the Dragon's Thirst
The South-North Water Transfer Project—Old Plumbing for New China?

By Carla Freeman

As the legend goes, when a man named Yu heeded the dragon's instructions about how to channel flood waters, he tamed China's rivers and was made emperor. China's rulers have long understood the critical importance of water in ensuring their country's prosperity—and the link between how effectively they manage these resources and their own political longevity. The pressures for efficient management of water today is similarly challenging as in the past—China's government must possess the ability to maintain the hydraulic systems necessary to mitigate flooding from China's great rivers but also to ensure an adequate supply of water for the needs of its people. As Joseph Needham in his epic history *Science and Civilization in China* observed, the challenges of flood control and of maintaining irrigation and water transportation networks, among other dimensions of water management, served as sources of innovation in Chinese civilization as it developed, stimulating technological invention and intellectual debate.[1]

AN UNQUENCHABLE THIRST

Today, China is confronting acute scarcity in its national water supply. Geographically, China's water resources are unevenly distributed, with northern China's water availability per person only a fraction of that in the rainy south. China's huge population of more than 1.3 billion, a third of which is concentrated in the relatively dry Huang-Huai-Hai river basins of north China, is a major factor in China's low per capita water availability. Low water productivity—or

the amount of water required per unit of yield—particularly in agriculture, but also in China's booming industrial and energy sectors, has also played a key role in exacerbating the country's water scarcity. Climate change is disrupting weather patterns and accelerating the evaporation of glaciers, further diminishing surface water supplies. In addition, increasingly widespread pollution from industrial and domestic wastewater discharges of China's surface water resources and 90 percent of China's rivers near urban areas has not only taken a toll on human health,[1] but also has contributed to shortages that have led to a rising dependence on groundwater. A consequence has been that critical rivers, lakes and wetlands are drying up. Water table levels also are falling, causing land subsidence in some areas.[2]

Water scarcity is already doing measurable harm to China's economic productivity, with reduced river flows affecting hydropower generation and limiting expansion of water-dependent industries—from coal mining and petroleum refining to steel production to higher-tech industries, such as semi-conductors—all are increasingly constrained by the lack of water. Notably, most of China's coal resources are in the arid north and some of China's largest coal reserves remain untapped due in great part to water shortages.

Finding ways to augment China's water supply is therefore an increasingly pressing concern of China's policy leaders. China's Premier Wen Jiabao has called China's water shortfall a threat to the very "survival of the Chinese nation."[3] Historically, water shortages in China have been redressed principally by engineering physical transfers of water to augment supply. Dating back to the Han Dynasty, chain pumps were used to move water from lower to higher elevations to irrigate fields or to provide water to urban dwellers. Mao Zedong continued this tradition using 20th century technology. For example, to ensure that farmers in arid northern China had access to ample irrigation water to boost grain production and other food staples, Mao encouraged the digging of tube wells, powered by gas or electric-powered pumps, to draw on water in aquifers. Such aggressive irrigation of agricultural land in northern China has continued, so that today around two-thirds of agricultural production in the region is at least partially irrigated, much of it by groundwater. The dangerously unsustainable nature of these pumping practices has become apparent as groundwater levels in the region have plummeted at a rate that suggests aquifers could be emptied by mid-century and many of north China's rivers now run dry during part of the year.[4]

REPLUMBING CHINA

As the sense of crisis has intensified, China's technocrats have pursued more ambitious efforts to expand supply. The past two and half decades have been an era of long-distance water transfer projects—all to dry northern cities. These have included projects involving transfers from the Biluhe River to Dalian, the Huanhe to Qingdao, the Lanhe to Tianjin, and the Luanhe to Tangshan, among others.[5] Much of the one trillion Yuan allocated for public investment in the water sector in China's 11th Five-Year Plan (2006-2010) was for diverting water supplies to cities experiencing water shortfalls.[6]

The most ambitious and best known of the diversion projects that has been launched was inspired by Mao Zedong, who included among his favorite allegories the story of the old man who set out to move the mountain standing between his home and the lake where the old man and his family drew water. According to the tale, the old man believed that although he would not live to see the feat completed, the efforts he began during his own lifetime to move the mountain would ultimately be achieved by succeeding generations. In 1952 Mao observed, "The South has plenty of water and the North lacks it, so if possible why not borrow some?" This idea gave rise to the extraordinary

vision of building the infrastructure that would enable the diversion of billions of cubic meters of water from flood-prone southern rivers to China's dry northern region.

