Chapter 85
Moving the River? China's South–North Water Transfer Project

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85.1 Introduction

China is not a water-poor country. As of 1999, China's per capita freshwater availability was around 2,128 m^3 (554,761 gallons) per year, more than double the internationally recognized threshold at which a country would be considered water-scarce (Gleick, 2006). The problem, however, is that there is no such thing as an average Chinese citizen in terms of access to water. More specifically, the geographic and temporal disparity of China's distribution of freshwater resources means that some parts of the country relish in (and at times, suffer from) an over-abundance of freshwater, whereas other parts of the country are haunted by the specters of draught and desertification, to say nothing of declining water quality. The example of China's Yellow River (*Huang He*) has become common knowledge. The Yellow takes its name from the color of the glacial till (loess) soil through which it flows for much of its 5,464 km (3,395 mi) journey (National Bureau of Statistics, 2007). After first failing to reach the sea for a period during 1972, it then suffered similar dry-out periods for a portion of the year in 22 of the subsequent 28 years (Ju, 2000). The river so important for nurturing the earliest kingdoms that came to comprise China, once known as "China's sorrow" because of its devastating floods, now has become a victim of over-abstraction, pollution, and desert encroachment, and a symbol of the fragility of the human-environment relationship on which our societies depend.

Meanwhile, in southern China, the Yangtze (*Chang Jiang*) suffers the opposite fate. The 6300 km (3915 mi)-long Yangtze's annual flow of nearly 951.3 billion m^3 (33.59 trillion ft^3 or 771.2 million acre-feet) is some 14 times greater than that of the Yellow (National Bureau of Statistics, 2007). Lanzhou, a city on the river in western China's Gansu Province, receives a paltry 87.92 mm/month (3.46 in) of precipitation in its rainiest month (August). Further east but still on the Yellow, Zhengzhou receives its peak rainfall of some 136.98 mm/month (5.39 in) in July. On the Yangtze, though, Wuhan peaks at 195.53 (7.70 in) mm/month in June (IWMI,

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2007). Long prone to severe seasonal flooding, the Yangtze came very close to inundating the important regional economic hub city of Wuhan in 1998. The rising waters threatened the lives and property of millions of people and resulted in some 4000 deaths. The disaster prompted central officials to institute a nationwide logging ban and widespread afforestation effort, especially in the headwaters area, soon after the river crested in the hopes of preventing future catastrophes. The event also lent increased credibility to those who touted the flood-control benefits that would result from completion of the Three Gorges Project upstream of Wuhan.

By several measures – installed generating capacity, number of migrants, reservoir volume, to name a few – the Three Gorges Project is to date the world's largest water engineering project (Chen, 2006). A second project underway on the Yangtze now, though, will likely make the dam look like a child's sandbox toy once completed. The South-North Water Transfer (SNWT) project aims to address the disparity in water resource availability between the Yangtze and Yellow Rivers through a series of inter-basin transfer canals that could allow for up to 48 billion m^3 (1.7 trillion ft^3, or 39 million acre-feet) of water per year to be diverted from the Yangtze basin to the drier Yellow in the north (Beijing Huaxinjie Investment Consulting Co. Ltd., n.d.). The transfer design calls for three channels: east, central, and west, each of varying technical complexity, feasibility, and potential for social and ecological impacts. To date, an inter-basin transfer of this scale has not been attempted elsewhere in the world. This chapter outlines the details of the SNWT project, situating it not only in the context of China's overall freshwater resources availability, but also in that of the socioeconomic and biophysical (both negative and positive) each channel will likely bring. In closing I briefly discuss the institutional and bureaucratic changes that have accompanied the project thus far, which in some ways represent fundamental shifts in the functioning of China's water governing apparatus.