Mao did not live to see ground broken on what is now known as the South-North Water Transfer Project (*nanshui beidiao gongcheng*). While he was at China's helm, economic and political disruptions associated with the mass campaigns and radical social and economic experiments he fostered marginalized work on this and other massive engineering projects, including the Three Gorges Dam. In fact, no project planning office was established for the massive water transfer project in the Ministry of Water Resources (then Ministry of Water Conservancy) until December 1979.[7] By the 1990s, with the backing of some of China's most senior leaders, the project was slated for implementation. A key supporter was former Premier Li Peng, a hydraulic engineer by training who has also been linked to the decision to proceed with the Three Gorges Dam. Other rising leaders of the time, such as current Chinese President Hu Jintao, a graduate of Tsinghua's Department of Water Conservancy program, shared similar engineering backgrounds. With such leadership support, 50 years after Mao articulated his vision—amid the additional stimulus to economic growth that had followed China's accession to the World Trade Organization—the State Council approved the project. Despite its initial projected total cost of $62 billion, two times the cost of the massive Three Gorges Dam, and projections that completing the project would take nearly half a century, a special limited liability company was established to execute the project and in late December 2002, construction on the project began.[8]

AND THEN THERE WERE THREE

When completed, the South-North Water Transfer Project will be a truly colossal waterworks, linking up China's four main rivers—the Yangzi, Yellow, Huaihe and Haihe rivers—and diverting water along three canals, the so-called Eastern, Central, and Western routes. The Eastern route will take water from the lower reaches of the Yangzi River, utilizing as its principal conduit the 1,800 kilometer-long ancient Hangzhou-to-Beijing canal (which dates from the 7th Century A.D) to convey a supply of water to Jiangsu, Anhui, Shandong and Hebei provinces, as well as the city of Tianjin. The volume of water it is expected to deliver should be adequate to meet the water needs of agricultural and industrial sectors in all of these areas. In addition, the extra water flow through the canal will make it navigable throughout the year.

The Central route will carry water from the Danjiangkou reservoir on the Han River (a Yangzi River tributary) to areas of Hubei, Henan, and Hebei, including more than a dozen cities, among them Beijing and Tianjin. The route has been designed so that water will flow from its source to its end point by gravity alone. A major engineering challenge has been the need to increase the storage capacity and therefore the height of the Danjiangkou Dam from its original 157m to 170m. In a striking display of Chinese engineering muscle, the Eastern and Central routes both will run under the Yellow River.[9]

The Western route is stunningly ambitious. It is designed to tap three tributaries of the Yangzi—the Tongtian, Yalong and Dadu rivers—on the Qinghai-Tibet plateau, where nearly one-third of China's water resources are concentrated, and move water nearly 500km through the Bayankala Mountain range involving elevations of 10,000 to more than 16,000 feet above sea level to northwest China where it will help replenish the Yellow River principally to provide water to irrigate millions of hectares in western China but also to meet the demands of urban, industrial, and energy development in the region.[10]

Significant sections of the overall project have already been completed. Current projections are that the Eastern route

will be fully completed in 2013. Work has also pushed ahead on key projects in the Central canal, starting by raising the height of the Danjiangkou Dam. Work on this section started in 2005 and is completed at its northernmost point, where a 307km channel has been designed to carry water from Hebei's reservoirs into Beijing. A six-month period of flow was started in September 2008 from reservoirs in Hebei through the channel to Tuancheng Lake in Beijing's Summer Palace.[11] Emergency water for the 2008 Olympics was also transferred to Beijing via a completed section of the Central canal project.

The completion of this canal will be a welcome relief for Beijing, which faces a massive water emergency. In late 2010 CNN reported that 62 percent of the Beijing's 51 reservoirs had run dry and the city's annual water shortage will reach 200 to 300 billion cubic meters,[12] which underscores the magnitude of thirst for the completed Central canal. Beijing is expected to receive one billion cubic meters of water annually from the diversion. Other significant projects that are moving the Central canal forward are underway: a multi-purpose dam on the Han River, construction of the trunk channel in Henan, and construction of a waterway connecting Nansi and Dongping lakes, the two largest freshwater lakes in Shandong Province.[13]

The Western section of the project remains at the planning stage. Technical analyses for it have been conducted; however, a start date for it has not yet been announced and it is not slated for completion until 2050.[14]