85.2 Socio-Terrestrial Engineering: The Appeal of Megaprojects

As noted above, China's Three Gorges Dam boasts many superlatives when compared to other megadams in the world. China is also the country of the Great Wall, the Grand Canal, the Qinghai-Tibet railway (detailed in this collection), the Long March, the terra cotta army, and numerous other large scale projects, both social and physical. Can we infer, then, that the country that is home to nearly one-quarter of the world's population has a particular penchant for megaengineering projects? Wittfogel (1957) argued that only a particular kind of regime, "Oriental despotism," could compel its populace to undertake such gargantuan projects. Not surprisingly, China and the former Soviet Union are often lumped together for, among other things, their perceived gusto for gigantism. Yet the "west" is no stranger to similar mega-projects; the U.S. boasts a long list of megadams and cascades built mostly in the first half of the 20th century, and Chinese policy makers and engineers are quick to equate the high levels of hydropower exploitation in the North

America and Europe with high levels of economic development in those regions. It is hardly surprising, then, that Chinese hydropower development companies, flush with favorable loans from Chinese central banks and brimming with technical expertise, should seek to tap the country's massive hydropower reserves with projects that are correspondingly massive in both scale and number.

85.3 Project Details

The SNWT project was first conceptualized in the early 1950s. Chairman Mao himself is said to have suggested on 30 October 1952 that the north should "borrow" water from the south (State Council Office of the SNWT Construction Committee, 2003a). At the time, exploration of potential western routes for such a transfer was already underway, though the SNWT (*nanshui beidiao*) moniker didn't appear until 1958, at the time of the Great Leap Forward (State Council Office of the SNWT Construction Committee, 2003b). The project was given the final go-ahead by the National Development and Reform Commission (NDRC) and the State Council in 2001 (Oster, 2008). According to the approved SNWT Comprehensive Plan, the project would link the Yangtze, Huai, Hai, and Yellow Rivers in a "four horizontals, three verticals" (*siheng sanzong*) arrangement to address water shortages in the North China Plain (Chinawater, 2007). Initial plans called for the project to be completed in three phases (routes) over time, according to the severity of water shortages in the north and to the level of economic development of the country (Fig. 85.1).

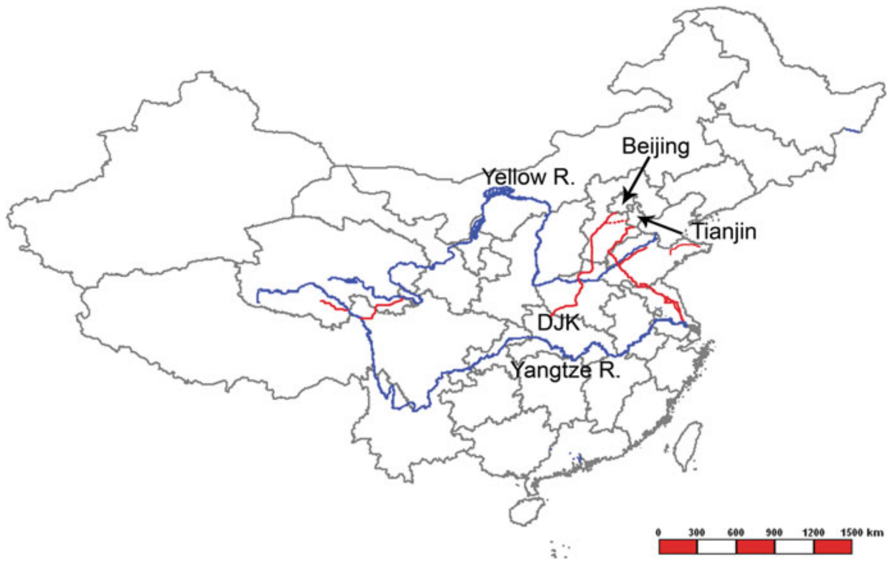

Fig. 85.1 Schematic of SNWT routes (west, central, east). DJK=Danjiangkou, site of intake for central route. (Adapted from Henan Water Conservancy Network at http://www.hnsl.gov.cn/look0/article.php?L_Type=1&id=698) (For color figure see online version)

Those plans envisioned water flowing through the eastern route by 2007, the central route by 2010, and the western route by 2030 (Jiangsu Bureau of Water Resources, 2005). The government now expects the eastern route to come online around 2013, with the others to follow.