A FLOOD OF CONTROVERSY

As work has moved forward on the South-North Water Transfer Project, the controversy surrounding it has grown louder. Western news reports in December 2008, quoting officials from China's State Council, indicated that completion of the project's Central route would be slowed in response to the need to mitigate its negative environmental impacts. The reports suggested that concerns raised by local environmental officials about the effects on river water quality of planned reductions of the water level of the Han River, given unusual attention by the Chinese media, underlay the delay. Revisions to the original project have been reported that will require an additional four years (from 2010 to 2014) to implement. These involve a scheme to divert water from the Yangzi to the Han to compensate for the reduced flows expected to result from the diversion.[15]

Prominent scientists and environmentalists in and outside government also have raised questions about the environmental impacts of the three canals since the transfer project's inception, with an increasing number willing to express their concerns publicly in recent years, in both the western and Chinese media. A major concern from the outset has been the potential to transmit disease, particularly snail-borne schistosomiasis, from southern China to the north. Numerous water treatment plants are part of the project's design, but many scientists and other environmental experts remain dubious that they will be effective in containing this and other waterborne health risks between regions. The project's impact on wetlands also has raised environmental red flags as reduced river flows will slow the deposit of sediments that are critical to wetland formation.

The construction process of the canals also poses potentially seriously harmful ecological consequences, including salt-water intrusion and habitat destruction. The May 2008 earthquake in Sichuan, where some sections of the western diversion project are located, heightened concerns about the impact of seismic activity on the project and the ecological repercussions in the event of significant disruptions.[16] These are only a few of a long list of concerns about the project's ecological and other adverse impacts.

Some of the criticism of the project from officials at the provincial level reflects unhappiness with the redistributive nature of the project, with local resources captured for the benefit of relatively better-developed regions. Prominent environmental advocate, Ma Jun, of the Institute of Public and Environmental Affairs and author of *China's Water Crisis* (2003), has repeatedly argued that given the project's huge financial and environmental costs, its benefits accrue predominantly to residents of Beijing.[17]

Source: *The New York Times*
http://www.nytimes.com/imagepages/2007/09/27/world/28china_map.html

THE MOUNTAINS ARE HIGH AND THE WATER IS FAR AWAY (BUT NOT FOR LONG)

Demands for Compensation

Officials in Hebei's capital, Shijiazhuang, who have sought to slow the project, have long seen Beijing's water requirements given precedence over its own.[18] Hebei's water conservation department has reported that endemic water shortages have become a drag on the province's growth. According to interviews with provincial water officials, water resources in the province have declined by 50 percent in recent years; the implication is that a large portion of this decline is due to water diversion.[19] Farmers in several counties in Hebei have been required to switch from growing rice to corn to conserve water for one of Beijing's two main reservoirs.[20] Some central Chinese leaders have joined with provincial and municipal authorities to urge the central government to compensate localities whose water has been diverted to northern areas; some cities located along the diversion route have been forced to shut down enterprises to make way for the diversion scheme, or because they were polluting water designated for drinking downstream. Some localities have faced reduced tax revenues and higher unemployment.[21]

Provinces Balk at the Costs

Notably, Hubei's Shennongjia district, home of the Shennongjia Nature Reserve in the upper reaches of the Yangzi River, have asked for financial subsidies to make up for losses to potential local GDP. Local officials have argued for compensation because they must provide ecological services for the Central transfer canal. Specifically, because development in their district must meet strict environmental standards to ensure that the Danjiangkou Reservoir's water level is sufficient to supply the South-North Water Transfer project, development in their region, including the ability to exploit the region's valuable mineral resources, has been constrained.[22] Problems that have accompanied the project's construction have caused additional economic losses to other local communities and some technical problems, some of which have required an "emergency response," including a special armed police hydropower force, to resolve them.[23] All the while, some central officials have complained that local leaders are not taking adequate steps to mitigate industrial discharges that are polluting water that is needed for the diversion.[24] Strikingly, some northern provinces and cities have balked at accepting the water if they must pay to clean it up.

Resettlement Challenges

Still more visceral and poignant local level challenges to the project revolve around citizen resettlement. Some of the at least 300,000 people expected to be displaced by the project—180,000 from Hubei and the remaining 150,000 from Henan—have begun to be relocated. At the time of the author's visit to the Danjiangkou Dam in March 2009, where construction of a massive cap designed to raise the height of the original dam was proceeding apace, she was struck by the large sign at the gate to the dam's fenced construction site that made clear that acts of protests or vandalism were prohibited, a reminder that just a month earlier farmers in the local village had verbally attacked village officials and threatened resistance over plans to resettle them elsewhere in central China.[25] Some current residents of the area formerly lived on the site where the Danjiangkou reservoir was constructed; for them this is a second displacement.[26]

GO WEST…THEN NORTH

The Western section of the project, which remains in the planning stage, has elicited the greatest controversy. Chinese scientists with China's National Academy of Engineering, including Qian Zhengying, a former Minister of Water Resources, issued a report in 2006 urging the government to suspend the project for further study. This report followed the publication in 2005 of papers and an edited volume in Sichuan Province (through which an extent of the Western diversion passes) that were sharply critical of the project's western route. Retired researchers from the Sichuan Provincial Academy of Social Sciences, Lu Jiaguo and Lin Ling, who promoted the book, had sought to draw the attention of the officials and the media to the question of whether the Western route of the South-North project would "save the Yellow River at the Yangzi River's expense?"[27] A letter by Lu to Premier Wen Jiabao questioning the Western route's viability and pointing to some of its likely negative impacts could have helped prompt a meeting between the Ministry of Water Resources and the Sichuan provincial government, which yielded a decision to delay the project.

China's Western canal plans have also alarmed some of its regional neighbors. China's diversion plan would draw water from the Yalong Tsangpo River at the so-called "Great Bend" or Shuomatan Point just before the river enters India as the Brahmaputra. Reduced water flows would impact millions in both India and Bangladesh. Indian leaders are concerned about the leverage the project could give China over India as Chinese water infrastructure projects exert greater control over the river's flow.[28] If construction on the Western water transfer canal proceeds, it will be built as the pace of glacial melt on the Tibetan Plateau is accelerating. It and other hydroelectric projects underway or planned in the plateau will impact the great rivers that flow from the Chinese side, including the Mekong, Salween, Irrawaddy, Brahmaputra, Sutlej, and Indus. India's Prime Minister Manmohan Singh reportedly raised the issue of international rivers originating on the Tibetan Plateau during his visit to Beijing in early 2008, but it was not until December 2010 that Premier Wen Jiabao announced during his visit to India that China would take into account downstream interests when damming in the Brahmaputra basin.[29] While the countries have renewed their MOU on sharing information on flooding in the basin, they have not held formal talks on the issue of water transfers out of it.[30] In the absence of international agreements on trans-boundary management of these rivers among the riparian states, water can be expected to emerge as an important international security issue for the region.

REENGINEERING DEMAND: CAN LESS MEAN MORE?

Some of the criticism surrounding the South-North Water Transfer Project has come from those who advocate more demand-side approaches to managing China's water resources. Recently, demand management appears to be

gaining traction even among China's most senior policymakers as a less risky and more sustainable solution to the country's water woes. New efforts to curb demand for water have taken several forms, with the principal emphasis on conservation, introducing more market mechanisms into the water sector, and adopting administrative reforms that seek to better integrate water resources governance at the central level, yet strengthen local capacity over some aspects of water supply management.

CONSERVATION POLICIES

China's leaders set ambitious targets for water conservation as part of the vision, as stated in its 11th Five-Year Plan (FYP), to become a "resource conserving society."[31] The 11th FYP (2006-2010) and associated 11th FYP for Water Resources Development set goals of managing water as a strategic resource. Objectives of the 11th FYP for the agricultural sector were to keep total water consumption for agricultural irrigation constant. The mandated target for industry in the plan was to reduce water consumption per unit of industrial added value by 30 percent.[32] China's central government has reported that it invested nearly 300 billion Yuan ($45 billion) on water conservation during the five years of the plan, with the total investment in water projects related to conservation in China from other levels of government bringing the total to approximately 700 billion Yuan.[33] Minister of Water Resources Chen Lei announced in late 2010 that China would double its average annual investment in construction related to water conservation over the coming decade.[34] New goals to manage water consumption and improve the efficiency of water usage announced for the 12th FYP period include limiting annual consumption of water in China to below 620 billion cubic meters and achieving an even more substantial reduction in industrial water usage than under the 11th FYP.[35]

The Chinese government has launched pilot projects to test the potential of various approaches to water conservation in a range of sectors. These include pilots in rural areas in which the Ministry of Water Resources is collaborating with the Ministry of Finance to provide subsidies to farmers to improve the efficiency of their irrigation systems.[36] This pilot program builds on efforts to improve water saving in rural areas through the introduction of technical solutions by a number of policy measures, including the 2005 *Water Saving Technology Policy* issued by the NDRC with several ministries (e.g., water resources, housing, agriculture and science and technology). These policies have accelerated the renovation of existing irrigation systems and in changing watering practices and techniques such as wet/dry irrigation for rice production.[37]