85.3.1 Eastern Route

The eastern route of the SNWT project is the most technically feasible since the channel uses the existing Grand Canal waterway, originally constructed as a trade artery connecting Hangzhou to Beijing. Ground was broken on the first section of the Grand Canal in 486 BC, but it took nearly a millennium for the various sections to be connected into one contiguous waterway. Yellow River floods, warfare, and imperial neglect left portions of the canal damaged and non-navigable at various points throughout history. At present, the stretch from Jining southward to Hangzhou is navigable, while the northern third is not. Some portions of the canal, especially near Shanghai and Hangzhou, are heavily used by barge traffic.

When completed, the eastern route is expected to deliver 14.8 billion m^3 of Yangtze water to northern China (Jiangsu Bureau of Water Resources, n.d.). One key challenge, however, complicates this portion of the transfer project: gravity. The Grand Canal's channel bed elevation above sea level gradually increases over the first (southern) two-thirds of the 1156-km length, rising roughly 130 ft (40 m) from Hangzhou (the southern terminus of the canal) to Jining in Shandong Province, where it reaches its maximum elevation (Fig. 85.2). Pumping is therefore necessary to ensure the flow of Yangtze water northward (uphill); pumping, in turn, requires energy, and eastern China has suffered from acute electric power shortages in recent years. A series of 13 low-lift pumping stations, each comprising multiple actual pumps (for a total of nearly 70 pumps), will lift the water upward and northward (State Council Office of the SNWT Construction Committee, n.d.).

Construction on the Eastern Route began in December 2002. In addition to the pumping stations, the project also requires constructing two parallel tunnels under the Yellow River (Figs. 85.3 and 85.4) and a host of investments in improved

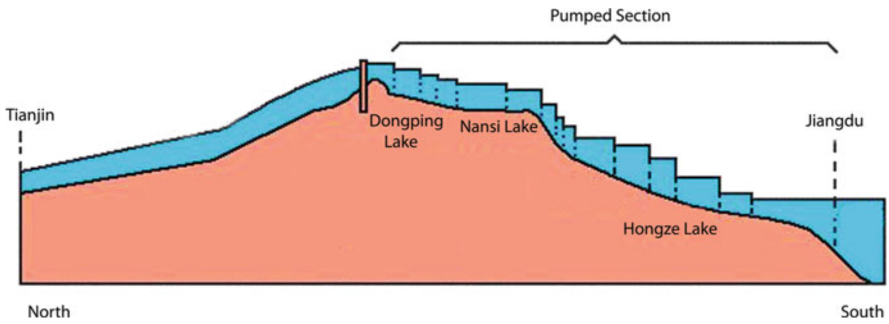

Fig. 85.2 Elevation profile of Eastern route

Fig. 85.3 Artist's rendering of parallel tunnels crossing underneath the Yellow river. Similar tunnels will also be part of the central route. (Source: Changjiang (Yangtze) Water Resources Network at http://www.cjw.gov.cn/news/detail/20070508/91050.asp. Xinhua News Agency Photo)

wastewater treatment. After exiting the tunnels, Yangtze water will then flow downhill to reservoirs near Tianjin. A report spearheaded by the China Environmental Planning Institute (*Zhongguo huanjing guihua yuan*) in 2005, jointly drafted by the NDRC, Ministry of Environment, and provinces and municipalities involved in the eastern route, called for wastewater treatment improvements in 23 cities and 105 counties along the channel's route (Jiangsu Bureau of Water Resources, 2005).

85.3.2 Central Route

In terms of operational energy demands, the central route of the SNWT is the most attractive, since water would flow by gravity for most, if not all, of the journey northward, dropping some 100 m (328 ft) from start to finish. Additional advantages of the central route include relatively good water quality and large service area (Changjiang Institute, 2005). Yet unlike the case of the eastern route, there is no existing channel for the central route, so the potential for social, economic, and ecological disruption resulting from constructing the channel are far greater. According to Beijing Huaxinjie Investment Consulting Company, a construction and engineering services firm attached to the National Development and Reform Commission

Fig. 85.4 Workers constructing part of the tunnel to cross under the Yellow river. (Source: Changjiang (Yangtze) Water Resources Network at www.cjw.gov.cn/news/detail/20070508/91050.asp. Xinhua News Agency Photo)

(NDRC), the objective of the SNWT central route is to address water shortages in Beijing, Tianjin, and the North China Plain, as well as in parts of Hubei and Henan Provinces along the transfer route (Beijing Huaxinjie Investment Consulting Co. Ltd., n.d.). This includes supplementing water supplies for municipal, industrial, and agricultural use, as well as for ecological demands.