WATER PRICING AND TRADING

Unlike many past pilots aimed at promoting more conservative use of water, over the past few years the Chinese government has been pushing for technical and technology-based efficiency gains to be accompanied by reforms on water rights and pricing. Such reforms could help reconcile the large discrepancy between the value of water and its current cost to users. Specifically, these reforms have been aimed at changing the way water is allocated, through the development of a system of water rights to facilitate water trading and ultimately water pricing—the latter has been a particularly hard sell in rural areas. The cost of water for agricultural use is extremely low, even free. Farmers who use groundwater, for example, frequently pay only the cost of the energy used to extract the water and water use is rarely metered. The Chinese government has pushed to shift the operation of water distribution and fee collection from village committee to Water User Associations and to encourage irrigation district agencies to operate on the more efficient and potentially transparent basis of commercial principles, whereby Water

User Association fees would be a key source of operating income, for example.[38]

Water trading also has been introduced through a number of pilot projects, including those based on "water certificates" granted to individual households, which permit farmers to purchase "water tickets" up to the level permitted by their certificate that can then be freely traded.[39] Despite these projects, the expansion of water markets to promote more efficient use of water in agricultural production is proceeding slowly. China's leaders are wary of compromising hard-won gains in rural incomes or jeopardizing the country's food security by depressing food production—particularly in the face of public discontent over rising food costs.[40]

Water tariff reform is well underway in China's cities, which have seen significant increases in water prices in recent decades. Across most cities, however, water prices still do not generally reflect costs for water distribution, sewerage and water management, with the result that water for China's city-dwellers costs a fraction of what residents of European cities pay, and about half of what it costs Brazilian consumers.[41] This is changing rapidly as China's municipal leaders recognize that, despite public opposition to increases in water tariffs, the reform of water prices to better reflect water scarcity offers a critical tool in promoting water conservation that could be a vital part of sustaining economic growth. In addition, as increasing numbers of sewage treatment plants are constructed, water tariffs must include the cost of sewage treatment.[42]

To mitigate citizen complaints and concerns about the regressive effects of price increases on those with lower incomes, the NDRC has promised subsidies to groups most affected by increases in water prices and has with the Ministry of Housing and Urban-Rural Development issued a circular requiring that local governments insure that low-income families have a basic standard of living when raising water prices, [43] which reflects deep-seated concern by government authorities about the potential for mass protests over hikes in the cost of water.[44]

CONSERVE—BUT ALSO CONSTRUCT?

Despite these efforts aimed at promoting conservation, Chinese leaders recognize that changing established patterns of water use is its own gargantuan project. The push for more efficiency in water use over the last several years has yielded only modest progress to date. After several years of disappointing data, a report to the National People's Congress in March 2010 indicated a reduction of 8.2 percent in the amount of water used per 10,000 Yuan of value added industry, finally exceeding expectations. [45] However, agricultural water usage continues to account for around 70 percent of total water use and productivity remains at about half the level of that of developed countries at 1.0 kg/m^3, with as many as half of the country's existing water conservation facilities related to agriculture still needing repair.[46] At the same time, government efforts to reduce consumption by raising the cost of water remains extremely unpopular, particularly amid rising food and energy prices. An online survey at www.people.com.cn, reported in the Chinese media, indicated that more than 60 percent of Chinese citizens are opposed to seeing increases in their water bills.[47]

Chinese officials recognize the potential for reducing pressures on water supplies by better protecting water resources through a range of measures, including tightening regulations to prevent water pollution and trying to improve planning for water allocation and the management of water quality through more integrated, river basin-wide approaches as well.[48] In addition, China is pursuing the construction of large-scale seawater desalination facilities. As water prices rise and as the price to desalinate seawater falls with the introduction of technological advances, desalinated seawater

is expected to become a major source of water for cities like Tianjin and Beijing.[49] None of these initiatives, however, sounds the death knell for continued progress on the South-North water transfer project's construction. Chinese leaders have remained committed to the project, including its controversial western section, with the Office of the South-to-North Water Diversion Project Commission of the State Council announcing in May 2010 that work on the project's East and Central sections had been accelerated.[50] Recent reports indicate that China has now earmarked 90.6 billion Yuan for the project, a significant increase from the 53.87 billion Yuan announced in 2009.[51]

While Chinese experts now acknowledge that the Tibetan glaciers that feed China's major rivers are not the inexhaustible source of water they once were and are melting at a "worrisome" speed,[52] the sense remains that, as former PLA Party Secretary, General Zhao Nanqi is said to have remarked a decade ago when evaluating the project, "Even if we do not begin this water diversion project, the next generation will. Sooner or later it will be done."[53]

Carla Freeman is a member of the faculty of the China Studies Department at Johns Hopkins SAIS. She can be reached at: cfreeman5@jhu.edu.

This brief is part of a series under the China Environment Forum's Cooperative Competitors: Building New Energy and Water Networks Initiative, made possible by support from the Blue Moon Fund, Rockefeller Brothers Fund, U.S. Agency for International Development, and Vermont Law School.

USAID FROM THE AMERICAN PEOPLE
blue moon FUND
VERMONT LAW SCHOOL
Rockefeller Brothers Fund
Philanthropy for an Interdependent World

[1] Jian Xie et al. (2009). *Addressing China's Water Scarcity: Recommendations for Selected Water Resource Management Issues*. The World Bank: xx-xxi.
[2] Ibid.
[3] Alison Leung. (2007,May 14). "Funds Flow into Water Industry." *The Standard*. [Online]. Available: http://www.thestandard.com.hk/news_detail.asp?pp_cat=20&art_id=44317&sid=13546891&con_type=1.
[4] Jim Yardley. (2007, September 28). "Choking on Growth: Part II." *The New York Times*. [Online]. Available: http://www.pacificenvironment.org/article.php?id=2580.
[5] L. Berga. (2006). *Dams and Reservoirs, Societies and Environment in the 21st Century, Vol.1*. (London: Taylor and Francis): 27.
[6] Interview notes, discussions with representatives of the Ministry of Water Resources (MWR), at MWR in Beijing, March 19, 2009.
[7] James E. Nickum. (2006). "The Status of the South to North Water Transfer Plans in China." *Human Development Report*. [Online]. Available: http://hdr.undp.org/en/reports/global/hdr2006/papers/James_Nickum_China_water_transfer.pdf.
[8] "South-to-North Water Diversion." *water-technology.net*. [Online]. Available: http://www.water-technology.net/projects/south_north/.
[9] National Group of China, ISRM, and National Society for Rock Mechanics and Engineering. (2009, December 3). "South-to-North Water Transfer Project." [Online]. Available: http://www.csrme.com/EN/News/2009-12/EnableSite_ReadNews713509261259769600.html.
[10] "Factbox: Facts on China's Water Transfer Project." (2009, February 27). *Reuters*. [Online]. Available: http://uk.reuters.com/article/idUKPEK91076.
[11] "Water from Hebei Eases Beijing Water Shortage." (2008, September 28). *chinaview.cn*. [Online]. Available: http://news.xinhuanet.com/english/2008-09/28/content_10129788.htm.
[12] "Water Shortages Reach Crisis Levels in China."(2010, September 13). *CNN Wire Staff*. [Online]. Available: http://articles.cnn.com/2010-09-13/world/china.water.crisis_1_water-shortages-water-supplies-drinking-water?_s=PM:WORLD.
[13] "China Launches Key Construction along Water Diversion Project." (2009, June 5). *People's Daily*. [Online]. Available: http://english.people.com.cn/90001/90776/90882/6672171.html.
[14] "Work Starts on Yangtze Dam for China's South-To-North Water Diversion Project." (2009, February 2). *www.hwc.gov.cn*. [Online]. Available: http://www.hwcc.gov.cn/nsbd/NewsDisplay.asp?Id=212539.
[15] Shai Oster. (2008, December 31). "China Slows Water Project." *The Wall Street Journal*. [Online]. Available: http://online.wsj.com/article/SB123064275944842277.html.
[16] "World's Oldest Irrigation System Said Safe After China Quake." (2008, May 14). *Xinhua*. [Online]. Available: http://news.xinhuanet.com/english/2008-05/14/content_8168758.htm.
[17] "Experts Warn China's Water Supply May Well Run Dry." (2003, September 1). *South China Morning Post*. [Online]. Available: https://probeinternational.org/.../experts-warn-chinas-water-supply-may-well-run-dry.
[18] "A Shortage of Capital Flows." (2008, October 9). *The Economist*. [Online]. Available: http://www.economist.com/world/asia/displaystory.cfm?story_id=12376698.
[19] See also "State Media Reports Province Supplying Beijing Water Drying Up." (2009, March 22). *AFP*. [Online]. Available: http://www.google.com/hostednews/afp/article/ALeqM5jhOwh9PpCR6-ZVuHNj9Ipp03sC8w.
[20] "Olympic Beijing Joins Hands With Neighbor for Adequate Water Supply." (2007, October 3). *NewsEdge*. Document Number: 200710031477.1_a7c200677be2359f.
[21] "Compensation Urged for Areas With Water Diverted To Thirsty Beijing." (2007, March 10). *Xinhua*.
[22] Ma Yujia. (2009, June 10). "China's Nature Reserve Facing Dilemma: Environment or Development: What's Wrong in Shennongjia?" *Zhongguo Wang*. [Online]. Available: http://www.china.org.cn/environment/features_analyses/2009-06/05/content_17895980.htm.
[23] Liao Dezhen & Xu Da. (2007, April 20). "Armed Police Hydropower Force Solves Seepage Problem for South-To-North Water Diversion Project." *Jiefangjun Bao*; "South-To-North Water Project Breach Floods North China Farms." (2008, November 28) *China Daily*. [Online]. Available: http://www.chinadaily.com.cn/china/2008-11/28/content_7252209.htm.
[24] "Legislator: Pollution Threatening Water Project, Rivers." (2007, August 26). *Xinhua*. [Online]. Available: http://en.ce.cn/National/environment/200708/27/t20070827_12689889.shtml.
[25] Chris Buckley. "China's Giant Water Scheme Opens Torrent of Discontent." (2009, February 27). *Reuters*. [Online]. Available: http://uk.reuters.com/article/idUKPEK312522.
[26] Nickum, Ibid: 5-6.
[27] "Sichuan Demands More Say in Major Water Diversion Project." (2006, September 27). *China.org.cn*. [Online]. Available: http://www.china.org.on/english/2006/Sep/l 8241 3.htm.