The central route aims to divert some 9.5 billion m^3 (7.7 million acre-feet, or 335 billion ft^3) per year for the first few years after the project is completed, with diversion volumes gradually increasing to a maximum of 12–14 billion m^3 by roughly 2030 (Changjiang Institute, 2005). The original plans for the central route, revised in 2001 and approved by the State Council in December 2002, called for water to be diverted northward from the Danjiangkou dam reservoir on the Han River, a tributary that enters the Yangtze from the north side in Hubei Province

Fig. 85.5 Workers increasing the height of the Danjiangkou Dam in 2008. (Source: South–North Water Diversion website at http://www.nsbd.gov.cn/nsbdgc/zxgc/djk/20080313/200803130017.htm)

upstream of the Three Gorges Dam. Those same plans set the completion date for 2010, which, as I discuss below, turns out to be unrealistic.

In addition to some 1,380 km (857 mi) of channel infrastructure, the diversion would require increasing the height of the existing multipurpose dam at Danjiangkou in northwestern Hubei (Fig. 85.5) by roughly 14.6 m (47.9 ft), to a new height of 176.6 m (579.4 ft) (Mid-Route Source Co., 2006). The resultant increase in reservoir elevation would enable water to flow unassisted toward Beijing and Tianjin, reaching the Yellow River some 462 km (287 mi) to the north, at which point approximately 5 billion m^3 (177 billion ft^3, or 4 million acre-feet) would be released directly into the Yellow. The remaining 9 billion m^3 (318 billion ft^3, or 7 million acre-feet) would then continue northward for another 774 km (481 mi) before reaching Tuancheng Lake at the Summer Palace in Beijing (Yan, 2009). A portion of the diverted volumes would also be piped another 144 km (89 mi) to reach Tianjin (Beijing Huaxinjie Investment Consulting Co. Ltd. n.d.). According to the project proposal, only 7% of the natural runoff in the Han River is currently utilized, leaving (in the minds of project proponents, at least) ample room for diversion of some of the river's average annual discharge of 59.1 billion m^3 (47.9 million acre-feet, or 2.08 trillion ft^3) to the drier regions of northern China.

The central channel will largely follow the route of the Beijing-Guangdong railroad line, traversing the Yue, Huai, Yellow, and Hai River watersheds along the way. The primary trunk from Danjiangkou to Beijing will require construction of nearly 700 new road bridges, along with the demolition of some 1660 preexisting structures along the channel route (Changjiang Institute, 2005). Work on this route began in late 2003 with the onset of the dam modification project at Danjiangkou, and was originally scheduled to be completed by 2010. The plan was recently delayed for further study of potential environmental impacts, including localized increases in in-stream pollution concentrations, for example, in late 2008, pushing back the expected completion date to 2014 (Oster, 2008); notwithstanding this, various pieces of the project seem to be moving forward apace, with the dam modification work and other components of the middle route are already well underway, including construction of tunnels, reservoirs, and resettlement villages along the channel route. Current modifications and additions to infrastructure within Beijing include a canal in the southern part of the city and a 37.5 million m^3 reservoir, expected to cost 3 Billion *yuan* (US$ 438 million) and 948 M *yuan* (US$ 138 million), respectively (Xie, 2009). The entire ensemble of infrastructural additions necessary for Beijing to fully utilize SNWT water likely won't be completed until 2020 (Yan, 2009).

Actual raising of the Danjiangkou dam was originally estimated to take 66 months to complete, while the tunnel under the Yellow River was projected to take 56 months. While a tunnel under the Yellow River and an aqueduct over it were both considered and determined feasible during the preliminary study period, planners opted for a tunnel in the expectation that it would cause fewer complications with the hydrodynamics and basin planning for the Yellow River. The tunnel will be 3.5 km (2.2 mi) long, consist of two parallel pipes of 7.5 m (24.6 ft) inner diameter, and be capable of moving water at 500 m^3/s (17,657 cfs) (Changjiang Institute, 2005).