[28] Sudha Ramachandran. (2008, November 9). "India Quakes Over China Water Plan." *Asia Times*. [Online]. Available: http://internationalrivers.org/en/node/3644.
[29] "China to listen to India on Brahmaputra issue." (2010, December 16) *Reuters*. [Online]. Available: http://in.reuters.com/article/idINIndia-53611320101216.
[30] Ravish Tiwari. "India, China Renew Brahmaputra Pact." (2010, April 29). *Indian Express.com*. [Online]. Available: http://www.indianexpress.com/news/india-china-renew-brahmaputra-pact/612817/.
[31] National Development and Reform Commission. (n.d.) *Outline of China's Five-Year Plan*. [Online]. Available: http://en.ndrc.gov.cn/hot/W020060531535882693159.jpg.
[32] Jian Xie et al. (2009): 27-29.
[33] Liang Chao. "China Intensifies Construction of Water Conservation Facilities." (2010, December 24). *China Daily*. [Online]. Available: http://www.chinadaily.com.cn/regional/2010-12/24/content_11753119.htm.
[34] "China to Spend $30 billion on Water Conservation in 2011." (2010, December 27). *Reuters*. [Online]. Available: http://www.reuters.com/article/idUSTRE6BO02P20101227.
[35] "China to Tighten Water Resource Management." (2010, November 22) *China Daily*. [Online]. Available: http://www.neworiental.org/publish/portal0/tab1127/info595512.htm.
[36] Ren Bo. (2008, July 11). "Irrigation Reform: Make Every Drop Count." *Caijing*. [Online]. Available: http://english.caijing.com.cn/2008-07-11/100074223.html.
[37] Shahbaz Khan, Munir A. Hanjra, & Jianxin Mu. (2009). "Water Management and Crop Production for Food security in China: A Review." *Agricultural Water Management*, Vol. 96. 354.
[38] It is not unusual around the world for water for irrigation to be supplied to farmers at a price close to zero. See also Ximing Cai. (2008, April). "Water Stress, Water Transfer and Social Equity in Northern China—Implications for Policy Reforms." *Journal of Environmental Management*: 14-25. Note also that in 2001 the then State Planning Commission with the Ministry of Water Resources and Ministry of Agriculture issued a formal commentary on the potential impact of water pricing reform on farmers' incomes. Further discussion in Jinxia Wang, Zhigang Xu, Jikun Huang, Scott Rozelle, Intizar Hussai & Eric Biltonen. (2004). "Water Management Reforms in the Yellow River Basin: Implications for Water Savings, Farm Incomes and Poverty." *The Comprehensive Assessment of Water Management in Agriculture Research Report 3*. [Online]. Available: http://www.iwmi.cgiar.org/assessment/FILES/pdf/publications/ResearchReports/CARR3.pdf.
[39] Roger C. Calow, et al. (2009). "Irrigation Development and Water Rights Reform in China." *International Journal of Water Resources Development*. 25(2): 227-248.
[40] Robert Speed. (2009). "Transferring and Trading Water Rights in the People's Republic of China." *International Journal of Water Resources Development*. 25(2): 269 - 281.
[41] Wang Xinbo. (2006)."*Water Governance in China: The Failure of a Top-Down Approach." The Water Revolution: Practical Solutions to Water Scarcity*. Sustainable Development Network: 164; Li Jing. "Water Shortage Threatens China." (2009, February 2) *China Daily*. [Online]. Available: http://www.chinadaily.com.cn/bw/2009-02/09/content_7455321.htm.
[42] Li Hang. (2009, August 10). "Water Prices Rising Across China." *Caijing*. [Online]. Available: http://www.caijing.com.cn/2009-08-06/110221092.html.
[43] Andrew Batson. (2009, July 31). "China Cities Raise Water Price in Bid to Conserve: Tariffs Remain Low by Global Standards." *Wall Street Journal*. [Online]. Available: http://online.wsj.com/article/SB124897577003694405.html; CCTV. (2009, August 4). "NDRC Price System Reform Underway." *CCTV9*. [Online]. Available: http://www.ebigear.com/res-1778-7777700096001.html; "Water Price Adjustments to Promote Resource Conservation and Environmental Protection." (2009, August 5). *People's Daily*. [Online]. Available: http://english.peopledaily.com.cn/90001/90778/90857/90860/6718475.html.
[44] "Water Price Adjustments to Promote Resource Conservation and Environmental Protection." (2009, August 5). *People's Daily*. [Online]. Available: http://english.peopledaily.com.cn/90001/90778/90857/90860/6718475.html.
[45] "Full Text: Report on China's National Economic, Social Development Plan." (2010, March 16). *Xinhua English*. [Online]. Available: http://english.sina.com/china/2010/0315/309038.html.
[46] Xie Peicong. "Agricultural Water-Saving Irrigation Measures." [Online]. Available: http://eng.hil38.com/?i273771_Agricultural_water-saving_irrigation_measures#; Lan Xinzhen. (2011, January 4). "Agricultural Resolution." *Beijing Review*. [Online]. Available: http://www.bjreview.com.cn/print/txt/2011-01/04/content_322446_2.htm.
[47] "Hike in Water Charges Increase Protests." (2009, August 17). *China Daily*. [Online]. Available: http://www.chinadaily.com.cn/bw/2009-08/17/content_8576015.htm.
[48] See, for example, the recent effort to improve the environmental evaluation process for new projects, including their impact on

water quality, "China passes draft regulation to enforce environmental evaluation on projects." (2009, August 13). *hwcc.gov.cn*. [Online]. Available: http://www.hwcc.com.cn/newsdisplay/newsdisplay.asp?Id=221989.

[49] "Seawater Desalination to Relieve Water Shortage in Beijing." (2007, March 23). *china.org.cn*. [Online]. Available: http://sientechina.china.com.cn/english/environment/204113.htm; "62b Water Project up for Debate." *Global Times*. [Online]. Available: April 2, 2010: http://china.globaltimes.cn/society/2010=4/518447.html.

[50] "State Council Construction Committee for South-to-North Water Diversion Project Holds the Third Plenary Session; Li Keqiang Urges to Promote Construction of South--to-North Water Diversion Project With High Quality and Efficiency and in a Better and Faster Way." (2008, November 1). *Xinhua*; "China To Accelerate South-North Water Project." (2008, December 15). *Reuters*. [Online]. Available: http://in.reuters.com/article/asiaCompanyAndMarkets/idINLF27490420081215; "China Accelerates South-North Water Project." (2010, May 28). *Global Times*. [Online]. Available: http://china.globaltimes.cn/society/2010-05/536555.html.

[51] Wang Guanqun. (2009, May 23). "China Earmarks 53.87 bln Yuan for South-to-North Water Diversion Project." *www.Chinaview.cn*. [Online]. Available: http://news.xinhuanet.com/english/2009-05/23/content_11423841.htm; "China Accelerates South-North Water Project." (2010. May 28). *Global Times*. [Online]. Available: http://china.globaltimes.cn/society/2010-05/536555.html.

[52] "China: Water-Source Qinghai-Tibet Plateau Glaciers Melting at 'Worrisome Speed'
Xinhua." (2009, February 4). *Xinhua*.

[53] "Controversial Plan to Tap Tibetan Waters." (2006, August 8). *Southern Weekend*. Translated by Shao Da for china.org.cn. [Online]. Available: http://www1.china.org.cn/english/MATERIAL/177295.htm.