Some have argued that, despite (or perhaps because of) the fragility of the North China Plain through which much of the central route passes, the ecological benefits to be derived from that route (in addition to the societal benefits in terms of augmentation of municipal and industrial supplies) are significant. Specifically, such ecological benefits could potentially include mitigating the amount of groundwater extracted for municipal, agricultural, and industrial uses; augmenting river channels along the way that have long suffered from drought conditions; and thereby creating (or restoring) ecological niches that have all but disappeared in some areas (Chen & Du, 2008). At the same time, however, others claim that removing significant quantities of water from the Han River will increase pollution levels in the river to the detriment of locals while benefiting far-away cities and industries (Oster, 2008). As I discuss below, decision-making regarding water resources in China is complicated and involves numerous areas of bureaucratic and legal ambiguity, making reconciliation of such conflicting concerns potentially difficult.

85.3.3 Western Route

The western route, consisting of several disjoint segments, is the most controversial, most technically difficult, and (currently, at least) the most economically infeasible of the three routes. The list of complications is short but significant. First, the route would traverse ecologically and culturally diverse areas of western China, potentially posing unwarranted risks in terms of species loss and challenges to human livelihoods, sites of cultural importance, and traditions. Second, redirected water would have to flow uphill at points over the eastern Himalayas, requiring large-scale tunneling projects, as well as pumping and siphoning to lift water over ridges, all of which would take place in extremely difficult terrain. Pumping demands would, in turn, create greater demand for more electricity in the southwestern part of the country. Third, the long-term impacts of major inter-basin transfers are poorly understood. This is especially important in the upper reaches of the Yangtze and its tributaries, where transferred volumes would comprise a greater percentage of in-stream flows in the Yangtze itself.

The principal objective of the western route would be to supplement flows in the Yellow River and its upper tributaries, primarily to meet industrial, municipal, and agricultural water demands in Qinghai, Gansu, Ningxia, Inner Mongolia, Shaanxi, and Shanxi Provinces. As with the other routes, the plan makes mention of reserving some transferred water for ecological demands, but does not specify how much, or how those demands might be estimated. Diversion points would be in the Tongtian, Yalong, and Dadu Rivers, all upper tributaries of the Yangtze, each of which would require construction of new dams. Adding further to the complexity of the project would be the need to bore a diversion tunnel through the Bayan Har[1] Mountain Range, which separates the upper Yangtze and upper Yellow drainage basins.

Not surprisingly, the elevations at which such engineering feats would take place are dizzying, ranging from around 3,000 to 4,500 m (roughly 10,000 to 15,000 ft) above sea level. Newly constructed dams would need to be 100–300 m (328–984 ft) high, towering over many of China's tallest dams.[2] Even though the siting of the dams and the size of the intake reservoirs in the Yangtze basin would yield reservoir elevations 80–450 m (262–1,476 ft) higher than the outlets in the Yellow River, the complexity of the topography would allow a simple gravity flow for only part of the diversion's total length, necessitating some combination of pumping and siphoning capacity. Indeed, the original planning report calls for diversion tunnels ranging from 30 to 130 km (19 to 81 mi) in length.

As early as the 1970s, one of the plans put forth for the western route included a transfer through no fewer than five basins outside the Yellow, beginning in the head-waters of the Nu River (upper Salween), and connecting to the Yellow by passing through the Lancang (upper Mekong), Jinsha (upper Yangtze), Yalong, Dadu and Min (tributaries of the upper Yangtze) (Liu & Ma, 1983).

85.4 Environmental and Socioeconomic Impacts of the SNWT Project

85.4.1 Eastern Route

As noted above, the eastern route crosses through Zhejiang, Jiangsu, Shandong, and Hebei Provinces, as well as the neighboring municipalities of Tianjin and Beijing. Environmental impacts for this route are expected to be relatively minor, primarily since the channel already exists and only requires minor modifications in some areas (e.g., dredging and installation of pumping facilities). Impacts on the downstream sections of the Yangtze are expected also to be minimal, since the outtake of water to be diverted northward occurs near the mouth of the river, where its volumes are greatest. Some experts have expressed concern that the diversions may increase the severity of saltwater intrusion into the Yangtze delta during parts of the year, due to diminished volumes of freshwater available for holding the seawater back. Yet this is likely only to pose a localized threat in the driest of seasons, and could potentially be mitigated by temporarily reducing diversions during those periods (Nickum, 2006). There is also some concern about the potential for increased incidence of schistosomiasis (bilharzia) due to expansion of prime habitat (i.e., slow-moving water) for a species of snail that is a key vector for the disease. Perhaps the most significant environmental concerns, though, revolve around the quality of water actually arriving in Beijing and surrounding areas.

Despite the attractiveness of the existing channel for moving Yangtze water northward through the eastern route, significant and well-founded concerns about water quality have persisted since the idea was first floated. Indeed, in much of the canal suffers from agricultural and industrial runoff, untreated sewage, and pollution from vessels plying its waters. This is not surprising, given the amount of barge traffic and the fact that the canal transects Zhejiang, Jiangsu, Shandong, and Hebei Provinces, as well as the municipalities of Tianjin and Beijing, all of which are densely populated and the site of much of eastern China's most highly polluting economic development. Indeed, one MWR press release noted that the very success or failure of the SNWT eastern route depended upon major improvements in wastewater treatment along the channel route (Ministry of Water Resources, 2008). Water quality testing conducted in 2005 on the eastern route found concentrations of seven out of 31 tested pollutants to be in excess of China's Class III standards (minimum standard for use as municipal raw water). Those included ammonium nitrate, permanganate, petroleum, nitrates, BOD, volatile phenols, and dissolved oxygen (Jiangsu Bureau of Water Resources, 2005). In certain tested reaches, concentrations of some pollutants were worse than average, exceeding Class IV standards or, in the case of the entire Hai River watershed and three other areas in Henan and Anhui, Class V.

In terms of socioeconomic impacts, there is some potential for increasing transportation utilization of some parts of the channel that had previously suffered from reduced water levels or increased sediment buildup. While potentially beneficial in some aspects, care will need to be taken to ensure that increased barge and boat traffic on the channel does not counteract water quality improvement measures vital to ensuring that the water which reaches Beijing and the surrounding areas is, in fact, suitable for municipal and agricultural use. Chinese Premier Wen Jiabao, along with his predecessor, former Premier Zhu Rongji, advocated a "Three First, Three Then" (*sanxian, san hou*) policy with regard to the eastern route: "first conserve water, then transfer water; first treat pollution, then channel water; first protect the environment, then use water," acknowledging the importance of addressing such pollution concerns particular to the eastern route, and serving as the motivation for a pollution control plan jointly drafted by the NDRC, the Ministry of Environment, and the relevant provincial and municipal administrative units transected by the route.

85.4.2 Central Route

When completed, the central route will traverse parts of Hubei, Henan, and Hebei Provinces, as well as Beijing and Tianjin municipalities. By far, the most significant socioeconomic impact will be the resettlement of more than 300,000 people, mostly from the area around the intake site at the Danjiangkou reservoir. More than half those individuals (179,000 people) will come from counties and municipalities within Hubei, with the remainder being resettled from areas in neighboring Henan Province (Mid-route Source Co., 2009). The increase in height of the Danjiangkou dam will result in a corresponding increase in the reservoir surface area, from its present area of 745 km^2 (288 mi^2) to 1050 km^2 (405 mi^2), an increase of some 40% (Mid-Route Source Co., 2006). Work on raising the dam height, as well as preparatory work for the increased reservoir size, is already well underway by the Mid-route Source of South-to-North Water Transfer Corporation, a subsidiary of the Hanjiang Group. According to a news release by the Hanjiang Group, preparatory work in the reservoir area has included removing an existing smaller dam, constructing resettlement villages, and improving provision of electrical, water, and communications services in the area surrounding the reservoir. The company is also working with relevant governmental authorities to arrange resettlement logistics, including compensation for residents of areas that will be flooded, recognizing that a smooth relocation process is crucial for the progress of the project (Wu & Jiang, 2006). This is especially true for the area around Danjiangkou, where many residents will likely have already been resettled for the construction of the original dam, which took place from 1958 to 1973 and required the relocation of some 383,000 people (Heggelund, 2004).

The plan for the central route that was approved by the State Council in late 2002 called for water to be taken only from the Danjiangkou reservoir. Further in the future, however, water could also be taken from the Three Gorges Reservoir to be sent northwards. Indeed, given that annual runoff entering the Danjiangkou reservoir is expected to drop by some 8% over the coming decades, from 38.8 billion m^3 (1.37 trillion ft^3, or 31.5 million acre feet) in 2005 to 35.6 billion m^3 (1.26 trillion ft^3, or 28.9 million acre-feet) by 2030, eventual diversions from the Three Gorges Reservoir seem highly likely in order to meet the expectations of increased volumes flowing northward by 2030 (Changjiang Institute, 2005).

Despite the recently announced delay in the completion date for the central route, the prospect of Beijing residents drinking abundantly from Yangtze water still holds currency. A Beijing news report from 29 April 2009, for example, fêted the future arrival of that water, proclaiming that Beijing households within the fifth ring road will be able to "relax" (*fang xin*) and drink Yangtze water as soon as 2014, once the central route and its accompanying storage, treatment, and distribution facilities in

Beijing are complete (Yan, 2009). In Beijing alone, the SNWT project is expected to require construction of an additional 13 water treatment plants with a combined delivery capacity of some 35 B tons of treated water each day. At the same time, though, concerns about water quality in the central route persist, including fears that withdrawals from the Han River at Danjiangkou could exacerbate eutrophication conditions downstream of the dam in dry years. As for water quality in the central channel itself, several measures are supposedly being taken to ensure that the Danjiangkou reservoir will be "a reservoir of clean water to send to Beijing" (*yiku qingshui song Beijing*), including constructing an ecological forest preserve of some 356,667 ha (881,342 acres) around Danjiangkou; establishing erosion control measures throughout 680 ha (1,680 acres) immediately surrounding the reservoir; and shutting down more than 800 small but heavily polluting businesses in the area[3] (Zhang, 2008).

85.4.3 Western Route

Given the long time-horizon and questionable feasibility of the western route, less research has been conducted on the specific socioeconomic and environmental impacts that might result from the project. One concern is that diverting water from the upper reaches of rivers such as the Yalong, Dadu, Tongtian, and Lancang will reduce the power generation capacity of downstream hydroelectric dams on those rivers (Ma & Wu, 2006). If, as the original plans specified, as much as 17 billion m^3 (13,782,044 acre-feet) of water stands to eventually be diverted from those and other rivers to the Yellow River Basin, then corresponding adjustments in the power generation expectations for downstream dams (including design parameters for new ones) should be made accordingly (Tan & Cui, 2003). Tan and Cui found that planned diversion volumes in 2020 (4 B m^3, or 3.2 M acre-feet), 2030 (9 B m^3, or 7.3 M acre-feet), and 2050 (17 B m^3, or 13.8 M acre-feet) in the western route would result in decreases in annual downstream hydropower generation amounting to 3.1 B kWh, 33.6 B kWh, and 111.7 B kWh, respectively. Interestingly, their study discussed such changes partly in a water rights framework, a fairly novel approach in China in 2003.

Aside from reduction in power generation, other socioeconomic disruptions in the area around the western route would be fairly minimal, given the remoteness and low population levels. Environmental impacts, however, might be more significant, since much of the area is considered ecologically fragile. According to one study, potential impacts could include disruption of ecosystem integrity, including in especially sensitive wetland, dryland, and protected ecosystems in the headwaters regions of the Yangtze, Yellow, and other rivers implicated in the diversion (Wu, 2007). This disruption would result partly from the construction of new dams in the headwaters region, the impoundments of which would submerge surrounding terrain and create standing lakes in places where rushing waters have long been the norm (Xuan, 2006). Such changes could alter food webs and diminish habitat for endemic species at the intake points, while also potentially threatening species in the upper reaches of the Yellow River watershed by permitting passage of flora and fauna from the sending watersheds through the diversion tunnels. There remains a clear need for further research on the likelihood, magnitude, and ramifications of such impacts, should they occur.

A final concern in the region surround the western route is seismic activity and the potential for landslides and slope failures. Disturbances to the physical environment of the western route could not only impact the long-term viability of the project as a whole, but may also bring about land degradation and increased likelihood of natural disasters that would threaten nearby human communities, many of which are comprised primarily of ethnic minority populations in areas targeted for development assistance through the Western Development Campaign (Ma, Chen, Chen, Shang, & Tu, 2006).

85.5 SNWT and Challenges to Water Governance in China

Governance of water resources on major rivers in China is often a murky affair, with bureaucratic restructuring, semi-privatization of many former state-owned enterprises, and changes in legal institutions resulting in many ambiguities and areas of overlapping jurisdiction (Magee, 2006, 2007). As James Nickum (2006), a long-time observer of major water projects in China, has noted, "The biggest challenges to the diversions are probably not ones of engineering or environment, but of institutions." Space restrictions do not permit a full-scale investigation of the water resources governance apparatus in China here; it is nevertheless important to include some mention of key institutions involved in order to envision the challenges that the SNWT presents in terms of water resources management and governance.

In principle, responsibility for comprehensive planning and management of the country's water resources rests with seven basin (or watershed) commissions named after principal river systems,[4] each encompassing numerous sub-basins. The bureaucratic rank of the commissions would seem to place them subordinate to the Ministry of Water Resources (MWR), yet in reality they have a high degree of autonomy from the Ministry, and from provincial and sub-provincial subordinates of the MWR. In addition, even though the Water Law of China delegates some enforcement authority (rather than just planning responsibilities) to the basin commissions, they frequently find their decision-making authority skirted by developers of water infrastructure (especially hydropower) who, as remnants of the former Ministry of Electric Power, retain close ties to central decision makers in the NDRC and State Council (Magee, 2006).

Part and parcel of the restructuring of the water and power sectors in China over the past decade has been a move toward "corporatization," where former ministries and state-owned enterprises have been transformed into stock corporations, many of which have subsidiaries that are listed on international stock exchanges. Though some might see this as "privatization," in most cases, the majority of the stock is owned by the central government through the State Assets Supervision and Administration Commission. Thus while the goals of corporatization were to encourage competition and reorient key industries in the direction of profit generation, in actuality central (political) decision-makers still retain influence over certain aspects of these corporations. The relevance to the SNWT project discussed here is that the design and construction work done on various components of the project is being carried out by dozens of provincial and sub-provincial subsidiaries of key national corporations, complicating immensely the task of understanding and explaining lines of authority and accountability. Key Chinese companies involved include Hanjiang Water Resources and Hydropower Company, which has undertaken much of the construction work on the eastern and central routes. Design work for the has been conducted by the Hai River Watershed Commission (likely with significant input from the Yangtze, Yellow, and Huai commissions as well) (South-to-North Water Diversion Project, China, n.d.). Foreign company participation is apparently limited to highly specialized tasks such as long-distance precision tunneling under the Yellow River, which is being done by Germany's Herrenknecht company (Herrenknecht, 2006).

Recognizing the magnitude, complexity and importance of the SNWT project, the State Council has established a specific office devoted to overseeing engineering and construction of the project. While one would expect close coordination between that office and the relevant basin commissions (Yangtze, Yellow, Huai, and Hai), as well as with the actual entities involved in design and construction, more research needs to be done to understand the mechanisms and effectiveness of that coordination. Indeed, inter-basin transfers such as the SNWT bring the very salience of "watershed," a natural delimiter all too often taken for granted, into question. The bureaucratic implications of such projects entail the creation of new offices, new laws, new regulations, and new enforcement mechanisms. The scholarly implications may be similarly complex, forcing us to think outside our comfortable analytical boxes in order to fully comprehend the nature, magnitude, and relevance of large-scale Earth engineering projects.

Notes

1. Occasionally Romanized as Bayankala or Bayankela, following the Mandarin Chinese transliteration.
2. The Xiaowan Dam on the Lancang (upper Mekong) River in Yunnan Province, currently under construction, will be China's tallest dam at 292 m (958 ft) when complete (Magee, 2006).
3. The so-called "15 small industries" include low-output tanneries, coking plants, paper mills, and other industries known for toxic discharges.
4. Namely, Yangtze, Yellow, Songliao, Huai, Hai, Zhu (Pearl), and Taihu (Lake Tai) commissions.

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